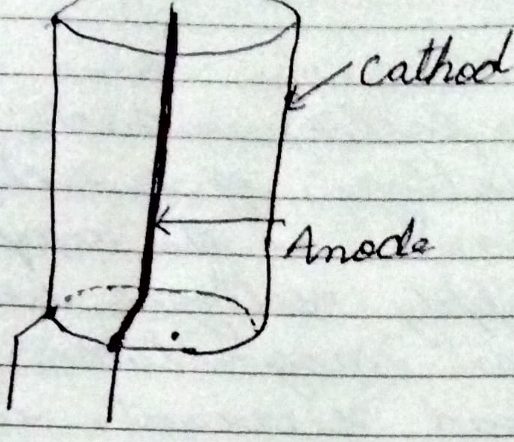
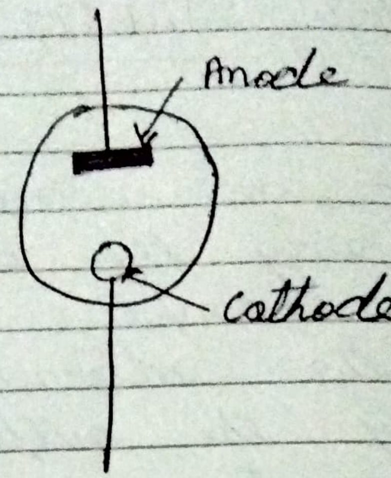
VOLTAGE STABILIZATION BY COLD CATHOD TUBE

There are a number of factors which tend to vary the output voltage of a rectifier. For example, fluctuations in the amplitude of the alternating supply voltage will vary the output voltage magnitude. Variations in the load current, which depend upon such factors as the type of filter employed, the transfer resistance and the tube resistance, also cause a variation in the output voltage delivered by the rectifier filter combination. In general, the output voltage decreases as the load current increases.

For proper operation of many electronic system it is necessary that the voltage applied to the load must be manitaed partically constant inspite of variation in input voltage regulator (VR) tube.

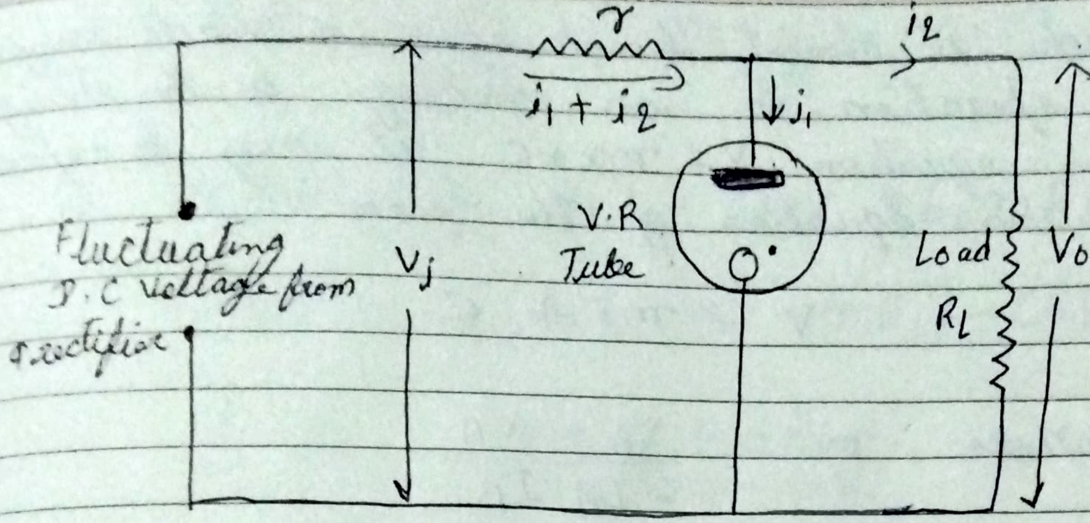
A V.R tube is a cold cathod discharge tube consisting of a central anode wire which is coaxial with a cylindrical oxide coated cathode. It is filled with an inert gas such as neon, argon or helium at a low pressure gives the symbolic diagram of a V.R tube where dot near the cathod indicates that the tube is gas filled.





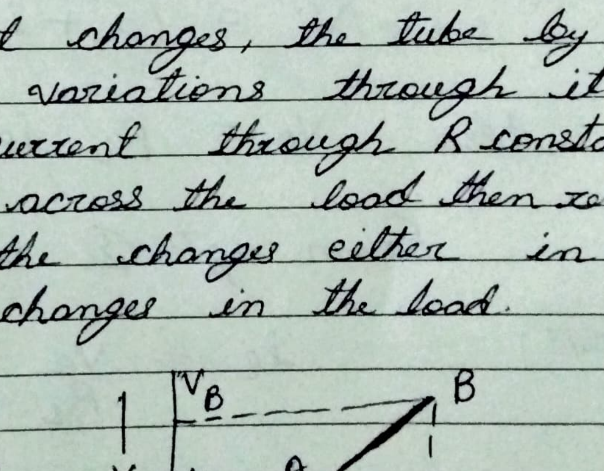
Due to cosmic radiation, some electrons and ions are always present in the gas. Ionization starts in the gas when a certain minimum potential is applied to the tube. Then a current flows through the tube the product of which with the internal resistance of the tube is equal to the voltage drop across the tube.

The voltage across a V.R tube remains fairly constant over a considerable range of current. When connected in the manner shown in fig. the voltage drop across the load remains more or less constant inspite of variation in the applied input voltage (E_i) specially, if a V.R - 150/30 is used the voltage across the load will be approximately 150 volts provided that the current through the tube does not exceed the prescribed 30ma value.



If the input voltage from the rectifier system increases, the voltage drop across the series resistor r increases and the voltage across the V.R tube remains substantially constant. If the input voltage from the rectifier decreases, then it causes a decrease in voltage drop across the resistor r and thus potential drop across the discharge tube remains substantially the same. On the other hand if the load current changes, the tube by passes the current variations through it, maintaining the current through R constant. The output voltage across the load then remains constant, inspite of the changes either in supply voltage or changes in the load.

Shows the volt ampere characteristics of a V.R tube



2010	MARCH				
Mon	1	8	15	22	29
Tue	2	9	16	23	30
Wed	3	10	17	24	31
Thu	4	11	18	25	
Fri	5	12	19	26	
Sat	6	13	20	27	
Sun	7	14	21	28	

2010	APRIL				
Mon		5	12	19	26
Tue		6	13	20	27
Wed		7	14	21	28
Thu	1	8	15	22	29
Fri	2	9	16	23	30
Sat	3	10	17	24	
Sun	4	11	18	25	

which is almost linear over a wide range of operation. In an analogy to the straight line equation, $y = mx + c$ it may be expressed by an equation of the form

$$V = mI + C$$

where $$m = \frac{V_B - V_A}{-I_A \; I_B}$$

and $$C = V_A - mI_A$$

where V_A and V_B are the voltages and I_A and I_B the currents ~~cco~~ corresponding to point A and B.

Now from the circuit diagram we have

$$V_i = (i_1 + i_2)r + V_0 \quad \text{—— ①}$$

Also $$V_0 = R_L \, i_2 = m i_1 + c \quad \text{—— ②}$$

From eqn ② it follows that

$$i_2 = \frac{V_0}{R_L} \quad \text{and} \quad i_1 = \frac{V_0 - c}{m}$$

Substituting these values in eqn ① we get

$$V_i = \left(\frac{V_0 - c}{m} \quad \frac{V_0}{R_L} \right) r + V_0 \quad \text{—— ③}$$

$$= \left(\frac{V_o R_L - C R_L + V_o m}{mR}\right) r + V_o$$

$$\text{or} \quad V_i m R_L = V_o \quad R_L r = C R_L r + E_o m R_L$$

$$V_i m R_L = V_o (R_L r + m r + m R_L) - C R_L r \quad \text{——} \; (4)$$

$$\therefore E_o = \frac{m R_L E_i + C R_L}{R_L r + m r + m R_L} \quad \text{——} \; (5)$$

This is the expression for the regulated output voltage V_o, unregulate input voltage V_i and the circuit parameters.

The variation of output voltage V_o with input voltage V_i is extremely important. The ratio dV_i/dV_o is known as the stabilization ratio and is found from eq^n (3). Thus

$$S = \frac{dV_i}{dV_o} = \left(\frac{1}{m} + \frac{1}{R_L}\right) r + 1$$

$$= \left(\frac{R_L + m}{m R_L}\right) r + 1$$

$$= \frac{r R_L + m r + m R_L}{mR} \quad \text{——} \; (6)$$

$$= \frac{R_L (r + m) + m r}{m R_L} \quad \text{——} \; (7)$$

Substituting the value of $rR_L + mr + mR_L$ from (6) in (4) we get.

$$V_i m R_L = V_o \cdot S m R_L - C R_L r$$

$$S = \frac{V_i m R_L + C R_L r}{m R_L V_o}$$

$$S = \frac{m V_i + C r}{m V_o} \quad \text{—— (8)}$$

This equation shows that for perfect regulation, i.e, infinite stabilization ratio, the dV_i/dV_o should be infinite. For best stabilization, m, and V_o should be small while C, V_i and r should be large. The regulation factor x is the reciprocal of stabilization ratio S and hence is given by

$$\boxed{\alpha = \frac{dV_o}{dV_i} = \frac{m V_o}{m V_i + C r}} \quad \text{—— (9)}$$

— x —