Aug. 23, 1949. E. G. LINDER 2,479,687

SUPER HIGH FREQUENCY FILTER

Filed May 17, 1943

Fig. 1.

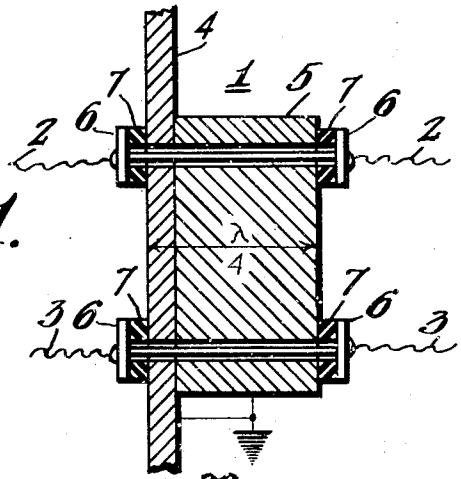


Fig. 2.

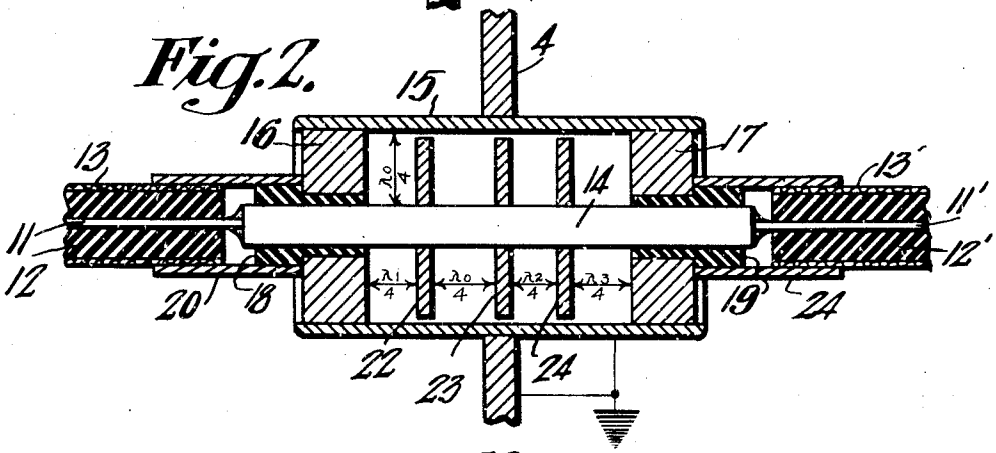
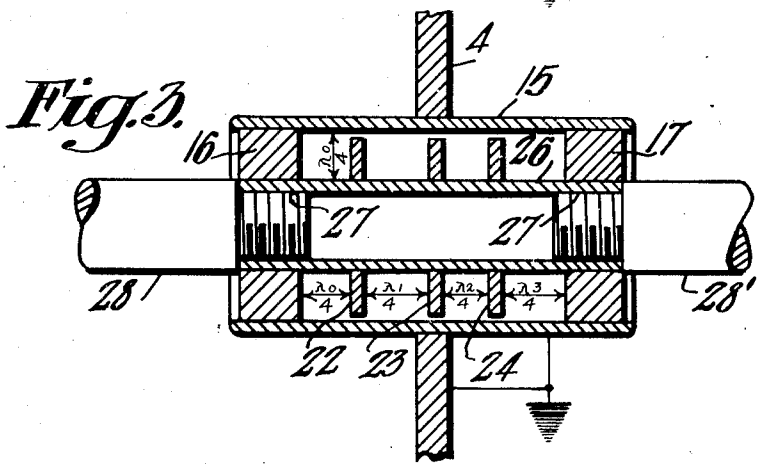


Fig. 3.



Inventor

Ernest G. Linder

By

Attorney

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SUPER HIGH FREQUENCY FILTER

Ernest G. Linder, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

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4 Claims. (Cl. 178—44)

1

This invention relates generally to super-high frequency apparatus, and more particularly to filters for attenuating super-high frequency energy on electrical power conductors or movable or rotating shafts.

Briefly, the invention contemplates the use of quarter-wave filter sections for attenuating super-high frequency energy on power conductors or rotating shafts which extend through super-high frequency shielding enclosures. The invention comprises a unique super-high frequency bypass device which offers extremely low shunt impedance to super-high frequency currents impressed thereon. The purpose of the filters is effectively to ground the super-high frequency energy at one or more points along a conductor at which super-high frequency voltage loops occur. The conductor is effectively grounded through a length equal to at least a quarter wavelength at the super-high operating frequency, whereby some point or points along the conductor will necessarily correspond to the occurrence of a voltage loop. This arrangement may be advantageously adapted to devices operating over a relatively wide range of frequencies, since the bypassing will be uniform and equally effective notwithstanding changes in the standing wave distribution along the line.

One of the several modifications of the invention, to be described in detail hereinafter, includes a quarter-wave bypass capacitor for filtering power leads extending through a shielding super-high frequency enclosure.

A second modification includes a more complex quarter-wave filter which comprises a central conductor coaxially disposed with respect to an outer cylindrical conductor, which is spaced therefrom a distance of the order of a quarter wavelength at the operating frequency. Insulation for direct current is provided between the conductors, and the outer cylindrical conductor is effectively grounded to the shielding enclosure and the shielding braid on the conventional power conductors. A plurality of annular conductive elements are interposed between the central conductor and the outer coaxial conductor at intervals of the order of a quarter wavelength within the operating super-high frequency range. The peripheries of the annular conductive members are in close capacitive relation with the inside surface of the outer concentric conductor, thereby providing extremely low impedance shunt circuits for the super-high frequency energy at intervals of the order of a quarter wavelength along the central conductor.

2

A third embodiment of the invention comprises means for effectively grounding a movable or rotating shaft which extends through an aperture in a super-high frequency shielding enclosure. A cylindrical outer conductor, securely fastened to the shielding enclosure, includes at each end thereof bearing members for the shaft. Interposed between the bearing members, at intervals of the order of a quarter wavelength at the operating frequency, are a plurality of annular substantially quarter wave conductive elements securely fastened to the movable or rotating shaft. The peripheries of these annular conductive elements are in close capacitive relation with the outer cylindrical conductor, which is effectively grounded to the shielding enclosure. If preferred, the complete filter may be constructed as a unit, and may include means for coupling the rotating or movable shaft to the inner and outer extremities of the central movable conductor of the filter.

Among the objects of the invention is to provide improved means for filtering super-high frequency energy. Another object is to provide an improved quarter wavelength filter for power leads extending into a super-high frequency shielding enclosure. A further object is to provide an improved quarter wavelength super-high frequency filter which includes a plurality of capacitive bypass elements at intervals of the order of a quarter wavelength at the operating frequency. A still further object of the invention is to provide an improved filter for super-high frequency shielding enclosure. An additional object is to provide an improved super-high frequency filter for conductive elements extending into a shielding super-high frequency enclosure, which includes a plurality of capacitive elements separated a distance of the order of a quarter wavelengths at operating frequencies extending over a predetermined frequency band.

The invention will be described in further detail by reference to the accompanying drawing, of which Figure 1 is a cross-sectional view of one embodiment of the invention, Figure 2 is a cross-sectional view of a second embodiment thereof, and Figure 3 is a cross-sectional view of a third embodiment thereof. Similar reference numerals are applied to similar elements throughout the drawing.

Figure 1 comprises a unique bypass capacitor 1, which may be employed to remove substantially all traces of super-high frequency energy from D.-C. or low frequency power leads 2, 3 which extend into a shielding enclosure includ-

ing an enclosure wall 4. The capacitor 1 comprises a block of brass, aluminum or similar material 5, having two holes drilled therethrough. The dimension of the block 5 and the thickness of the enclosure wall 4 along the axis of the holes is approximately a quarter wavelength at the average operating frequency. As a matter of convenience, its width may be of the same order, while its length is of any convenient dimension, which will depend upon the number of conductors to be filtered. It will be understood that any number of filter sections may be provided, although only two have been illustrated.

The metal block 5 may be securely mounted on the wall 4 of the shielding enclosure in any manner which provides good electrical contact therewith. Each conductor passes through one of the holes provided in the brass block. To increase the capacity between the conductors and the grounded block, capacitive discs 6 may be soldered to the leads adjacent each surface of the block and insulated therefrom by suitable insulators 7 of mica, or the like.

The purpose of this arrangement is to make certain that the leads are grounded at a point which is not a voltage node. Since the leads are effectively grounded through a length equal to a quarter wavelength at the average operating frequency, some point within the block will necessarily be that corresponding to a voltage loop, and hence the grounding will be effective. This arrangement is particularly advantageous where the device is operated over a wide range of frequencies, since the bypassing will be uniform and equally effective notwithstanding variations in the standing wave distribution along the lines.

Figure 2 comprises a quarter-wave filter for a power conductor extending into a shielding super-high frequency enclosure, wherein a plurality of quarter wave capacitive elements are provided effectively to bypass any super-high frequency energy which would normally follow the power conductor. A shielded power conductor includes a central conductor 11, an insulating layer 12, and an external shield 13 which may be in the form of a layer of lead or a layer of woven metallic braid. The filter includes a central conductor 14, to the extremities of which the power conductors 11, 11' are soldered or attached in any other convenient manner. The central filter conductor 14 is surrounded by a concentric cylindrical conductor 15, which is securely supported and grounded by the apertured enclosure wall 4.

The central conductor 14 and the outer cylindrical conductor 15 are supported in concentric relation by means of annular metallic members 16, 17 which are insulated from the central conductor 14 by suitable insulating inserts 18, 19, respectively. A conductive sleeve 20 extends from the annular conductive member 16 a short distance along the shielding layer 13 of the power conductor and provides a good contact therewith. Similarly, a conductive sleeve 24 extends, from the metallic member 17, a short distance along the shielding sleeve 13' of the internal power conductor.

A plurality of metallic discs 22, 23, 24 are disposed longitudinally along the central conductor 14, intermediate the annular supporting members 16, 17. The metallic discs 22, 23, 24 are spaced from the annular supporting members 16, 17, and from each other distances of the order of a quarter wavelength within the band of super-high operating frequencies. If filtering is desired over a relatively wide frequency band, the relative spacing of the metal discs 22, 23, 24 may be varied

$$\left(\frac{\lambda_0}{4}, \frac{\lambda_1}{4}, \frac{\lambda_2}{4}, \frac{\lambda_3}{4}\right)$$

to extend the filter attenuation characteristics. The peripheries of the metal discs 22, 23, 24 are in close capacitive relation with the internal surface of the outer cylindrical conductor 15. It will be seen that the several shunt capacitances provided thereby will be disposed at intervals of the order of a quarter wavelength along the filter section, whereby standing waves of the order of the operating frequencies will be attenuated effectively.

Figure 3 is similar to Figure 2, in that a plurality of capacitive elements are arranged at intervals of the order of a quarter wavelength between a central conductor and an outer cylindrical conductor substantially concentric therewith and electrically grounded thereto. This modification provides a convenient and effective means for filtering and bypassing super-high frequency energy on a rotating or otherwise movable shaft extending into a shielding super-high frequency enclosure. The outer cylindrical conductor 15 is securely supported by and electrically connected to the wall 4 of the shielding enclosure. The annular conductive elements 16, 17 provide bearings for supporting a central cylindrical conductor 26, substantially coaxially with the outer cylindrical conductor 15. The central cylindrical conductor 26 may include threaded holes 27 at each end thereof to receive complementarily threaded portions of the rotating shafts 28, 28'.

Effective filtering of super-high frequency energy which penetrates the bearings 16, 17 is provided by a plurality of substantially quarter wave metallic discs 22, 23, 24 attached to the central cylindrical conductor 26 at intervals of the order of a quarter wavelength

$$\left(\frac{\lambda_0}{4}, \frac{\lambda_1}{4}, \frac{\lambda_2}{4}, \frac{\lambda_3}{4}\right)$$

at the operating super-high frequency. The peripheries of the metallic discs 22, 23, 24 are in close capacitive relation with the inside surface of the outer cylindrical conductor 15 and operate in a manner similar to that described for the device of Fig. 2.

Thus the invention described comprises three embodiments of quarter wave super-high frequency filters for effectively bypassing super-high frequency energy on power conductors or rotating elements extending into shielding super-high frequency enclosures.

What I claim is:

1. A filter for super-high-frequency energy including a central conductor, a cylindrical conductor concentric with said central conductor and spaced therefrom a distance of the order of one quarter wavelength at the operating frequency, annular conductive members adjacent each end of said cylindrical conductor supporting said conductors in said relatively concentric relation, and at least one annular conductive element connected to and supported by said central conductor intermediate said annular members and capacitively coupled to said cylindrical conductor.

2. Apparatus according to claim 1 including means for moving said inner conductor with respect to said outer coaxially disposed conductor.

3. A filter for super-high frequency energy including a movable central conductor, a cylindrical conductor concentric with said central conductor and spaced therefrom a distance of the order of one quarter wavelength at the operating frequency, annular conductive bearing members adjacent each end of said cylindrical conductor supporting said conductors in said relatively concentric relation, and at least one annular conductive element connected to and supported by said central conductor intermediate said annular members and capacitively coupled to said cylindrical conductor.

4. Apparatus according to claim 1 including a plurality of said capacitive annular elements spaced the order of one-quarter wavelength at

a plurality of attenuated operating frequencies of said energy.

ERNEST G. LINDER.

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