# The All-Toob Strobo


## A Neon Tube Stroboscopic Demonstration Device[1]

[1] A fitting companion to the All-Toob Dekatron Spinner….

# Safety Warning


***Bright flashing objects, such as the All-Toob-Strobo, can trigger seizures in those susceptible to photosensitive epilepsy (PSE) or other light sensitivities. Please do not operate this piece of equipment around those you know that can be triggered by such visual stimuli.***

From Wikipedia..

“People with PSE experience epileptiform seizures upon exposure to certain visual stimuli. The exact nature of the stimulus or stimuli that triggers the seizures varies from one patient to another, as does the nature and severity of the resulting seizures (ranging from brief absence seizures to full tonic–clonic seizures). Many PSE patients experience an "aura" or feel odd sensations before the seizure occurs, and this can serve as a warning to a patient to move away from the trigger stimulus. The visual trigger for a seizure is generally cyclic, forming a regular pattern in time or space. Flashing lights (such as strobe lights) or rapidly changing or alternating images (as in clubs, around emergency vehicles, near overhead fans, in action movies or television programs, etc.) are examples of patterns in time that can trigger seizures, and these are the most common triggers.”[2]


**Caution!** Like most equipment that uses vacuum valves/tubes, the All-Toob-Strobo uses high voltages in order to operate. You need to respect this and other hazards inherent in these circuits.

[2] https://en.wikipedia.org/wiki/Photosensitive_epilepsy

**Caution!** The All-Toob-Strobo must only be operated with the case securely in place around the electronics. Keep the internals away from prying hands and stray pets!

**Caution!** This device uses mains/line voltages with no isolation and cannot be earthed/grounded. Special care must be taken if the device is powered when not in an enclosure.

**Caution!** This device uses high voltages in the region of 400V DC during operation!

**Caution!** If a metal enclosure is used as a case, then the device must be fully isolated from it and the enclosure itself must be earthed/grounded.

**Caution!** Do not touch the electronics while the device is in use or has been recently operated. Treat this device with the same level of common sense as any mains-powered electrical item – do not expose to wet environments, keep out of the reach of children, animals etc. Do not eat!

**Caution!** Some components may be warm to the touch during use. This is a perfectly normal consequence of their operation, but you should remember it when handling the board or considering alternative enclosures.

**Legal Statement**



In addition you should note the following (in the event that there is any conflict between these notes and the License given above, then the License shall take priority).

The All-Toob-Strobo may be hazardous if not assembled and operated by suitably knowledgeable and practised persons or if abused. It is your responsibility to carefully review the documentation, the design and the kit contents and to assure yourself that you have the necessary expertise to construct and/or operate the device safely. In particular, it is also your responsibility to ensure that the completed All-Toob-Strobo meets any necessary safety and other regulations or guidelines for such items in your jurisdiction. It is possible that in some jurisdictions, a completely different type or construction of enclosure may be required to obtain regulatory compliance. Assembly instructions in the kit documentation are intended as a starting point, to be amended or not according to the judgement and expertise of a suitably qualified constructor.

The hazards of this kit include, but are not limited to, high voltages, the generation of heat during operation, the presence of toxic substances within the components of the kit and the presence of sharp and/or fragile glass and metal items. Not all components within this kit comply with the Restriction of Hazardous Substances regulations (RoHS), though compliant components have been selected in most cases.

In summary, you own, construct and use the All-Toob-Strobo entirely at your own risk. To the maximum extent permitted by law, we disclaim all liability for any and all adverse outcomes associated with your ownership, construction and use of this item.

**Warranty Information**

Upon receipt of the kit of parts, any missing or broken pieces will be replaced. It is incumbent upon the recipient to check the contents in a prompt manner against the supplied parts lists found within this manual. As a kit of parts, no warranty can be provided pertaining to the quality of construction and operation of the final product as this is the duty of the purchaser and is dependent upon their skill. The All-Toob-Strobo may be hazardous if not assembled and operated by suitably knowledgable persons and it is the owners responsibility to carefully review all the supplied documentation. The authors have made their best attempts to explain and detail the construction and hazards associated with operation of the device within this manual. Within the All-Toob certain hazards are present, namely high voltages and due care and attention should be paid when handling said items. If you have purchased a complete operational All-Toob-Strobo then a limited warranty is provided in a separate document supplied with your device. If the kit or complete device has arrived in a damaged state such that an insurance claim is likely to be made, then please notify us immediately (within a few days of receipt). It is likely that photographic evidence will be asked for to make the insurance claim.

No refunds on partially or fully constructed kits are possible.

Right, with that out of the way, now on to the main course…

# What is a Strobotron?

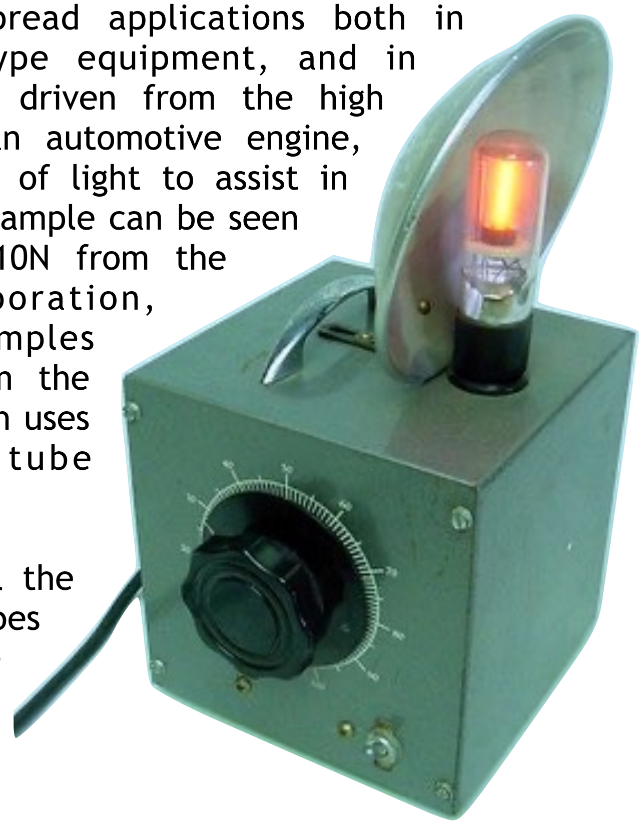
'Strobotron' lamps became popular during the 1930's as a light source intended for producing high energy light pulses of extremely short duration. The gas used was neon at a pressure of 15 Torr (20 mBar).


The 631-P1 illustrated was a Sylvania Electric Products device. Basic operating details are: Anode Voltage: 220 - 380 DC, Trigger Voltage: 70 DC, Typical Anode Current: 100 A. The base was UX4 and the grid was a graphite ring. Maximum flash rate: 200 Hz. Produced from about 1950.

In effect they function rather like a thyratron[3] valve but optimised for light output. The anode is a cup shaped electrode at the top end of the tube, usually consisting of iron or nickel with a coating of pure caesium[4] over its surface for good electron emission. The cathode is similarly shaped and mounted directly above the glass stem press. This is separated from the so-called 'grid' electrode by a graphite cylinder with a small hole at its centre.

A DC voltage of about 220 to 380V should be applied across the tube, typically from small capacitors of only about 1 to 10 µF. Then, with a relatively low trigger voltage of around 70V or so at the grid, the neon gas inside the glass bulb illuminates with the resulting electrical arc discharge. This takes the form of an intensely bright and narrow column running the length of the tube, and with the aid of a small specular parabolic reflector, a very bright beam of light can be projected that is clearly visible in daylight. Although the flash of light only lasts for about 10 milliseconds, the current is of the order of several hundred amperes, resulting in a very high intensity flash.

These lamps found widespread applications both in traditional stroboscopic type equipment, and in specialised units that were driven from the high tension ignition circuit in an automotive engine, producing synchronised pulses of light to assist in adjusting its timing. One such example can be seen here, a Stroboscope model E-10N from the Wabash Instrument Corporation, Indiana, USA. Other examples included the Strobotac from the General Radio Company which uses the 631-P1 Strobotron tube pictured above.



They were widely used until the 1960s when xenon flash tubes were introduced, offering higher intensity and the advantage of a white coloured flash.

[3] https://en.wikipedia.org/wiki/Thyratron

[4] Cesium to our American cousins…

## Building the Kit

Which Strobotron tube?

The Strobotron socket is the only part that will change depending on what type of Strobotron tube you plan on using. Strobotron tubes that have been tested are:


- NSP1[5]
- CV220[6]
- NSP2[7]
- CV2296[8]
- SN4[9]
- 1D21[10]
- 1D21/SN4
- 631-P1[11]

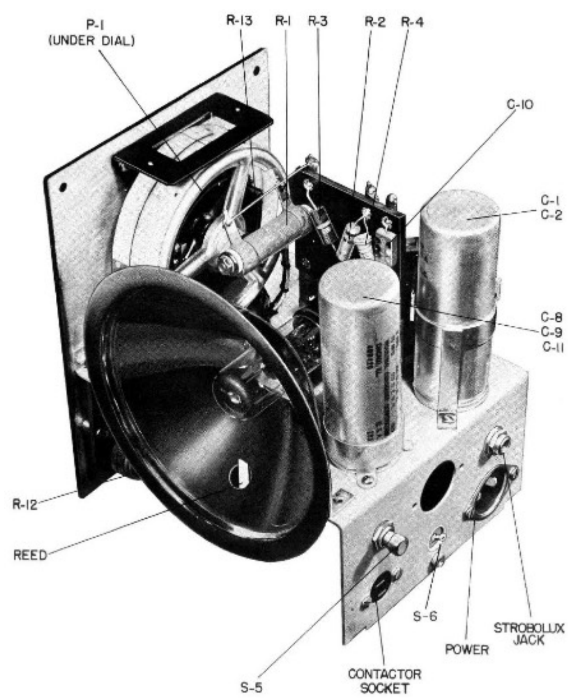
Tubes that should work but are (currently) untested include:

- NHP1
- CV310[12]
- GN10[13] (the anode connector is a top cap so the design will need to be modified)
- EN10[14]

All have an UX4 base except the NSP2 and EN10 which have an international octal base (B8U).

*Tools required*

TYPE 631-BL STROBOTAC




The following tools are essential to build the board:

- Small flat blade screw driver
- Small adjustable spanner (wrench)
- Wire cutters
- Wire strippers
- Soldering iron
- Solder (60:40 Tin:Lead, rosin core)

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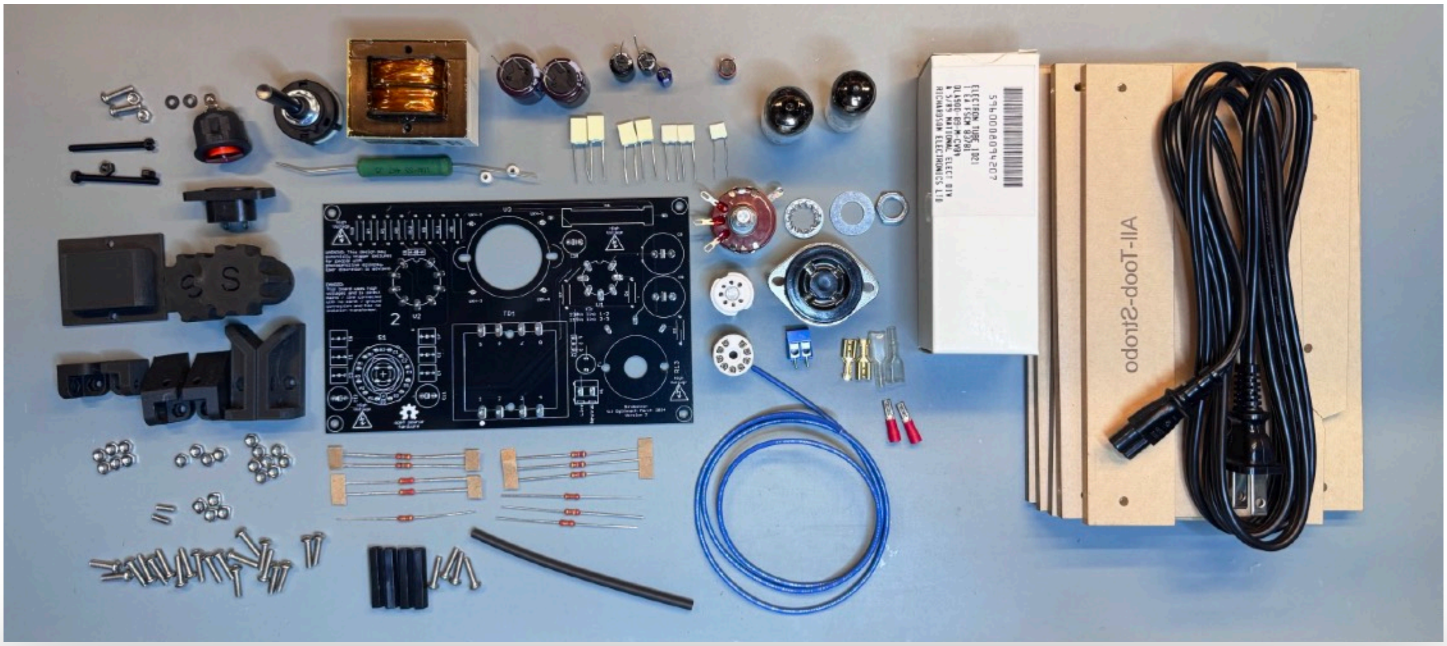
[5] http://www.r-type.org/exhib/aaa0473.htm
[6] http://www.r-type.org/exhib/aai0313.htm
[7] http://www.r-type.org/exhib/acf0138.htm, http://www.r-type.org/boxes/box365.htm
[8] http://www.r-type.org/exhib/aaa1253.htm
[9] https://frank.pocnet.net/sheets/137/s/SN4.pdf
[10] https://www.radiomuseum.org/tubes/tube_1d21.html
[11] http://www.r-type.org/addtext/add073.htm
[12] http://www.r-type.org/exhib/aai0196.htm
[13] http://www.r-type.org/exhib/aaa0449.htm
[14] http://www.r-type.org/exhib/aaa0449.htm

## *Kit Contents*[15]



A Complete Set of Parts to Build a Strobotron, Including Optional Acrylic Case Components

## *Parts List*

The following parts are included in the standard kit. If you are building the board having bought just the PCB or are building it another way, then there is a spreadsheet on the project Dropbox[16] that contains more information on each part (critical dimensions etc.).

| Tick | Quantity | Number | Value | Type |
|---|---|---|---|---|
| ☐ | 1 | R1 | 24k | 1W 5% Metal Film |
| ☐ | 1 | R2 | 12k | 1W 5% Metal Film |
| ☐ | 3 | R3, R4, R8 | 47k | 1W 5% Metal Film |
| ☐ | 2 | R6, R7 | 220R | 1W 5% Metal Film |
| ☐ | 2 | R9, R10 | 1M | 1W 5% Metal Film |
| ☐ | 1 | R11 | 15k | 1W 5% Metal Film |
| ☐ | 1 | R12 | 150k | 1W 5% Metal Film |
| ☐ | 1 | R5 | 4k7 | 10W Wire Wound |
| ☐ | 2 or 4 | Ceramic stand offs to hold R5 (which gets hot in normal operation) away from the PCB | | |
| ☐ | 1 | C5 | 1n | 400V DC Film 10% |
| ☐ | 2 | C1, C2 | 22n (see note 1) | 400V DC Film 10% |
| ☐ | 2 | C3, C4 | 47n | 400V DC Film 10% |

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15 Given different suppliers, your kits contents may be *slightly* different, but still complete and also dependent on whether you order the case or not.

16 http://www.sgitheach.org.uk/strobotron2.html#documentation

| Tick | Quantity | Number | Value | Type |
|---|---|---|---|---|
| ☐ | 2 | C6, C7 | 10n | 400V DC Film 10% |
| ☐ | 2 | C8, C9 | 47µ | 400V DC Electrolytic 20% |
| ☐ | 1 | C10 | 1µ | 400V DC Electrolytic 20% |
| ☐ | 1 | C11 | 2u2 | 400V DC Electrolytic 20% |
| ☐ | 1 | C12 | 4u7 | 400V DC Electrolytic 20% |
| ☐ | 1 | F1 | 115V, 500mA or 230V, 250mA | Slow blow, location specific |
| ☐ | 1 | R13 | 100k | Potentiometer 2W |
| ☐ | 1 | S1 | Rotary switch | 4 pole 3 way |
| ☐ | 1 | TR1 | Transformer | Dual 115V primaries<br>Dual 6.3V 1A secondaries |
| ☐ | 2 | M3 40mm nylon bolt, washer & nut to secure TR1 and 3D printed protective cover | | |
| ☐ | 1 | V1 | EZ90 or equivalent (see note 2) | Double diode rectifier |
| ☐ | 1 | V1 | B7G | Valve socket, PCB mounting |
| ☐ | 1 | V2 | 12AV7 or equivalent (see note 3) | Double triode |
| ☐ | 1 | V2 | B9A | Valve socket, PCB mounting |
| ☐ | 1 | V3 | NSP1 or equivalent (see note 4) | Strobotron |
| ☐ | 1 | V3 | UX4 (see note 5) | Valve socket, chassis mounting |
| ☐ | 1 | V3 | NSP2 or equivalent | Strobotron |
| ☐ | 1 | V3 | International Octal (see note 5) | Valve socket, chassis mounting |
| ☐ | 2 | V3 | M3 nut, washer, 6mm bolt to mount the UX4 or IO socket | |
| ☐ | 1 | V3 | Connecting wire | |
| ☐ | 1 | X1 | Screw connector | 2 way |
| ☐ | 1 | PCB | | |

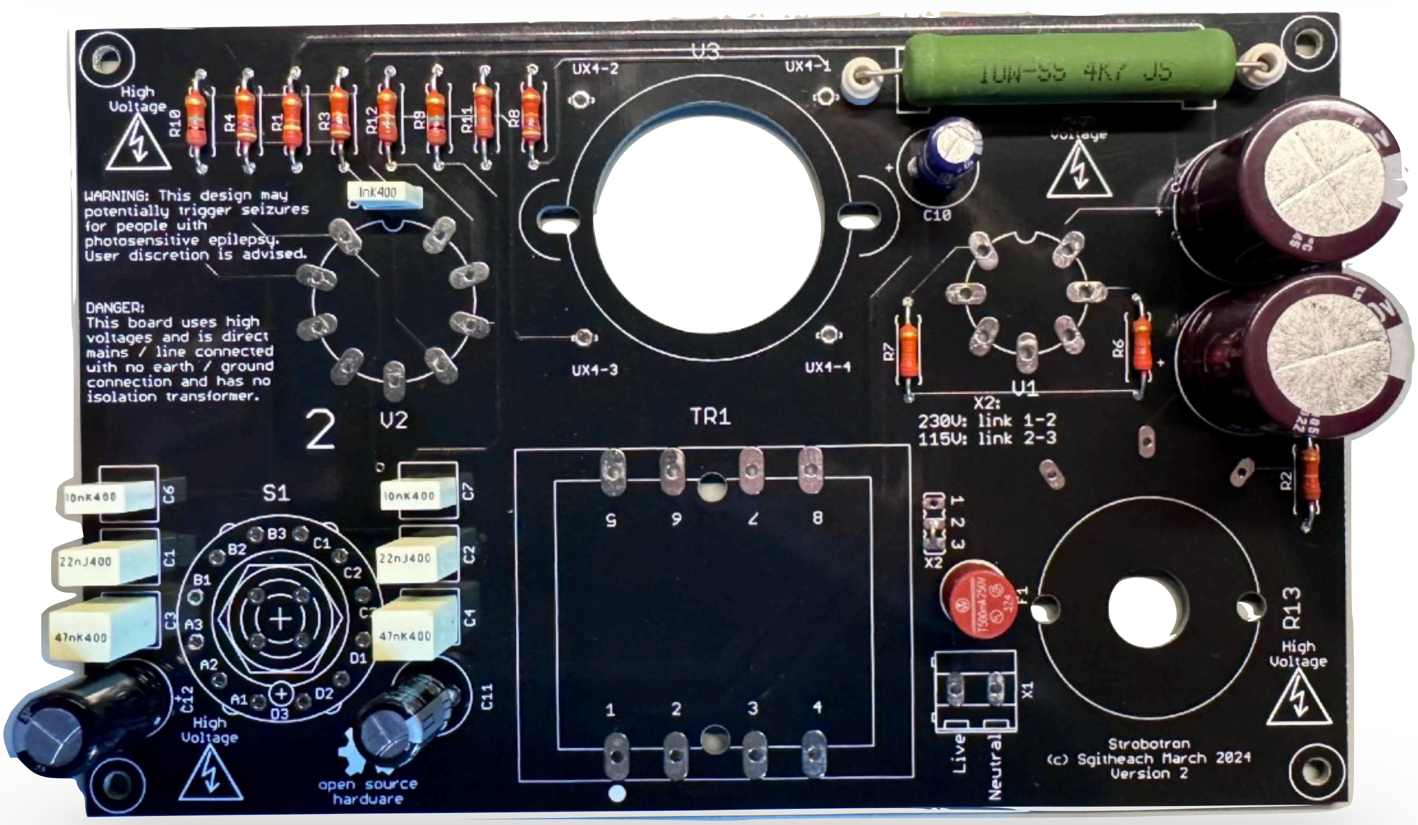
Notes:

1. C1, C2, C3, C4, C6 and C7 set the flash frequency ranges selected by the rotary switch. They can be changed to increase/decrease the frequency if so desired, but the capacitors used must be the same type and voltage rating.
2. EZ90 equivalents include 6Z31, 6X4, CV493, U78, VX7061, QA2407, CV4005, 6063
3. 12AV7 equivalents include 6BK7B, CV10175, 5965
4. Strobotron equivalents are listed above.
5. Depending on the Strobotron tube used the socket required is either a UX4 or Octal type.

## *Assembly*

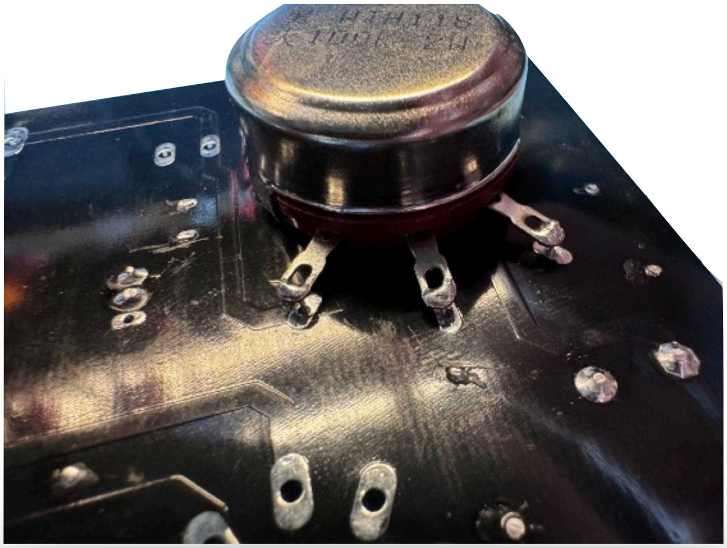
If you are an experienced kit constructor then you'll probably only need a quick look through these notes before continuing. A general guide to any electronics kit assembly is to start with the smallest and lightest components (resistors usually, always check their resistance with a multimeter!) and move to the largest/heaviest last (the transformer, certainly). Don’t forget the wire link (using a resistor lead off-cut perhaps) that selects 115V AC or 230V AC operation.


Resistors mounted, note wirewound resistor is elevated from the PCB and the wired link at X2 for 115V operation




Fuse and all the capacitors fitted, note the correct orientation of the electrolytics!

Connections between the potentiometer R13 and the board are made with wire offcuts. The correct fuse will have been selected when you ordered the kit.

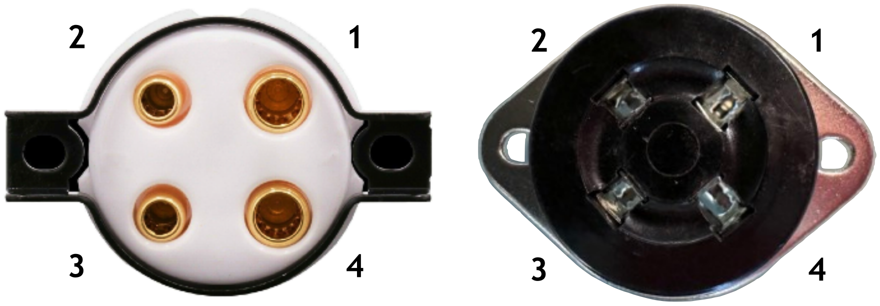


After attaching the potentiometer to the PCB with the supplied nut and washer, use some resistor offcuts to connect the lugs to the solder pads.

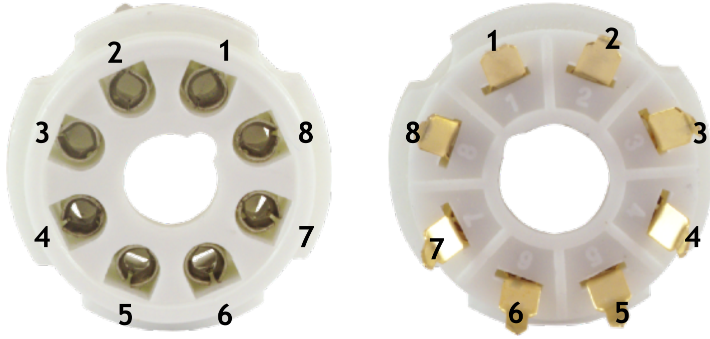

The switch can be fitted in two orientations, make sure that the silkscreen profile on the PCB matches the switch's outline. Also, the shaft of the switch should measure 20mm in length and may need cutting to size.

The Strobotron V3 socket is mounted using M3 bolts, washers and nuts. Orientate the socket as follows:

- UX4 socket[17] with the two thickest pins, 1 and 4, towards V1 on the PCB (the EZ90)




- International Octal socket with the keyway towards V1 on the PCB (again the EZ90)



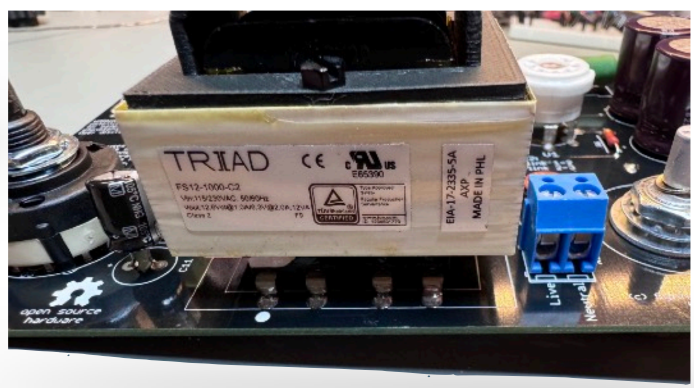

[17] A couple of UX4 examples shown, your kit will probably not include such a high quality ceramic and gold affair as this one (sorry). The photo is used here as the pin socket diameters are so clearly visible, the black socket needs a little closer examination, but is still obvious.

The Strobotron socket (V3) is then wired as follows (the bottom silkscreen is labelled to assist you):

| Bottom Silkscreen Marking | UX4 pin | International Octal pin |
|---|---|---|
| UX4-1<br>IO-4 | 1 | 4 |
| UX4-2<br>IO-3 | 2 | 3 |
| UX4-3<br>IO-5 | 3 | 5 |
| UX4-4<br>IO-8 | 4 | 8 |


Wiring up the UX4 socket to the PCB

The last item to fit will probably be the transformer. It can fit two ways around but only one is correct! Pin 1[18] on the transformer is marked with a splodge[19] of white paint. There is also a white dot on the silkscreen. The silkscreen has the transformer pin numbered as well so you can be sure of its orientation. As the transformer has 'exposed' windings, there is a 3D printed cover that should be installed over the top to keep things safe from prying fingers or sharp objects. It is easier to fit the two 40mm bolts before soldering the transformer connections.




Correct orientation of the transformer. Note the 3D printed cover is held in place with the long nylon screws and fastened under the PCB.

[18] Look carefully and you'll see the transformer has tiny numbers by each pin, 1 – 4 on one side and 5 – 8 on the other.
[19] A technical term…

If all has gone to plan, now may be a good time to temporarily wire up power to the All-Toob-Strobo to test it before installing the PCB in the case. We would also recommend temporarily installing the 3D printed knobs on the switch and potentiometer during testing.


The completed circuit board with tubes installed, note the protective cover over the transformer and the standoffs in place for attachment to the acrylic cover

***Be careful as there is high voltage on the circuit board!***

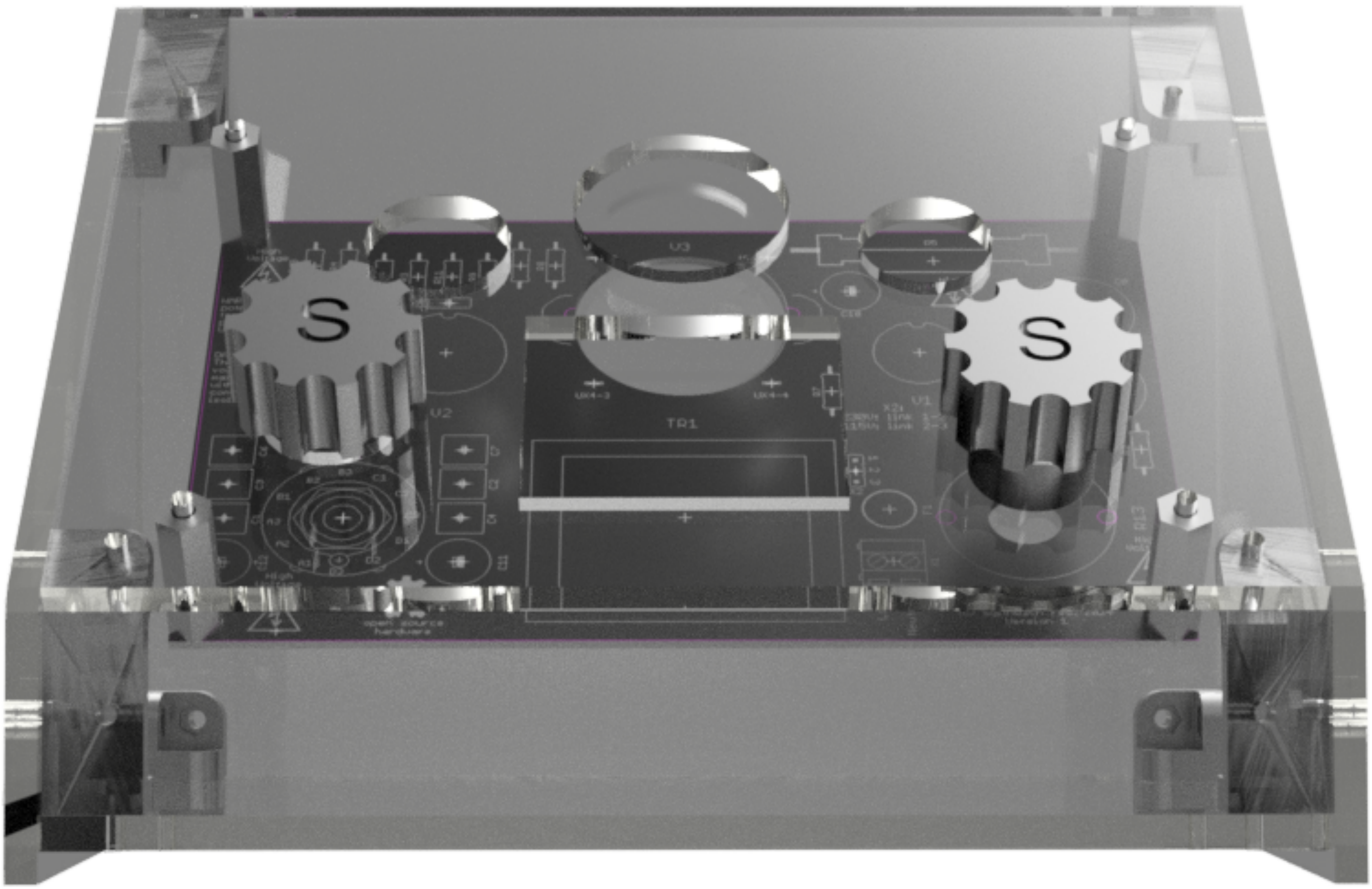
Once plugged in, it will take a few moments for the heaters to warm and the tube to start firing correctly. It'll be pretty obvious once it does…. If you run into issues, then please contact us[20] an we'll try to help. Remember, this is a high-voltage device, so the utmost care must be taken when testing it *outside* of a protective case.

[20] http://www.sgitheach.org.uk/contact.html or stocksclocks@gmail.com

## Case Building

Now you have a functioning Strobo[21], it needs a nice home. Here's a monochrome view of the assembled case with the bare PCB in it. The following link will take you to a full-featured 3D view that can be manipulated to gain insight into how the case is constructed…

http://www.sgitheach.org.uk/strobotron2.html#case




A Rather Nice Rendering of The Complete Strobo Case!

[21] Hopefully!

**Tools Required**

The following tools are essential to build the case:

- Small and medium flat blade screw drivers
- Medium cross-head screw driver
- Small adjustable spanner (wrench)
- 2mm hex key (Allen key or Allen wrench)
- Slip joint pliers (channel-locks) or similar
- Wire cutters
- Wire strippers
- Soldering iron, solder

A hot air gun is useful for heating shrink wrap insulation, but not absolutely necessary.

**Parts List**

Where an item is shown in brackets, such as (15mm), it is a supplied as an alternative when using 6.35mm thick (¼ inch USA) acrylic instead of 5mm thick acrylic (RoW).[22]

| Tick | Quantity | Parts | Notes |
|---|---|---|---|
| ☐ | 6 | Corner connectors | 3D printed - see below |
| ☐ | 1 | Potentiometer knob | 3D printed |
| ☐ | 1 | Rotary Switch knob | 3D printed |
| ☐ | 1 | Transformer Cover | 3D printed |
| ☐ | 2 | 40mm nylon screws + nuts | To mount transformer cover |
| ☐ | 4 | Square M3 nut | To mount knobs and for top rear Låda pieces |
| ☐ | 2 | 6mm grub screw | To mount knobs |
| ☐ | 1 | “Figure of 8” mains inlet | |
| ☐ | 1 | “Figure of 8” mains cable | USA and UK only |
| ☐ | 2 | M3 12mm (15mm) bolt, washer and nut | To mount mains inlet |
| ☐ | 1 | Mains switch | |
| ☐ | 2 | Crimped wire connectors (can be pre-crimped on request) | To connect mains inlet, switch and to the screw terminals on the PCB |
| ☐ | 2 | Connecting wires | Brown/Blue (EU), Black/White (USA), RoW according to local codes |
| ☐ | 50mm | Heat shrink tubing | To cover mains inlet and switch connections |
| ☐ | 18 | M3 nuts | Push fit into the 3D printed parts |
| ☐ | 20 | M3 12mm (13mm) bolt | Assemble panels onto 3D printed parts |

[22] <rant> Because it appears to be very difficult to obtain 5mm acrylic on the west side of the Atlantic!! Good grief…when will we all come to a measurement consensus and go metric!! </rant>

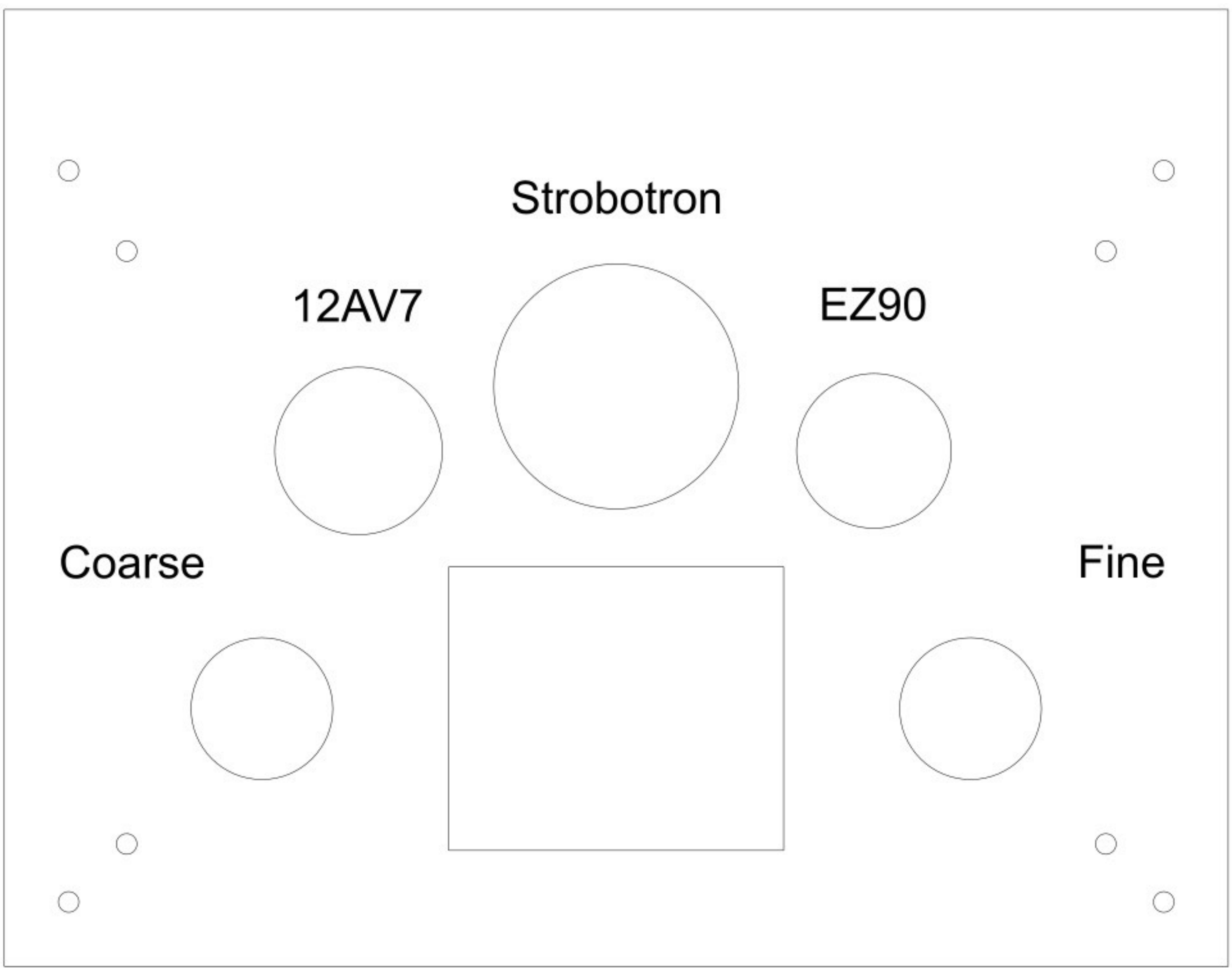
| Tick | Quantity | Parts | Notes |
|---|---|---|---|
| ☐ | 4 | M3 22mm (25mm) female-male nylon stand off (depending on acrylic thickness) | To space PCB off front panel |
| ☐ | 4 | M3 12mm screw | Mount PCB stand-offs on front acrylic |
| ☐ | 4 | M3 nut and washer (see note 1) | Mount PCB on stand-offs |

Notes:

1. The kit can be supplied with a variety of standoffs that may need different hardware, which is included.

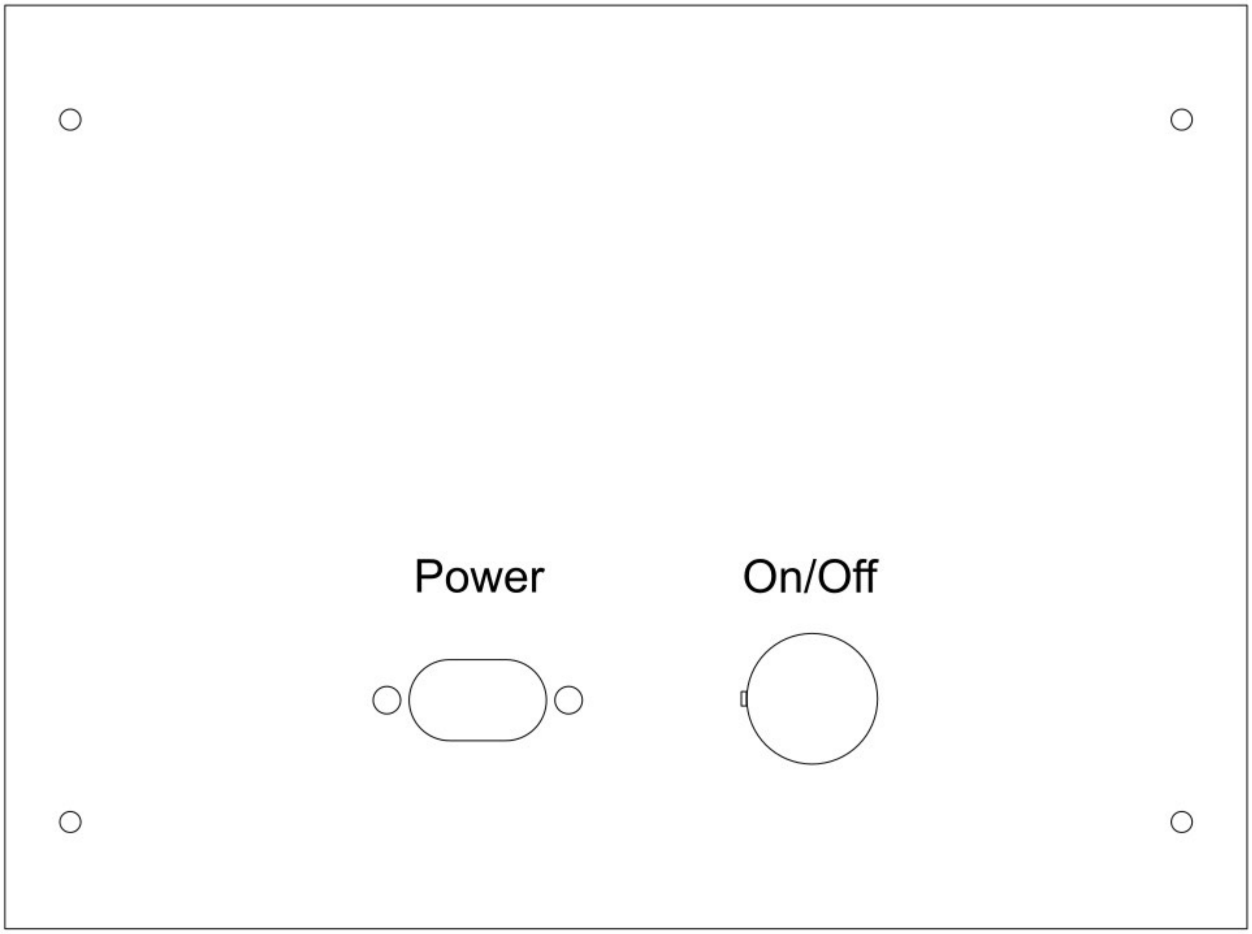
## Acrylic Panels[23]

It is recommended to read the "Sgitheach-Acrylic Care" PDF in the Commoners folder of the Sgitheach public Dropbox. Also when handling and assembling the acrylic it is worthwhile wearing (cheap) cotton gloves to avoid finger prints on the acrylic panels once the protective film has been peeled off.

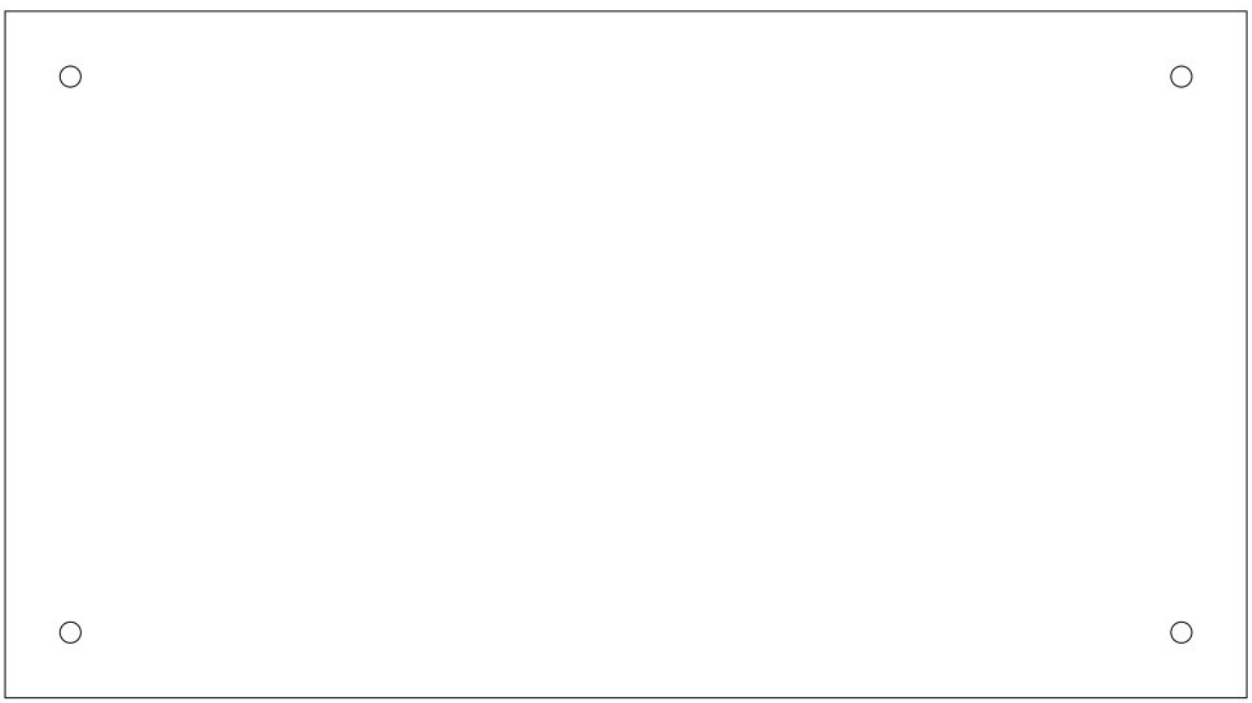



Face Panel

[23] These are supplied in the kit in clear acrylic…..all the plans are Open Design, so if you're building your own feel free to make your own colour statement!. Depending on the mains switch supplied, the rear acrylic piece may look different. Hey if you build your own, share a photo!

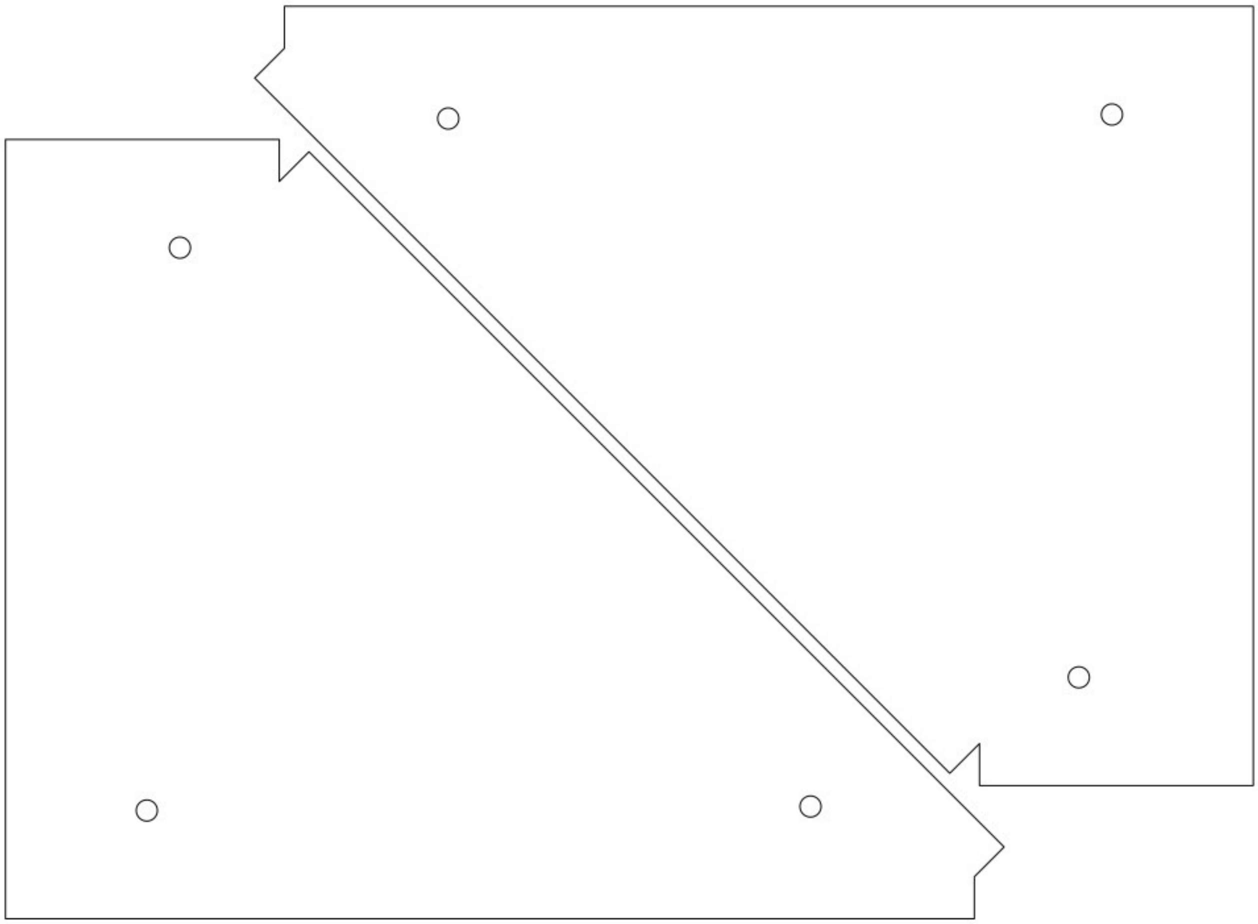



Rear Panel (switch cutout maybe different depending on switch supplied)



Bottom Panel

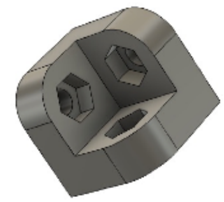
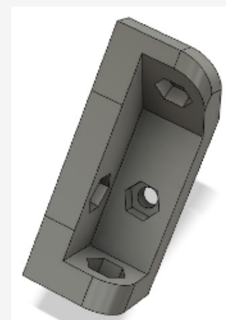
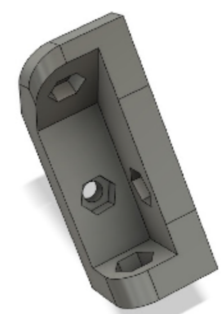
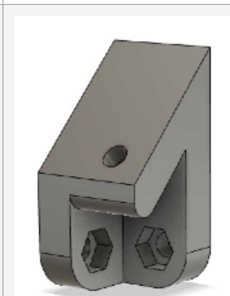


Side Panels

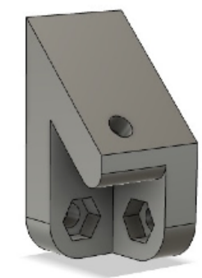
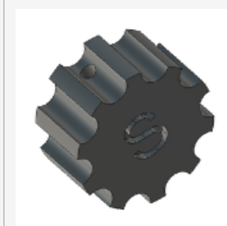
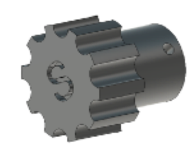
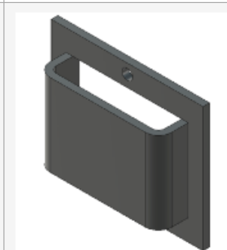

Nameplate

### 3D Printed Parts

There are six 3D printed parts[24] that form corner connectors between the laser cut acrylic panels, one potentiometer knob and one rotary switch knob. The connectors are based on Låda[25] 3D printed parts. You can learn how to assemble the nuts into the holes correctly by reading the Låda chapter in the "Sgitheach-Commoners" PDF on the Sgitheach public Dropbox.

| 3D Part Quantity | Image |
|---|---|
| Bottom Back Corners - 2 off |  |
| Bottom Left |  |
| Bottom Right |  |
| Top Left |  |

[24] All the parts are Open Design so you can print in any colour of your choosing if you have your own 3D printer.
[25] http://wyolum.com/lada-a-custom-project-box-system/

| 3D Part Quantity | Image |
|---|---|
| Top Right |  |
| Rotary Switch Knob |  |
| Potentiometer Knob |  |
| Transformer Cover |  |

**Case Assembly**

1. Complete the låda[26] parts.

As instructed insert 18 nuts into the recesses and insure they will not drop out.[27] There are tolerances in both 3D printed parts and sometimes also the nuts themselves. You may find that the nuts are too tight to seat into the part. If so, we recommend following the guidance in the aforementioned ‘Commoners’ manual by carefully using a soldering iron to heat the nut and melt it into the recess. Conversely, if too loose, then deft usage of an adhesive to keep the nut in place is recommended.

2. Preliminary wiring

Attach two lengths of wire to the screw terminals on the PCB. Use the provided wire divided into two roughly equal lengths.

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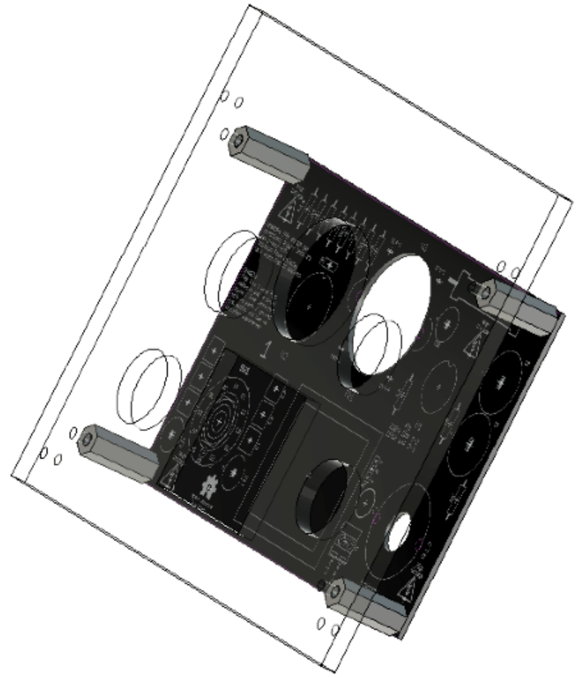
[26] I have to admit to some disappointment when I discovered that låda means “box” in Swedish - I was hoping for something more *evocative*

[27] This can be a PITA, especially when it’s *the very last one…*

3. Assemble the PCB to the face acrylic panel (Obviously all the components are mounted on the PCB and it has tested successfully!)

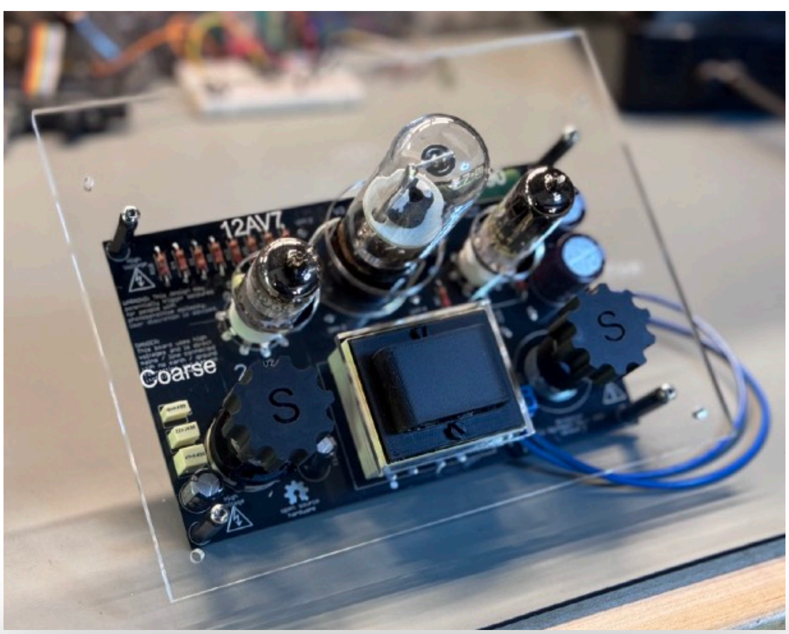
Use four M3 nuts and washers to fix the nylon stand-offs to the PCB and then four M3 12mm bolts to fix the stand-offs to face acrylic panel (or 4 more screws depending on the type of standoff supplied).



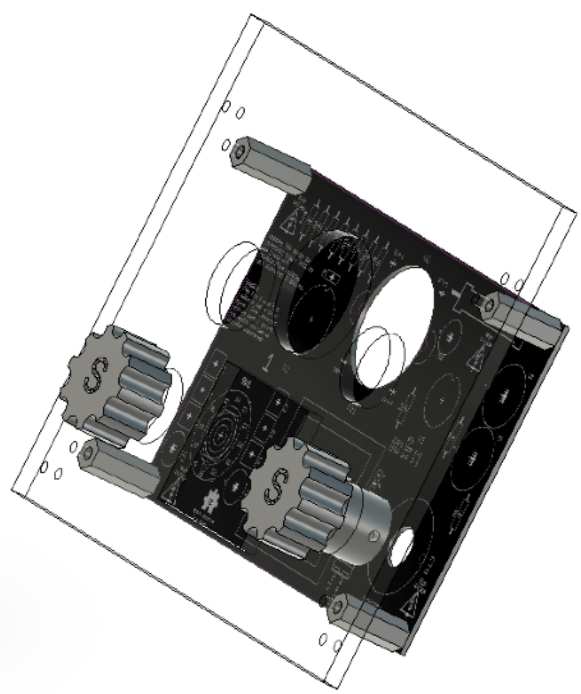
4. Attach the potentiometer and rotary switch knobs

Slide a M3 square nut into the slot in the potentiometer knob and screw in the 6mm grub screw so that it is engaged with the square nut but not so far that it protrudes into the shaft hole. The knob can be slipped over the potentiometer shaft and the grub screw tightened.

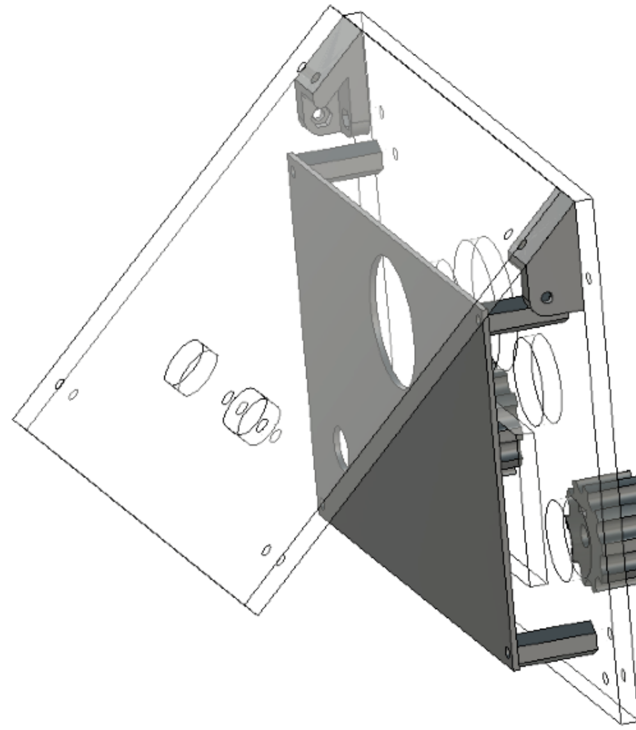
Repeat with the rotary switch knob.




Board should look like this with the acrylic cover attached and the mains inlet wires already secured tightly in the screw block.



5. Add the rear acrylic panel



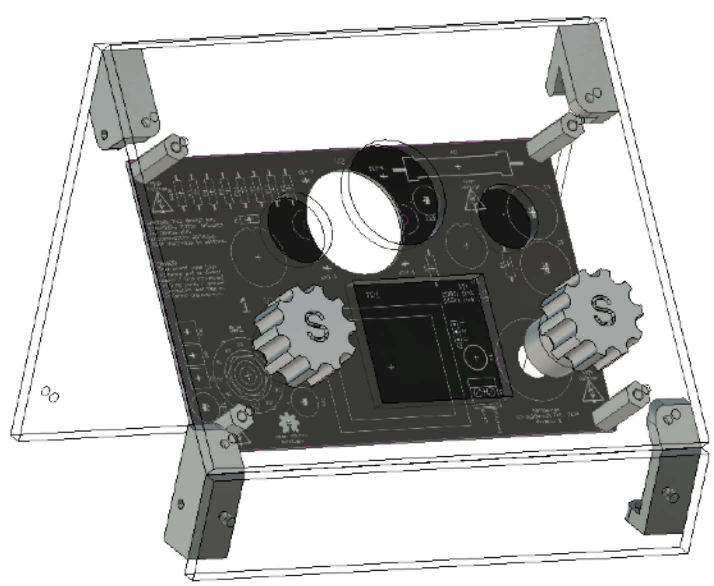
Attach the mains switch into its hole on the rear acrylic panel. Bolt the “figure of 8” connector using two M3 12mm (15mm) bolts, washers and nuts.

Attach the back acrylic panel using two M3 12mm bolts and the top left and top right 3D printed parts but don't fully tighten the bolts. Some small movement in the case will help assemble the remaining panels. These låda parts have one M3 square nut inserted into each respective slot.

6. Complete the wiring

You can now connect a wire (of the appropriate colour for neutral) from the PCB neutral screw connector to the "figure of 8" inlet. Now connect a wire (of the appropriate colour for live) to the other side of the "figure of 8" inlet, shorten the lead to a length that will generously reach the switch. Attach a crimp connector and plug it into one side of the switch. Connect the remaining live colour wired to the PCB live screw connector. Attach a crimp connector to the live wire and plug it into the switch. **Do not solder the wire directly to the switch but use the crimped connector**.[28]

7. Add the front acrylic panel

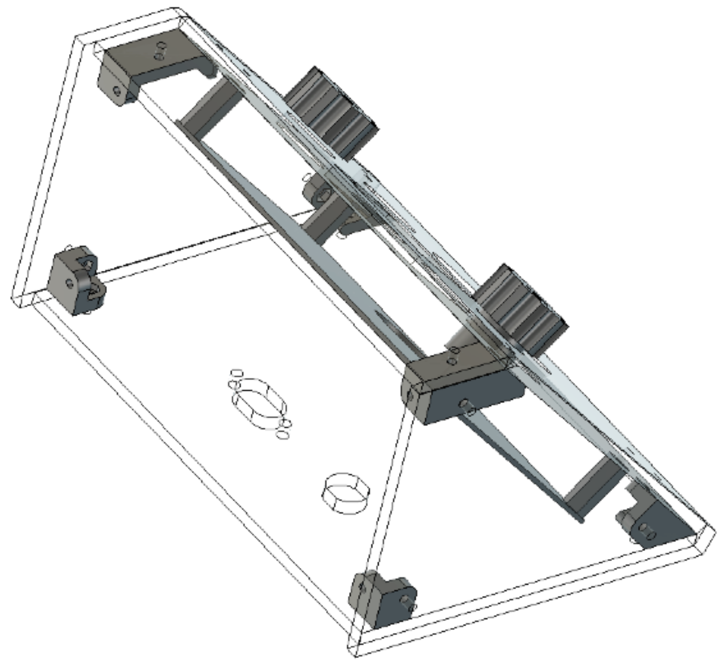


Attach the front acrylic panel using two M3 12mm bolts and the bottom left and bottom right 3D printed parts.

[28] The crimped connectors are a tight fit by design - if you find they’re a little too tight whilst trying to attach them, gently rock the connector from side to side to open up the jaws a little. Take care not to force them too hard and bend the pins!

8. Add the side acrylic panels

Add the two side acrylic panels using six M3 12mm bolts and the two bottom back 3D printed parts. The side panels will connect to other 3D parts already fitted.

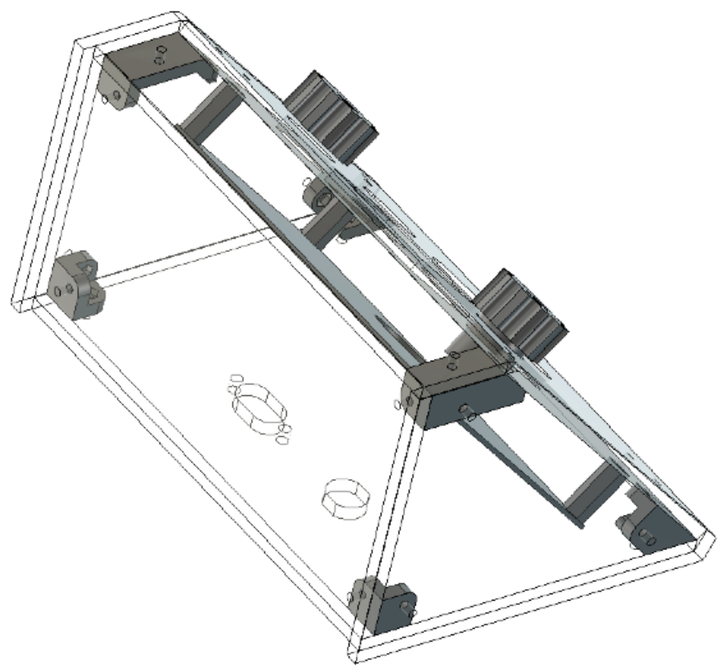


9. Add the bottom acrylic panel

Finally bolt on the bottom acrylic panel using four M3 12mm bolts.

10. Case complete!

Check the tightness of the bolts you left slightly loose.

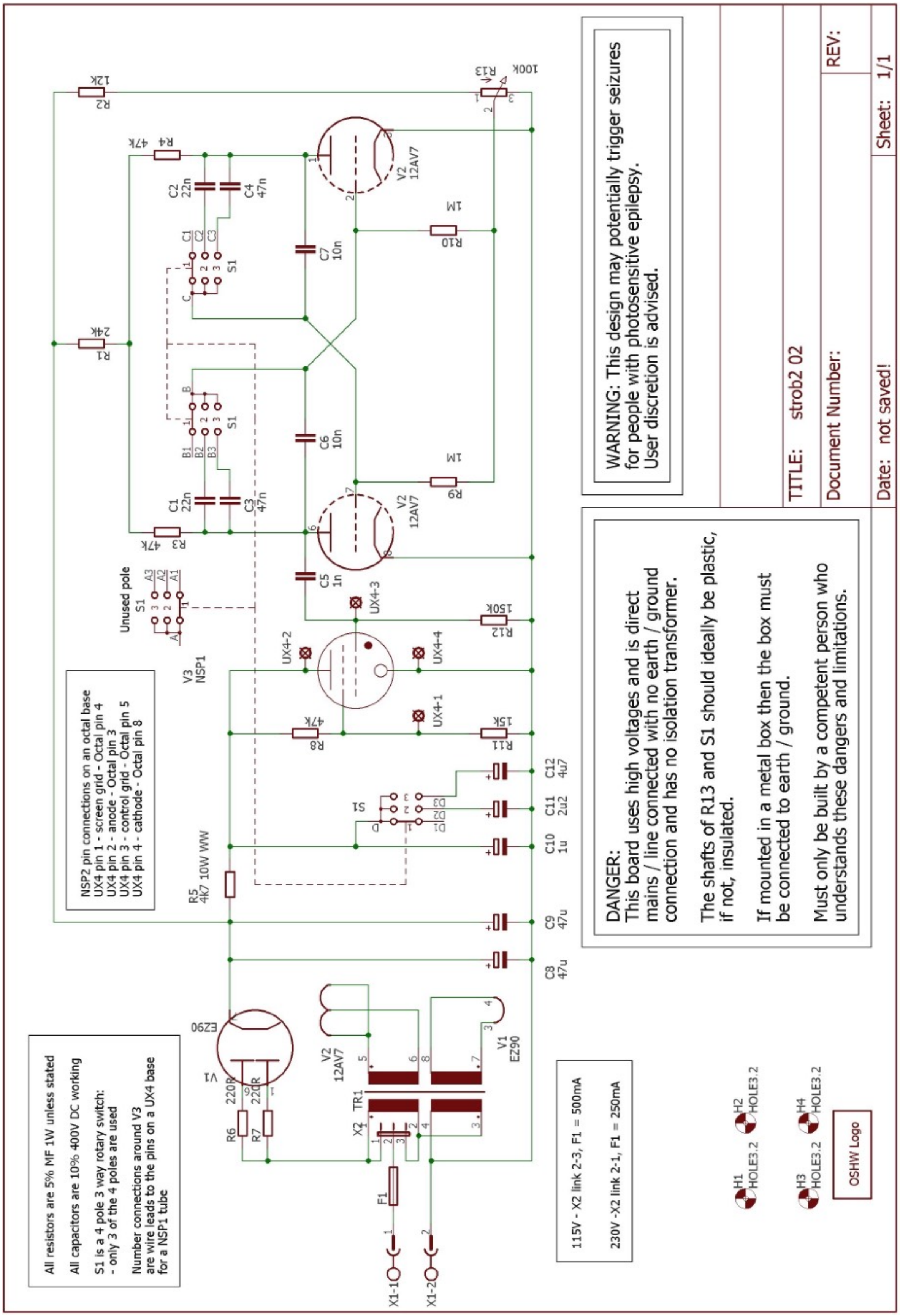


Now plug the All-Toob-Strobo into the mains and enjoy. You'll probably note that the device isn't really intended for non-stop use (unless that's your thing…)[29]. Strobotron tubes have a finite lifespan and as such we recommend using this as a demonstration piece or for some fun experiments to 'motion capture' fast moving objects like electric fans etc.

[29] No judgment from us!

# How It Works!




The Complete All-Toob-Strobo Schematic

The schematic breaks down into 3 sections and each is discussed in the pages that follow.

- Power Supply
- Multivibrator oscillator
- Strobotron tube

The design is almost entirely based on an article published in Practical Electronics in July 1957. The full article is in Annex A. Two more recent designs can be found here[30] and here[31].

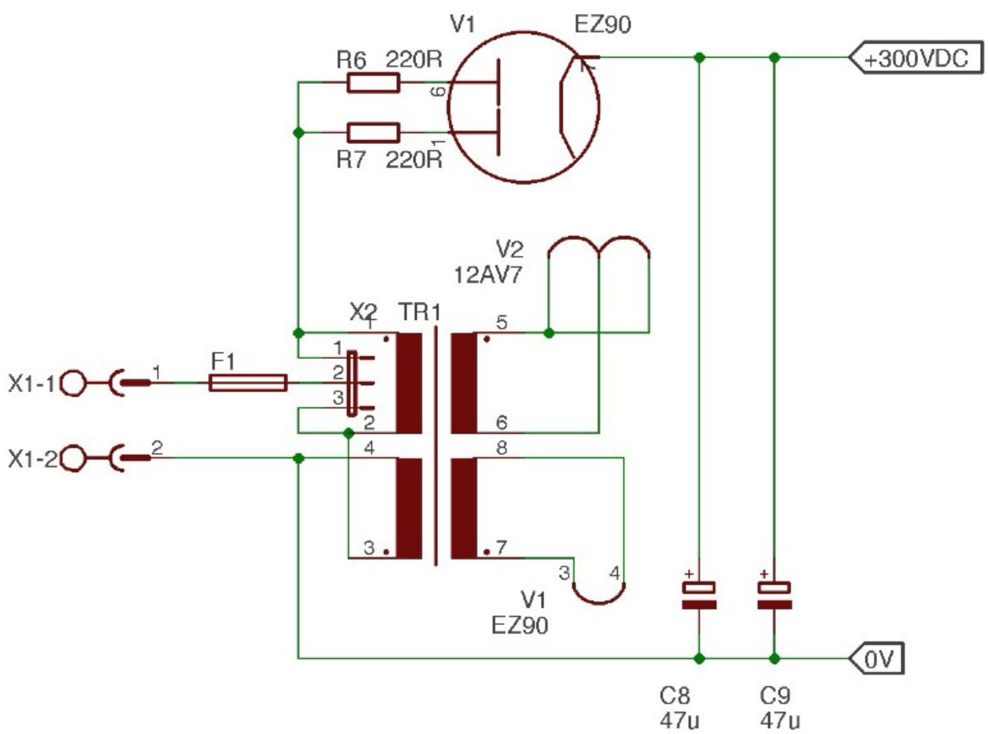
**Power Supply**

**Safety First!**

**The line/mains supply is rectified directly and therefore there is no isolation and the "0V" line cannot be connected to line/mains ground/earth!**

The rectifier[32] valve V1 is directly fed from the mains/line. It is arranged as a half-wave[33] rectifier and produces about 300V DC nominally. C8 and C9 provide voltage smoothing. The transformer TR1 provides isolated 6.3V AC for the EZ90[34] rectifier and the 12AV7[35] double triode V2 used as a multivibrator[36] (see following pages).

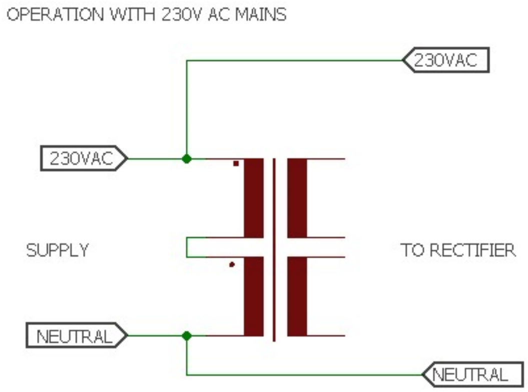
X2 allows the selection of operation with either 230V AC mains or 115V[37]. It may not be immediately clear what is going on so here are the two modes of operation explained:

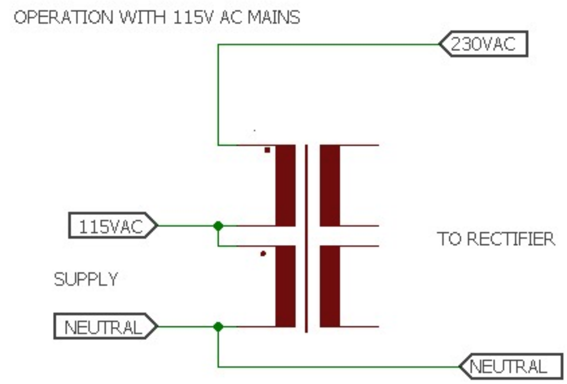



With a 230V AC supply the two 115V primary windings are in series. Note that the winding phasing has to be correct. The 230V AC mains is passed to the rectifier. For 115V AC operation only one primary winding is

30 https://www.electronixandmore.com/projects/strobe/index.html
31 http://www.sgitheach.org.uk/strobotron.html
32 https://en.wikipedia.org/wiki/Rectifier
33 https://en.wikipedia.org/wiki/Rectifier#Half-wave_rectification
34 http://www.r-type.org/exhib/aaa0433.htm
35 http://www.r-type.org/exhib/aag0081.htm
36 https://en.wikipedia.org/wiki/Multivibrator
37 50Hz or 60Hz operation is of no consequence here..

connected to the supply. The other winding is used as an autotransformer[38] to produce 230V AC to pass forward to the rectifier.

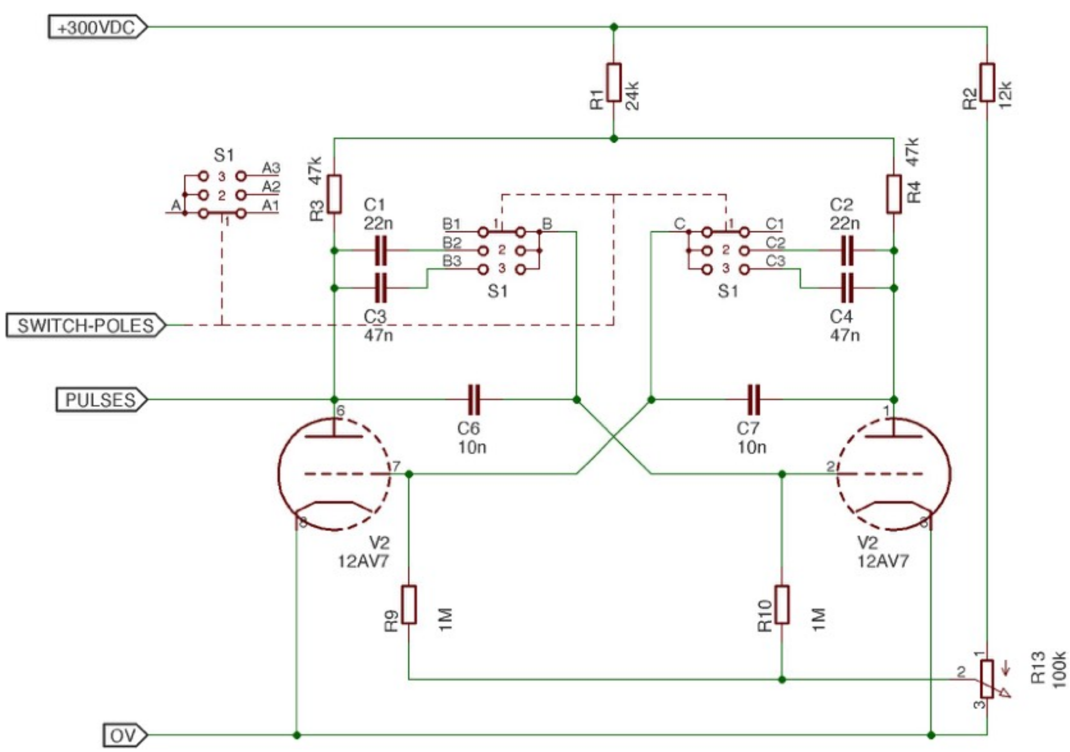



## Multivibrator Oscillator

The double triode V2 is arranged as an astable multivibrator in which the circuit is not stable in either of its two states. It continually switches from one state to the other. It functions as a relaxation oscillator[39].

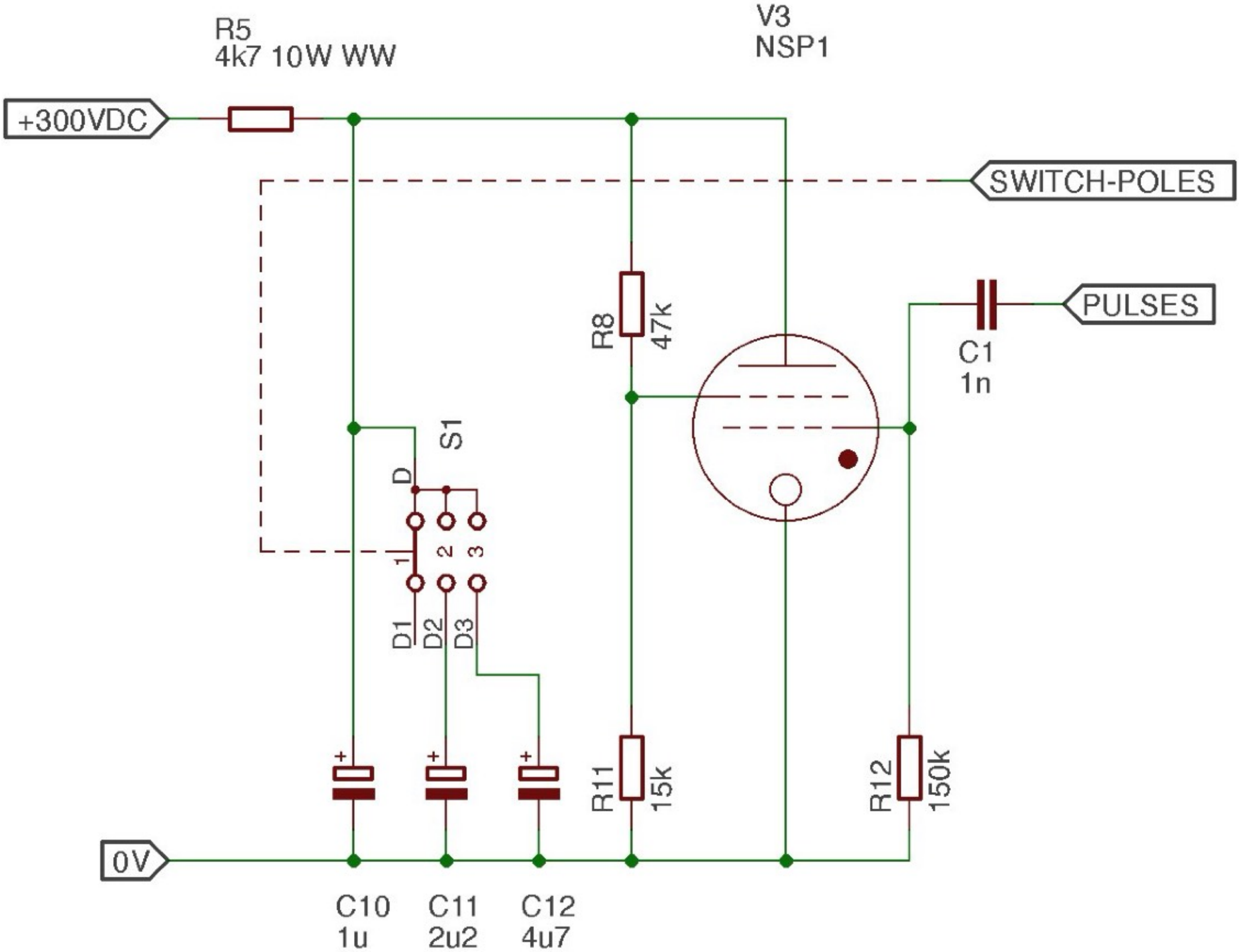
The frequency of oscillation can be changed using the potentiometer R13 or by switching in additional capacitors (C1, C2, C3, C4) across the timing capacitors C6 and C7. Pulses from the oscillator are fed to the Strobotron tube via capacitor C5.




[38] https://en.wikipedia.org/wiki/Autotransformer
[39] https://en.wikipedia.org/wiki/Relaxation_oscillator

## Strobotron

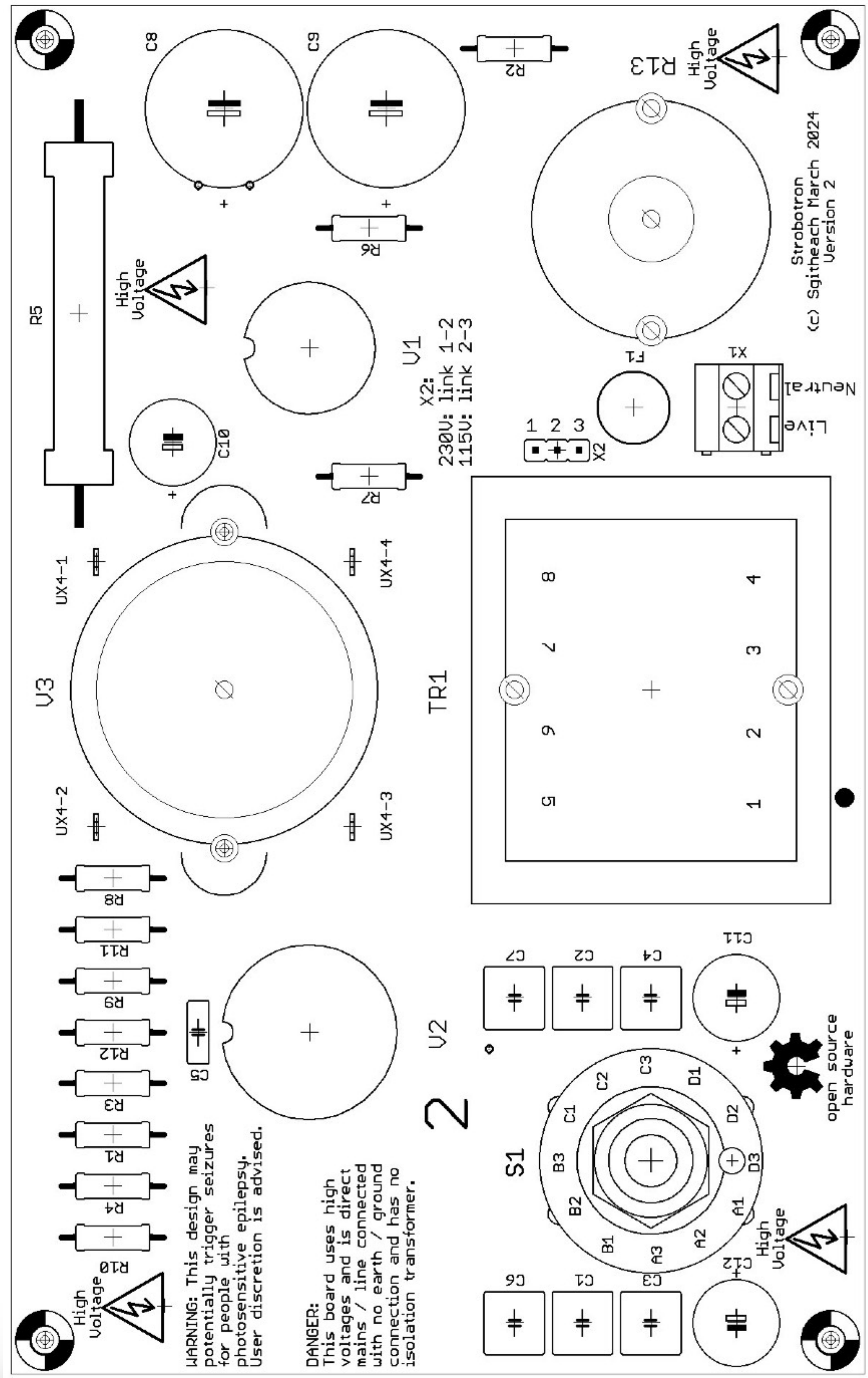
More information on arc[40] discharge tubes can be found in Annex C.




The DC voltage applied to the anode, the shield grid (via resistor R8) and the cathode is such that the tube does not breakdown and fire by itself. The multivibrator sends pulses which are differentiated by C1 and R12 converting the multivibrator square wave into sharp voltage spikes. When a negative voltage spike is applied to the control grid the neon[41] ionises and the main cathode-anode gap ignites. This discharges capacitor C10. This sudden discharge, which may be as high as 100A, causes the emission of the bright orange flash. Capacitors C11 and C12 can be switched to be in parallel with C10 to produce more light in lower frequency ranges.

[40] https://en.wikipedia.org/wiki/Electric_arc
[41] https://en.wikipedia.org/wiki/Neon

# Annex A - All-Toob-Strobo PCB Layout



# Annex B - Practical Electronics Article - July 1957

This contains a huge number of errors, especially in the assembly drawing. Take care!

# THE "VARISTROBE"

## High Speed Stroboscope Freezes Motion

By HARVEY POLLACK

**Uniformly** moving machinery, speaker cones, electrical appliances, etc., can be studied while they are in operation.

WOULD YOU LIKE to examine the contortions of your high-speed circular saw, drill or bandsaw under conditions that seem to slow it down to a crawl? Any repetitive movement, whether rotary or reciprocating, can be viewed as though the moving body were at rest or in very lazy motion—under the flashing illumination of this wide-range "Varistrobe" (variable flash-rate stroboscope).

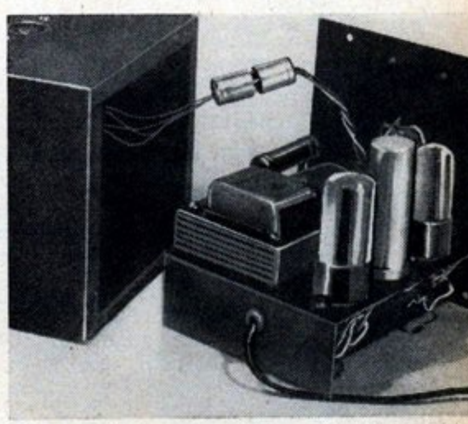
The "Varistrobe" consists essentially of a power supply, a time-base circuit or variable multivibrator, and a strobotron neon tube (631-P1, also called 1D21/SN4) which is triggered by the impulses from the multivibrator. On the *LOW* setting of the *RANGE* switch, the flash-rate may be varied from about 15 cps to a little above 60 cps; when set in the *HIGH* position, frequencies between 60 cps and 240 cps are easily covered. The intentional overlap of the two ranges permits the user to obtain any flash-rate from 15 cps (900 flashes per minute) to 240 cps (14,400 flashes per minute). The latter is the upper limit of the rating of the strobotron.

Each flash lasts between 1/2500 second and 1/5000 second. When the flash-rate is synchronized with the moving object, most of the motion occurs in darkness. The object is thus illuminated briefly in approximately the same spot each time it comes around, so that it appears stationary. If the flash-rate is a bit slower or faster than the number of rps, the rotation or reciprocation will be seen as a lazy, crawling motion.

**Construction.** Many of the chief structural details are shown in the photographs and illustrations. The power transformer, filter capacitor, discharge capacitor, and frequency control potentiometer all appear above the chassis; the smaller components and the *RANGE* switch are mounted below the chassis.

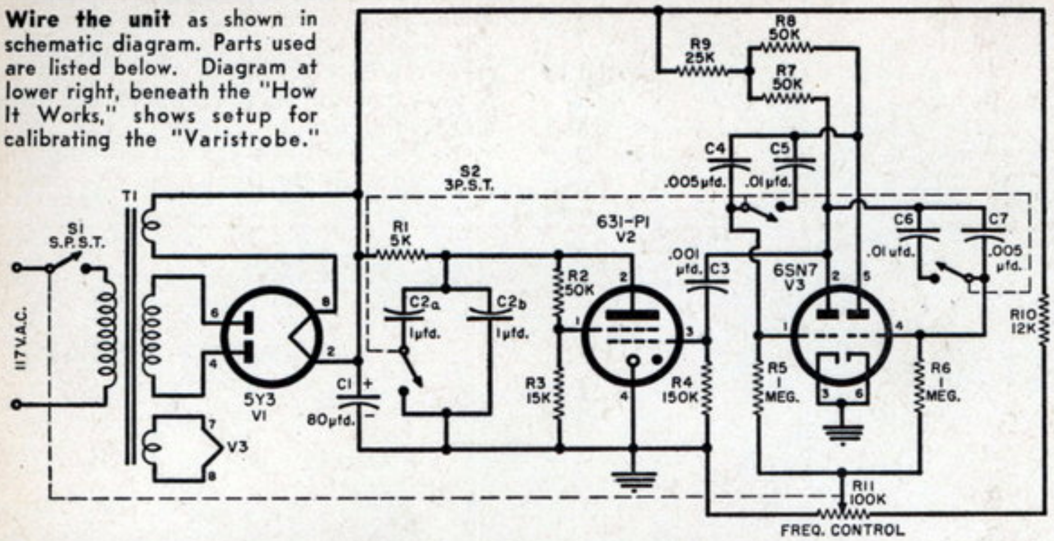
The *RANGE* switch is a four-circuit, double-throw type. It was chosen for its availability in standard catalogs and for its small size. Only three of the contacts are employed in a single-throw arrangement. When you are wiring this switch into the circuit, be careful to arrange the contacts so that all three of the *LOW* setting capacitors (*C2a*, *C5*, and *C6*) are connected across their mates (*C2b*, *C4*, and *C7*) when switch is in *LOW* position.

You'll take real pride in the unit if you add panel decals, a high-quality knob and



**Components are mounted** as shown here. Miniature cable connectors which join the four leads that go to strobotron socket on top of case make it simple to remove chassis for inspection or repairs.

**Wire the unit** as shown in schematic diagram. Parts used are listed below. Diagram at lower right, beneath the "How It Works," shows setup for calibrating the "Varistrobe."




C1—80-µfd., 450-volt capacitor (Sprague TVL-1735, twistlok type, can ground)
C2—2 x 1.0 µfd., 600-volt capacitor (Cornell-Dubilier DYR 6110, can type, one lug common, can not part of capacitor)
C3—0.001-µfd., 450-volt tubular paper capacitor (Sprague 68P1)
C4, C7—0.005-µfd., 1-kv. capacitor (Centralab button type, Hi-cap 502)
C5, C6—0.01-µfd., 600-volt capacitor (Centralab button type, Hi-cap 103)
R1—5000-ohm, 10-watt wire-wound resistor (Sprague Type 10 KT or Type 10 NIT)
R2—50,000-ohm, 1-watt, 10% resistor
R3—15,000-ohm, 1-watt, 10% resistor
R4—150,000-ohm, 1-watt, 10% resistor
R5, R6—1-megohm, ½-watt, 10% resistor
R7, R8—50,000-ohm, ½-watt, 10% resistor
R9—25,000-ohm, 1-watt, 10% resistor
R10—12,000-ohm, 1-watt, 10% resistor
R11—100,000-ohm, linear taper potentiometer—frequency control (Mallory U-41)
S1—S.p.s.t. On-off switch mounted on R11 (Mallory U-41 control to take US-46 switch)
S2—3p.s.t. or 4p.2t. rotary type, non-shorting range switch (Mallory 3242J)—see text
T1—Power transformer, 235-0-235 sec. volts at 40 ma., 5 volts at 2 amp., 6.3 volts at 2 amp. (Stancor PM-8401)
V1—5Y3 rectifier tube
V2—631-P1 strobotron (Sylvania)
V3—6SN7GT multivibrator tube
1—6" x 6" x 6" cabinet, black wrinkle steel with built-in chassis (ICA Type 3823)
1—Case handle, 4½" over-all length, chrome (ICA 3500)
1—5"-diameter parabolic reflector for strobotron
1—4"-round dial, 325° rotation, chrome silver finish (ICA 2168)
1—Vernier dial marker for 4" dial (ICA 2191)

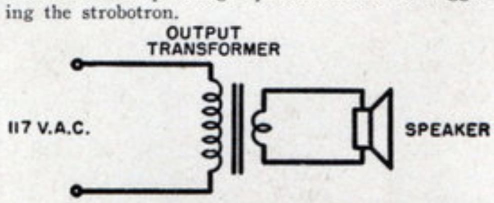
## HOW IT WORKS

D.c. voltages applied to the anode, the shield grid, and the cathode of the 631-P1 strobotron are such that the tube is ready to fire when the remaining grid is suddenly driven negative. Shield grid voltage is obtained through the voltage divider comprising *R2* and *R3*. Each time the strobe grid is pulsed negative by the multivibrator, the strobotron ionizes and instantly discharges *C2b* (or both *C2b* and *C2a* if *S2* is closed). This sudden discharge which may mount to 100 amperes, or more, causes the emission of a bright orange-red flash.

The multivibrator produces approximately a square-wave output at a frequency which is determined by the time constant in the grid circuits of the two halves of the tube and by the grid bias which is governed by the setting of *R11*. Connecting *C5* and *C6* in parallel with *C4* and *C7* respectively when *S2* is closed increases the time constant and causes slower firing. If the wiper of *R11* is moved down to ground potential and *S2* is closed, the lowest flash rate is obtained.

On the *LOW* setting, *C2a* is connected in parallel with *C2b*. This provides a greater discharge capacitance to keep the strobotron glowing for a longer time. Thus, the light intensity on the low-frequency range is increased to yield about the same total of illumination as on the high-frequency range.

*C3* and *R4* make up a differentiating network which changes the square-wave output of the multivibrator to sharp voltage spikes suitable for triggering the strobotron.




vernier indicator, and a carrying handle. Effectiveness of the strobotron illumination is heavily dependent upon the quality of the reflector used behind it. The one shown in the pictures comes from an inexpensive Bower pocket flash.

**Testing.** Set the *RANGE* switch on *LOW* and rotate the potentiometer knob (*R11*) clockwise until the switch just clicks on. In about 30 seconds or less, the strobotron should start to flash at its slowest rate. *At this point, it is very important to remove the 6SN7GT from its socket while the strobotron is flashing.* This should extinguish the glow in the strobotron completely. If the flashing continues with the multivibrator tube removed, it indicates that the anode grid voltages on the strobotron are incorrect—which may be caused by one or more of the following faults:

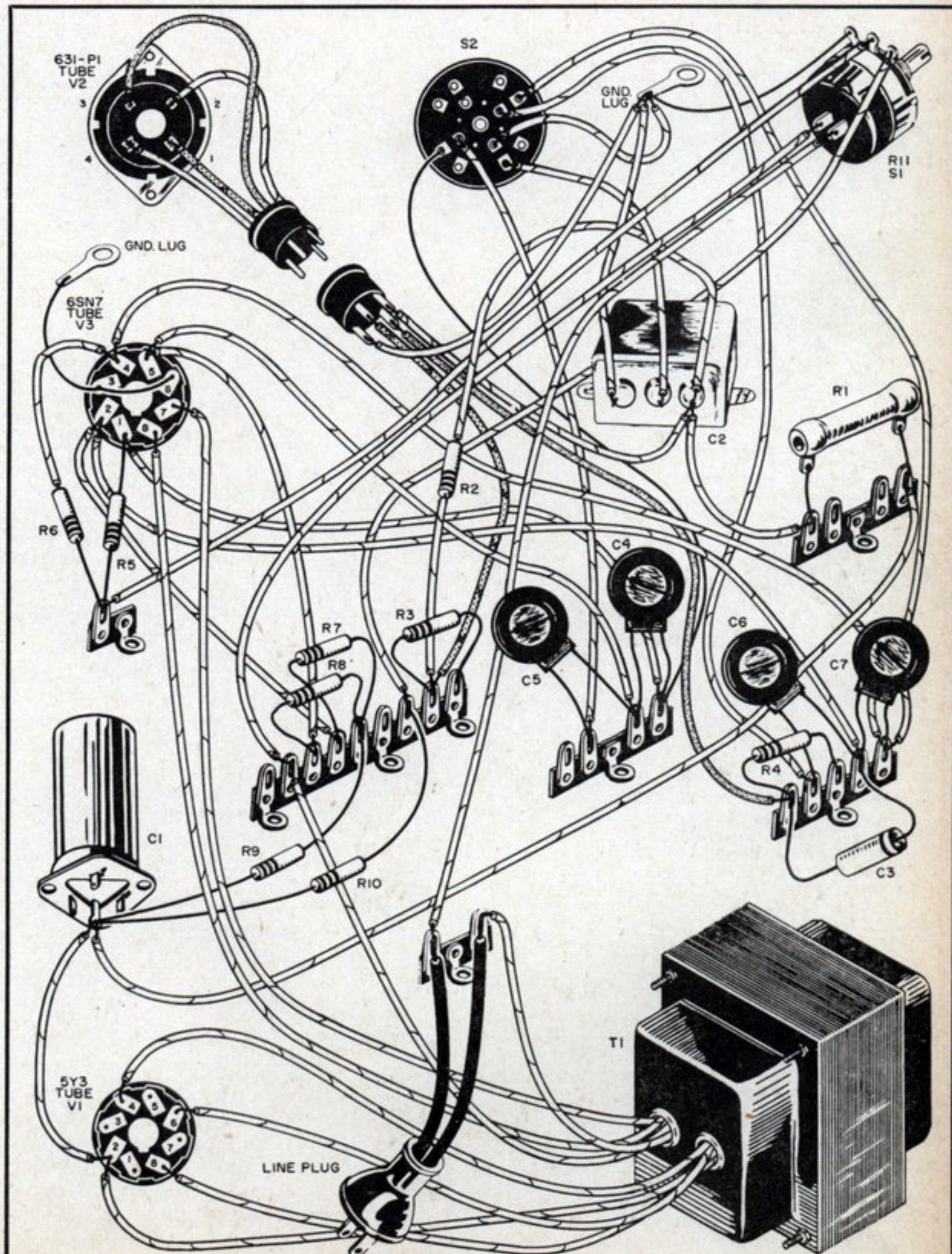
(a) *R2* and *R3* may have been interchanged.

(b) *C3* may be leaky or shorted.

(c) *R1* or *R2* or both may be shorted by some incorrect connection.

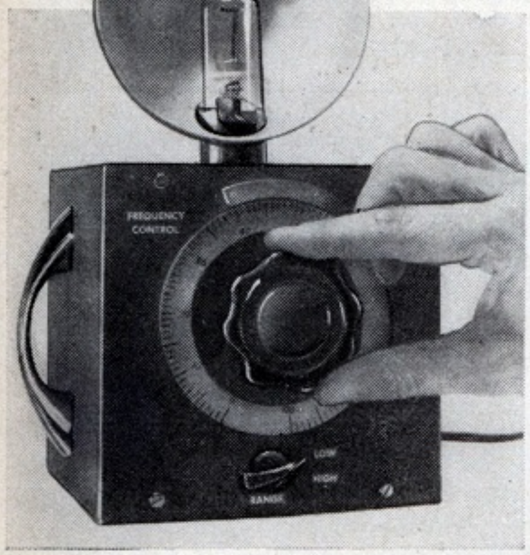
(d) The voltage output of the transformer may be too high if any other but the specified type is used. The voltage measured across the filter capacitor (*C1*) should be just about 300 volts.

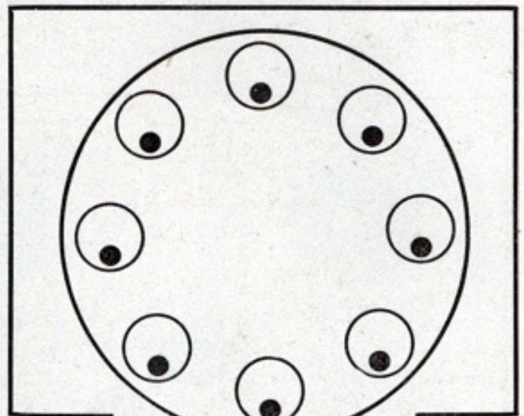
If everything is working correctly, replace the 6SN7GT in its socket, and allow it to warm up once again. Slowly rotate the *FREQUENCY CONTROL* knob clockwise. The flash-rate should rise smoothly and evenly. As the frequency increases, the




**This is the way** to hook up the various components of the "Varistrobe."

**Model is attractively housed** in black wrinkle steel cabinet with panel decals, a high-quality knob and vernier indicator, and a carrying handle. The 5"-diameter parabolic reflector, taken from a Bower pocket flash unit, slips easily over the strobotron.



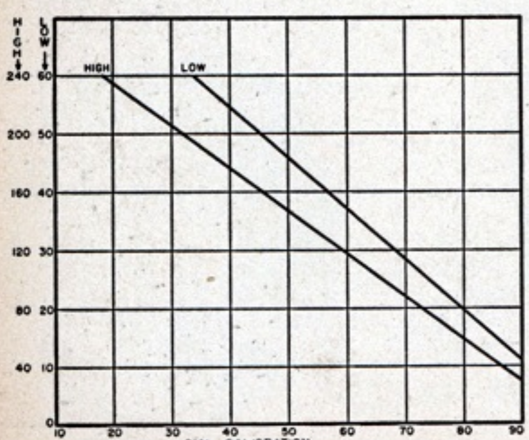



**In strobe pattern** above, black circles seem to rotate inside larger circles as disc is whirled under stroboscopic light of slightly higher or lower frequency than rpm of motor rotating the disc.

"song" of the strobotron rises in pitch and becomes a note of roughly 60 cps at the extreme clockwise position of the knob.

Return the control to its original counterclockwise position with the *ON-OFF* switch still *ON*, and turn the *RANGE* switch to its *HIGH* position. The flash-rate should advance appreciably and, as the knob is rotated clockwise again, should become much higher in pitch.

**Calibration.** The procedure is straightforward. First obtain some finely divided graph paper. Mark off the horizontal axis (see sample calibration chart) in terms of dial readings. The vertical axis carries two columns of figures: one for the *LOW* setting of the *RANGE* switch and one for the *HIGH* position. For *LOW*, the numbers run from 0 to 70 cps, and for *HIGH* they range from 0 to 280 cps.




**Sample calibration** chart. See text for details.

Set the "Varistrobe" in operation and let it run at its lowest frequency for a minimum of ten minutes to allow it to stabilize fully. While waiting, set up an old loudspeaker and output transformer and plug it into the 117-volt receptacle; the cone should hum loudly at 60 cps.

Keeping the *RANGE* switch on *LOW*, rotate the *FREQUENCY CONTROL* knob completely clockwise (frequency now being a bit higher than 60 cps), turn out the room lights, and illuminate the speaker cone with the strobe light. Slowly reduce the "Varistrobe" frequency until the cone appears to be absolutely stationary. Do it carefully so that you don't miss the first point where this occurs. The "Varistrobe" frequency is now exactly 60 cps, and a point may be placed on the graph with a hard, sharp-pointed pencil.

Again reduce the frequency slowly until the cone appears to "freeze" at the next setting; this is 30 cps, the cone being illuminated on every *alternate* vibration. Mark a point opposite the 30-cps scale level and above the new dial reading for this frequency. Repeat the procedure for 20 cps (cone illuminated every third vibration) and for 15 cps (cone illuminated every fourth vibration). This gives four coordinate points which may now be joined together by a straight line.

Using the same process on the *HIGH*

(*Continued on page* 116)

trodes will still be at ground potential and the patient will not be in danger of possible electrocution!

After placing the patient between two suitable electrodes, the machine is tuned until a milliammeter in the plate circuit swings to maximum. This shows that the entire load circuit, including the patient himself, is in resonance with the oscillator. In effect, the patient acts as a dielectric between the electrodes.

Although the FCC has approved several different models of self-excited oscillator diathermies, some manufacturers claim that such equipment can never be relied upon to remain on the legal frequency. These manufacturers swear by crystal-controlled units which provide pin-point frequency stability and remove all the guesswork during the life of the machine regardless of tube changes or dislocation of wiring or components. As for output power, about 400 watts is considered by the medical profession as just about right to produce deep-seated heating in bone and cartilage tissue.

The erstwhile "miracle of medicine" that sprang directly from radio experimentation is now shorn of false claims and unreasonable expectation. Yet its very real merits have earned for it a firm and respected place in the doctor's office for specific, limited application. In the home, diathermy equipment should be used only on a doctor's advice. In either case, increasing public dependence on radio-operated devices demands that every diathermy user know the necessary precautions to safeguard radio service from interference. —30—

## The "Varistrobe"

(*Continued from page* 54)

setting of the *RANGE* switch yields the calibration line from 60 cps to 240 cps. This may be drawn on the same sheet of paper as shown in the sample. In this case, start from 60 cps and work your way up in frequency. Cessation of motion can be observed for 60 cps, 120 cps, 180 cps, and 240 cps, giving four points for the second calibration line. Now your tachometer graph is ready for use.

To find the speed of any rotating or reciprocating body, scratch or chalk it in one spot that will be clearly visible while it is in motion. Next, determine the *highest frequency* which freezes the reference mark so that it is visible in only one place. The dial may now be read and translated in cps from the graph. To convert cps into revolutions or reciprocations per minute, multiply the cps by 60. —30—

## Annex C D.M. Neale says…

In Chapter 6 of Cold Cathode Tube Circuit Design by D.M. Neale (D.Van Nostrand Inc. 1964) it says:

### Arc Discharge Tubes

If a cold cathode tube is connected directly in parallel with a charged capacitor, breakdown of the anode-cathode gap allows the discharge to carry a current which is limited only by the 'internal resistance' of the discharge and by resistance and inductance of the leads from capacitor to tube or in the capacitor itself. It follows that, unless the capacitance is kept so small that it discharges before the tube has become heavily ionized, the discharge will pass rapidly through the normal and abnormal glow regions to become an arc (Fig. 2.2).

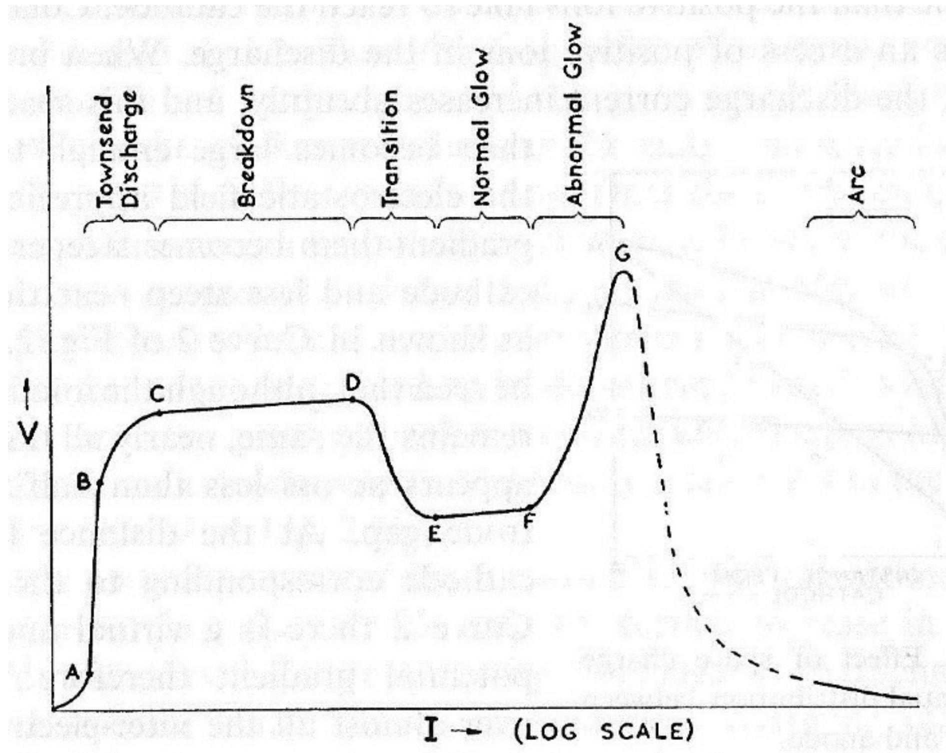



*Fig 2.2 Typical voltage-current characteristics of gas discharge*

The discharge then centres on a small spot on the cathode and the high current density (100-1,000 A/cm$^2$) leads to rapid destruction of a cathode not suited to this mode of operation.

Three classes of cold cathode arc tubes are discussed here:

1. Stroboscopic flash and switching tubes provided with internal electrodes permitting triggering from low-voltage, low-energy pulses.
2. …

### Arc Discharge Tetrodes

In 1928 Steinert described the first use of a neon tube to provide a high-resolution stroboscope with no moving parts. A saturated-core transformer connected to the supply mains generated a peaked wave-form which was applied to a neon diode and 'tuning capacitor' connected in shunt across the secondary winding. On each half-cycle of the supply the lamp produced a flash of duration estimated at 20 µsec.

Four years later, Quarles described a neon-flash stroboscope with many features characteristic of modern devices, but using the KU-610 hot cathode tube. This grid-controlled tube provided a 0.3 μsec flash in response to triggering pulses from a multivibrator or electrical contacts.

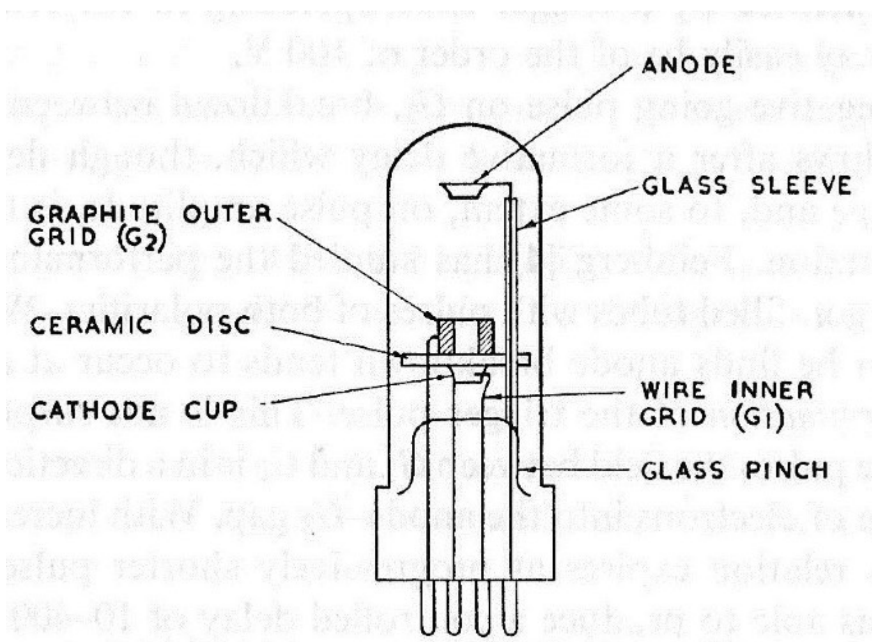



*Fig 6.1. Electrode structure of are tetrode (Sylvania 1D21/631P1)*

The work of Edgerton, Germeshausen, and Grier led to the cold cathode neon tetrode exemplified in the Sylvania 'Strobotron' and Ferranti 'Neostron'. Hilliard describes the Sylvania lD2l/631Pl illustrated in Fig. 6.1. Between anode and cathode lie a cylindrical graphite outer grid, G2, and, nearer the cathode, a wire probe inner grid, G1. The control characteristics of the tube are complicated by the number of variables involved: given suitable applied voltage, a discharge may be initiated in either direction between any pair of electrodes.

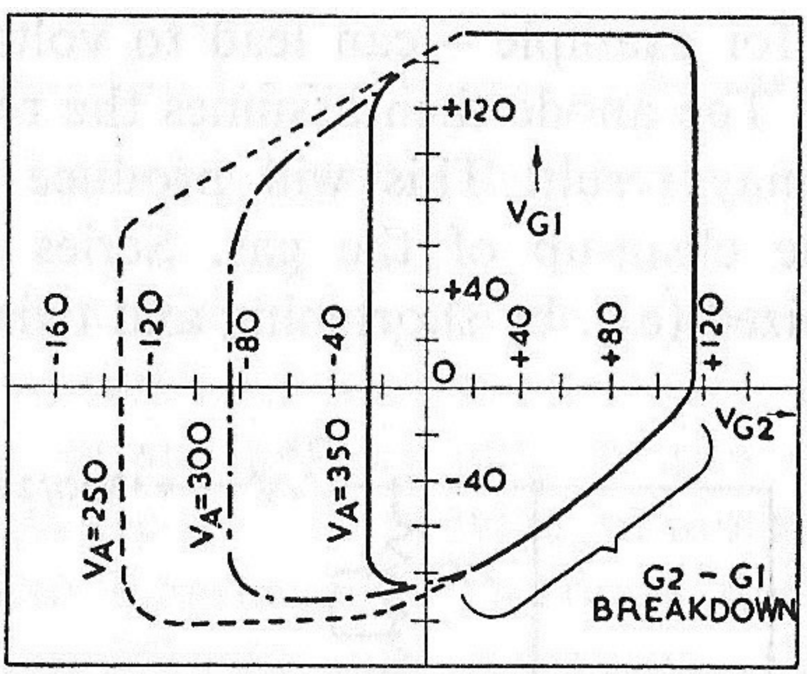



*Fig 6.2. Ignition characteristic of arc tetrode. Triggering is usually deflected by breakdown between G2 and G1*

A study of the triggering characteristics in Fig. 6.2, however, shows that the anode voltage has little effect on the critical grid potentials for the normal mode of operation. This comprises holding G2 positive and applying a negative-going pulse to G1. A pulse of -30V will suffice with a positive bias of about 100V on G2. The triggering characteristics tend to change during the life of the tube, however, and it is therefore preferable to bias less critically and apply a much larger trigger pulse. If this is generated by a trigger tube operating in the self-quenching mode this may easily be of the order of 100V.

With a negative-going pulse on G1, breakdown between anode and cathode follows after a formative delay which, though dependent on anode voltage and, to some extent, on pulse amplitude, is independent of pulse duration. Feinberg has studied the performance of neon-filled and argon-filled tubes with pulses of both polarities. With positive pulses on G1 he finds anode breakdown tends to occur at a fixed time after the termination of the trigger pulse. This is not surprising, since with positive pulses the field between G1 and G2 is in a direction to oppose the diffusion of electrons into the anode-G2 gap. With increasing anode voltage this relation expires at progressively shorter pulse durations. Feinberg was able to produce a controlled delay of 10-400 μsec.

Once an anode-cathode breakdown is established, it is important that the cathode current be allowed to rise rapidly to a sufficiently high value (≈5 A) to produce an intense cathode spot and so allow the discharge to become an arc. To this end, a cathode is used containing caesium. The capacitor discharges rapidly through the arc until a charge of only 20V remains. At this voltage the discharge normally extinguishes. As the arc impedance is low, excessive series inductance due to long leads, for example - can lead to voltage backswing and inverse conduction. The anode then assumes the role of cathode, and severe sputtering may result. This will produce blackening of the envelope and some clean-up of the gas. Series inductance should therefore be minimized (e.g. by shortening and twisting leads) or, if it is unavoidable, sufficient circuit resistance should be introduced to provide critical damping.

A simple free-running stroboscope may be constructed to the circuit of Fig. 6.3. In operation such a stroboscope may show some 'jitter' due to its sensitivity to changes in supply voltage and tube characteristics. It is accordingly preferable to synchronize the stroboscope tube by applying negative-going pulses to G1 from a separate multivibrator or blocking oscillator.

In addition to the neon-filled tubes, similar tubes are available with other gas-fillings (e.g. argon) better suited to photographic application.

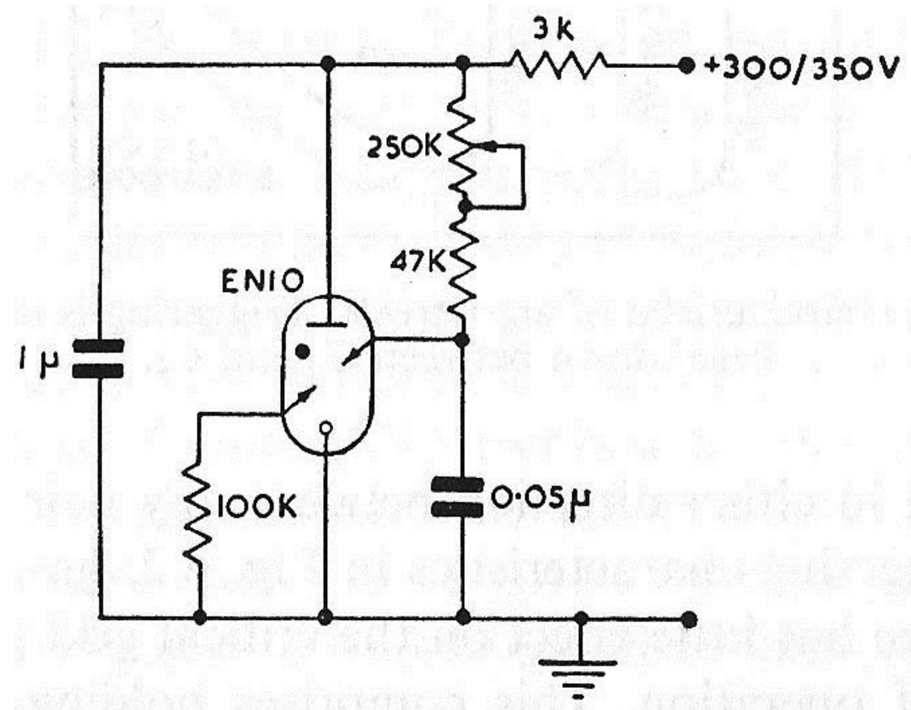


*Fig 6.3. Free-running stroboscope*

Page 1. (No. of pages :- 3)
MINISTRY OF SUPPLY (S.R.D.E.)

VALVE ELECTRONIC CV220

| | |
|---|---|
| Specification No. MOS/CV220/3<br>Dated : 25.9.45.<br>To be read in conjunction with<br>K1001 ignoring clauses 5.2, 5.8. | SECURITY<br>Specification: Restricted<br>Valve: Restricted ← |

⟶ Indicates a change

| | |
|---|---|
| TYPE OF VALVE : Cold cathode four electrode neon discharge tube.<br>ENVELOPE : Glass.<br>COMMERCIAL PROTOTYPE : 631.P.1. | MARKING<br>As in K1001/4 ← |

| RATING | | Note |
|---|---|---|
| Anode voltage D.C. (max)(volts) | 350 | A |
| Anode voltage D.C. (min)(volts) | 220 | A |
| Average anode current (max)(mA) | 100 | |
| Grid 1-Grid 2 voltage (max)(volts) | 150 | |
| Frequency (max) (p.p.s.) | 250 | |
| Peak discharge current (max)(amps) | 250 | |
| **Typical Operating Conditions** | | |
| Anode voltage D.C. (volts) | 330 | A |
| Average anode current (mA) | 35 | |
| Peak discharge current (amps) | 100 | |

BASE

USS4

| Pin | Electrode |
|---|---|
| 1 | G2 |
| 2 | A |
| 3 | G1 |
| 4 | C |

DIMENSIONS

See K1001/A1/D1

| mms. | Min. | Max. |
|---|---|---|
| A | 45 | 110 ← |
| B | - | 35 |

NOTES

A. Refers to D.C. supply voltage (across C1 in Fig. 1)

B. The Tube shall operate normally between the ambient temperatures -35°C and +60°C.

41102-1

# CV 220



TESTS

To be performed in addition to those applicable in K1001.

| | Test Conditions | Test | Limits Min. | Max. | No. Tested |
|---|---|---|---|---|---|
| a | In test circuit of Fig. 1 or in strobotac unit the tube is triggered at frequencies of 50 p.p.s. and 250 p.p.s. with 330V D.C. across reservoir condenser C1. The accuracy of the tube to be tested by an approved method (see Note 1). | Frequency test<br>The tube shall flash steadily at both frequencies | | | |
| b | Using test circuit of Fig. 2 with switch set to position (b), 330V D.C. is applied across the reservoir condenser. The voltage on Grid 2 is raised until tube fires. | Grid 2 starting potential<br>Grid 2 breakdown potential (measured just before discharge)(volts) | 80 | 130 | 100% |
| c | Using test circuit of Fig.2 with the switch set to position (c),330V D.C. is applied across reservoir condenser. | Anode-Grid 2 Breakdown<br>The tube shall not fire | | | 100% |
| d | In test circuit of Fig. 1 the tube is triggered at 50 p.p.s. with 330V across reservoir condenser. Notes 1 and 2. | Life Test<br>Life (hours) | 300 | | 1% |

NOTES

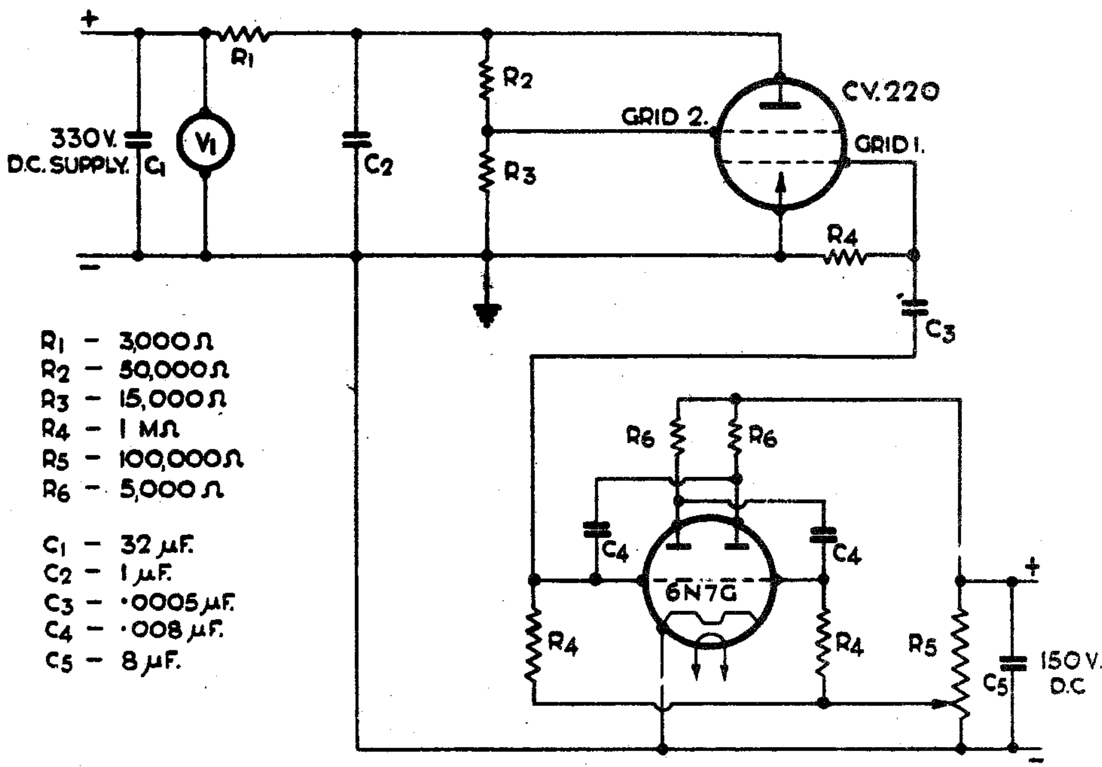
1. A recommended method is to use an oscilloscope with a split phase 50 cycle supply for producing an elliptical image. Strobotron pulses are superimposed on a deflector plate to enable pulses at 50 and 250 cycles to be examined.

2. The tube shall be considered to have reached its life end point when it will not fire or fires at a frequency not directly controlled by the multivibrator, or shows a continuous discharge.

k1102-1

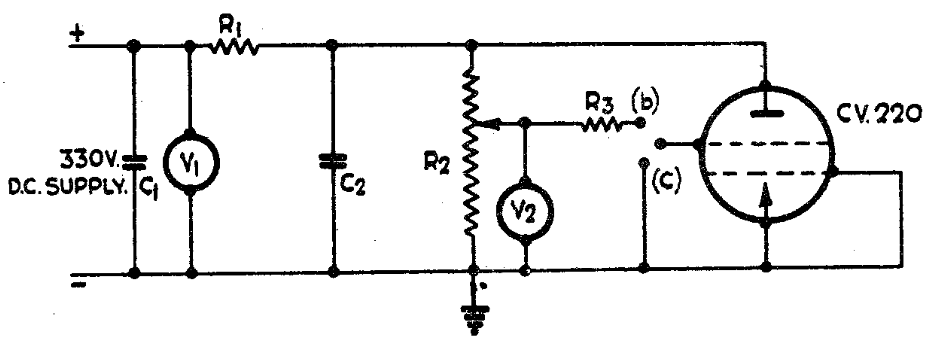
# CV220




R1 − 3,000Ω
R2 − 50,000Ω
R3 − 15,000Ω
R4 − 1 MΩ
R5 − 100,000Ω
R6 − 5,000Ω

C1 − 32 μF.
C2 − 1 μF.
C3 − ·0005 μF.
C4 − ·008 μF.
C5 − 8 μF.

FIG. 1.




R1 − 3,000Ω.
R2 − 500,000Ω.
R3 − 20,000Ω.

C1 − 32 μF.
C2 − 1 μF.

V1 − MOVING COIL METER.
V2 − MOVING COIL METER OF 5,000Ω. PER VOLT MINIMUM

FIG. 2.

M1102 - 1

MINISTRY OF SUPPLY - DLRD(A)/RRE(South) VALVE ELECTRONIC **CV2296**

| Specification MOS(A)/CV2296 | SECURITY | |
|---|---|---|
| Issue 2 Dated 28. 4. 55 | Specification | Valve |
| To be read in conjunction with K1001 & BS.448 | UNCLASSIFIED | UNCLASSIFIED |

Indicates a change.

TYPE OF VALVE - Gas-filled Tetrode
CATHODE - Cold
ENVELOPE - Glass - Unmetallised
PROTOTYPE - NSP2

**MARKING**

See K1001/4.

**BASE**

Octal
BS.448 : B8-0

**RATING**

| | | | Note |
|---|---|---|---|
| Max. Anode DC Voltage | (V) | 380 | A |
| Min. Anode DC Voltage | (V) | 220 | A |
| Max. Peak Anode Current | (A) | 250 | B |
| Max. Mean Anode Current | (mA) | 40-100 | C |
| Peak Inverse Anode Voltage | (V) | 350 | |
| Trigger Voltage | (V) | 80-130 | D |
| Max. Average Grid Current | (mA) | 10 | |
| Max. Flashing Frequency | (per sec) | 250 | |
| Ambient Temperature Range | (°C) | -35 to +60 | |
| **STARTING CHARACTERISTICS** (See Note E) | | | |
| Min. Trigger Current (Va = 380V) | (uA) | 50 | |
| Min. Trigger Current (Va = 200V) | (uA) | 300 | |
| Max Delay Time | (usecs) | 40 | F |
| **TYPICAL OPERATING CONDITIONS** | | | |
| DC Supply Voltage | (V) | 330 | |
| Screen Grid Voltage | (V) | 70 | |
| Trigger Pulse Amplitude | (V) | 70 | G |
| Charging Resistor | (ohms) | 3000 | |
| Discharge Capacitor (uF) for operation at (c/s) 6 - 35 | | 4 | |
| 30 - 50 | | 3 | |
| 45 - 80 | | 2 | |
| 80 - 150 | | 1 | |
| 140 - 250 | | 0.5 | |

**CONNECTIONS**

| Pin | Electrode |
|---|---|
| 1 | No connection |
| 2 | No connection |
| 3 | Anode |
| 4 | Screen Grid |
| 5 | Control Grid |
| 6 | Pin omitted |
| 7 | No connection |
| 8 | Cathode |

**DIMENSIONS**

See K1001/A1/D1.

| Dimension (mms) | Min. | Max. |
|---|---|---|
| A | - | 103 |
| B | - | 32 |
| L | - | 89 |

**MOUNTING POSITION**

Any

Z.9131.R. CV2296/2/1

## NOTES

A. DC Supply Voltage.

B. A minimum of 5 amps is necessary for the formation of an arc discharge with a tube drop of approximately 20 volts. If the main gap current is less than 5 amps peak, a glow discharge is likely to form with a 70 volt drop and result in excessive cathode dissipation.

C. Limitation due to heating of cathode, dependent on peak current and duty cycle.

D. For triggering between screen and grid.

E. With control grid 80 - 130 volts negative with respect to screen grid.

F. Less than 40 µsecs dependent on circuit conditions. With higher energy pulses the delay time can be considerably reduced.

G. Negative with respect to screen voltage.

**TESTS**

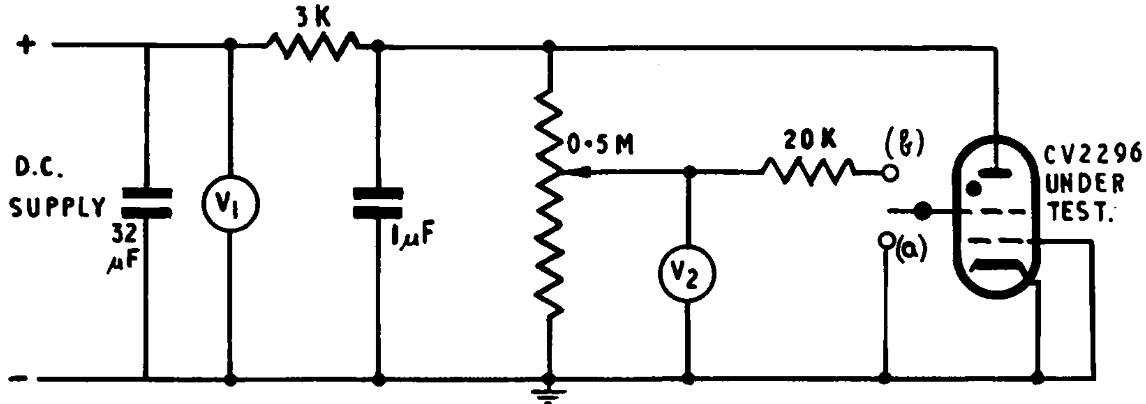


To be performed in addition to those applicable in K1001

| | Test Conditions | Test | Limits Min. | Limits Max. | No. Tested | Note |
|---|---|---|---|---|---|---|
| a → | With the valve operating in the test circuit shown in Fig. 1 on Page 4, and switch set to position (a), 330V DC shall be applied across the reservoir condenser. | Anode-Screen Grid Breakdown Voltage (V1) (V) | 330 | - | 100% | |
| b | As for Test (a) but switch in position (b); 330V DC shall be applied across the reservoir condenser. The screen grid voltage shall be increased until the valve fires. | Screen Grid Starting Potential Screen grid breakdown potential measured just before conduction starts. (V) | 80 | 130 | 100% | |
| c | The valve shall be operated in the test circuit shown in Fig. 2 on Page 4. | Life (hrs) | 300 | - | TA | |

CV2296/2/3

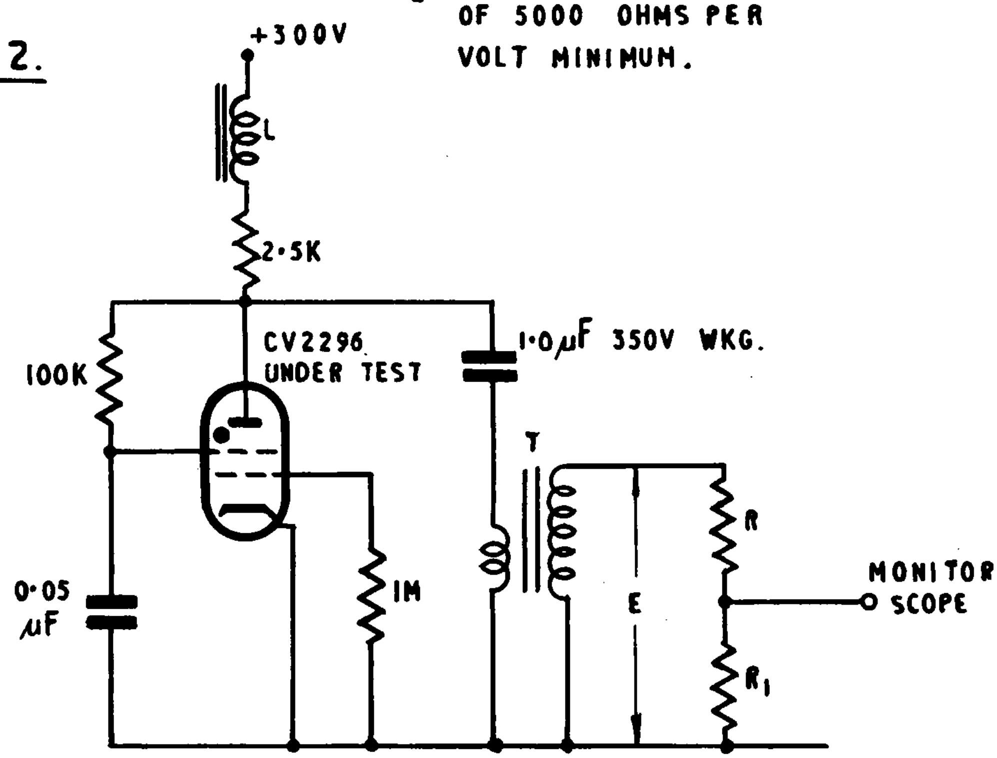
## FIG. 1. TEST CIRCUITS FOR CV.2296




$V_1$ – MOVING COIL METER

$V_2$ – MOVING COIL METER OF 5000 OHMS PER VOLT MINIMUM.

## FIG. 2.



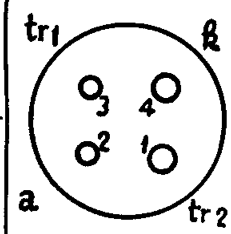

CHOKE L AND TRANSFORMER T ARE CONTAINED IN TRANSFORMER – TYPE 2932 (A.M. REF. 10K/16995)

# FERRANTI

## COLD CATHODE TETRODE

NSP1

The Ferranti "Neostron" type NSP1 is a cold cathode tetrode gas discharge valve. Developed primarily as a stroboscopic light source emitting a neon-red light, it is equally suitable for other uses where pulses of very high peak current are required.




Base Connections
Underside View of Base

PHYSICAL SPECIFICATION.

| | |
|---|---|
| Base ... ... ... ... | UX 4 pin. |
| Max. Seated Height ... ... | 96 mm. ($3\frac{3}{4}$in.). |
| Max. Overall Length ... ... | 110 mm. ($4\frac{11}{32}$in.). |
| Max. Base Diameter ... ... | 33 mm. ($1\frac{5}{16}$in.). |
| Length of arc ... ... ... | 24 mm ($\frac{15}{16}$in.). |
| Mounting Position ... ... | Any. |

BASE CONNECTIONS.

Pin 1—Trigger Electrode 2. Pin 3—Trigger Electrode 1.
Pin 2—Anode. Pin 4—Cathode.

RATINGS (Absolute).

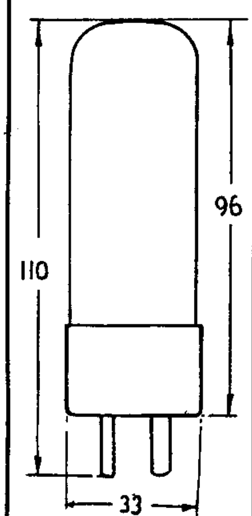
| | |
|---|---|
| Max. Anode Voltage (static) ... ... ... | 440 volts. |
| Max. Anode Voltage (working) ... ... | 380 volts. |
| Min. Anode Voltage (working) ... ... | 220 volts. |
| Max. Peak Inverse Anode Voltage ... ... | 350 volts. |
| Max. Average Anode Current ... ... ... | 100 mA. |
| → Max. Discharge Capacitance ... ... ... | 16 µF. |
| Max. Average Trigger Current ... ... | 10 mA. |

CHARACTERISTICS.

| | |
|---|---|
| *Static striking voltage ($tr_2$ to $tr_1$) ... | 80–130 volts. |
| Max. flashing frequency ... ... | 250 per sec. |
| Min. trigger current required at $V_a$ 380 | 50 µA. |
| Min. trigger current required at $V_a$ 220 | 300 µA. |

→ †Peak Anode Current
Peak Luminous Intensity
Flash Duration
} The discharge of a 2 µF capacitor charged to 380V. gives a peak anode current of approx. 230 amps. and a Peak Luminous Intensity of approx. 460 candelas with a flash duration of 10 microseconds at half the peak light output.

Delay Time ... ... Less than 40 microseconds, dependent on circuit conditions. With higher energy pulses the delay time can be considerably reduced.




TYPICAL OPERATION as Stroboscopic Light Source :

| | |
|---|---|
| DC. supply voltage ... ... | 300–330 volts. |
| ‡$Vtr_2$ at triggering instant ... | ... 70 volts. |
| §Trigger pulse amplitude ($Vtr_1$) | ... 150 volts min. |
| Charging resistor ... ... | ... 3000 ohms. |

Discharge Capacitor for Operation at:—

| | |
|---|---|
| 6–35 c.p.s. ... ... ... | 4 µF. |
| 30–50 c.p.s. ... ... ... | 3 µF. |
| 45–80 c.p.s. ... ... ... | 2 µF. |
| 80–150 c.p.s. ... ... ... | 1 µF. |
| 140–250 c.p.s. ... ... ... | 0·5 µF. |

For typical circuits and further information refer to NSP2 Data Sheet under "Notes on Operation."

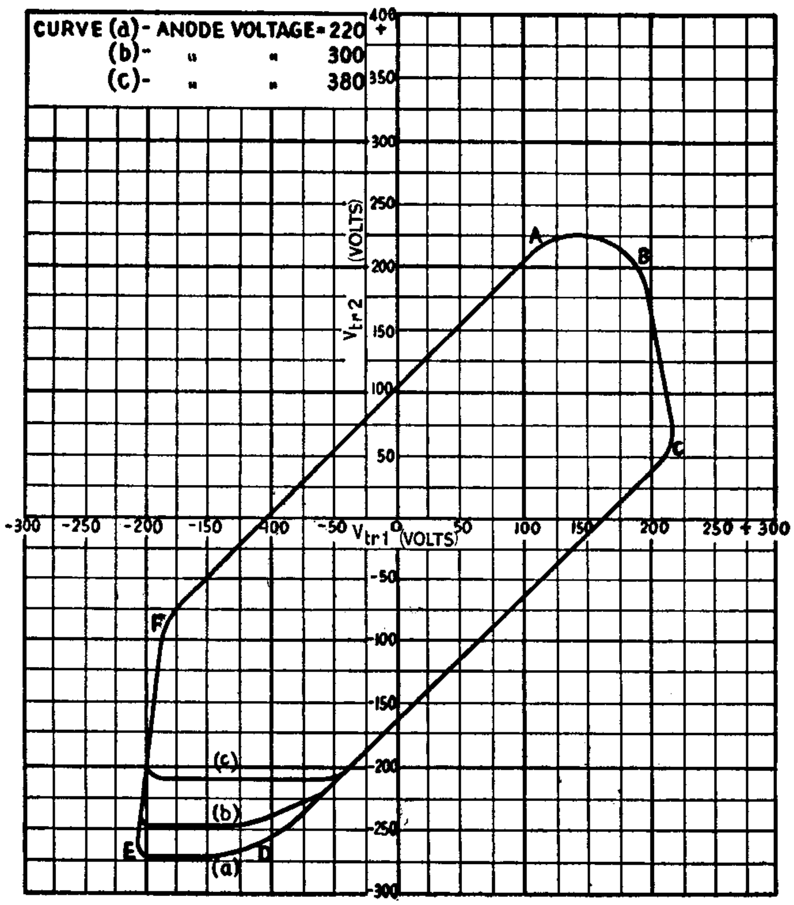
All dimensions shown are in millimetres.

*$tr_1$ negative to $tr_2$.
→ †A minimum peak current of 5 amps. is recommended. This ensures the formation of an arc discharge with an anode–cathode volt drop of approx. 20 volts. If the peak current is less than 5 amps. a glow discharge is likely to form with a volt drop of 70 volts which may result in permanent damage to the valve.
‡Positive with respect to cathode.
§Negative with respect to cathode.

Issue 7
July, 1957

FERRANTI

FERRANTI LIMITED, GEM MILL, CHADDERTON, OLDHAM, LANCS.




AVERAGE STATIC TRIGGERING CHARACTERISTICS

The area enclosed by the loops is an area of non-conduction. If the vector sum of the voltages on two electrodes lies within the loop the valve will not fire. Any change of either or both of these voltages which causes the vector sum to fall outside the loop will trigger the valve.

For pulse operation it is usually necessary to ensure that the pulse has a sufficient excess voltage (see "Notes on Operation" on NSP2 data sheet).

As the triggering impulse carries the vector sum of the applied voltages outside the loop the point at which it crosses the loop indicates the manner in which the valve is triggered as follows :—

Between AB Trigger Electrode 2 to Cathode Breakdown.
BC Trigger Electrode 1 to Cathode Breakdown.
CD Trigger Electrode 1 to Trigger Electrode 2 Breakdown.
DE Cathode to Trigger Electrode 2 Breakdown.
EF Cathode to Trigger Electrode 1 Breakdown.
FA Trigger Electrode 2 to Trigger Electrode 1 Breakdown.

The most reliable operation is ensured by triggering between $Tr_2$ and $Tr_1$, i.e., between F and A on the diagram.

# SYLVANIA engineering data service
electronic products

## SYLVANIA SN4
## 1D21/SN4

### STROBOTRON TYPE SN4 & 1D21/SN4
### DESCRIPTION

The Types SN4 and 1D21 Strobotrons are internally-triggered, cold-cathode, inert-gas-filled electronic tubes which are capable of excellent service in condenser discharge circuits involving high peak currents at low average currents. One of their primary uses is as a source of stroboscopic light pulses of short duration. As a stroboscopic tube, the Strobotron provides a neon-red flashing light under whose illumination rotary and reciprocatory motion may be studied. The frequency of the flashes is easily controlled over relatively wide limits, the maximum pulse frequency being 60 pulses per second for the SN4 and 240 for the 1D21/SN4. For flexibility, two internal grids are incorporated, allowing adaptation to a wide variety of driving circuits. The intensity of the light is sufficient for visual observation.

The SYLVANIA Types SN4 and 1D21/SN4 Strobotrons are of equal value as electronic relays or controls wherever high peak currents but low average currents are desired. With these tubes, switching is possible without the interruption of service which results from deterioration of moving parts and contacts. Best results for high-current operation may be expected when the circuit constants are so proportioned as to give peak cathode currents of from 10 to 200 amperes at average levels of 50 milliamperes or less. Under favorable duty cycle conditions, peak currents as high as 300 or 400 amperes are possible.

### AVERAGE CHARACTERISTICS AND RATINGS
### MECHANICAL SPECIFICATIONS

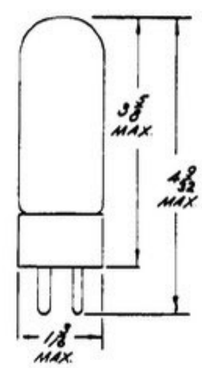
| | |
|---|---|
| Envelope | T9 |
| Base | Small 4 pin |
| Mounting Position | Any |

### ELECTRICAL RATINGS AND OPERATING CONDITIONS

| | |
|---|---|
| Anode Voltage | 300 volts max.—Note 1 |
| Peak Inverse Anode Voltage | 50 volts max. |
| Average Cathode Current | 50 ma. max. |
| Peak Cathode Current | 5 amps. min.—Notes 2 & 3 |
| Grid Firing Voltage | 80-125 volts—Notes 4 & 5 |
| Control Grid Bias Voltage | −50 to +50 volts |
| Shield Grid Bias Voltage | −50 to + 50 volts |
| Average Grid Current | 15 ma. max. |
| Minimum Trigger Grid Current (Surge) | 1 ma. |
| Control Grid Circuit Resistance | 5 megohms max. |
| Pulse Frequency SN4 | 60 p.p.s. max. |
| Pulse Frequency 1D21/SN4 | 240 p.p.s. max. |
| Tube Voltage Drop | |
| Glow Discharge | 75 volts approx. |
| Arc Discharge | 20 volts approx |
| Ambient Temperature Range | −55 to + 90° C |

Note 1. Measured between shield grid and anode.
Note 2. Current required to initiate arc discharge.
Note 3. Maximum anode circuit capacitance, 50 μf.
Note 4. Applied to shield grid, zero bias on control grid.
Note 5. Average starting range. Holds only for tubes used in approved circuits under specified conditions. Circuit design should provide for a trigger pulse of at least 175 volts. Tube may be started by initiating glow discharge between grids or between either grid and cathode. Either grid may be used for control with proper bias on the remaining grid.

## MECHANICAL DATA



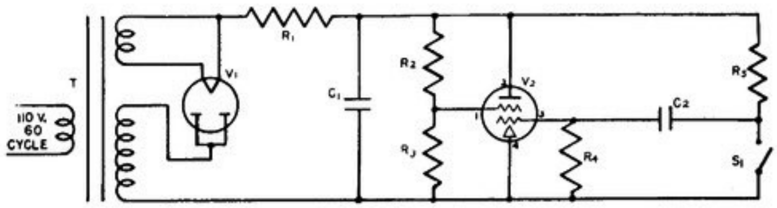
SYLVANIA ELECTRIC PRODUCTS INC. ELECTRONICS DIVISION
1740 Broadway, New York 19, New York

# SN4
# 1D21/SN4

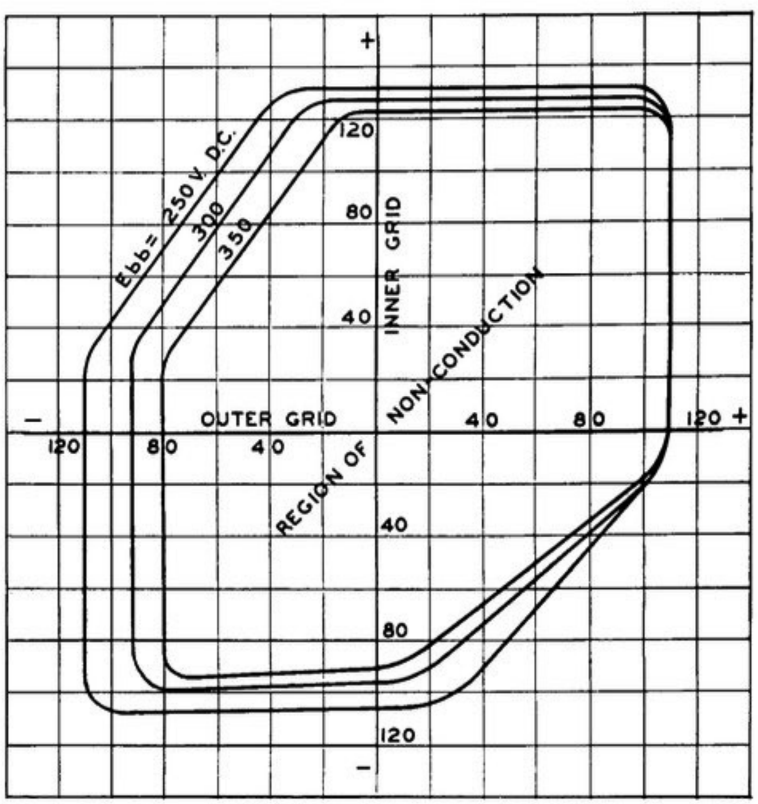
## TYPICAL CIRCUIT

The circuit shown below is only one of many which may be used to operate the SN4 and 1D21/SN4. The switch $S_1$ is ordinarily operated either mechanically or electronically. In general, circuits are designed around specific applications. SYLVANIA engineers invite inquiries concerning your particular problems.

PATENTS—SYLVANIA Strobotron tubes are liscensed under Edgerton, Germeshausen & Grier patents 2,185,189 and 2,201,167.




T Power Transformer
$C_1$ 2μf, 600 W.V.D.C.
$C_2$ 0.03 μf. 600 W.V.D.C.
$R_1$ 3000 ohms, 10 watts
$R_2$ 1.0 megohm, 1 watt
$R_3$ 0.1 megohm, 1 watt
$R_4$ 1.0 megohm, 1 watt
$R_5$ 0.1 megohm, 1 watt
$S_1$ Momentary Contact Switch
$V_1$ Low Voltage Rectifier
$V_2$ Type SN4 or 1D21




## TYPICAL DYNAMIC CHARACTERISTICS

If the vector sum of the grid voltages lies within the region on non-conduction, the tube will not fire, but as soon as the voltage on either grid reaches a value outside of the critical limits portrayed in the curve above, the tube will fire. (Note: This graph is indicative of general behavior only.)