Equivalent Circuit of Recorder as for 16th Oct 1929
only \( H = 6000 \)
Resonant Freq = 250v
Stylus length = \( l \) so that \( Z = 2500 \).

\[ H = \text{field} \]
\[ r = \text{radius of moving coil} \]
\[ \omega = \text{angular velocity, rad/sec} \]
\[ T = \text{torque in dyn. cm} \]
\[ l = \text{length of gap} \]
\[ V = \text{Volts} \]

All electrical properties reduced to 500 turn secondary.

\[ V = 2Hl x 10^{-3} \times 500 \]
\[ T = 2Hl x 10^{-6} \times 500 \]

Put 500 x 2Hl = \( R \).

\[ V = kx_{10^{-3}} \]
\[ T = kx_{10^{-1}} \]
\[ V = kx_{10^{-8}} x T x 10 \]
\[ T = kx_{10^{-2}} \]

In present case \( V = 0.8 \)
\( l = 1 \)
\( H = 6000 \)
\( k = 2.3 \times 10^{-10} \times 0.8 \times 1 \times 10^6 \)
\( = 4.8 \times 10^6 \)
\( k = 2.3 \times 10^{13} \)

Angular Inertia = \( \frac{T}{\omega} = \frac{kx_{10^{-1}} x R}{V x 10^8} \)
\( = R^2 x 10^{-9} \)
Al resistance required \( R_a = 92.7 \Omega \)
Copper,"\( R = 5.8 \)
Sag 100\( \Omega \) Total.

\[
\frac{R}{L} = \frac{2.3 \times 10^{-9} \times 10^{13}}{100} = 2.3 \times 10^2
\]

Radius to make needle point
Impedance = 25,000.

\[
\frac{1}{\frac{R}{L}} = 25,000
\]

\[
\frac{R}{L} = \frac{2.3 \times 10^3}{2.5 \times 10^3} = 0.92 \text{ cm}^2.
\]

\[
R_1 = 0.303 \text{ cm}.
\]

Radius of coil = 0.8 cm.

Normal recording level corresponds to needle point velocity of 4.2 cm/sec.

Angular velocity = \( \frac{4.2}{0.303} = 13.95 \text{ rad/sec} \)

Volts wound = \( 2 \times 10^{-8} \)

\[
= 4.8 \times 10^{-6} \times 13.95 \times 10^{-8}
\]

\[
= 6.7 \times 10^{-2}
\]

\[
= 0.67.
\]

Moment of inertia = 0.186 gr cm\(^2\) M

\[
\text{Torque to accelerate} = M \times \frac{1}{L} = J \times \omega M.
\]

\[
Z = \frac{1}{L} = b \times 99 = \frac{L \times 10^{-6}}{T \times 10^{-8}} = \frac{L \times 10^{-9}}{\omega M} = \frac{1}{2.3 \times 10^{-8} \times \frac{1}{\omega}} = \frac{2.3 \times 10^{-4}}{426}
\]

\[
= \frac{J \times 0.186 \times 10^{-8} \times \frac{1}{2.3 \times 10^{-8}}}{J \times 216 \times 10^{-8}} = \frac{2}{J} \times 10^{-4} = C = 21.1 \text{ M}.
\]
Stiffness to resonate at 250\(\nu\) = 1570\(\nu\).

\[
S = \frac{j\nu}{k} = \omega^2 M.
\]

\[
= 1570^2 \times 9.86 \times 1.20 \times 10^6
\]

\[
\frac{I}{k} = \frac{S}{\nu} = \frac{120 \times 10^6}{\nu}
\]

\[
Z = h^2 \times 10^{-9} \times \frac{\nu}{1}
\]

\[
= h^2 \times 10^{-9} \frac{\nu}{1.2 \times 10^6}
\]

\[
= \frac{2.3 \times 10^{13} \times 10^{-9}}{1.2 \times 10^6} \frac{\nu}{12} = 2.3 \times 10^{-2} \frac{\nu}{12} = 0.1915 \times 10^{-3}
\]

\[
= \frac{\nu}{19.15 \times 10^{-3}}
\]

\[
L = 19.15 \text{ mH.}
\]

\[
\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{19.15 \times 21.1 \times 10^{-6}}}
\]

\[
= \frac{10^4}{\sqrt{40.5}}
\]

\[
\omega = 1570 \times 10^4
\]

\[
= 15700
\]
Check from previous analysis assuming 10,000 lines/m².

\[ C = 7.6 \times \left( \frac{10}{6} \right)^2 = 211 \text{ M.F.} \]

Impedance looking back was to be 7.6 ohms.

Now must be \[ 7.6 \times \left( \frac{10}{6} \right)^2 \times \left( \frac{1.8}{303} \right) \]

\[ = 7.6 \times \left( \frac{1.6 \times 1.8}{303} \right)^2 \]

\[ = 7.6 \times \left( \frac{3.57}{303} \right)^2 \]

\[ = 84 \text{ ohms} \]

Volts required \[ = 187 \times \frac{6}{10} \times \frac{1.8}{303} \]

\[ = 187 \times 3.56 \]

\[ = 0.67 \text{ volts} \]

This is O.K.