Aim :-

To study BH curve of iron (Solenoid) and to determine the energy ion by hysteriss.

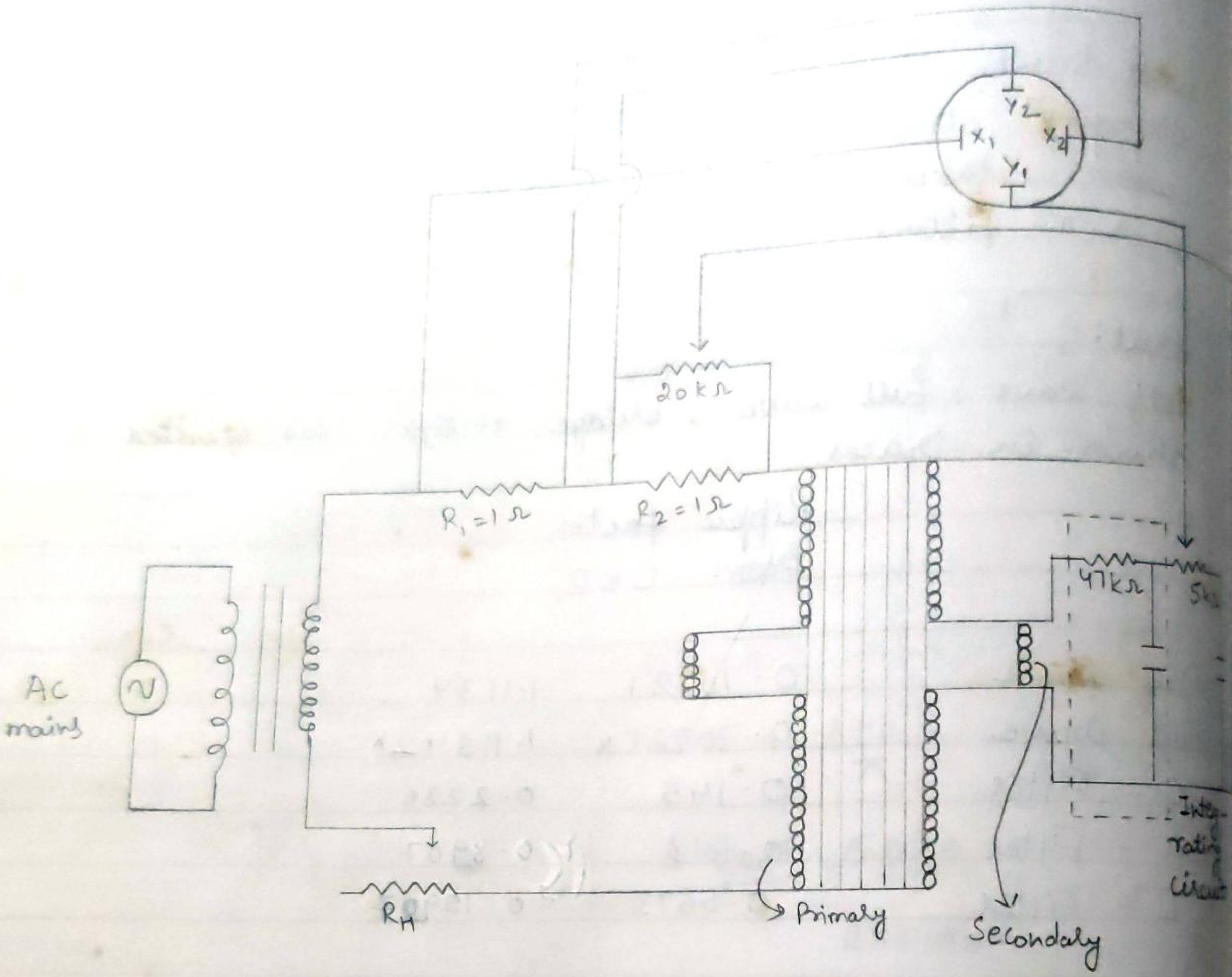
Apparatus:-

C.R.O, a metal ring having a primary and a secondary coil wound on it, a resistance box, a capacitor of known Capacitance, Connecting wires etc.

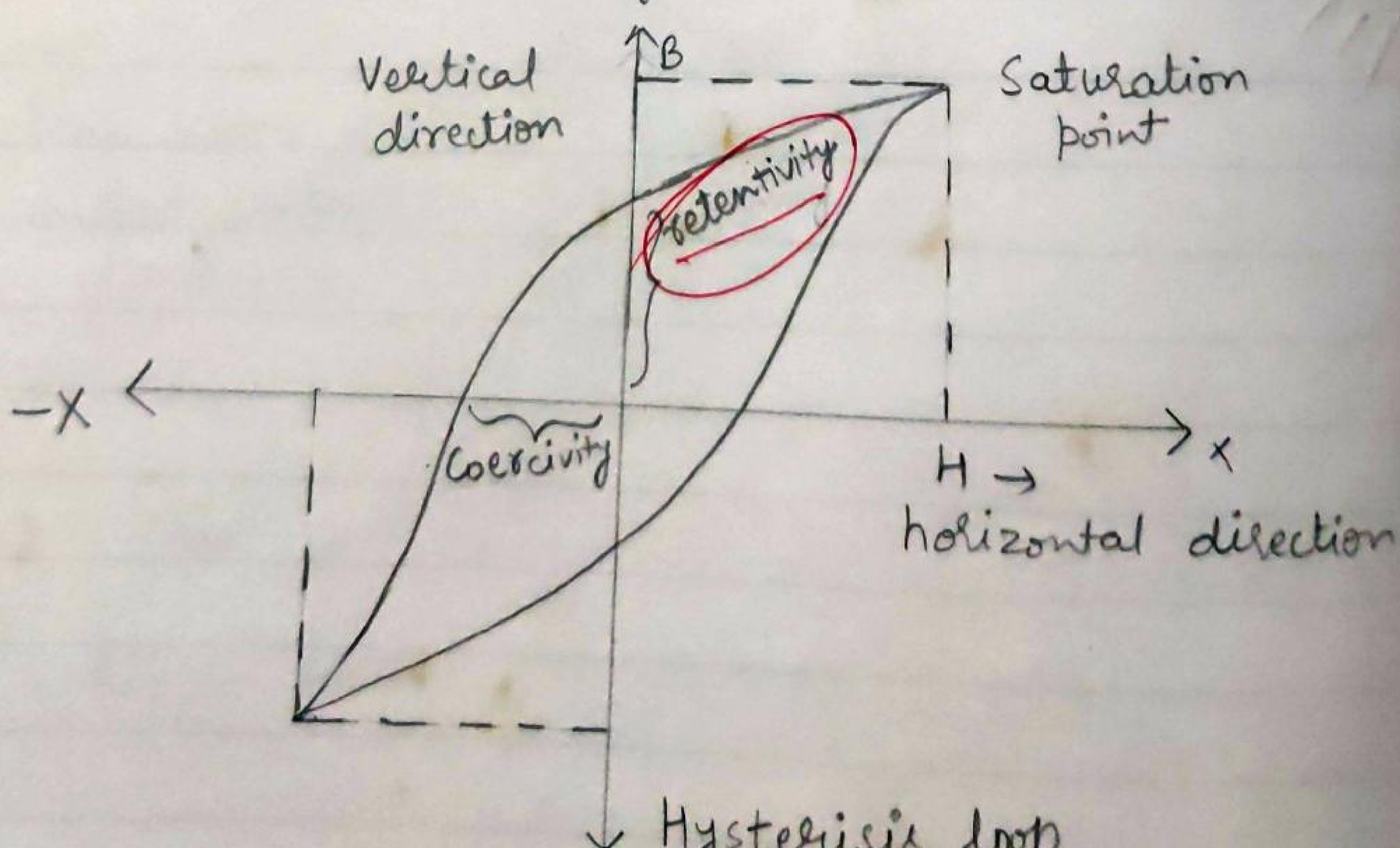
Theory:-

when a speciman is taken through a complete cycle of magnetisation more work is done on the material than that recovered from it. Thus there is net ion of energy in each cycle of hysterisis. The ion of energy per unit vol. of the material per cycle of hysterisis is equal to the area of I-H Loop = $\frac{1}{4\pi}$ x area of BH curve. The a.c voltage drop across the resistance 'r' in the primary circuit of a transformer is fed to the horizontal input terminals of C.R.O and the ac voltage drop across the capacitance C in the secondary circuit of the transformer is fed to the 'vertical point' terminals of the C.R.O. The vertical input voltage is proportional to the magnetising field H. As the a.c voltage supplied to the primary of the transformer completes one cycle, the material of the transformer core is taken through a complete cycle of magnetisation. The fluoroscent spot on the C.R.O moves in response to the BH values. The frequency of the a.c mains source

Teacher's Signature : ____________



Cirluit diagram



Hysterisis loop

being 50 cycle per second, the spot traces the loop 50 times in one second & due to the persistance of vision, a stationary hysterisis loop can the C.R.O screen is observed.

Let I_p be the current in the primary Ckt of transformer & Q_s the magnetic flux linked with each turn of the secondary due to it. If 'a' is the area of cross - section of the transformer core & B is the magnetic induction then

$$Q_s = Ba$$

$$V_s = N_s \frac{dQ_s}{dt} = N_s\, a \frac{dB}{dt} \quad \text{— (1)}$$

V_c = Voltage drop across the capacitor or,

$$V_s = V_c + RI_s$$

$$Q = CV_c$$

$$I_s = \frac{dQ}{dt} = C\frac{dV_c}{dt} \quad \text{— (2)}$$

$$N_s\, a \frac{dB}{dt} = Rc \frac{dV_c}{dt}$$

$$dB = \frac{Rs}{N_s a} dV_c$$

$$B = \frac{Rc}{N_s . a} \qquad V_c = \text{Vertical input}$$

The magnetising field 'H'

$$H = \frac{4\pi N_p I_p}{10 l}$$

$I_p = V_x / r$, $H = \dfrac{4\pi N_p V_x}{10 r l}$

V_x = horizontal input

The energy ion per unit volume per cycle of hysterisis in c.g.s units is given by

$$u = \frac{1}{4\pi} \int H\,dB$$

$$\boxed{u = \frac{1}{4\pi} \frac{Rc}{N_s a} \frac{4\pi N_p}{10 r l} \int V_x\,dV_c}$$

The total loss of energy in the transformer core,

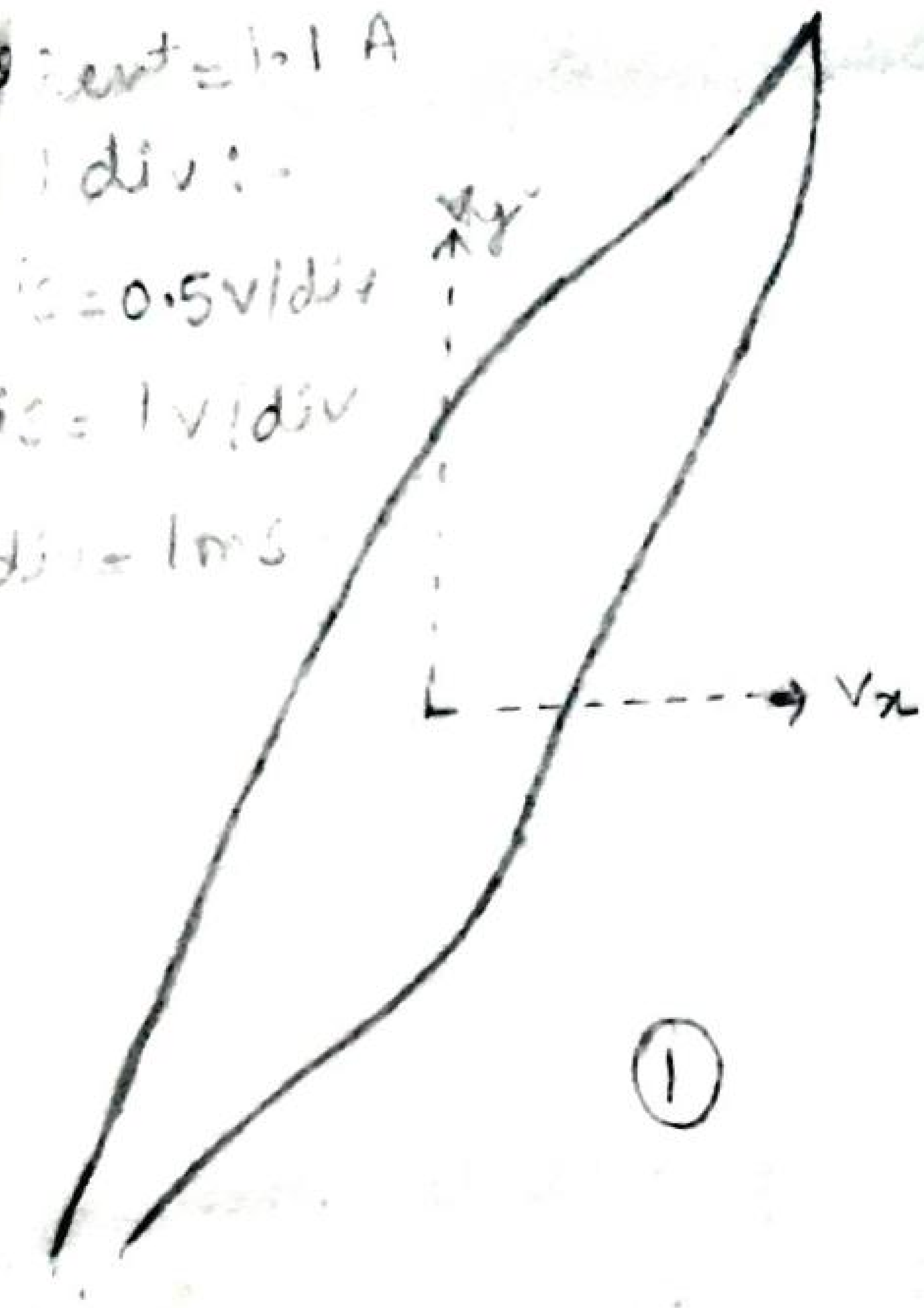
$$u = u \times \text{vol. of core}$$
$$= u a l$$
$$u = \frac{R N_p}{r N_s} \frac{c}{10} \int V_x\,dV_c \text{ joule}$$

Procedure:-

- A diagram showing the connection was drawn & connections was made accordingly. The resistance box 'r' was a fractional resistance box.

- The C.R.O was connected to the a.c mains & a fine bright spot in the screen (at centre) was obtained. The sweep controll ~~is~~ was turned to off position by setting it to external input position.

Current = 1.1 A
volt/div:-
X-axis = 0.5 v/div
Y-axis = 1 v/div
Time/div = 1ms



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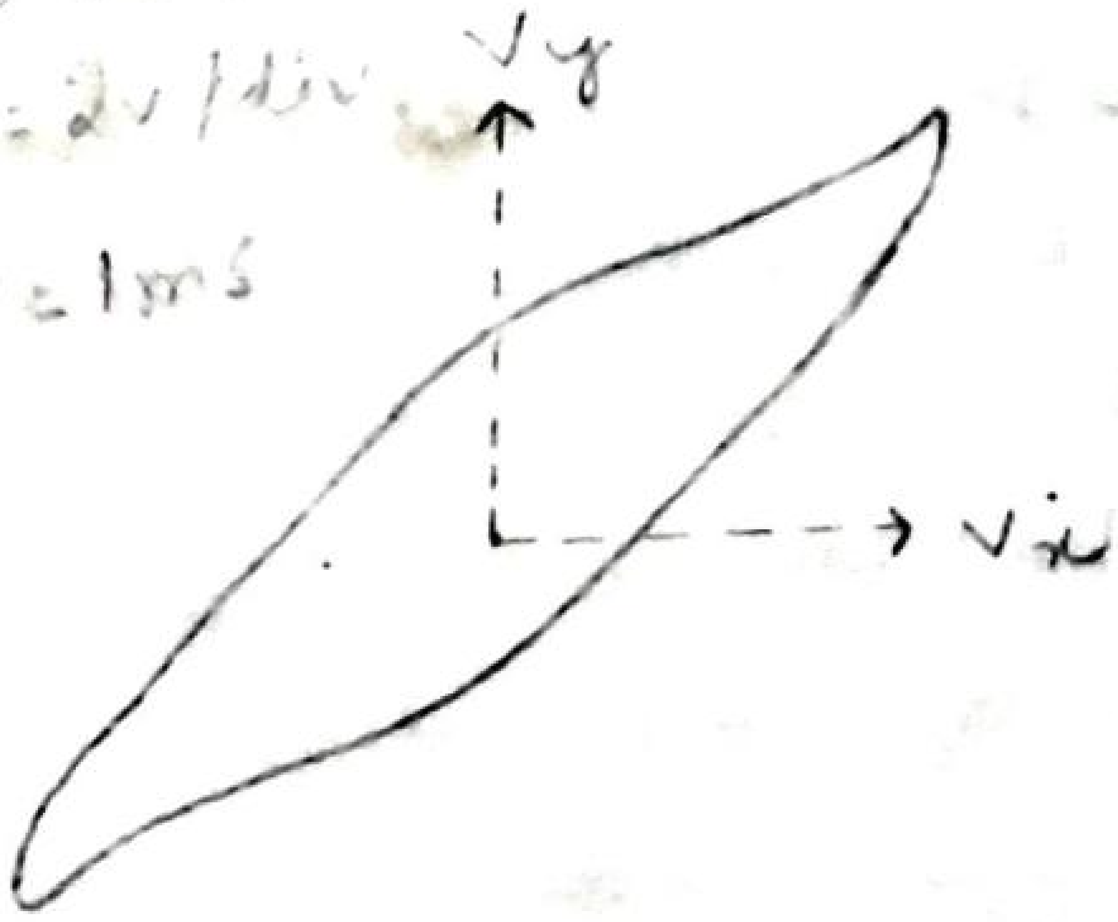
Current = 1.5 A
volts/div:-
X-axis = 0.5 v/div
Y-axis = 2v/div
Time/div = 1ms



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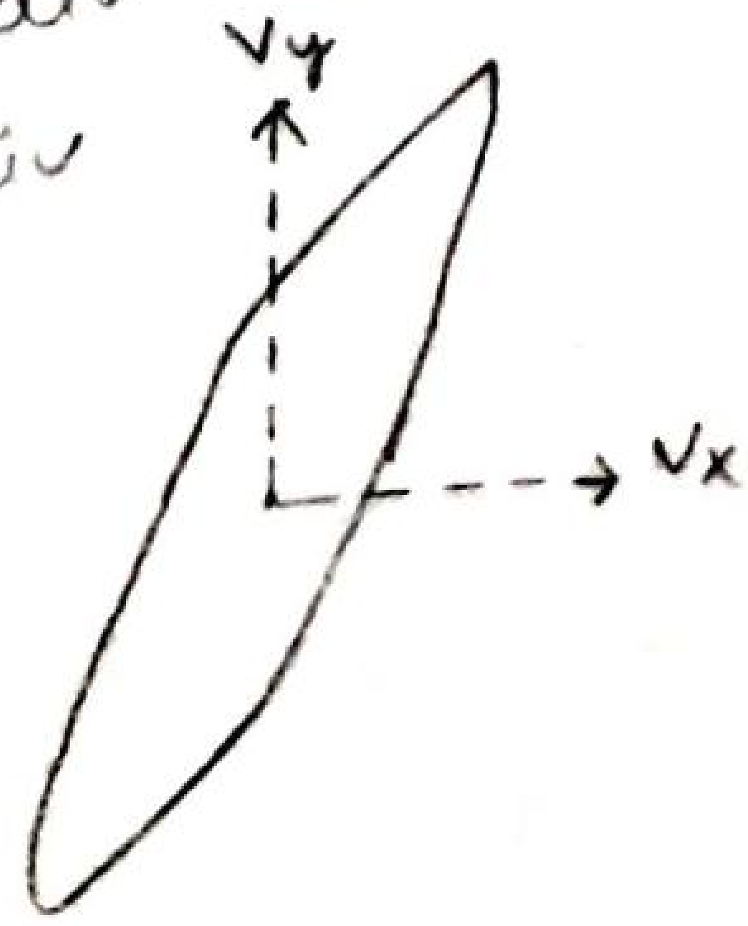
Current = 1.2 A
volt/div:-
X-axis = 1v/div
Y-axis = 2v/div
Time/div = 1ms



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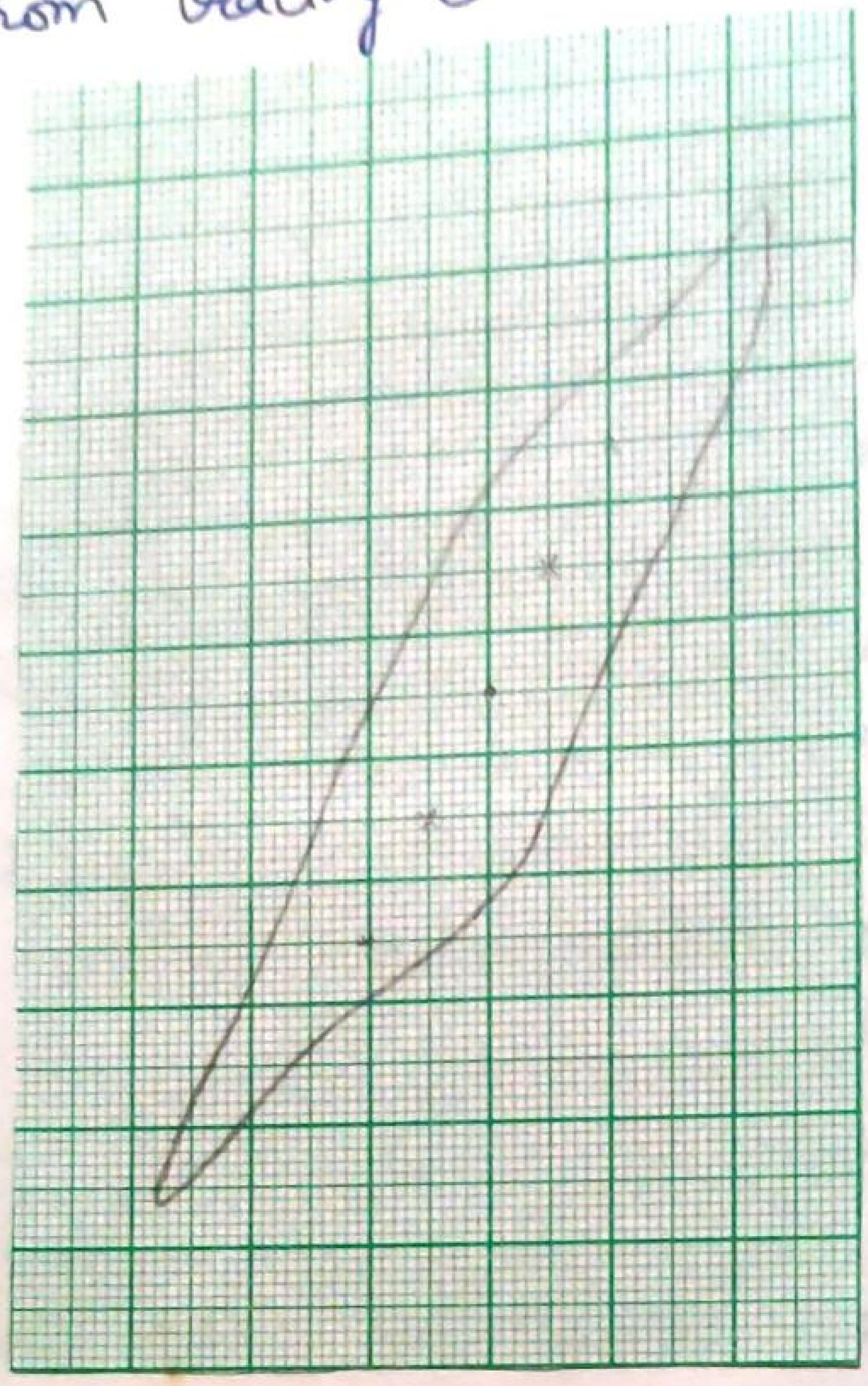
From tracing ①



Calculation:-

From the graph total no. of small box within the curve = 995

where $x = 0.5 \text{ V/cm}$

$y = 1 \text{ V/cm}$

Hysterisis loss per cycle per unit volume $= \frac{1}{4\pi} \times \text{Area}$

$$= \frac{1}{4\pi} \times 995 \times \frac{1}{10} \times \frac{0.5}{10}$$

$$= \frac{497.5}{1256} = 0.3960 \text{ erg } cm^{-3} \text{ cycl}$$

Total loss of energy $(u) = \frac{R}{r} \left| \left(\frac{N_P}{N_S} \right) \right| \frac{C}{10} \int V_x \, dV_c$

$$= \frac{47 \times 10^3}{1.15} \times 800 \times \frac{1 \times 10^{-6}}{10} [0.3960]$$

$$= \frac{14889.6}{11.5} \times 10^{-3}$$

$$= 1294.7478 \times 10^{-3} \text{ erg/cm}^3\text{/cycle}$$

- A resistance of about 2000 Ω it taken out from the resistance box R & about 2 Ω from 'r'. Ac mains supply to the transformer was switched on. A hysterises loop will be obtained on the screen. The vertical & horizontal gains are adjusted as to get a loop of the proper size. The values of R & r were adjusted. The loop was obtained on a transparent paper.

- The position of the vertical & horizontal gain is kept constant. The vertical & horizontal sensitivity for this gain position as already explained.

Result:-

Hysterises loss per cycle per unit volume.

$I_1 = 1\,amp$, $u_1 = 1294.7478 \times 10^{-3}$ erg / cm³ / cycle

$$u_1 = \frac{1294.7478 \times 10^{-3}}{10^5 \times 10^2} \text{ Joule / m}^3\text{/cycle}$$

$$u_1 = 0.12947 \text{ Joule / m}^3\text{/ cycle}$$