MARK ARNOLD

A. Unpacking*
   1. Find the inventory and parts list.
   2. Unpack the items from the main box but leave smaller parts in their packaging; Ex: Pull out the pack of resistors but leave the resistors in that sack.
   3. Place a check mark by the items on the parts list that you have, leave things like resistors in their packaging, and put a check by all the resistors or whatever (if a part is missing you will soon know it).
   4. Put everything back into the main box and leave it there until you are instructed to unpack the items.

B. Inventory
   1. Control Panel
      1 100 pf capacitor
      1 .022 µf capacitor
      1 1.0 µf capacitor
      100 LED's
      1 IC -- NE555
      1 IC -- SN74H00
      5 IC -- SN7404
      16 IC -- SN7406
      1 Pointer Knob
      1 Round Knob
      1 Jack
      1 Plug
      1 Control Panel
      1 Pot with 2 nuts and 2 lockwashers
      1 3 Position Switch with 2 nuts and 2 lockwashers
      96 470 ohm Resistor
      1 680 ohm Resistor
      1 10,000 ohm Resistor
      2 1,000 ohm Resistor
      1 8 Pin Solder Tail Socket
      22 14 Pin Solder Tail Socket
      12 Pushbutton Switches -- nut and 2 lockwashers
      13 Toggle Switches -- nut, posit washers, and flat washers
      10" Teflon Tubing
      25' White Wire
      2.5' Red Multistrand
      3.5' Black
      2' Blue
      2' Non-insulated Wire
   2. Box
      1 Grommet
      1 Fuse Holder
      1 Fuse
      8 Nylon Insulators or Spacers
      4 6-32 x ¼" screws
      4 6-32 x ½" screws

*If you are missing any part write to: Logic Design, Inc.; Box 3991; University Station; Laramie, Wyoming 82071

3. Power Supply is assembled on box except for:
   1 Line Cord
   1 Power Switch
   1 Fuse Holder
   1 Fuse, 1 amp
   Wire required to make connections
4. Back panel is completely assembled except for:
   1 14" Horizontal Brace
   2 12" Vertical Braces
   3 6/32 x 1" screws
   8 6/32 x ½" screws
   7 Hexagonal Nuts

   If IC's for the CPU have been ordered, they will be in their assigned sockets in the back panel. These IC's include:

15	SN7400	2	SN74133
8	SN7402	1	SN74150
17	SN7404	12	SN74151
1	SN7406	2	SN74154
9	SN7410	1	SN74157
2	SN7420	2	SN74163
8	SN7430	8	SN74174
2	SN7442	3	SN74181
1	SN7451	3	SN74194
5	SN7474	1	SN74L00
1	SN7486	3	Fairchild 9024
3	SN7489		

   Total = 110 IC's

C. Soldering
   1. Let the solder flow all over the connection.
   2. Don't use more solder than is necessary.
   3. Wipe the tip of the iron on a wet sponge or rag frequently; this removes excess solder and flux from the tip.
   4. If solder should connect the plated metal strips on the panels (a solder bridge), then:
      a. Take the piece of braided wire.
      b. Place the wire on the solder bridge, and put the iron on the wire; wait until the solder is soaked up by the braid.
      c. Move the braided wire around in the molten solder.
      d. The solder should have been soaked up.
      e. If the above action is not completely successful, carefully scrape the solder bridge away with a penknife or a similar sharp tool.

D. Terms for Control Panel
   1. Front side - the side that has "Logic Design" etched into it.
   2. Back side - has all the metal plated strips.
   3. Top, above, upper - indicates positioning near the edge of the panel which has the gold plated fingers which fit into the 100 pin connectors.
   4. Bottom, below, lower - indicates positioning near the edge which is opposite the top.
   5. Right side - the right edge of the panel.
   6. Center, middle - indicates positioning between the left and

right sides.
7. Pad - a plated circle with or without a drilled hole to which components are soldered.
8. Lead - the wires that extend from a component.

E. Instructions
There is a set of parentheses next to each step number.
After you have completed a step:
1. Recheck your work.
2. Put a check mark in the parentheses.

I. Box Assembly

When received, 5 of the 6 sides of the "Box" will have been assembled, and the power supply will have been assembled inside (some parts outside) the box. The bare control panel will be the sixth side of the box; this should be slid out and laid aside until work is begun on it. The back side of the box will have approximately 1¼" removed to permit the circulation of air. There are three holes in the back of the box. As viewed from the outside, the right hand, and smallest, hole should contain a rubber grommet. The next hole to the left is for the fuse holder, and the left hand hole is for the power switch.

( )1. Install the grommet in the small hole if not already in place.
( )2. Install the switch. The on/off lever should be outside the box. The switch should be positioned so that one of the connectors is on the bottom (inside the box).
( )3. Install the fuse holder.
( )4. Insert the power cord through the grommet.
( )5. Tie a knot in the cord (inside the box) leaving enough cord length to reach the transformer.
( )6. Split the free end of the cord.
( )7. Solder one wire to one of the two pins on the transformer (pin #1).
( )8. Trim the other wire so that it is of a convenient length to reach the fuse holder.
( )9. Solder the second wire to one connector on the fuse holder.
( )10. Cut a piece of black wire and solder it from the second side of the fuse holder to the bottom switch contact.
( )11. Cut a piece of black wire and solder it from the upper switch contact to the second of the two pins on the transformer (pin #2).
( )12. Install the four spacers on the back of the box with 6/32 x ¼" screws.

II. Control Panel Assembly

F. Lights (Light Emitting Diodes)
(✓)1. Unpack the LED's, control panel and solder; keep the LED's in their packages until they are needed.
(✓)2. Take out one LED; find the flat face on the edge of the base of the LED. When the short lead is specified, it means that it is the lead closest to this flat face. The long lead must be positive with respect to the short lead in order for the LED to light.

( )3. Below the etched "LOGIC DESIGN" there is a row of 16 etched circles with two holes in each circle. The LED's which are to be placed in this row will be oriented differently with respect to the control panel than will the LED's in the other five rows.

( )4. Place the short lead of the LED in the upper hole of the first position; the flat face should be pointing toward the top.

( )5. Splay the leads apart far enough that the LED won't fall out of the panel when it is turned upside down.

( )6. Flip the panel over to the backside, solder one lead and trim it.

( )7. Remelt the connection. Push on the LED to make its base flush with the board. Remove the soldering iron, but hold the LED in place until the connection solidifies.

( )8. Solder the other lead and trim it.

( )9. The base of the LED should be flush with the panel. If not, repeat step 7 on both leads until it is flush.

( )10. Put LED's in the other 15 positions in the first row. Insure that the short lead is in the upper hole and that the flat face points up.

( )11. Splay the two leads on each LED.

( )12. Flip the panel over and solder one lead on each LED.

( )13. Repeat step #7 for each of the 15 LED's and make their bases flush with the panel.

( )14. Solder the other leads and trim.

( )15. Check for proper orientation of the LED's, bad soldering and position.

The positioning directions given above apply to the first row only. The directions given below concern the positioning of the LED's in the other five rows. In the 2nd through 6th rows of LED's, in all places to the left of column 3 (it has an etched 3 above it) and including column 3, the flat face on the base of the LED points to the left. The positive lead is on the right when viewed from the front of the control panel. In all the spots to the right of column 3, starting with column 4, the flat face points to the right. For this latter group, the positive lead is on the left when viewed from the front of the control panel. Note that all positive leads are connected on the back of the panel to the bus marked "+12UR".

( )16. Solder and check LED's in the second row.

( )17. Solder and check LED's in third row.

( )18. Solder and check LED's in the fourth row.

( )19. Solder and check LED's in the fifth row.

( )20. Solder and check LED's in the sixth row.

G. Resistors

( )1. Unpack the 96 470 Ohm resistors (yellow, violet, brown).

( )2. Unpack one 1000 ohm resistor (brown, black, red).

( )3. Locate the row of 17 sets of parallel etched dashes, on the front side of the panel above "LOGIC DESIGN". This does not include the one set directly under the two drilled holes, and at a different (lower) level than the 17.

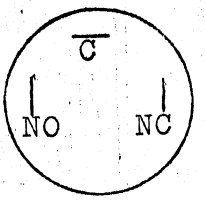
( )4. Locate the far left set of dashes; it will be referred to as the first set; the far right set will be referred to as the 17th set, etc.
( )5. Take six of the 470 ohm resistors and bend the leads at position #5 on a ¼watt lead bender guide. If you don't have a lead bender guide, bend the leads with needle nose pliers so that the leads will fit into the holes in the first set.
( )6. Starting at the far left of the first set, insert the six 470 ohm resistors, making sure that the silver or gold bands point in the same direction. There will be one pair of empty holes in the set.
( )7. Bend the leads toward the panel on the back side, so that the resistors will stay in place.
( )8. Flip the panel over and solder one lead of each resistor.
( )9. Make that side of the resistor flush with the panel.
( )10. Solder the other leads.
( )11. Make the resistor flush with the panel.
( )12. Cut off the excess leads and save them until the entire computer is finished.
( )13. Repeat steps #6 through 12 for all the other sets of dashes except #9 which is the small set. Set #8 will have two pairs of empty holes.
( )14. Place the 1000 ohm resistor in the left pair of holes in set #9.
( )15. Solder it in place and cut off the excess leads.
( )16. Check all of the resistors for position, bad soldering and improper color orientation.
( )17. Make sure that you saved the resistor leads. If you didn't, fish them out of the waste basket.
( )18. Bend 20 clipped leads at position #5 on the bending guide.
( )19. Insert them in the 20 empty pairs of holes in the sets.
( )20. Solder them and trim the leads.
( )21. Check to make sure that none of the 20 wires is touching metal plating on the front side of the panel.
( )22. Check for bad soldering.

H. IC Sockets

( )1. Unpack five 14 pin IC sockets.
( )2. Locate two sets of parallel dashes running vertically on the front of the panel and located to the left of the LED's.
( )3. Turn the panel over to the back side. You should see two groups of rectangular pads with 14 pads in each group. Near one end of each group there is a letter. All IC socket positions are lettered, although the letter may be by the side of the group of pads. For these two IC socket positions the letters should be "S" and "T".
( )4. Insert IC sockets in positions "S" and "T".
( )5. On the right side of the panel (front view) there are two more socket positions labeled "U" and "V".
( )6. Insert sockets in each of the positions "U" and "V".

( ) 7. Above the LED's, below the resistors and in the center (front view) there is socket position "W".
( ) 8. Insert a socket in position "W".
( ) 9. All sockets should have been inserted from the front. Flip the panel over to the backside.
( ) 10. On each of the five sockets solder one corner pin and make the sockets flush with the panel.
( ) 11. On each of the five sockets solder the corner pin diagonally opposite from the one already soldered.
( ) 12. Check and insure that all sockets are flush with the panel. This will be the only chance to do this, because after the other twelve pins on a socket are soldered, it cannot be moved.
( ) 13. Solder the remaining pins on each socket.
( ) 14. Check for bad soldering and especially for solder bridges.

I. Pushbutton switches
( ) 1. Unpack six pushbutton switches.
( ) 2. Locate a vertical row of six ¼" holes to the left of the LED's. Lettering at the top should be "STOP" and at the bottom, "DEP".
( ) 3. Install all six switches in the six holes with one lockwasher on the back side of the panel and another on the front side.
( ) 4. Put the nuts on finger tight only.
( ) 5. Turn the panel over to the back side.
( ) 6. Examine the plastic body of the switch near the three terminals. They are labeled as shown:



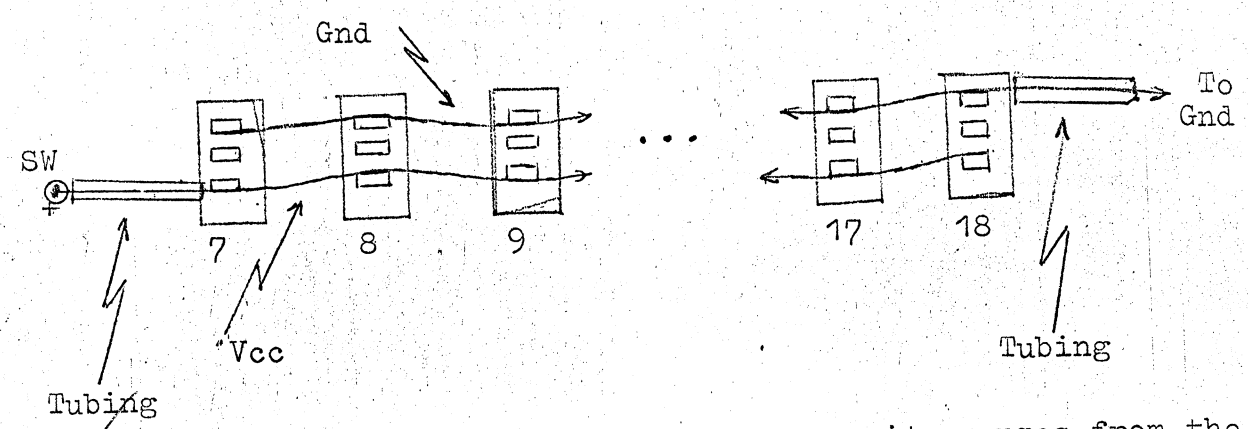
( ) 7. Align the switches so that the "C" terminal is toward the ~~bottom.~~ TOP
( ) 8. Tighten the nut firmly so that the switch is held solidly in place.
( ) 9. The ¼" mounting hole is surrounded by an annular plating ring. To the bottom right there is a small projecting pad.
( ) 10. Melt some solder on each pad.
( ) 11. Cut 18 white stranded wires, 1.5" long. Strip 1/8" of insulation from each end.
( ) 12. Solder a wire to the pad with solder on it. Solder the other end to terminal "C". Repeat for each switch.
( ) 13. Near each switch there are two double pads, one of which is labeled "H", and the other, "L". Melt solder onto the inner half of each double pad (the pad closest to the switch).
( ) 14. Solder a wire between the "H" terminal and the "NC" switch terminal. Repeat for each switch.

( )15. Solder a wire between the "L" pad and the "NO" switch terminal. Repeat for each switch.
( )16. Unpack 6 more pushbutton switches.
( )17. Locate a column of six ¼" holes to the right of the LED's (front view). Lettering at the top is "MA", and at the bottom, "AC".
( )18. Install the six switches finger tight with one lockwasher on the back side of the panel and one on the front.
( )19. Turn the panel over to the back side. ~~top~~ Bottom of the panel.
( )20. Align each "C" terminal toward the
( )21. Tighten each nut firmly so that each switch is held solidly in place.
( )22. Each annular ring around the ¼" mounting holes has a projecting pad to the upper left. Melt solder onto these pads.
( )23. Cut 18 white wires, 1.5" long. Strip 1/8" of insulation from each end.
( )24. Solder a wire from the soldered pad to the "C" terminal of each switch.
( )25. Each switch except the "MAN CLK" switch has a pair of double pads near it, one marked "H", and the other, "L". Melt solder onto the inner pads of all of the "H" and "L" sets.
( )26. The "MAN CLK" switch has a pair of single unmarked pads next to it and in the same relative position as the inner pads of the "H" and "L" pairs. Melt solder onto them, and treat them in the following steps as "H" or "L" pads.
( )27. Solder a wire from the "H" pad to the "NC" switch terminal on all 6 switches.
( )28. Solder a wire from the "L" pad to the "NO" switch terminal on all 6 switches.

J. Toggle switches, Jack and Miscellaneous

( )1. Unpack the 13 toggle switches.
( )2. Locate the horizontal row of holes below the LED's at the bottom of the panel. They will be numbered from 7 to 18 inclusive.
( )3. Remove the nut and positioning washer from the switch, and insert the switch from the back side of the panel.
( )4. Replace the nut and positioning washer, making sure that the positioning washer tab is in the small hole above the switch. For looks, adjust the bottom (second) nut so that when the top nut is tightened, its top will be flush with the end of the screw threads.
( )5. Similarly, install 11 more switches in the row.
( )6. Install the remaining switch in the hole above "SING INST" (left side of panel, front view).
( )7. Turn the panel so that the back side is exposed.
( )8. Unpack one 680 ohm resistor (blue, grey, brown).
( )9. Locate the three pads to the left of the row of toggle switches; one of them is marked "SW +".
( )10. Solder the 680 ohm resistor between the two pads having "R5" plated between them. Cut off the escess leads. Actually, any value from 500 to 1000 ohms is adequate for this current limiting resistor.

( )11. Cut a piece of tinned copper wire 8" long.
( )12. Cut a piece of tubing 7/8" long.
( )13. Locate the pad to the left of the toggle switches and having "SW +" plated beside it.
( )14. Solder one end of the 8" wire to that pad.
( )15. Slide the piece of tubing down the wire until it touches the soldered connection.



( )16. Solder the wire at the point where it emerges from the piece of tubing to the bottom connector of the left toggle switch. Do not cut the wire, since it must also be soldered to the 11 other bottom connectors of the toggle switches.
( )17. Weave the wire in and out between the eleven remaining bottom connectors. Do not run the wire through the holes in each connector; permit it to make contact on either side of the connector.
( )18. Solder the wire to the bottom connector of the right hand switch and trim off any excess.
( )19. Solder the wire to the other 10 bottom connectors.
( )20. Cut a piece of tinned copper wire 10" long.
( )21. Cut a piece of tubing 3" long.
( )22. Locate the plated strip about three inches to the right of the row of switches and marked "SW GND".
( )23. Solder one end of the 10" wire to the rounded (top) end of the strip.
( )24. Slide the tubing down the wire until it touches the soldered connection.
( )25. Solder the wire at the point where it emerges from the piece of tubing to the upper connector of the right hand switch.
( )26. Weave the wire between the upper switch connectors.
( )27. Solder the wire to the upper connector on the left hand switch. Cut off the excess.
( )28. Solder the wire to the ten other upper connectors on the switches.
( )29. Check for bad soldering.
( )30. Unpack the jack.
( )31. Mount the jack in the hole above socket "V" using two ¼" lockwashers, one on the back and one on the front of the panel.
( )32. Align the jack so that its two connector arms are to the left (back view).

K. Mount IC Sockets A to R inclusive, and X and Y.

( ) 1. These sockets are for the 7406 lamp drivers and for the clock. All sockets are 14 pin sockets except for "Y", which has 8 pins. Look at the back side of the panel and study the conductor pattern on socket "A".

( ) 2. Note that some of the pins use rather thin conductors and pads.

( ) 3. The proper technique for soldering is to place a small chisel tip iron vertically on the side of the pin away from the narrow conductor. Feed in only enough solder to make the joint.

( ) 4. IF YOU PLACE THE IRON ADJACENT TO THE NARROW STRIP, YOU WILL ALMOST SURELY GET A SOLDER BRIDGE. IF SUCH SHOULD OCCUR, REFER TO #4 UNDER SOLDERING.

( ) 5. Insert sockets one at a time in positions A through R, and in positions X and Y. After a socket is in place, solder one pin to hold it there. The pin soldered will usually be pin #1.

( ) 6. Make sure the socket is flush with the panel after step 5, and then solder pin #14 (#8 in the case of socket Y). Note that the sockets have small feet, and that even when tightly secured, there may appear to be space between the sockets and the panel.

( ) 7. Solder the remaining pins in each socket. Observe precautions 1 to 4.

( ) 8. Check for solder bridges with a magnifying glass or microscope.

L. Resistors and Capacitors

( ) 1. Unpack the 10,000 ohm resistor (brown, black, orange).

( ) 2. Cut the resistor leads to a length of 3/16".

( ) 3. Beneath and slightly to the left of socket Y there are two pads with "R2" between them.

( ) 4. Solder the resistor to these two pads.

( ) 5. Unpack one 1000 ohm resistor (brown, black, red).

( ) 6. Cut two pieces of tubing 3/16" long.

( ) 7. Cut the resistor leads to a length of 1/4".

( ) 8. Slip the tubing on the resistor leads.

( ) 9. Locate "R1" above socket Y.

( ) 10. Solder the resistor from the pad connecting with socket Y on the left side to the pad connecting to the third pin from the top (socket Y) on the right side.

( ) 11. Unpack the .022 mfd capacitor.

( ) 12. Locate "C1" to the right of socket X.

( ) 13. Cut the capacitor leads to a length of 3/16".

( ) 14. Solder the capacitor to the two pads above and below "C1".

( ) 15. Check for bad soldering on the last three components.

M. POT

( ) 1. Unpack the POT. It is made with one metal positioning arm on its periphery and parallel to the shaft. Cut this small metal piece off. Otherwise it may short a lead on the back side of the panel. If the control shaft has not already been cut, use a hack saw to cut it so that the remainder of the shaft projects 3/8" beyond the threaded collar.

( )2. Mount the POT in the hole between the IC sockets "H" and "J" (bottom of two holes near the top of panel). Mount it finger tight with a lockwasher and nut on the back of the panel and a locksasher and nut on the top of the panel. For looks, adjust the bottom nut so that the top nut is even with the end of the screw threads.

( )3. Position the two left arms (viewed from the back) of the POT over the plated lettering "POT"; then tighten the top nut; it must be tight! Bend the left arm (viewed from the back) down about 30° so that it will not come in contact with the three position switch when it is installed.

( )4. Melt solder onto the two pads below the two left hand arms. When looking at the POT from the back of the panel, the right hand arm will have no connection.

( )5. Solder two clipped resistor leads from the pot arms to the two pads; cut off excess.

N. Three position switch

( )1. Unpack the three position switch, 100 pf capacitor, and the 1 mfd capacitor. If the shaft of the switch has not already been cut, use a hack saw to cut off the shaft so that a length of ~~5/8"~~ 1/2" projects beyond the threaded collar.

( )2. Place the switch on the work table so that the shaft is pointing away from you and the four connectors are on top.

( )3. Insert the 100 pf capacitor from the second connector to the fourth connector (counting from the left).

( )4. Cut the leads of the 1 mfd capacitor to ~~1-1/8"~~ 1 1/4"

( )5. Cut two pieces of tubing 1" long.

( )6. Slide the two pieces of tubing over the two capacitor leads.

( )7. Insert the 1 mfd capacitor from the second connector to the third connector on the switch.

( )8. Solder all components on the switch. + trim excess

( )9. Cut a piece of insulated white wire 1-3/4" long; strip ¼" of insulation from each end.

( )10. Solder one end of the wire to the pad at the top end of "R2". This is the end closest to socket Y.

( )11. Mount the three position switch in the upper hole (above the POT) with a nut and lockwasher behind the panel and a lockwasher and nut in front of the panel. For looks, adjust the second nut so that the first (top) nut is even with the end of the screw threads.

( )12. Rotate the switch so that the four connectors are to the right (back view) and with the straight edge of the switch parallel to the edge of the panel. Tighten the top nut; it must be tight. The connector which has no connection should be directly over a pad on the control panel (back). This pad should be the only one located in the vicinity of the three way switch and to which nothing has been soldered.

( )13. Solder the wire which is attached to "R2" to the second connector of the switch. This is the connector to which both capacitors have been soldered.
( )14. Immediately below the first connector of the switch there is the pad previously mentioned. Put some solder on it.
(L)15. Use a clipped resistor lead to connect the pad and the empty connector on the switch. Cut off the excess.
( )16. Check for bad soldering.

O. Knobs.
( )1. Unpack the two knobs.
( )2. Put the pointer knob on the three way switch. It may be necessary to flatten a portion of the switch shaft with a file in order to have the knob grip the shaft sufficiently.
( )3. Put the round (small) knob on the POT shaft.

P. Wiring Instructions
In the following steps you will be wiring the back of the control panel. This wiring is number coded. General directions are:
(L)1. Solder one end of the wire to the specified pad or switch connector.
(L)2. Note the number plated on the panel near the pad or switch.
(L)3A. Locate a pad with the same number elsewhere on the panel.
( )4A. Solder the free end of the wire to the same numbered pad.
OR
( )3B. You will locate the same number by a hole in the panel immediately below the gold plated fingers which plug into the 100 pin edge connectors.
( )4B. Insert the free end of the wire into the hole. Pull it to remove as much slack as possible.
( )5B. On the front side of the panel, solder the end of the wire where it protrudes.

Q. Control Panel Wiring
( )1. Unpack the black and red wire.
( )2. Cut a piece of black wire ~~1-3/4~~ 1 5/8" long and strip 3/16" of insulation from each end.
( )3. Turn the panel so that you may work on the back side.
( )4. Locate two pads above the bottom row of LED's and which have the number "30" plated by each of them.
( )5. Solder the wire from one pad to the other.
( )6. Cut a piece of red wire 4-3/4" long and strip 3/16" of insulation from each end.
( )7. Solder one end to the double pad (#31) beneath the upper left arm of the jack.
( )8. Locate a second number 31 at the top of the panel near the hole marked "6". This pad #31 is bussed to a second pad marked "+5" and having a hole in it. Pass a cut off resistor lead through this hole and solder the lead to <u>both sides</u> of the panel.

( )9. Solder the free end of the 4-3/4" red wire to the pad #31 directly below and connected to the pad marked "+5". After this is done, cut off the excess resistor leads on both sides of the panel. Do not cut them off before soldering the red wire, because the solder may run permitting the resistor lead to move.

( )10. Cut a 20" piece of red wire. Strip 3/16" of insulation from one end and ½" of insulation from the other. Tin that stripped portion which is ½" long.

( )11. Slip the ½" stripped end through the hole in the upper jack arm and solder it to the double pad directly beneath the jack arm. Then solder the lead to the jack arm itself.

( )12. Refer to the directions preceding the wiring section, page 11, especially 3B and 5B.

( )13. Locate the numbering beside the push button switches. On the left (back view) it should be "1" to "6"; on the right it should be "24" to "28"; one switch is not numbered.

( )14. Near each switch are two pads labeled "H" and "L". The "H" pad will go high and the "L" pad will go low when the switch is depressed (with power on). Melt a small amount of solder onto each of the "L" pads.

( )15. Unpack the white, multistrand wire.

( )16. Strip 1/8" of insulation off the free end of the white wire.

( )17. Solder that end of the wire to the "L" pad of switch #1.

( )18. Now run the wire to a point about ½" beyond hole #1 and cut it; this will be done for each pair of pads (or switches) and holes. Try to avoid having too much slack after both ends of the wire have been soldered.

( )19. Strip 3/16" to ¼" of insulation off the fee end of the wire.

( )20. Push the wire through hole #1; pull to remove most of the slack and solder (wiring instructions #3B and #5B) to the front side of the panel. Cut off the excess.

( )21. Repeat steps #16 to 20 for pad and hole numbers 1 to 6 and 24 to 28. If you solder the pads and holes in numerical order, there will be less chance of melting the insulation of stray wires.

( )22. For holes #7 to 18 and #23 the wire is soldered to the middle toggle switch connector. For #7 to 18 run the wire <u>under</u> the bare wire connecting the toggle switches to ground (wire connected to top connectors on toggle switches). Solder the wires for #7 to 18 and #23.

( )23. Check for bad soldering and incorrect connections.

( )24. Solder a wire from the lower connector of switch #18 to the upper connector of switch #23.

( )25. Solder a wire from the bottom connector of switch #23 to the pad at the base of the switch.

( )26. Check for bad soldering and incorrect connections.

( )27. Cut a piece of black wire 20" long and strip 3/16" of insulation off of each end.

( )28. Solder one end of this wire to the bottom arm of the jack. Check the positions of the red and black wires and the two connecting arms. A plug for the logic probe will be inserted into the jack. This is a point where a dead short from +5 volts to ground can occur very easily.
( )29. Cut a piece of blue wire 24" long and strip its ends.
( )30. Solder one end to the pad near the "+12UR" lettering located between the third and fourth row of LED's.
( )31. Slip the free end around the shaft of the pot and tie an overhand knot around the shaft.
( )32. Check for bad soldering.

R. Connecting the Power Supply
( )1. Solder the blue wire from the panel to the center pin of the transformer, pin #4.
( )2. Solder the red wire from the panel to the "+out" post.
( )3. Solder the black wire from the panel to the "-out" post.
( )4. Check for improper connections and bad soldering.

S. Trouble shooting the LED's
( )1. After all tests and before soldering, turn off the kit.
( )2. Make sure the fuse holder contains a fuse (1 amp) and is connected correctly.
( )3. Check for solder bridges with an ohm meter.
( )4. Place the control panel in a bench vice so that the panel stands vertically with the gold plated fingers on top. Do not permit the panel to touch the box. Be careful that the vice does not cause a short.
( )5. Unpack sixteen SN7406 IC's.
( )6. Insert these IC's in sockets A to H, J to P, and R. Note: <u>The small circular indentation or notch on the IC is placed in the end of the socket having an etched circle beside it</u>.
( )7. Plug the kit in. Turn on the main power switch. All LED's should light. If none of the LED's light, go to step 8. If some of the LED's light, go to step 14.
( )8. Check the tightness of the jack.
( )9. Check the connections from the jack to the power supply and to the panel.
( )10. Check the power switch.
( )11. Check the fuse holder.
( )12. Check the IC orientation.
( )13. Check the connections from the "+12UR" pad to the power supply.

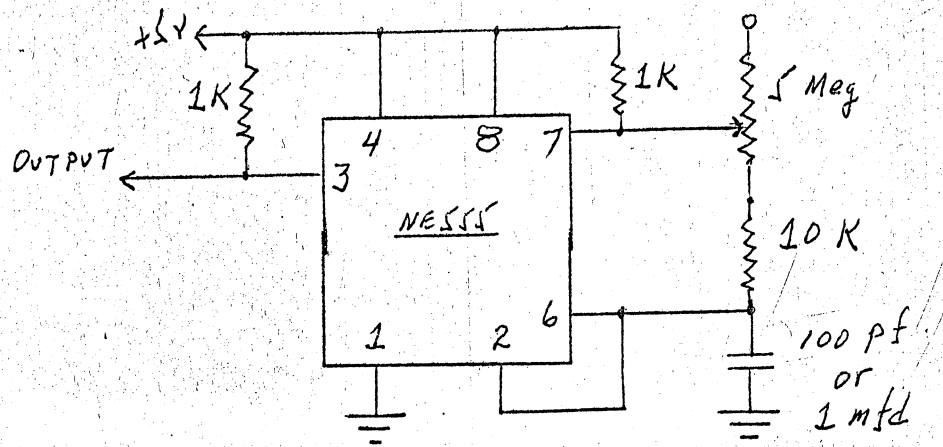
If the power supply has shut down, there is probably a short from 5 volts to ground someplace. Remove the IC's and see if the power supply still shuts down when power is turned on. If so, obtain a power supply which will put out 8 to 10 amperes. Disconnect the control panel from its own power supply, and connect it to the substitute power supply. Make the red and blue lead both positive. Turn on the substitute power supply and turn up the load until the panel is drawing about 8 amperes. If a short is present, the voltage will probably be less than a volt. Leave the power supply for a few minutes. Then search for a hot spot. The presence of such a spot will give a good indication as to the location of the short.

( )14. If a column of LED's does not work, check the 7406 concerned. Then continue with step 15. If individual LED's do not work, then go to step 16.
( )15. Check IC orientation.
( )16. Check for solder bridges at the sockets.
( )17. Check for solder bridges at the resistors.
( )18. Check that none of the connecting resistor leads in the row of resistors is touching the panel. Use ohm meter.
( )19. Turn power OFF.
( ) 20. Replace the IC controlling the column of LED's in which one or more fail to light with an IC that has all of its six LED's working. Turn power ON.
a. If all of the LED's in the column now work, set aside the original IC; it is probably defective. However, before discarding it, check for bent pins.
b. If any of the six LED's still fail to light, check the socket connections.
( )21. If an individual LED fails to light, and if you can find no error in steps 15 to 20, take a spare LED and touch it to the two points where the LED giving difficulty is soldered. Be sure that you get the long LED lead on the positive bus. If the spare LED should light, then the installed LED is defective and must be replaced.
( )22. When all LED's are lighted, temporarily attach a wire about 18" long to the negative side of the power supply (ground). This wire may be tack soldered at some position on the control panel known to be ground.
( )23. Touch the free end of the ground wire to the gold fingers on the back of the control panel in succession. The LED's should go out in succession, and then relight as the wire is moved to the next finger.
( )24. If any LED fails to go out, go back to steps 16 to 18. Generally it will be found that a solder bridge exists somewhere. Since a specific LED is involved, the difficulty is usually easy to spot.
( )25. If no solder bridge can be found and the LED still fails to go out, check the IC for an adequate high output when its input is grounded.

T. Trouble shooting the switches.
( )1. Insert four SN7404 IC's in sockets U, V, S, and T (notch in IC by etched hole in panel).
( )2. Use either a logic probe or an oscilloscope.
( )3. Place the probe on the "L" pad and push the switch. The indication should go from high to low. A low must be less than .65 volts, and a high must be greater than 2 volts. However, a low in the vicinity of .2 volts and a high in the vicinity of 4 volts are much to be preferred. If the value(s) observed fall in some intermediate range, replace the IC concerned. If there is no voltage change, go to step #4.
( )4. Tighten the switch and repeat step #3. If the test still fails, go to step #5.

( )5. Check the connections from the switch to the pad. Check that the correct switch connector is soldered to the pad.
( )6. Check the IC orientation. If a 7404 is in backward, it will become quite hot.
( )7. Check for solder bridges and for areas in the insulation of the white wires where the wire may be exposed.
( )8. If the switch works, go to step 12; if it doesn't, then go to step 9.
( )9. Replace the IC concerned.
( )10. If this clears the difficulty, go to step #12; if it doesn't, go to step #11.
( )11. Check all connections at switch, socket and IC. If no trouble is found, replace the switch.
( )12. Put the probe on the H pad of the switch and repeat steps 3 to 11 as necessary. In this case the observed result should go from low to high when the push button is pushed.
( )13. Repeat steps three to twelve as necessary for all push button switches.
( )14. Check that the center connector of each toggle switch shows a high when the switch arm is pushed toward the center of the panel, and a low, when the switch arm is pushed toward the edge of the panel.

U. Check out clock
Insert the NE555 in socket Y, an SN7404 in socket X, and the SN74H00 in socket W. Put the three position switch on "S" (slow), and turn the potentiometer fully counter clockwise. Using an oscilloscope, look at the output from either of the gold connector fingers on the back of the control panel and nearest the center of the panel. One of these is negative clock and the other is positive clock. A good square wave with approximately a 50% duty cycle should be observed. If such a wave is not observed, look at pin #3 of the NE555 which should be generating a wave which is approximately triangular in form. If not, check the same pin after removing the 74H00 from its socket. If there is still no wave being generated, obtain another NE555 and try it. If the difficulty is still present, check for correct assembly in the areas in the vicinity of the three way switch and the potentiometer. The basic timer circuit is:



The 74H00 and the 7404 are used as buffers and for clock boost. The final output should be a reasonable square wave. Look at pin #6 of the 74H00 (output) and pin #6 of the 7404 (output). If the 555 is operating properly, it should not be difficult to determine whether there is a problem with either of the other two IC's. The inputs for both are at Pin#1.

V. Complete the mechanical assembly
( )1. Mount the 12" vertical braces on the back panel with 6/32 x ½" screws.
( )2. Mount the horizontal brace on the back panel below the two 100 pin connectors with three 6/32 x 1" screws.
( )3. Slide the control panel into the top groove of the box from the rear. There should be sufficient slack in the three wires connected to the power supply to permit this. Tuck these wires carefully into the box.
( )4. Secure the control panel with two 4/40 self tapping, Phillips head screws. There are two holes in the two forward corners of the control panel, and two fittings in the forward corners of the box. The gold plated fingers for the hundred pin connectors are at the rear.
( )5. Place the front of the box on against your stomach.
( )6. Push the hundred pin connectors over the fingers on the rear of the control panel. Perform this operation with care; considerable force is required to seat the connectors.
( )7. Fasten the back panel vertical braces to the four spacers on the box with four 6/32 x ½" screws.

W. Wirewrapping back panel
Refer to wire lists and Lab Manual.