Clock in a bottle PART NO. 2172623

This is a unique clock that uses a Russian Numatron tube. The tube is a seven segment display that uses incandescent filaments for each of the segments. This technology is from the same period as the now popular Nixie tubes, however it operates at low voltage and glows with a yellow color. The kit contains incandescent Edison base tube as the display case for this single digit clock, it is a bulb within a bulb. A single digit clock flashes out the time one digit at a time. There are four bulbs that indicate which digit is currently displayed (Tens of Hours, Hours, Tens of Minutes and Minutes).

Time Required: 3-4 hours depending on experience

Experience Level: Beginner

Required tools and parts:

Soldering Iron
Wire cutters and strippers
1/8" drill
180 grit wet dry paper
Two or more 40W-60W bulbs
1/16" heat shrink tubing
1/4 wooden dowel
Hot glue gun
Digital Multi Meter
X1-Crystal ECS-40-18-10
4-40 screws and nuts
Black Clay
Numatron Tube: IV- nixie series

Bill of Materials:

Part No.	Qty.	Description
14162	1	3 V Lithium Battery
29891	10	10uF 50V Capacitor
35975	10	Diode
36038	10	Diode
51262	1	Voltage Regulator

101178	1	DC Power Jack
145111	1	Microcontroller IC
149948	1	Switch
355434	1	Battery Holder
38360	10	Transistor
141066	4	Incandescent Lamp
112231	10	Socket
77501	4	Spacer
15407	10	Capacitor,22pF
22577	1	Wire Wrap
675489	1	Enclosure
690902	10	Resistor,1.5 K
690785	10	Resistor,470
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Step 1 - Prepare the bulb envelope

You will need a bulb that you can mount the Numatron tube within itself. This will take a couple of attempts as undoing the construction of a light bulb is not an easy task. You can start with a clear bulb (the simplest) or with a frosted bulb (the most common). The first part is to get the glass envelope separated from the base without breaking it. The easiest way is to remove the socket by peeling it carefully away from the glass. Once you have the glass removed from the base, use the wet-paper to grind off the base of the bulb. This takes a while and you must be patient and careful, it is easy to break the bulb at this point. When the bulb is separated from the stem the frosting within the bulb can easily be washed out with water leaving a crystal clear bulb.

Step 2 - Prepare the bulb base

The best place to get a clean base is from a failed CF-replacement lamp. On a standard incandescent bulb the base is filled with solid material that would need to be chipped out and you will have a hard time not denting the aluminum screw base. In a CF bulb the base is much cleaner as it interfaces with a plastic case that holds the electronic control PCB. To remove the base, it is held by a series of dimples that can be drilled out or you can melt, break or cut out the plastic. Drilling out the dimples is the best way since it is easy to score the thin metal. Once the base is separated from the bulb the next step is to remove the solder from the button at the bottom of the base. This can go several ways depending on the construction of the base, most are based on the original glass insulator. In the best case the bottom will leave a riveted button to the glass insulator. You may also end up with all the metal falling off and will be left with just the glass. What you want is a hole in the bottom that you can pass 9 wires (wire-wrap wire) through. Note: Save the CF PCB, as it has a useful 200V Cap and a 100uH inductor.

Step 3 - Wire up the Numatron tube

First you need to create 9 pieces of insulation for the wires of the tube. To do this, strip 1&1/4 inch lengths from black 24 AWG hookup wire. Slide each of these onto the leads of the Numatron, there should be a short length of wire still exposed. I used a 1/4 inch dowel and masking tape to secure the leads. Now cut the wire-wrap wire into 5 inch lengths make one wire of 7 inches. This will be the pin1 wire. Solder each of the wire-wrap wires to each of the pins and cover with a small piece of heat shrink tubing. When all of the wires are soldered, heat the tubing to shrink it. At this point the dowel can be removed.

Step 4 - Add the sculpty clay

Roll as small piece of clay into a cylinder the same diameter as the dowel. Insert the cylinder at the junction between the wire-wrap wire and the Numatron leads. At this point you can adjust the leads so that they are evenly spaced. Roll a ball of clay around the middle of the dowel. Press this ball into the lamp base sliding it down the dowel. This will allow the wires to be threaded through the base of the lamp. Cut the clay in the base with a razor blade to be level with the top of the base. Use the dowel to center and enlarge to hole to accommodate the cylinder and the wires.

Step 5 - Final assembly of the lamp

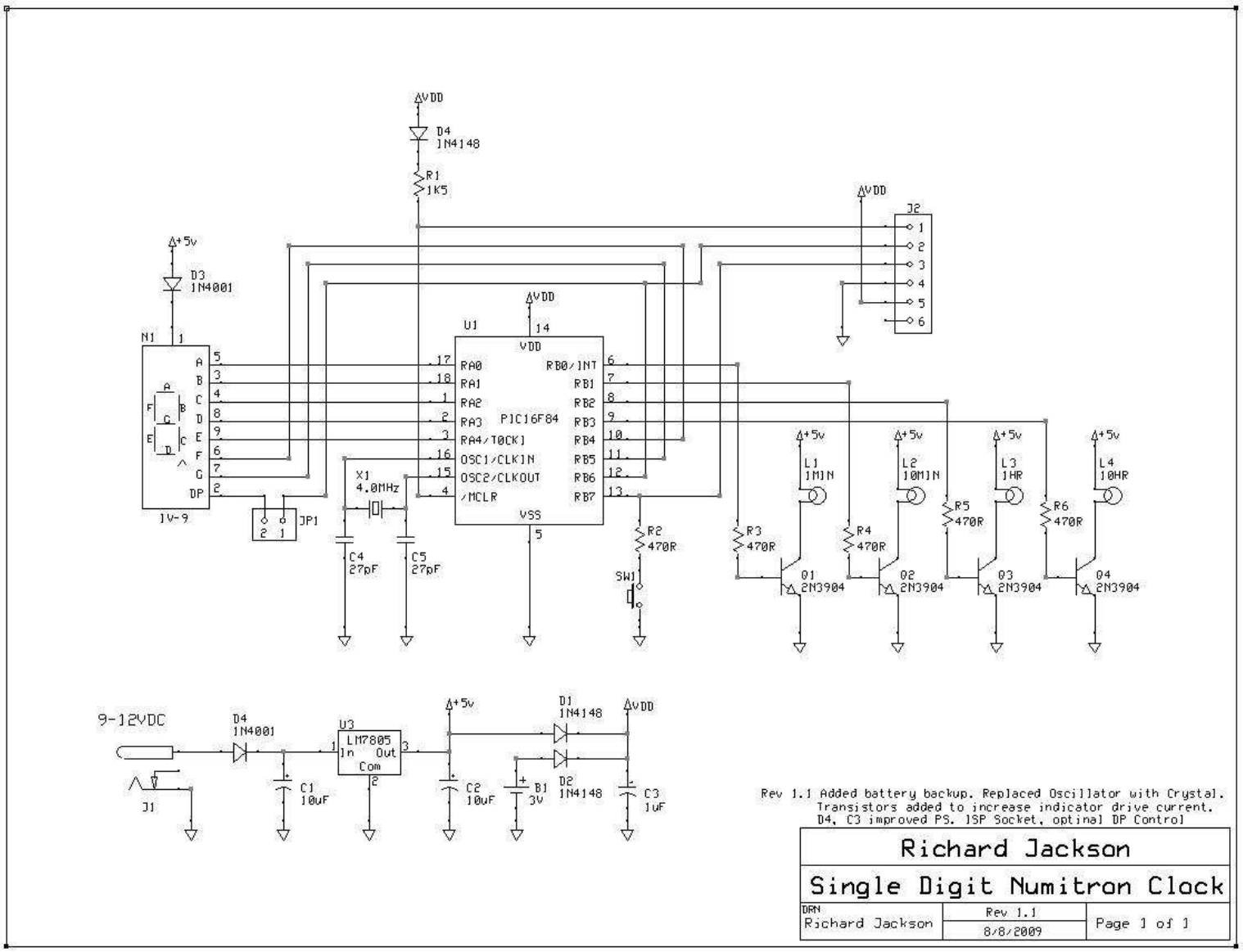
Twist the wire-wrap leads together at the end and thread them through the base and out the end. If you have sized the hole in the lamp base correctly the Numatron / wire assembly should snug down into the hole. You now can smooth out the clay at the top to get a nice finish. The final step is to push the glass bulb into the clay to finish the assembly. The assembly could be hardened by baking in an oven according to the manufactures instructions. I have not hardened the clay and if you are unsure of any of the wire joints you should just leave the clay soft.

Step 6 - Identify the wires.

At this point you should have an assembly with 9 unidentified wires. To start separate the wires and find the long wire. This is the common wire, Mark this as pin 1. Strip the ends so that you can test out the signals and connect the common to a 3V source (red). Two AA batteries in a battery pack is a good source. Connect the other lead (black) to each of the other leads until you find the decimal point (an upside v at the bottom of the tube). Mark this as pin 2. The remaining segments are identified as A through G with A at the top of the tube with the remaining segments labeled clock wise with G in the center. The pins are numbered as follows: A-5, B-3, C-4, D-8, E-9, F-6 and G-7.

Step 7 - The Circuit

The circuit is quite simple. The PIC controller directly drives all seven segments of the display by sinking each of the digits to ground. The diode D3 is used to drop the voltage applied to the display by 1.1V to 3.9V. The display was originally rated at 4.5V (I may be wrong but I cannot read Russian) and this should extend the life of the display. The original design used four LEDs as the HH:MM indicators, but in this design I used 2N3904 transistors to sink the larger current required by the Incandescent bulbs. The result of these changes is that all of the resistors can have the same value of 1K5. The components B1, D1 and D2 allow battery backup, the clock will still keep time if the primary supply is interrupted. D1 and D2 act as a steering circuit for the power supplied to the PIC micro controller, when power is supplied by J1 the output of the 5V regulator (U3) and D1 reverse bias D2, so the battery is cut out of the circuit. If the power fails the output of the regulator will drop below 3V at which point D2 will become forward biased and D1 will become reversed biased. This prevents the battery form powering the indicators and draining it.



Step 8 - Populate the PCB

Start by placing all of the passive components starting with the resistors. Follow this with the diodes and capacitors and then the transistors. Install U3 being careful with the orientation. You now can populate the electro mechanical parts U1 socket (note the orientation notch) , SW1 (note the orientation) and J1. Finally add in the lamps L1-L4 and X1. Be careful with these parts as they have delicate wires and should be handled as little as possible. I suggest soldering in the lamps with the leads untrimmed as you will need to adjust their position when you assemble the board in the case. Do not wire up the Numatron, the battery holder or insert U1 yet.

Step 9 - Check before Powering

Using a DMM to do a continuity check. Check U1 pins 14 and 5 and each of the following pins 1, 2, 3, 10, 11, 12, 13, 15, 16, 17 and 18 should be open circuit. Check between pin 14 (+) and 6, 7,8 and 9 should read around 2K, between pin 5 (+) and 6,7,8 and 9 should show a high value (>100K Ohms) or open. Check between pin 4 and pin 14 should read 1500 ohms.

Step 10 - Check your work

Connect a 9-12V DC supply to the board, center positive 2.1mm. If anything smokes or gets hot (touch U3) unplug it quickly and check for shorts. If any of the lamps light you have a short. If everything looks OK measure the voltage between U1-pin5 (-) and both sides of D4, you should read the the supply voltage. If you do not read the correct voltage on either side of the diode check that the plug and socket have the correct polarity and are making contact. If you get a voltage only on one side of the diode, check the orientation of D4. Now check the between both sides of D1 and pin 5 of U1 (-) you should read around 5V on both sides. If you do not read 5V on either side check the U3 for correct orientation and shorts. Now check pin 14 of U1 and pin 5 of U1 you should read 5V the same should be measured between pin 4 and pin 5. By now you know the routine check your board. Next check between pin 14 and pin 13 when you push SW1 you should read 5V if you read 5V constantly SW1 is probably rotated 90 degrees. Next using a jumper wire between pin 14 and 6 through 9 one at a time, L1 through L4 should light in turn.

Step 11 - Let U1 do its job

Insert U1 into the socket and apply power. You should see L1 through L4 light up in sequence and the pause and repeat.

Step 12 - Connect the Numatron

Using the full length of the wire-wrap wire connect each of the leads to the outline for the tube. Remember that for IC's the pin-out is counter clockwise when viewed from the top while with a vacuum tube it is clock wise from the bottom of the tube. Pin 1 is the 12 o'clock and is the face of the tube. If everything so far works the last bits should be a slam dunk. However test this before you package it into your final assembly. Power up with SW1 pushed and the clock should sequence through all of the digits. If this works power up again and the clock should start up flashing 1200 (12:00) with L1-L4 indicating each digit.

Step 13 - Set the time

To set the time wait for the correct 10Hour, 1Hour, and 10Min and 1Min indicator to light up. Push the switch to advance the digits until the correct digit is displayed. To fully set the time wait until the clock sequences through to the next digit to set. Since the crystal is not accurate to more than a few seconds a year you will need to set the ones of minutes a few times a year.