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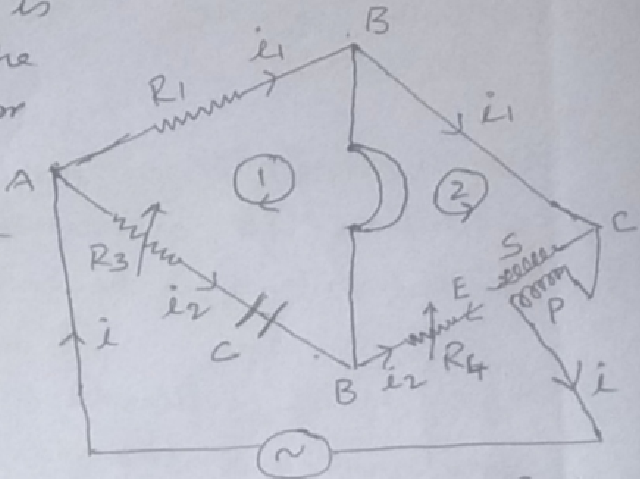
Questions:- Give the theory of Carry Foster's A.C Bridge. Draw its vector diagrame when it is balanced.

Answer:- Carry Foster's Bridge:→

The bridge measures the mutual inductance between two coils in terms of a standard capacitance and two known non inductive resistances. In fact it is not desirable to classify this as a bridge, but it is usual practice

The second arm BC is shorted by a thick wire. One of the coils, say S, of the mutual inductor is placed in the fourth arm DC through a variable non-inductive resistance R_4. The first arm AB is a non-inductive resistance R_1 and the third arm AD contains the standard capacitor C and a variable non-inductive resistance R_3. The other coil P of the mutual inductor is connected in series with the source. The balance condition is not given by usual general condition of an a.c bridge. Let 'i' be the instantaneous current in the source branch i_1 through R_1 and i_2 in ADC branch at balance of the bridge.



By Kirchoff's point rule we get,

$$i = i_1 + i_2$$

By loop rule from loop (1)

$$R_1 i_1 - i_2\left(R_3 + \frac{1}{JWC}\right) = 0 \quad \text{or.} \quad R_1 i_1 = i_2\left(R_3 + \frac{1}{JWC}\right) \quad \text{--- (1)}$$

By loop rule from loop (2)

$$i_2(R_4 + jWL) + \left(-M\frac{di}{dt}\right) = 0$$

$$\Rightarrow i_2(R_4 + JWL) = M\frac{d}{dt}(i^{JWt}) = j\omega M i$$

$\Rightarrow i_2(R_4 + j\omega L) = j\omega M(i_1 + i_2)$ ------ (I)

$\Rightarrow i_2(R_4 + j\omega L - j\omega M) = j\omega M i_1$ ------ (II)

Substituting the value of i_1 from (I) and (II) we get

$i_2(R_4 + j\omega L - j\omega M) = j\omega M \cdot \frac{i_2}{R_1}\left(R_3 + \frac{1}{j\omega C}\right)$

$\therefore R_4 + j\omega(L - M) = \frac{j\omega M R_3}{R_1} + \frac{M}{C R_1}$ ------ (a)

Equating real parts

$R_4 = \frac{M}{C R_1}$ or $M = R_1 R_4 C$ ------ (b)

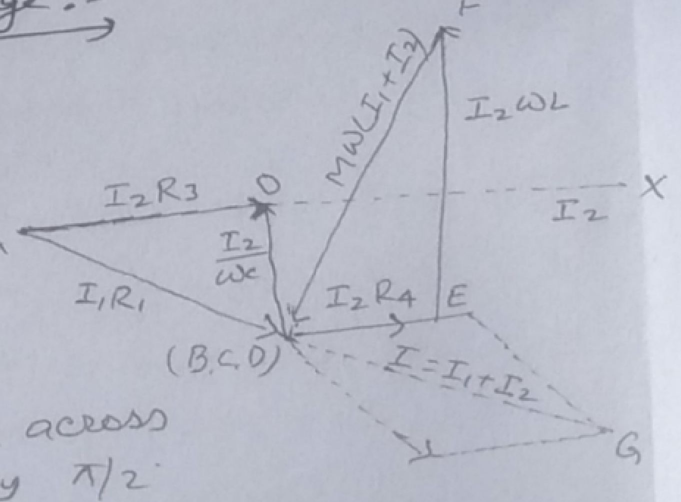
Equating imaginary parts,

$L - M = \frac{M R_3}{R_1}$ or $L = M\left(1 + \frac{R_3}{R_1}\right)$

The two balance conditions are independent of one another. changing R_4, the first condition is acheived and changing R_1 the second condition is acheived.

It is to be noted carefully that the sign of M depends on the windings of primary and secondary and the way in which their leads ~~never possible~~ are connected. If the leads are the wrong way round, then a balance is never possible. In this hard case then leads must be reversed to be balance.

Vector diagram of the bridge :-



Let AX represent the direction of current I_2 through the ADC at balance. cut off a length $AO = R_3 I_2$ to represent Voltage across C is $\frac{I_2}{\omega C}$.

Since the voltage across a capacitor lags the current by $\pi/2$

Draw a line $OD = I_2 \cdot \frac{1}{\omega C}$ in the anticlockwise direction $\perp$ to AO at O. Since D, B and C lies at the same potential at balance of the bridge, they lie at the same point in the vector diagram. Thus $AB = I_1 R_1$ and AB is the direction of the current I_1. Draw a line $DE = I_2 R_4$ parallel to AX to represent the voltage across R_4. Then draw $EF = I_2 \omega L$ $\perp$ to DE. join F & D. Then

$FD = \omega M(I_1 + I_2)$.

The direction of the total current $I = I_1 + I_2$ is a line DG $\perp$ to FD at D.