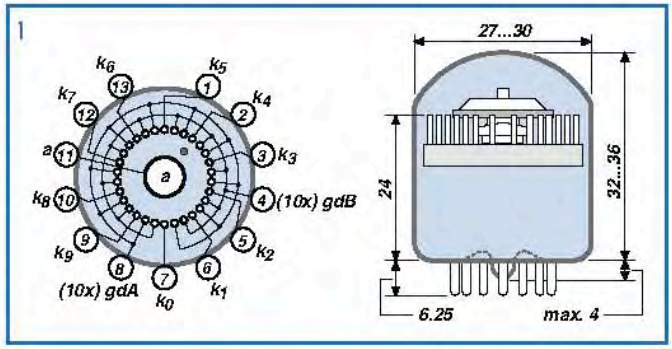
The 'Dekatron' decimal counter valve

Jean Herman

These valves were developed in the 50s and lasted right up to the end of 1970. They were used as up/down decade counters in applications like calculating machines, counters of all types, and especially in the nuclear industry as particle counters. Even quite recently I've had digital voltmeters using Dekatrons in for repair. The whole measurement cycle was controlled by a cycling Dekatron: zeroing, measurement, range-changing, display, printout, zeroing, and so on.



Operation

The Dekatron consists (see **Figure 1**) of a central circular anode (a) and ten cathodes (k), numbered from 0–9. Between adjacent cathodes are two transfer electrodes, guides (A) and (B).
A voltage applied between the anode (a) and the cathodes causes ionization of just one of the cathodes. To move on to the next cathode, a short negative pulse is applied to the next cathode. To drive a Dekatron takes a minimum of one triode or one transistor or a transformer, together with a differentiator circuit followed by an integrator. In the 60s, transistor circuits were developed for this purpose.
Note that the Dekatron shown in Figure 1 has a different pinout from the one in the circuit diagram. They are two quite different devices.

Application

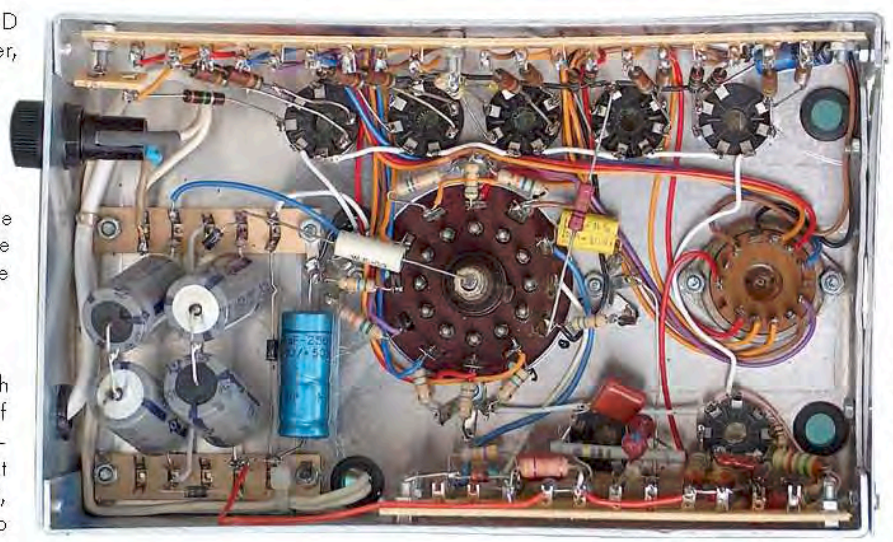
I found a stray GS10D Dekatron in my drawer, and for old times' sake, I thought it would be interesting to get this valve working again. So I built an instructional counter module (circuit in **Figure 2**) like those used back in the 50s.

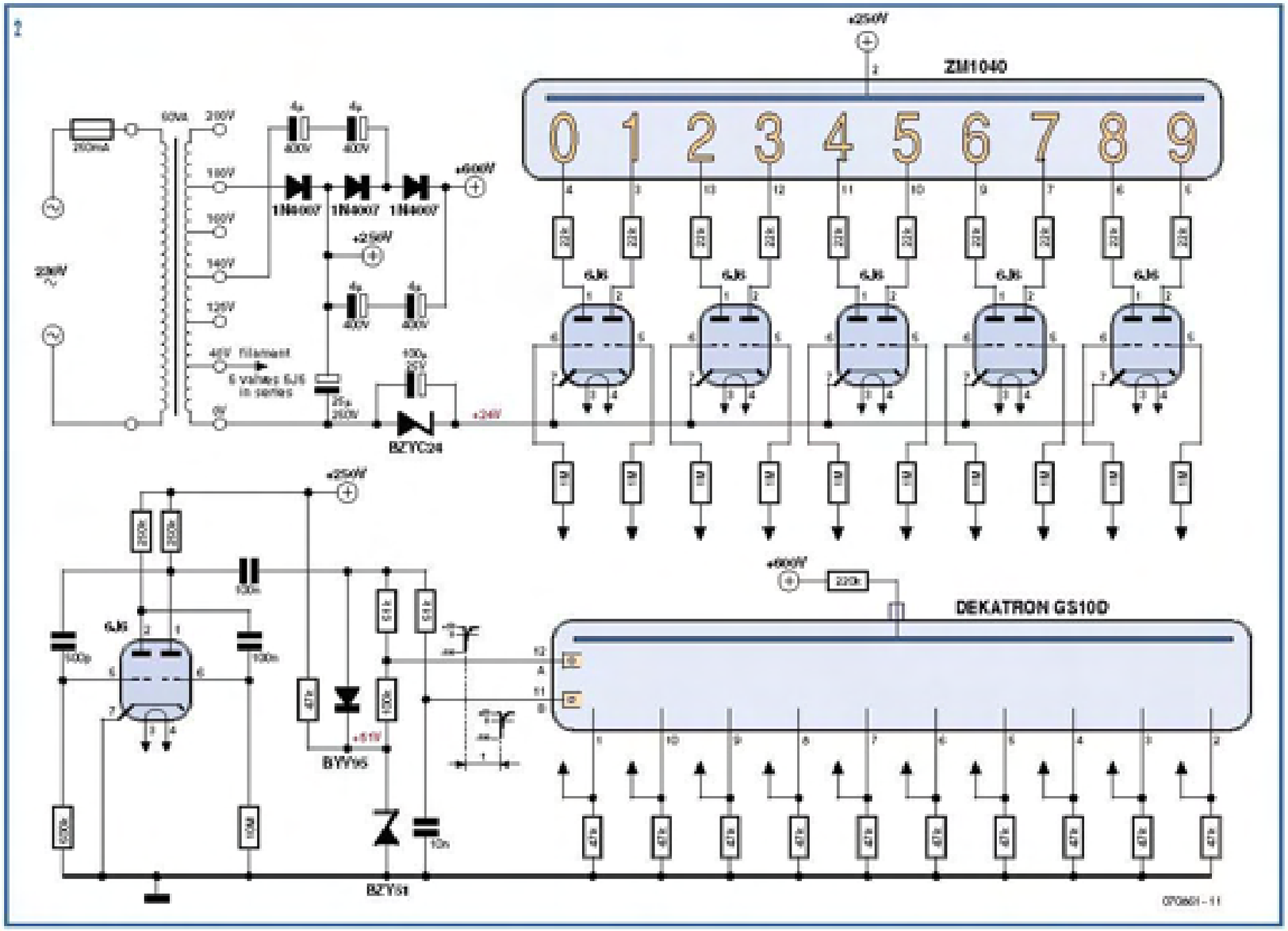
Power supply

This valve operates with an anode voltage of 475 V @ 1 mA (minimum, at an ambient temperature of 20 °C!!!), as it's not always easy to get them to ionize cold. It also has to be said that it is 50 years old, so it's will come as no surprise if it's a bit cantankerous! A cannibalized transformer will do the trick. A first rectifier to give 250 V, followed by a voltage multiplier to give a no-load 600 V. The valves are recovered 6J6 double triodes, with their 6.3 V/0.4 A heaters all in series across the 40 V winding. Luckily, this multi-tapped transformer made it easy to play around with the voltages.

Guide voltage generator

This is a 6J6 valve arranged as a highly asymmetrical astable multivibrator (250 kΩ/500 pF/500 kΩ **and** 250 kΩ/0.1 µF/10 MΩ). The output frequency on anode 1 is 5 Hz, so as to be able to follow the movement of the ionization in the Dekatron with the eye. This frequency could be up to 10 kHz. Quiescent, the guides are pulled up to +51 V, which is the normal voltage of the ionized cathodes. When anode 1 switches negative, guide A receives the negative-going spike first via the 0.1 µF and 51 kΩ; guide B (0.1 µF/51 kΩ/10 nF circuit) receives the negative spike delayed by the 51 kΩ/10 nF RC network.
In this way, the jump from cathode *n* to cathode *n*+1 is achieved.
By reversing the drives to guides A and B, the set-up will also work as a down-counter.
The GS10D valve displays the count directly, but when the valve is shut away inside a rack, a separate display has to be added. For this instructional circuit, I've chosen the large ZM1040 valve with 31 mm high figures (magnificent!). The ZM1040 is powered at 170 V and draws a current of 4.5 mA, limited by the 22 kΩ **resistor**. Obviously, the GS10D Dekatron can't control the ZM1040 display directly. One triode per digit is required, i.e. five 6J6 double triode valves. The cathodes of the Dekatron are taken to ground via 47 kΩ resistors, generating a potential of 40 V when ionized (and hence cathode current is flowing). The cathodes of all the 6J6s are returned to a 24 V zener diode, and their grids are connected to the counter tube cathodes via 1 MΩ resistors. In this way, the 6J6 grids are hard driven: –24 V valve Off, +15 V valve On (with respect to the +24 V on their cathodes). The ZM1040 valve ionization voltage is 140 V.
Valve current: 250 V – (140 V + 24 V) = 81 V/22 kΩ = 4 mA.
And all this just to cre-





ate one decade of counting – imagine the amount of hardware needed for even six digits, as well as the power consumption (25 W just for this circuit)! There have been several brands and lots of models of Dekatrons on the market.

For example:

– Philips: Z502S (4 kHz), Z504S (5 kHz), and Z505S (50 kHz)

– Hivac: GS10D (10 kHz), GCA10G (5 kHz), and GS10H (5 kHz)

– Elesta: ECT100 (100 kHz), EZ10B (100 kHz)

– Cerberus: the GZ22 which can drive the GA11 and GA21 displays

– Beeston: the type VS10K trochotron (200 kHz) and its GR10H display

P.S. I'm on the lookout for Dekatrons to build a digital voltmeter for instructional purposes. If any readers have any, I'd be very glad to hear from them. Thanks in advance!

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Web Links

http://nixietube.info/Nixie.html

http://www.wps.com/projects/decimal-tubes/index.html

Ed: the original spelling is Dekatron (a trademark of Elliott).

Retronics is a monthly column covering vintage electronics including legendary Elektor designs. Contributions, suggestions and requests are welcomed; please send an email to editor@elektor.com