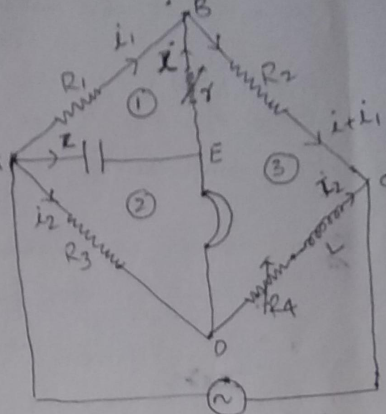
{ B.Sc Part II Physics Hons
Dr Satyadeo Narayan Singh
S.B College, Ara }



Q. Describe the Anderson's bridge method for the measurement of the inductance of a coil. Draw the vector diagram of the balanced bridge

Ans **Anderson's bridge:-**

This is the modified form of Maxwell's bridge which gives inductance L in terms of a fixed standard capacitor C. But here the imperfection of the capacitor has no effect on the measured value of L. So in this respect it is superior to Owen's bridge and it is the most preferred bridge for measuring L. Here the test coil L is placed in the fourth arm in series with a non inductive resistance $R_4$. All other branches consists of non inductive resistances. A non inductive variable resistance $r$ is connected in series with the detector and the junction E of the detector with $r$ is joined to A through the standard capacitor C. The balance condition is not given by the general balance condition of an a.c bridge. Suppose $i$ be the instantaneous current through C from A to E, $i_1$ through $R_1$ from A to B and $i_2$ through $R_3$ from A to D. At balance there is no current through the head phone. The current through $r$ is also $i$ and through $R_2$ is $(i+i_1)$ by point rule and that through L is $i_2$




Applying loop rule to loop ①

$$\frac{i}{j\omega C} + ir - i_1R_1 = 0 \quad \text{or} \quad i_1 = \frac{i}{R_1}\left(r + \frac{1}{j\omega C}\right) \quad \cdots\cdots ①$$

Applying loop rule to loop ②

$$\frac{i}{j\omega C} - i_2R_3 = 0 \quad \text{or} \quad i_2 = \frac{i}{j\omega C R_3} \quad \cdots\cdots ②$$

Applying loop rule to loop ③ ③

$$ir + (i+i_1)R_2 - i_2(R_4 + j\omega L) = 0 \quad \cdots\cdots$$

from ①, ⑪ and ⑪ we have

$$ir + \left\{i + \frac{i}{R_1}\left(r + \frac{1}{j\omega C}\right)\right\}R_2 - \frac{i}{j\omega C R_3}(R_4 + j\omega L) = 0$$

or, $$r + R_2 + \frac{R_2}{R_1}\left(r + \frac{1}{j\omega C}\right) - \frac{R_4}{j\omega C R_3} - \frac{L}{CR_3} = 0$$

Equating real part to zero $$r + R_2 + \frac{R_2 r}{R_1} - \frac{L}{CR_3} = 0$$

or, $L = CR_3\left[r\left(1+\frac{R_2}{R_1}\right)+R_2\right]$ . . . . . . . . . . (4)

Equating imaginary part to zero $\frac{R_2}{R_1\omega C} - \frac{R_4}{\omega C R_3} = 0$

$\therefore \frac{R_1}{R_2} = \frac{R_3}{R_4}$ . . . . . . . . . . . . (5)

The Second balance condition is satisfied by adjusting $R_4$ and the first condition is satisfied by adjusting $r$. Therefore by adjusting $r$ and putting the value of $R_1, R_2, R_3$ and $C$ in eq$^n$ (5) we may calculate self Inductance $L$. from eq$^n$ (4) & (5) it is also clear that the condition of the balance is independent from the source frequency.

For the condition of balance it is necessary that $L > CR_2R_3$ otherwise '$r$' will be negative. In the experiment we always take $R_1 = R_2$ $\therefore$ for condition of balance $R_3 = R_4$. In this situation self Inductance will be $L = CR_3(2r+R_2)$.

The accurate value of $L$ will be obtained only when the bridge is ~~balanced~~ sensitive. For the sensitivity of the bridge

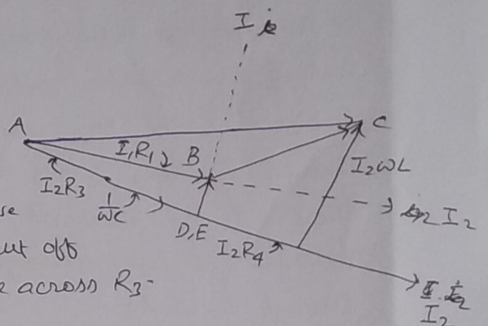
$C = \frac{L}{2R_4^2}$ or $\frac{C}{L} = 2R_4^2$

Now taking $R_3 = R_4$ we get $\frac{L}{C} = 2R_3^2 = R_3(2r+R_2)$

or. $2R_3 = 2r + R_2$ or $R_3 = \frac{2r+R_2}{2} = r + \frac{R_2}{2} = R_4$

Thus for the sensitivity and balance of the bridge $R_4$ and $r$ should be adjusted.

<u>vector diagram of bridge</u>:-




Let AC represent the applied voltage. The current $I_2$ through branch ADC lags the applied voltage as it is inductive. So draw a line at A in the clockwise direction. This line gives the direction of $I_2$. cut off a length $AD = R_3I_2$ to represent the voltage across $R_3$. Draw CO $\perp$ from C on AO.

Then $CO = I_2\omega L$ and $DO = I_2R_4$

Since D and E are at the same potential E lies at the same position as D in the vector diagram. Therefore $AE = AD = \frac{1}{\omega C}$

$I_1 =$ . . . r.m.s value of current in ABC

$I_2 =$ . . . r.m.s value of current in ADC

Since current leads the voltage in a capacitor, the current $I$ is $\perp$ to AE in a anticlock wise direction. cut off a length $EB = rI$ along $I$ to represent the voltage across $r$. Join B with C and A. Then AB is the direction of $I_1$ and $AB = I_1R_1$ and $BC = (I+I_1)R_2$.