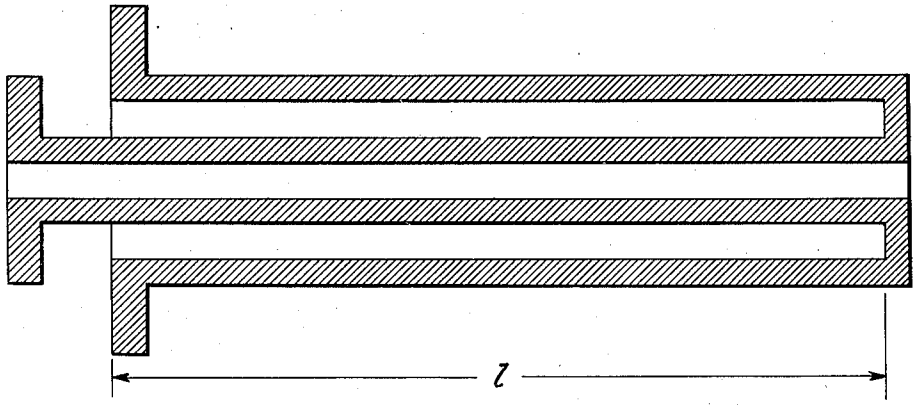
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OHMIC RESISTANCE FOR HIGH FREQUENCIES

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INVENTOR
HANS O. ROOSENSTEIN
BY
ATTORNEY

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OHMIC RESISTANCE FOR HIGH FREQUENCIES

Hans Otto Roosenstein, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

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3 Claims. (Cl. 178—44)

The invention discloses an embodiment of a resistance whose dimensions are so chosen that it will possess a pre-calculable pure ohmic resistance up to the highest occurring frequencies. Such resistances are of great practical value for various purposes in radio frequency work, for instance, in power or energy measurements, balancing of bridges, and determining phase angles. According to this invention they consist of a line being short-circuited at its free end. The conditions which a line of this kind should satisfy in order to represent between its input terminals a purely ohmic resistance shall be calculated in what follows.

It is known that for the impedance Z_a representing a line containing resistance and leakance between its input terminals there holds good the following formula:

$$Z_a = W \cdot \text{Tanh}\, g = W \cdot \frac{e^g - e^{-g}}{e^g + e^{-g}} \qquad (1)$$

where

$W = \sqrt{\frac{R + i\omega L}{G + i\omega K}}$ = surge impedance of line

$i = \sqrt{-1}$

ω = cyclic frequency
R = resistance per unit of length
L = inductance per unit of length
G = leakance
K = capacity
e = basis of nat. log.

There is further:

$$g = l \cdot \sqrt{(R + i\omega L) \cdot (G + i\omega K)}$$

the known wave measure of the line, where l is the length of the line.

In the case of a line having a length that is small compared with λ, there may be written with sufficiently close approximation:

$$e^g = 1 + g + \frac{g^2}{2}$$

so that Equation (1) will change into this approximate formula:

$$Z_a = W \cdot g \cdot \left(1 - \frac{g^2}{2}\right) \qquad (2)$$

By introducing the values above indicated for W and g and by making the imaginary part of the equation equal to 0, for the condition that Z_a should be purely ohmic there follows this equation:

$$0 = 2 \cdot \frac{L}{K} + \omega^2 L^2 l^2 - R^2 \cdot l^2 \qquad (3)$$

In deriving this formula the presupposition has been made that leakage G of the line is practically of zero value.

If

$$W_1 = \sqrt{\frac{L}{K}}$$

the surge impedance of a similarly designed, but lossless line it can be said that

$$\omega L = \frac{2\pi W_1}{\lambda}$$

and Equation (3) changes into this form

$$0 = 2W_1^2 + \frac{4\pi^2 W_1^2 l^2}{\lambda^2} - R^2 l^2$$

or approximately for $l << \lambda$

$$Rl = W_1 \cdot \sqrt{2}$$

By introducing this value of W_1 into Equation (2) there results for the value of the initial impedance Z_a with close approximation this formula:

$$Z_a = l \cdot R$$

which indicates that this impedance is of a purely ohmic nature.

For carrying into practice the basic idea of the invention there is particularly well suited a concentric tube line being short-circuited at the end as shown in the drawing. For making very small resistances $Z_a = lR$, also

$$W_1 = lR/\sqrt{2}$$

must be very reduced, so that it is useful in a case like this to choose for the dielectric of such a line wholly or partly a solid or a liquid material having the highest possible dielectric constant and involving but low dielectric losses.

I claim:

1. A circuit arrangement exhibiting substantially pure ohmic resistance characteristics especially for use in high frequency work comprising a transmission line short-circuited at one end, the length of which is small compared to

the wave-length of the working frequency upon the line, said line being characterized by that its leakage is negligible and its resistance per unit length multiplied by its length is approximately equal to $\sqrt{2}$ multiplied by the characteristic impedance of a geometrically similar but dissipationless line.

2. An arrangement such as described in the preceding claim wherein the transmission line comprises two spaced concentric tubular members.

3. A circuit arrangement exhibiting substantially pure ohmic resistance characteristics for a predetermined wide range of frequencies especially for use in high frequency work comprising, a transmission line open at one end so as to form the connecting terminals for the circuit arrangement and short-circuited at the other end, the length of the transmission line being small in comparison to the wave length of the working frequency upon the line, said line being characterized by that its leakage is negligible and its resistance per unit of length multiplied by its length is equal approximately to $\sqrt{2}$ multiplied by the characteristic impedance of a geometrically similar but dissipationless line.

HANS OTTO ROOSENSTEIN.