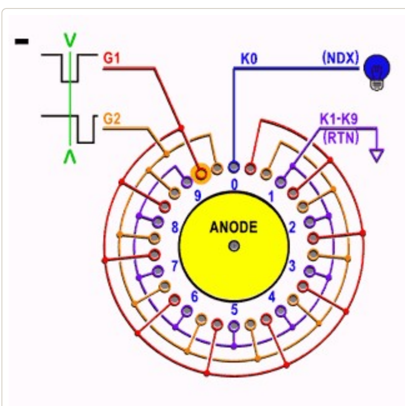
Dekatron Stuff

Animated .GIF Courtesy of me.

A dekatron was the tube era decade counter "integrated circuit" (IC). It did a full divide-by-10 function, all in one tube. It didn't do it the modern way, by cramming a bunch of components onto a silicon chip, as in a modern *semiconductor* IC. It did it *elegantly* using metal structures arranged such that pulsing it, a plasma **GLOW** would hop, from one electrode, to the next. The added benefit, was that the count position, is visible, thru the top of the tube.

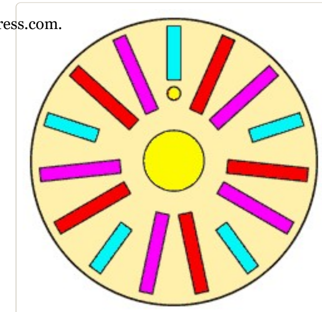
Dekatrons typically have a central disc shaped anode, and 30 little rod cathodes encircling it. These cathodes are in three groups. Two guide groups (G1 & G2), and a *Main* (K) group, where the tube usually idles. They are arrange (clockwise) in the order G1, G2, Kn, G1, G2, Kn+1, G1 ...



Dekatrons need a very high supply voltage. 400V at a safe minimum. They are filled with neon gas, at fractional atmospheric pressure. Like all cold cathode tubes, its the operating current that really matters. The voltage is needed, just to get ionization started, but the current must be limited with an anode *ballast* resistor. Usually to ~350uA (micro amps; 0.000350A). Under normal operation, with a 400V supply, the voltage at the anode is ~200V, the guides (G1 & G2) biased to ~+30V, and the mains tied to ground. The **glow** will find the lowest cathode, which will be one of the *mains*, and not a guide, since they are slighty more positive. Which *main* is basically random.

To make the dekatron count (step), the guides must be pulsed, in sequence, much in the same way a stepper motor is operated. Note all the G1 rods are tied to each other, and so are the G2 rods. The *main* rods, may, or may not, be tied together. That depends on the model of the tube. To initiate a step, G1 is pulsed down ~80V (from +30V to -50V). Now G1 is more negative, than the main (Kn), where the glow

Now, when G1 rises, the glow will favor G2 (at -50V), and the glow will bump to that G2 rod. When G2, now rises, the nearest *main* is Kn+1, and the count now has stepped over by one. The count can be reversed, if the pulse where applied 1st to G2, then to G1.



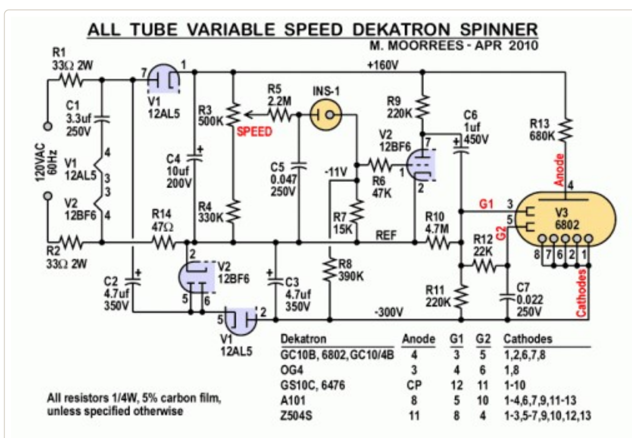
Like a stepper motor, the above, would be a full step. like a stepper motor has *half-step* capability, a dekatron does also. But its really a *1/3rd-step*. In the old days, due to circuit limitations (mostly cost), only full step operation was used. In modern times, circuitry is cheap. As you may have noticed, the glow rests at the lowest voltage point. This can be any cathode, not just a *main*. It can be a guide, too. That way with modern circuit drive, the resolution of the glow can be increased, from 10, to 30, per revolution.

A few projects to entertain you (*Click on drawings for better resolution*):

All Tube Variable Speed Dekatron Spinner:

Don't worry about blowing the filaments, from C1's initial surge. The peak current is too low, over the small surge duration. Filaments have decent thermal inertia to remain undamaged. Just for peace-of-mind, I rigged a test jig to pulse a tube, 1000 times, with a pulse twice the amplitude for twice the pulse length.

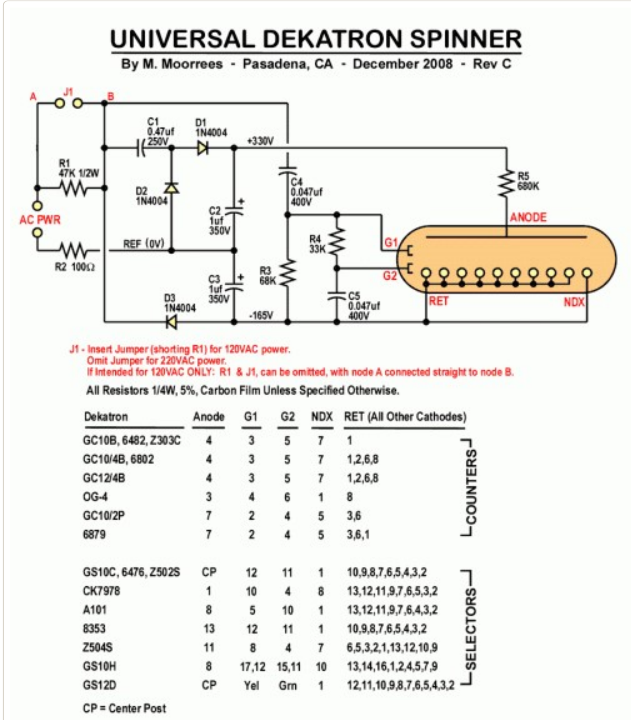
C5 can be varied from 0.022uf to 0.47uf, if you want a different speed range.



Click here to video of *All-Tube Spinner*.

Universal Dekatron Spinner:

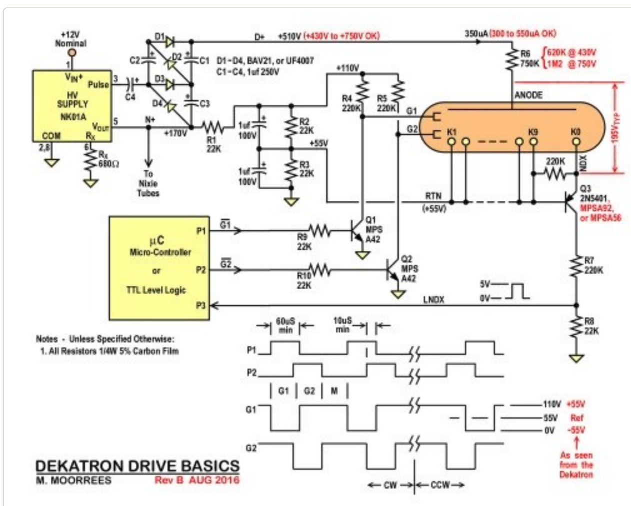
Line Frequency Dependent. 5 rev/sec in Europe (50Hz), and 6 rev/sec in North America (60Hz).



Dekatron	Anode	G1	G2	NDX	RET (All Other Cathodes)	
GC10B, 6482, Z303C	4	3	5	7	1	COUNTERS
GC10/4B, 6802	4	3	5	7	1,2,6,8	
GC12/4B	4	3	5	7	1,2,6,8	
OG-4	3	4	6	1	8	
GC10/2P	7	2	4	5	3,6	
6879	7	2	4	5	3,6,1	
GS10C, 6476, Z502S	CP	12	11	1	10,9,8,7,6,5,4,3,2	SELECTORS
CK7978	1	10	4	8	13,12,11,9,7,6,5,3,2	
A101	8	5	10	1	13,12,11,9,7,6,4,3,2	
8353	13	12	11	1	10,9,8,7,6,5,4,3,2	
Z504S	11	8	4	7	6,5,3,2,1,13,12,10,9	
GS10H	8	17,12	15,11	10	13,14,16,1,2,4,5,7,9	
GS12D	CP	Yel	Grn	1	12,11,10,9,8,7,6,5,4,3,2	

CP = Center Post

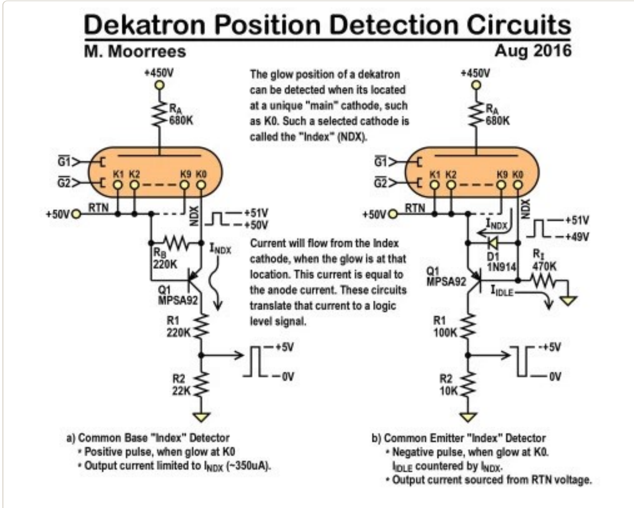
Interfacing a Dekatron – to modern logic circuits *(Click on drawing to enlarge)*:



Using a modern microcontroller (µC) to step a dekatron, allows you to idle at either a *main* or Guide (G1 or G2) cathode, at any of the 30 radial locations. You can also switch from stepping *CW* or *CCW* (clockwise or counter-clockwise), any time you want.

One of the *main* cathodes, almost always, has its own connection (K0). This one is usually used as a carry bit, but also can serve as an *index marker* (NDX). The NDX signal will allow your code to know, physically, the glow position. You can use this info, to step **n**-times, to where you want the glow to actually be. This is called *relative* positioning. In the circuit above, the input impedance of the µC should be at least 200K, and preferably higher.

Here are the *Index* circuits, separated from the rest *(Click on drawing to enlarge)*:

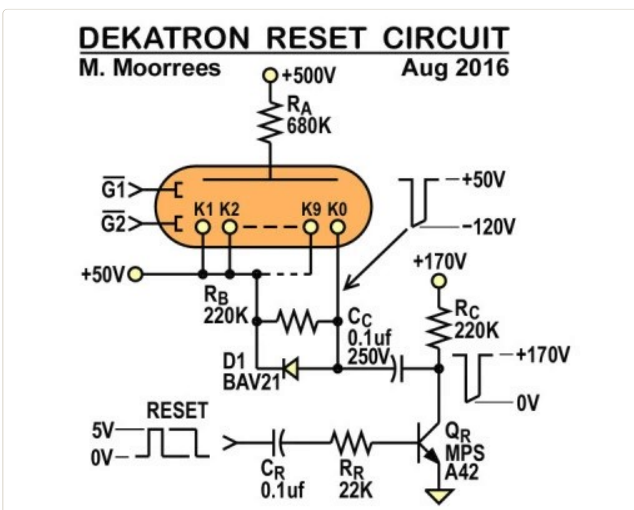


If you are connecting the index circuit to a microcontroller, then circuit (a) is preferred. All the current flowing thru R1 & R2, comes from the dekatron, thru the *NDX* pin. Its a *common base* circuit. The input is Q1's emitter. Some of the current flows from the emitter to the base (tied to RTN; "Return"), turning ON the Emitter-Collector path, where most of the current will pass. A logic-1 will occur, when the glow is at the *index* position. Normally, it idles at logic-0 (0V).

Circuit (b) is a *common emitter* circuit. This is how most **rookies** think, a transistor can only be used. Here to make it work, Q1 is normally biased '**ON**', by providing a current path, from its base to ground. So during '*idle*', current will be passing thru R1 & R2, presenting a logic-1 (+5V). When the glow gets to K0, the index current will raise the voltage of Q1's base. This will reverse bias its BE junction, turning it **OFF**. In turn, collector current is shut off, generating a logic-0 (0V). The reverse BE bias, is clamped by D1. Current to the logic output is originated from the RTN (Return) leg. So R1 & R2 can be chosen to a value, that does not unduly load the RTN (+50V) source. If this is a TTL input, R2 may be as low as 220 ohms. This means ~8mA must flow thru the output leg during the idle period. The +50V supply must be robust enough to supply this current without sagging, too much.

With either circuit (a) or (b), an additional buffer stage may be added, if its intended to run old fashion TTL logic.

Dekatron Position Reset: Sometimes you want to force the glow to a certain position. This can be done, if any of the cathodes is at least 140V more negative, than the other cathodes. The circuit below, does this function:



Note: as drawn, the intended reset position is K0. But there is some strange behavior, dependent on the tube type. As of Aug 14, 2016, I've tried this circuit on 3 types of dekatrons: A101, 6802, and GC10B. On the A101, it behaves as intended.

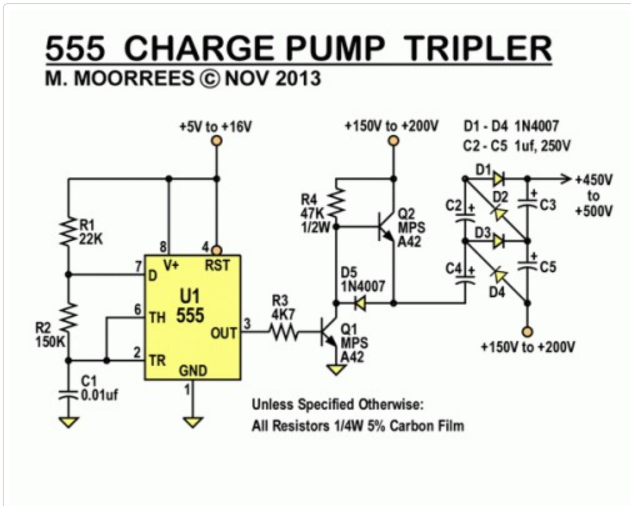
commutating guides seem to "backstep" it. But for only certain tubes.

Cc can vary from 1000pf to 0.47uf. Cr can 220pf to 0.1uf.

Power Requirements: Dekatrons need higher voltages to operate than most cold cathode tubes. Neon filled dekatrons need at least 380V to strike (anode-to-cathode). Fortunately, they don't use much current. Only 330μA for the neon types.

The guides also need to transition more negative than the *main* cathodes. One way to do this, is to cap couple the guides, but this requires the guides voltages to always be changing. The better way, is to use an old analog trick used with other tubes. Common vacuum tubes (triodes & pentodes) need a negative bias on the grid. To do this with a *single* supply, the cathode was biased to some positive value. That way, with the grid, at *ground potential,* looks negative relative to the cathode. This can also be done with dekatrons. In the circuit, above, the main cathodes are biased to +50V. So when a *guide* is lowered to ground, its 50V below (negative) the main cathodes, so the glow transfers to it.

Simple 555 Charge Pump Tripler:



If you have an existing HV source, such as a 170V nixie supply, this circuit will triple that voltage. 170V will triple to just over 500V. Plenty of voltage to run any dekatron. It uses common parts, since the frequency is only around 450hz. A common 1N4007 can switch adequately at this lower frequency.

More Dekatron Projects:

Dekatron – Article at Wikipedia

... of Dekatron Projects

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