Page taken from: http://homepage.ntlworld.com/electricstuff/dekatron.html

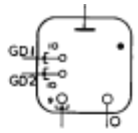
This was OCR'd from an old 1954 Ericsson catalogue, and so may contain a few typos.

Double-pulse dekatron counters

GC10B, GC10B/S (CV2321)

The Dekatron counter is used for counting pulses and displaying the total. Suitable pulses may be produced from the closure of contacts, interruption of a light beam, a tachometer generator, or from a Geiger-Muller type of tube. Dekatrons present a convenient method of dividing down from one frequency to another or by registering the number of cycles of a stable frequency occurring between two events, give a measure of the time interval. These tubes have also been used to provide time marker pulses for oscillographic work.

scale-of-ten counters **GC10B & GC10B/S**



(Specification for GC10B/S—CV..2271)

Characteristics

Counting rate : Sine wave and rectangular pulse drive circuits		0—4000 ppS
Running voltage at 300 μA	GC10B/S	191 ± 5 V
	GC10B	191 ± 6 V

Limit Ratings

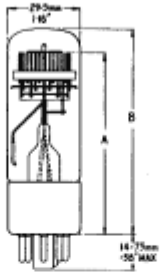
Maximum total anode current	550 μA
Minimum total anode current	250 μA
Minimum supply voltage, anode to cathode (normal room illumination)	350 V
Maximum potential difference between guides and cathodes	140 V

Recommended Operating Conditions

Anode current	310 μA ± 20%	
Output cathode load	150 kΩ	100 kΩ
Bias on output cathode	—20 V	—20 V
Resultant pulse	40 V	25 V

The required anode current may be obtained from a 475 V supply via an 820 kΩ resistor.

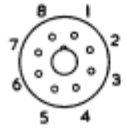
Mounting position	Any. For visual indication the tube is viewed through the dome of the bulb.
Alignment	Cathode "0" is lined up with pin No. 6 to an accuracy of ± 12°.
Weight	43 g. (nominal)
Escutcheons	N.78211 Bakelite, or N.79368 Brass.



Dimension	Nominal	GC10B		GC10B/S	
		Min.	Max.	Min.	Max.
A	72·5 mm. (2·85")	68·5 mm.	76·5 mm.	69·5 mm.	75·5 mm.
B	85 mm. (3·35")	81·5 mm.	88·5 mm.	82·5 mm.	87·5 mm.

Base : International octal

Base Connections (Underside view)



Pin 1	Common cathodes
2	—
3	1st Guides
4	Anode
5	2nd Guides
6	—
7	Cathode "0"
8	—

The Dekatron Principle

Double-Pulse Dekatrons consist basically of 30 cold-cathode diodes in a common gas-filled envelope. The rod cathodes are mounted in a ring around a common anode disc. When the anode is connected through a high resistance to the positive terminal of a d.c. supply of some 400--500 V, and the cathodes are returned to the negative terminal, one of the anode-cathode gaps ionizes, and the glowing cathode is easily visible through the dome of the glass bulb. The anode current flows through the resistor, and the anode potential drops to the maintaining voltage of the glow, which is less than the voltage required to strike a further discharge, so that only one cathode glows. Suppose now a cathode adjacent to that already glowing is slowly made negative. Due to the proximity of the ionized gas, the breakdown voltage is only a few volts greater than the maintaining potential, and soon this next cathode strikes. Two adjacent cathodes are now glowing, but as there is a constant p.d. between anode and glowing cathode, the anode "follows " the negative going cathode potential. This reduces the voltage across the gap which was originally glowing until the p.d. is insufficient to maintain the discharge, and the glow extinguishes, leaving the second cathode to carry the whole anode current. Thus to cause the glow to circulate, the waveforms of the voltages applied to the cathodes must be such that each electrode is, in turn, the most negative. It has been established that the voltage required to transfer the glow to an electrode two positions removed is some five times that which is necessary for a step to an adjacent electrode, and so the direction of circulation of the glow is quite definite.

Because of this, it becomes possible to connect internally the first, fourth, seventh, etc., cathodes into one ring, and the second, fifth, etc., into a second ring. All but one of the remaining cathodes are commoned by a third ring, and the odd electrode has an individual connection to a pin on the valve base. Circuit description is facilitated by referring to the electrode series of which one element glows when the tube is quiescent as " Cathodes," the group occupying the next clockwise position as " First Guides," and the remaining electrodes as " Second Guides."

Basic Method of Operation

A ten-position register is of little use by itself, but when it can be made one decade of a multi-stage counter, the sphere of application is very wide. Such a unit, besides displaying the count, must also produce one output signal for every ten input signals. The simplest Dekatron drive is from a three-phase a.c. supply, with the cathodes connected to one phase and a group of guides to each other phase, but in this case every electrode is supplied with the input waveform, and the extraction of an output signal presents some difficulty. The recommended drive circuits use positive guide bias so that the output cathode can be isolated from the input pulses.

The second guides are normally positive with respect to the cathodes by a potential at least equal to the transfer voltage. Then at the cessation of the pulse on these electrodes, the following cathode will appear negative, and the glow will leave the second guide. To ensure a move forward to the cathode and not backward to the first guides, these latter are also biased positively. The effective bias is the sum of the applied potential and that produced by the flow of anode current through the guide leaks. This latter term is dependent on the waveform of the input pulses, and to ensure accurate counting, it is desirable to clamp the guides to a fixed bias voltage via a diode.

The nine commoned cathodes are wired directly to earth, and the output cathode has a load resistor in series with it so that a positive pulse is produced every time the glow invests this electrode. When the glow current begins to flow through a load resistor, the potential of the associated cathode rises, and tends to oppose the growth of current to that cathode. The resultant positive potential also assists the glow to transfer from the output cathode to one of the commoned electrodes. When the output cathode is returned to a potential negative with respect to the commoned cathodes, the opposite effect is produced. Hence by relating the value of the resistor to the negative voltage to which it is returned, quite large output voltages can be produced with no sacrifice to maximum speed. The maximum speed of the tube will, however, be reduced if the glow rests on one cathode for more than 2,000 hours without being circulated. The recommended output circuits are designed to obtain the maximum static life from the tube by ensuring that the glowing area includes the adjacent guides.

Input Wave-forms

Sine waves may be applied to the tube via a simple 45" phasing network (Circuit Section, Pig. 11) for applications such as frequency division and time pulse generation where the input is continuous. Where it is desired to count the number of cycles in a train of waves, the sine waves should be converted into approximately rectangular pulses and applied to the variable duration pulse circuit (Figs. 3 and 8).
Two pulse drive circuits are recommended. Pig. 8 will handle pulses of 130-160 volts amplitude with any duration exceeding 50 ~S providing the pulses are separated by at least 200 IIS quiescent period. The optimum conditions are 145 volts amplitude, 2:7 mark/space ratio.
A drive circuit with a higher input impedance is shown in Fig. 10. The limits on pulse size for this circuit are :-Amplitude 140-170 volts, duration 29-36 uS.
Pairs of negative rectangular pulses, in which the leading edge of the second pulse is coincident with the trailing edge of the first pulse, provide another form of drive, illustrated in Pig. 12. One pulse is applied to each of the guide rings, and a quiescent period allows the glow to invest the cathodes. Each pulse should have a minimum duration of 60 ciS, and the minimum separation between the trailing edge of the second pulse and the leading edge of the first pulse of the following pair is 125 uIS. The effective pulse amplitude, i.e., total pulse minus guide bias, should be 60 +/- 10 volts.

Inter-decade Couplings

The pulse produced at the output cathode has not sufficient power to drive the succeeding counter directly, and either a cold cathode or thermionic valve must be used to amplify and shape the pulse.
The GTE175M trigger tetrode has been specially designed to couple Dekatrons, and the recommended circuit is shown in fig. 13.

Alternatively one CV858 twin triode can be used for two couplings. The circuit (pig. 14) is similar to the one described for variable duration pulses, but has different component values to suit the longer rise time of the input pulse. The triode is coupled to the preceding Dekatron by a small capacitance so that the " carry " takes place as soon as the glow of the previous counter invests its output cathode. The grid is heavily biased to prevent the negative pulse produced when the glow moves off the output cathode from appearing as a large positive pulse on the guides and damaging the succeeding Dekatron.

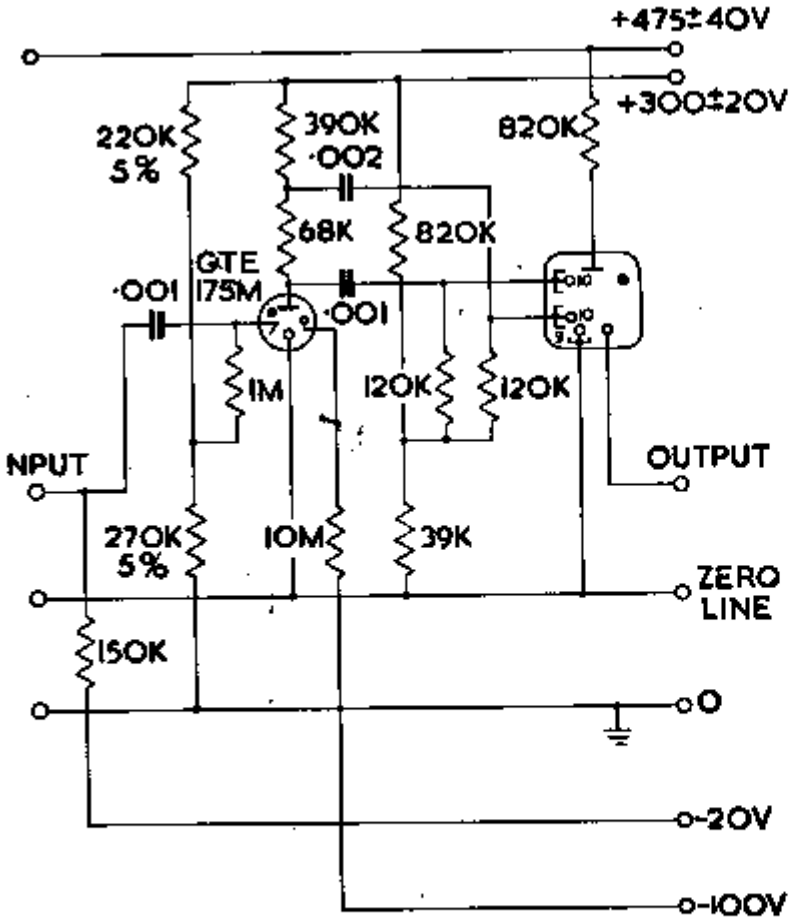


Fig. 13

Cold-Cathode Coupling between Two Double-Pulse Tubes
0—500 "carries" per second

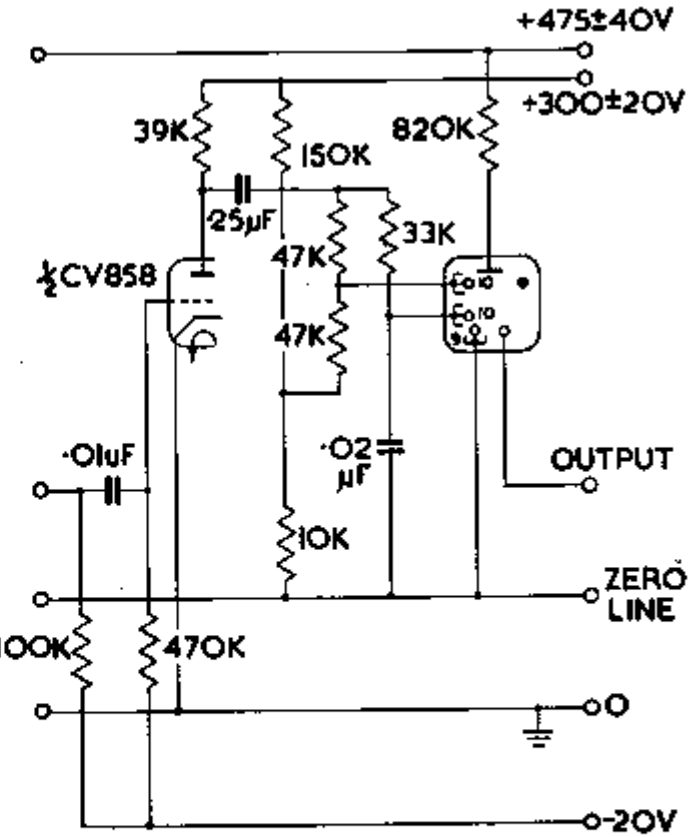


Fig. 14

Hard Valve Coupling between Two Double-Pulse Tubes
0—250 "carries" per second

Re-setting

To enable the counters to be set at zero, two h.t. negative lines should be provided. One, directly earthed, receives the returns from the Dekatron output cathodes (or the potential dividers feeding them), the cathodes of any thermionic coupling valves, and the negative bias supply for these valves. The other line takes all the remaining returns, and is connected to earth via a resistor which is shorted during counting.
Operation of the " zero key " removes the short, and the current from the counters and bleeders flows through the unshorted resistor. This raises the potential of all Dekatron electrodes except the output cathodes, and causes the counters to reset. The value of the reset resistor depends on the number of decades and the couplings used, and should be chosen to produce a p.d. of 100 volts.

Double-pulse dekatron computing tubes

GC10/4B, GC12/4B

It was explained in the description of Counter Tubes that the First and Second Guides were thus designated because negative pulses applied in that order would cause clockwise rotation of the glow. If the pulses be applied in the reverse order, the circulation is anti-clockwise, so allowing addition and subtraction. For muIti-decade subtraction, the negative "carry" must take place on "9" and direction sensing circuits usually require at least one intermediate output. The computing tubes therefore, besides being tested in both directions, have four individual cathodes, A, B, C and D, brought out to pins on the valve base, the remaining cathodes being internally connected to a common ring which should be wired to earth. The spacing of the output cathodes is so arranged that, by making the appropriate cathode act as zero, an output pulse can be obtained at any intermediate count. The method of connection is shown in the table on the relevant data sheet.

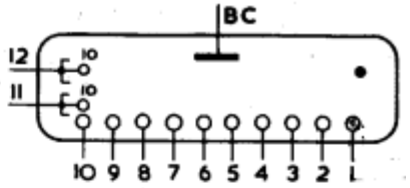
One method of obtaining reversible coupling into the succeeding decade is described in Ref. 4, page 45. Another method is to provide two standard coupling circuits with the first guide output on one cross-connected to the second guide output of the other through two rectifiers wired back-to-back, the guide being taken to the junction of the rectifiers. The other guide is connected to two more rectifiers similarly connected to the remaining guide feed points.

Double-pulse dekatron selectors

GS10C, GS12C

bi-directional 10-way selector tube GS10C

(Specification CV. 2325)



Characteristics

Counting rate :—

Sine wave and rectangular pulse drive circuits	0—4,000 ppS

Limit Ratings

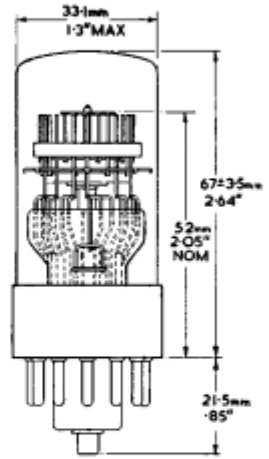
Maximum total anode current	550 μA
Minimum total anode current	250 μA
Minimum supply voltage, anode to cathode (normal room illumination)	400 V
Maximum potential difference between guides and cathodes	140 V

Recommended Operating Conditions

Anode current	325 μA ± 20%
Running voltage at this current	192 V
Cathode load resistors (see curve, page 29).	0—270 kΩ

The required anode current may be obtained from a 475 V supply via a 680 kΩ resistor.

Mounting position	Any. For visual indication, the tube is viewed through the dome of the bulb.
Alignment	Cathode No. 1 is lined up with pin No. 11 to an accuracy of ± 12°.
Weight	53 g. (nominal).
Escutcheon	N.80977.



Base : Duodecal with bottom cap

Base Connections (underside view)

Pin	1	Cathode 0
	2	,, 9
	3	,, 8
	4	,, 7
	5	,, 6
	6	,, 5
	7	,, 4
	8	,, 3
	9	,, 2
	10	,, 1
	11	2nd Guides
	12	1st Guides
B.C.		Anode

Dekatron selectors have found many uses in frequency dividers, batching counters, generators of " staircase " waveforms, and in marking one selected lead from a group.

Selectors differ from Counters only in that each cathode has its individual connection to the valve base. Cathodes which are not required to produce an output pulse should be wired directly to earth, the output cathodes obtaining their earth return through the load resistor. Because the number of commoned cathodes will be only a fraction of the total, there is no advantage in taking the cathode loads to a negative voltage, as is suggested for counter tubes. Instead, the positive guide bias should be increased so that in the quiescent state, the guides are always at a higher potential than a glowing cathode. To keep the effective pulse at the recommended value, the peak amplitude of the driving waveforms must be increased by a similar amount. With these circuit alterations, a 45 volt output pulse can be produced at the rated counting speed.

If desired, one output resistor can be common to several cathodes, and this connection is often used to obtain division ratios which are some fraction of the total number of cathodes.

If a particular cathode be made very negative (of the order of 140 volts) to all the others, the glow will move directly to it. When the chosen cathode is used as "0" in a multi-decade counter, it is necessary to block the coupling circuit to prevent a carry pulse being produced. An alternative method of setting is described in reference 6, page 45.

Single-Pulse Dekatron counters

GC10-D

Unlike other Dekatrons, these tubes require only a single pulse for each count. They are similar in appearance to doublepulse counters, but have three guide electrodes instead of two between successive cathodes.

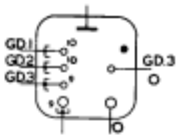
The negative input pulses are applied via a high resistance to the first guides and directly to the second guides. These two groups of guides are normally biased positively with respect to the earthed cathodes. The cathodes are preceded by the third guides, which are connected to earth through a high resistance. The receipt of an input pulse transfers the glow from a cathode to a first guide, and the anode current by flowing through the first guide resistor, raises the voltage of the guide. When the potential difference between first and second guides is equal to the transfer voltage, the glow moves (auto-transfers) to the second guide, where it rests until the pulse voltage is removed. The return of the first and second guides to the positive bias potential moves the glow to the third guide, and again an auto-transfer takes place to the cathode, so completing one count. The rate of change of voltage on the guides is kept to a suitable figure by small capacitors in parallel with the auto-transfer resistors.

It is not anticipated that the GC1OB with its wide tolerances in operating conditions, will be replaced by the GC1OD for low speed applications. Hence, the recommended output circuit (Fig. 7, page 52) is a pulse-shaping amplifier which increases the amplitude and duration of the GC1OD output pulse sufficiently to operate a GC1OB.

If the output cathode be made some 140 volts negative with respect to the commoned cathodes, the glow will jump directly to it. In a multi-decade counter it is necessary to block the coupling circuits during re-setting to prevent "carries:' being produced.

scale-of-ten counter tube
for single pulse operation

GC10D



Characteristics

Counting rate	0—20 kp/S.

Limit Ratings

Maximum total anode current	1·2 mA
Minimum total anode current	700 μA
Minimum supply voltage, anode to cathode (normal room illumination)	420 V
Maximum potential difference between guides and cathodes	180 V

The output cathode must not rise above the potential of the commoned cathodes, and may be made more than 18 V negative only when re-setting.

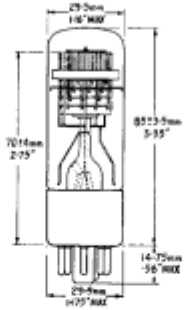
Recommended Operating Conditions

Anode current	800 μA
Running voltage at this current	215 V
Forced setting voltage	140 V
Output cathode load, R_O	82 kΩ

The required anode current may be obtained from a +475 V supply via a 330 kΩ resistor, R_a.

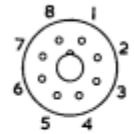
Note : To reduce the effect of stray capacity to a minimum it is essential that the anode resistor must be wired not more than $\frac{1}{4}$" (6·4 mm.) from tag 4 on the valve holder.

Mounting Position	Any. For visual indication, the tube is viewed through the dome of the bulb.
Alignment	Cathode "0" is lined up with pin No. 6 to an accuracy of ± 12°.
Weight	44 g. (nominal).
Escutcheons	N.78211 Bakelite or N.79368 Brass.



Pin 1 Common cathodes
2 3rd Guides
3 1st Guides
4 Anode
5 —
6 Output Cathode
7 Output 3rd Guide
8 2nd Guides

Base Connections (underside view)



Base : International octal

Component Values in Counter Drive Circuits shown at the end of the Handbook

Random Pulse Drive. (Fig. 7)

Negative pulse amplitude 144 ± 12 V

Pulse duration Minimum 25 μS
Maximum is limited by repetition rate

Quiescent time Minimum 25 μS
Maximum is limited by repetition rate

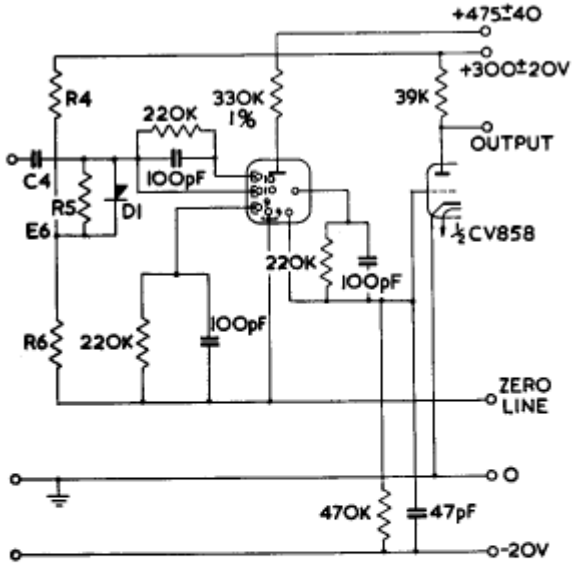
R_4	56 kΩ (5%)	C_4	·02 μF
R_6	10 kΩ (5%)	D_1	CV.469 or Q3/3
E_6	+ 72 ± 12 V		
R_5	1 MΩ		

Sine Wave Drive. (Fig. 7)

Input volts 50—80 V r.m.s.

C_4 is chosen in conjunction with R_{12} to pass the lowest frequency required.

R_4	2·7 MΩ	D_1	not required
R_6	68 kΩ		
E_6	+12 ± 2 V		
R_5	0		



Resistor	*Sine Wave (D1 not required)*	*Negative Pulse*
R4	2·7 MΩ	56 kΩ (5%)
R5	0	1 MΩ
R6	68 kΩ	10 kΩ (5%)

Fig. 7

Coupling GC10D to Variable Duration Drive of GC10B

Register Tubes

GR10A

In order to count pulses at rates greater than 20 kp/S, it is essential to precede the Dekatron scaler with hard valve decades. To preserve uniformity of display, the register tube has been introduced. Like a Dekatron it has a common anode and ten cathodes, but there are no guides. The difference between striking and extinction voltage of the gaps is of the order of 25 V which can be readily obtained from a coincidence matrix fed by the binary decade. Thus it is possible to have a uniform presentation even though the scaler may contain both Dekatrons and hard valve decades.

A conventional binary scale of sixteen modified by feedback into a scale of ten has eight anodes each with two stable potentials. It is possible to select ten combinations of at most four anodes which are all in the low potential state at one count only. These are connected via isolating resistors to one cathode of the register tube the anode of which is connected to some higher voltage.

The register tube cathode is required to glow when all its four associated anodes are low, and must not glow when three are low and one is high. Thus the amplitude of the binary anode swings must be at least four times the difference between the striking and extinguishing voltages of the cold cathode diodes forming the register tube. The recommended circuit and base connections have been designed to allow the maximum tolerance in operating conditions, and to this end some cathodes are connected to more scaler anodes than is needed to satisfy the normal glow conditions.

The de-ionization time of the gas limits the rate at which the circulation of the glow will follow the counter. At speeds greater than some 50 kp/S the discharge will completely extinguish, but when the pulse rate drops to a lower value, the tube will strike again and display the correct count.

References

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