

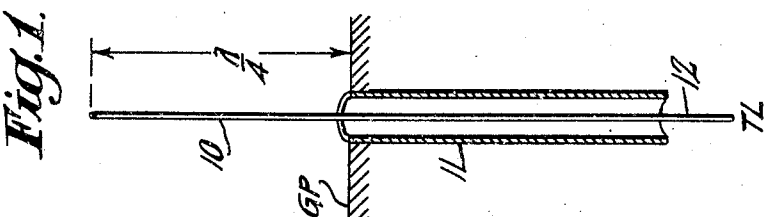
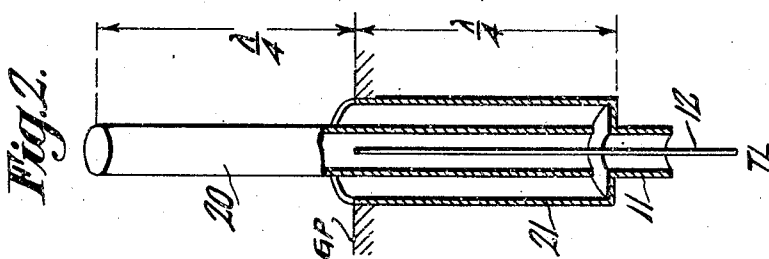
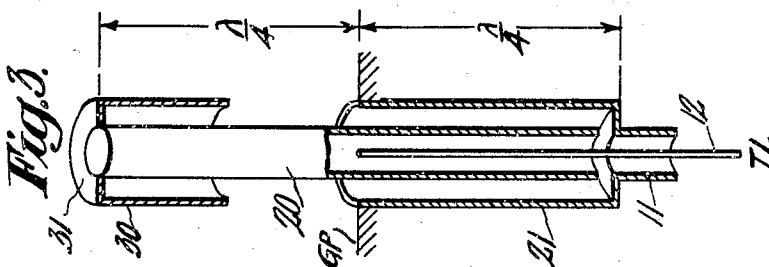
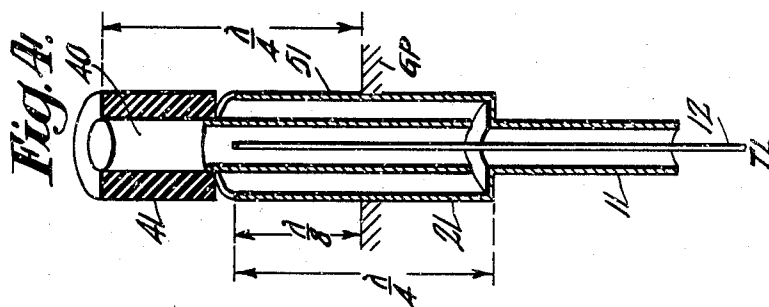
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The present invention relates to antennas and more particularly for arrangements for increasing the band widths of antennas.

An object of the present invention is to improve the wide band characteristics of short wave antennas.

Another object of the present invention is the provision of means for compensating for variations in antenna characteristics with variations in the frequency of radio frequency energy applied to the antenna.

A further object of the present invention is the provision of an antenna for wide band operation which is simple and rugged in construction.

Still a further object of the present invention is the provision of simple means for both reactance and resistance compensation of antennas designed to operate over a wide frequency band.

When compensating an antenna for variations in its characteristics with variation in the frequency of energy applied thereto in order that the operating frequency band may be widened, it is observed that both the reactance and the radiation resistance of the antenna vary with frequency. The magnitude of said variations as appearing in the transmission line connected to the antenna depends greatly upon the choice of the feed point to which the transmission line is connected and the means by which the transmission line is coupled to the antenna. Even after choosing the optimum feed point and method of coupling, there still remains a certain amount of variation of resistance and reactance with variation of frequency. Additional matching circuits may be supplied for a further reduction of the impedance variation.

Both reactance and resistance variations of the antenna basically derive from a change in the distribution of the field about the antenna with the change in frequency. However, the reactance variations and the resistance variations tend to follow different laws of variation with respect to frequency changes. It may be said that reactance variations are more easily compensated for, since in general, they can be reproduced in a line element connected to the transmission line. On the other hand, for simplified resistance compensation, the compensation should be applied at the source; that is, in the antenna structure itself.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

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Figure 1 illustrates a simple quarter wave radiator, while

Figure 2 illustrates partly in section an application of the present invention to the antenna of Figure 1;

Figure 3 illustrates a modification of Figure 2, while

Figure 4 illustrates still another modification in accordance with the principles of the present invention for providing increased band width of the antenna.

Figure 1 shows a simple quarter wave radiator 10 extending above ground plane GP which may be a metallic sheet forming a part of the supporting structure for the antenna. Transmission line TL has an outer sheath 11 connected at its uppermost end to the ground plane GP while the inner conductor 12 is directly electrically connected to the lower end of quarter wave radiator 10. Here the virtual resistance introduced by radiation at the feed point; that is, in the plane of ground plane GP, is in series with the reactive components of the antenna. Thus, the band width of the antenna decreases with increase of magnitude of the reactive components. In other words, since the radiation resistance component of the antenna impedance is largely independent of the diameter of the radiator, it will be seen that the effective band width of the antenna of Figure 1 increases with an increase of diameter of the radiator 10.

Figure 2 illustrates a way in which the reactive variation of the antenna of Figure 1 may be further compensated. Here the quarter wave radiator 20 is of comparatively large transverse dimensions and has a total overall length substantially equal to one half of the operating wavelength. A length of the antenna equal to one quarter of the operating wavelength; that is, substantially half of it, is surrounded by an outer cylinder 21 below the ground plane GP. The upper half of radiator 20 radiates as a large diameter quarter wave radiator perpendicular to a conductive ground plane. Transmission line TL has its outer sheath 11 connected to the bottom end of outer sleeve 21. The wall of inner conductor 12 extends within the hollow lower portion of member 20 a distance equal to a quarter of the operating wavelength. Thus, it will be seen that the point where the transmission line enters the antenna conductor; that is, at the lower end of sleeve 21, and the point where the antenna protrudes into space and is coupled to the surrounding space; that is, the top end of the sleeve 21, are approximately a quarter wave

apart. The enclosed portion of antenna conductor 20 within sleeve 21 thus forms a quarter wave transmission line element which is matched to the antenna resistance while the enclosed transmission line element; that is, the portion of conductor 12 within the hollow lower portion of conductor 20, forms a series reactance in the line. The series reactance in the line is made as nearly equal to the series reactance of the antenna as possible. The two series reactances being substantially a quarter wave apart, one compensates for the other. If necessary, the series reactance in the line may be located at a distance from the antenna feed point as long as its distance therefrom is of the order of an odd number of quarter wavelengths so as to obtain the same compensation effect as before. Such relocation depends somewhat upon the particular frequency band requirement since it will be seen that if a large number of quarter waves appear between the two reactance points in the system, a comparatively small change in frequency may result in a large total change in ineffective electrical position. That is, the chosen line length may be an odd number of quarter waves at one frequency and an even number at a slightly different operating frequency if the band width is too great. Such conditions must be avoided. It will be observed from the drawing that the conductor 20 has its lower end spaced from the sheath 11 and its extension which forms the connection with the sleeve 21, as well as being spaced from sleeve 21. Thus the interior of the hollow portion of conductor 20 communicates with the space between conductor 20 and sleeve 21 for the passage of electromagnetic energy.

In Figure 3 there is illustrated a means where the radiation resistance of the antenna may be kept more constant. The antenna and matching sleeve construction is the same in Figure 3 as in Figure 2 and will not again be described. However, the upper end of the radiating portion of antenna 20 is here surrounded by a conductive sleeve 30. Sleeve 30 is maintained in position relative to the antenna conductor 20 by spacing means such as plate 31 at the top of the antenna. The surrounding body around the top of antenna 20 effects a redistribution of the field about the antenna in such a way that counter-effect is obtained against the effect of the variation in distribution of the field by a change in frequency.

Figure 4 illustrates how reactance compensation may be applied to a sleeve type of antenna. Here the outer sleeve 21 of the antenna has the upper half above ground plane GP as indicated by 51. Thus, the quarter wave radiator consists of two end-to-end eighth wave portions, energized at their junction. Due to the change in position of the ground plane GP with respect to the sleeve 21, the inner member 40 is here only three eighths of a wave in length. Reactance compensation is applied in this form of the invention by means of a sleeve 41 of dielectric material surrounding a selected portion of radiator rod 40. If the dielectric sleeve 41 has a relatively high dielectric constant, a sufficient redistribution of the field about the antenna occurs whereby a more constant radiation resistance is obtained. The conductive radiation redistributing shield 30 of Figure 3 may be employed with Figure 4 instead of the dielectric sleeve 41.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several

elements employed and in their arrangement without departing from the spirit and scope of the invention.

What is claimed is:

1. An antenna including an elongated conductor having an overall length substantially half of the operating wavelength, substantially one half of the said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor, said conductor having an opening between the interior of the said hollow portion within said sleeve and the exterior thereof.
2. An antenna including an elongated conductor having an overall length of substantially a half of the operating wavelength, substantially one half of said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, said conductor having an opening providing communication for the passage of electromagnetic energy between the interior of said hollow portion within said sleeve and the space between said sleeve and said conductor.
3. An antenna including an elongated conductor having an overall length of substantially a half of the operating wavelength, substantially one half of said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, a portion of said conductor which is outside said sleeve being surrounded by means so redistributing the field about said antenna as to counteract the variation in impedance of said antenna with a change in frequency, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.
4. An antenna including an elongated conductor, a portion of said conductor being surrounded by a sleeve having a length equal to a quarter of the operating wavelength, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to an odd multiple, including unity, of one quarter of the operating wavelength, said antenna extending perpendicular to a conductive sheet a distance equal to a quarter wavelength, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.
5. An antenna including an elongated conductor having an overall length of substantially a half of the operating wavelength, substantially

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one half of said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, a portion of said conductor which is outside said sleeve being surrounded by means so redistributing the field about said antenna as to counteract the variation in impedance of said antenna with a change in frequency, said means including a conductive sleeve member surrounding the outer end of outer conductor and connected thereto, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.

6. An antenna including an elongated conductor having an overall length of substantially a half of the operating wavelength, substantially one half of said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, a portion of said conductor which is outside said sleeve being surrounded by means so redistributing the field about said antenna as to counteract the variation in impedance of said antenna with a change in frequency, said means including an insulating sleeve of high dielectric material surrounding outer end of said conductor, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.

7. An antenna including an elongated conductor extending normal to a conductive sheet constituting a ground plane and having an overall length of substantially three eighths of the operating wavelength, a length of said conductor equal to one quarter of the operating wavelength being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.

8. An antenna including an elongated conductor extending normal to a conductive sheet con-

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stituting a ground plane, a length of said conductor equal to one quarter of the operating wavelength being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to an odd multiple, including unity, of one quarter of the operating wavelength, the extension of said antenna above said sheet being one quarter of the operating wavelength, said conductor having an opening, the interior of said hollow portion of said conductor communicating through said opening with the space between the said sleeve and said conductor for the passage of electromagnetic energy.

9. An antenna including an elongated conductor extending normal to a conductive sheet constituting a ground plane and having an overall length of substantially three eighths of the operating wavelength, a length of said conductor equal to one quarter of the operating wavelength being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor a distance equal to one quarter of the operating wavelength, substantially one half of said sleeve extending above said ground sheet, said tubular conductor having an opening at the end thereof above said sheet.

10. An antenna including an elongated conductor having an overall length of substantially a half of the operating wavelength, substantially one half of the said conductor being surrounded by a sleeve, at least the portion of said conductor which is within said sleeve being hollow, a coaxial line having an outer sheath and an inner conductor, said outer sheath being connected to said sleeve and said inner conductor extending into the hollow portion of said conductor, the end of said conductor including said hollow portion within said sleeve being insulatingly spaced from said sheath and said sleeve to afford communication for the passage of electromagnetic energy between the interior of said hollow portion of said conductor and the space between said sheath and said conductor.

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