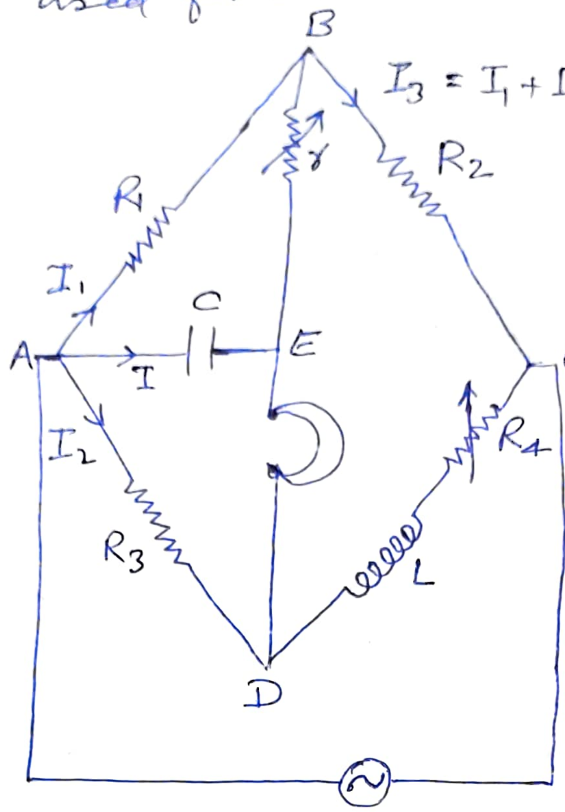
Bsc II (H)

Anderson's Bridge

Dr. S. K. Shrivastava
Principal

This is one of the most accurate bridge which is commonly used for the measurement of self inductance



Dr. (Prof.) S. K. Shrivastava
P. G. Dept. of Physics
A.N.S. College, Barh (Patna)

Fig. 1

in terms of standard capacitance. The double balance is obtained by adjusting resistances only, the standard condenser being of a fixed value. In this bridge a non inductive resistance r is put in series with the condenser, the combination being in parallel with R_1, the other components and the detector are placed as shown in figure.

At the time of balance, the potential at E is equal to the potential at D. Applying kirchoff's laws we have

For mesh ABEA

$$R_1 I_1 - \left(r + \frac{1}{j\omega C}\right) I = 0 \qquad \text{--- (1)}$$

for mesh AEDA

$$\left(\frac{1}{j\omega C}\right) I - R_3 I_2 = 0 \qquad \text{--- (2)}$$

$R_2 (I_1 ...$

Substituting values of I_1 and I_2 from equation (1) and (2) in equation (3), we have

$$\frac{R_2}{R_1}\left(r + \frac{1}{j\omega C}\right) I + R_2 I - \frac{(j\omega L + R_4)}{j\omega C R_3} I + r I = 0 \quad \text{(4)}$$

Equating real and imaginary parts, we get

$$\frac{R_2}{R_1} r + R_2 - \frac{L}{C R_3} + r = 0$$

or $$L = C R_3 \left[r\left(1 + \frac{R_2}{R_1}\right) + R_2 \right] \quad \text{(5)}$$

and $$\frac{R_2}{R_1 \omega C} - \frac{R_4}{R_3 \omega C} = 0$$

or $$\frac{R_1}{R_2} = \frac{R_3}{R_4} \quad \text{(6)}$$

These conditions are independent of the frequency of the source and can be satisfied independently of each other by adjusting R_1 (the variable resistance in series with the induction coil L) in the latter case and r in the former case. Equation (5) shows that the ac balance is possible only when $L > C R_2 R_3$, otherwise r will be negative. Since there is no other inductance, all mutual reaction between neighbouring inductance is avoided.

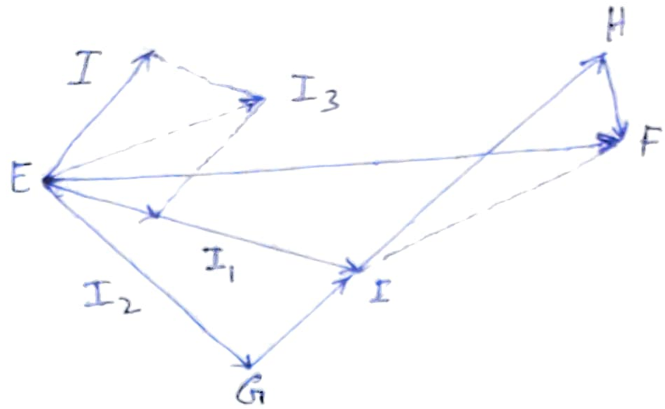
It is best to use $R_1 : R_2 = 1:1$

The formula then reduces to

$$R_3 = R_4$$

and $$L = C R_3 [2r + R_2] \quad \text{(7)}$$

Vector diagram.



The vector diagram of Anderson's bridge is shown in figure. In it EF is V, the potential vector for the applied source and is also equal to the potential difference between terminals A and C. If I_2 represents the current in ADC, then $EG = R_3 I_2$, $GH = j\omega L I_2$ and $HF = R_4 I_2$, so that HF is parallel to EG. and GH is perpendicular to EG or HF. Since the potential of point E is the same as that of D, $V_{AE} = V_{AD}$ or $\left(\frac{1}{j\omega C}\right) I = R_2 I_2$. This relation shows that I is in ~~quadratur~~ quadrature with I_2. If we draw $GI = I$, then the vector EI is $R_I I_1$. The vector IF is ~~R_3~~ $R_2 I_3 = R_2 (I_1 + I)$. The direction of I_1 and I_3 are thus determined from this diagram.

First of all the circuit is arranged as a simple Wheatstone's bridge connecting the inductance in the unknown arm CD. The resistance R_1 and R_2 are fixed to 10 Ohm each and R_3 is varied until the galvanometer deflection changes direction. The expected value ~~Can~~ is calculated with the formula (6)

The experiment is repeated with $\frac{R_1}{R_2} = 10$ and 100 and the actual resistance in the inductance arm R_L is calculated. Now, R_1 and R_2 are readjusted to the ratio 10 : 10 and a fractional resistance R'

Now, R_3 and

in galvanometer. In this case, $R_1 + R' = R_4 = R_3$. To increase the sensitivity resistance are so arranged that $R_1 = R_2 = \frac{1}{2} R_3$

Now, galvanometer and dc source are replaced by headphones and ac source (oscillator) respectively and capacitance C and resistor r (0 to 10k Ω) are inserted as shown in fig ①. R_1, R_2, R_3 and R_4 are kept as such and the bridges is balanced for minimum sound with the help of resistance r. ~~Ther~~ The experiment may be repeated by taking different capacitances. Substituting these values in equation ⑦, self inductance of a given coil can be calculated.

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