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P. M. PAN

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LOOP ANTENNA UTILIZING CONDUCTIVE CABINET

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FIG. 1.

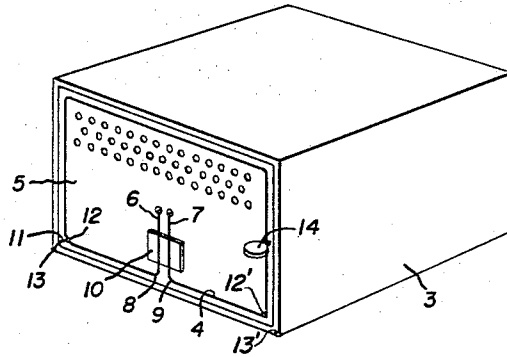
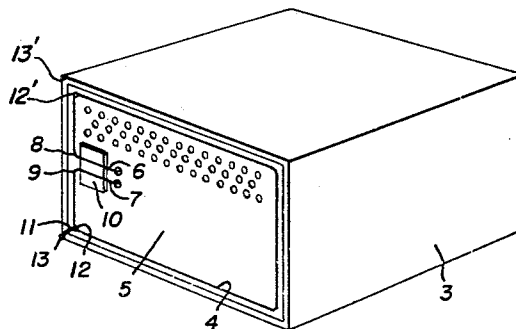


FIG. 2.



INVENTOR:

PAUL M. PAN,

BY *Donald H. Timbre*
HIS ATTORNEY.

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LOOP ANTENNA UTILIZING CONDUCTIVE CABINET

Paul M. Pan, North Syracuse, N.Y., assignor to General Electric Company, a corporation of New York

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This invention relates to an antenna arrangement for use with any electronic equipment contained in metal cabinets.

In television receivers having wooden or plastic cabinets, an inexpensive antenna has been provided by stringing wire around the inside of the cabinet. Such an antenna has generally yielded as good, if not better performance than simple indoor antennas mounted externally of the cabinet so that the need for such unsightly and relatively expensive antennas is avoided. Of course, neither of these antennas performs as well as an expensive antenna array mounted externally of the house in which the receiver is located, but in a majority of locations, such an expensive arrangement is not necessary.

Recently, more and more television receivers have been mounted in metal cabinets so that suitable antennas cannot be provided by the simple and inexpensive expedient of stringing wire inside the cabinet. The reason for this is that the cabinet shields the antenna. Hence, the usual procedure is to provide an antenna that may be mounted externally to the receiver. Such antennas are often cumbersome, unsightly and expensive.

Accordingly, it is an object of this invention to provide an improved inexpensive antenna arrangement for use with electronic equipment mounted in metal cabinets.

It is another object of this invention to provide an improved antenna for electronic equipment mounted in a metal cabinet that does not necessarily extend outside of the cabinet to any substantial degree.

The invention is also applicable to cabinets made of non-conducting material as such cabinets may be coated or lined with conducting material. Whereas it might seem at first that such coating or lining would be unnecessary, in view of the fact that standard antennas mounted within a cabinet of non-conducting material are not shielded, the fact is that in smaller cabinets there is not enough space so that it is customary and even necessary to mount the antenna outside the cabinet if a reasonably good antenna is to be provided. Furthermore, even if the cabinet is large, the provision of a metallic lining so as to take advantage of this invention may be less expensive and ultimately more desirable than any other antenna arrangements.

Briefly, one way of achieving these objectives in accordance with the principles of this invention is by making the metal cabinet operate as a parasitic element of the antenna array. In most instances one or both ends of the metal cabinet are open. A conductor is mounted adjacent the periphery of one end and the ends of the conductor serve as a lead-in wire to the electronic equipment. In addition, a direct electrical connection is made between points of the metal cabinet and the conductor having conjugate impedances.

The manner in which these objectives may be attained in accordance with the principles of this invention will be more clearly understood after the following discussion of the drawings in which:

Figure 1 illustrates a cabinet in which the lead-in is

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made at the approximate center of the conductor adjacent the side of a rectangular cabinet having the greater dimension; and

Figure 2 illustrates a cabinet in which the lead-in is made at the approximate center of the conductor adjacent the side of the cabinet having the lesser dimension.

In the drawings, the numeral 3 indicates the metal cabinet or the metal coating or lining of a cabinet of non-conducting material. In Figure 1, a loop antenna 4 is mounted in any suitable manner on a sheet 5 of non-conducting material which is secured to the cabinet 3 in any suitable fashion. The ends 6 and 7 of the conductor forming the loop antenna 4 are bent in at points 8 and 9, respectively, and are constrained to be parallel by mounting them in any suitable manner to a piece 10 of non-conducting material. It is readily apparent that the conductor of the loop antenna 4 could be cut at points 8 and 9 and joined as by soldering to parallel conductors of any suitable transmission line. A conducting element 11 is connected so as to make direct electrical contact between a point 12 on the conductor 4 and a point 13 on the cabinet 3. The conducting element 11 may be fabricated in a variety of ways and may be in the form of a hook at one end so that that end may be hooked into a hole or around a lug on the metal cabinet 3.

The arrangement shown in Figure 2 is similar to that of Figure 1 and for this reason corresponding components are indicated by the same numerals. The main difference is that the points 8 and 9 are at the side of the antenna loop 4 instead of at the bottom.

In either Figure 1 or Figure 2, it is important that the loop 4 not be so close to the cabinet 3 as to provide any substantial amount of capacitive coupling between them at the frequencies at which the antenna is to operate. In one practical embodiment of this invention, the metal cabinet 3 had a height of approximately 11 inches, a width of approximately 13 inches and a depth of approximately 16 inches, and it was determined, for the VHF channels, that capacitive coupling manifested itself when the loop 4 was within one quarter of an inch from the edge or periphery of the metal cabinet 3. Actually, the loop 4 was mounted about one half an inch from the edge of the cabinet 3.

The loop 4 can be mounted within the cabinet 3, but as it is inserted further in the cabinet, the effects of shielding by the cabinet become more pronounced. However, if this seems desirable, the spacing between the loop 4 and the cabinet 3 can be such as to prevent substantial capacitive coupling. The loop 4 can also be moved axially to a position outside of the cabinet.

Actually, the antenna loop 4 can be mounted in any position, but as the distance between it and the cabinet 3 increases, care must be taken to make the connection between them have the proper length with respect to the wavelengths involved. However, it is preferable that the antenna loop 4 be so close to the cabinet 3 that the conducting elements 11 be extremely short with respect to the wavelengths involved, thus avoiding problems of improper phasing.

In general, it is desirable that the area within the loop 4 be as large as possible without the conductor forming the loop being more than a few inches from the cabinet 3. Therefore, the loop 4 may be larger than the cross-section of the cabinet 3 and mounted at various positions along its axis. However, for reasons of convenience and appearance, this is not generally desirable.

It is not required that the shape of the loop 4 correspond to a cross-section of the cabinet, so that the loop 4 may be circular or in fact have any shape desired,

It is apparent that the distance between the loop 4 and the cabinet 3 is a small fraction of a quarter wave of the frequencies involved so that the cabinet 3 acts as a parasitic element of the antenna loop 4. However, with such relatively close spacing, the amount of electromagnetic coupling is extremely small so that the effectiveness of the cabinet 3 as a parasitic element is slight. In order that there be coupling between the loop 4 and the cabinet 3, the conducting element 11 is provided as previously described. The selection of the point 12 on the loop 4 and the point 13 on the cabinet 3 is made as follows: With the electronic equipment mounted in the cabinet 3, but with the loop 4 missing, a plot of the impedance between corresponding points on opposite sides or between corresponding points of the top and bottom of the cabinet 3 is derived either from calculations or tests well-known to those skilled in the art; for example see chapter 2 or 6 of the "Handbook of Microwave Measurements" published by the Polytechnic Institute of Brooklyn. Such a plot could be made on the well-known Smith chart. Then a plot, on a Smith chart or otherwise, is made by well-known calculations or similar tests of the impedances between points that are similarly located with respect to the lead connections of the conductor forming the loop antenna 4. The points 12 and 13 have conjugate impedances, i.e., impedances having equal resistances and equal reactances, the latter having opposite signs. In the television cabinet described above, the points having conjugate impedances for a frequency in the approximate center of the VHF television bands came out to be the corners of the loop 4 and the cabinet 3 shown. Of course, there are usually two other points of conjugate impedance, such as 12', 13', symmetrically located with respect to the lead-in of the loop 4. Any points of conjugate impedance can be connected, but it is preferable to connect those that are closest.

Whereas it is generally preferable that the antenna loop 4 be symmetrical with respect to the lead-in, this is not essential for this invention. In fact, if the antenna loop does not have a point having an impedance that is a conjugate of a point on the cabinet, or if such points are not conveniently located, it may be desirable to make the loop unsymmetrical.

If there are no points having conjugate impedances, the connection may be made between those points having the closest approximation thereto or the impedance of the cabinet 3 or of the loop 4 can be varied by selective loading methods well-known to those skilled in the art. For example, the impedance of the loop 4 can be rotated about the center of the Smith chart so that there are points diametrically opposed to points of the impedance plot of the cabinet 3 by moving a wafer 14 of conducting material along the loop 4 while in electrical contact therewith.

Instead of plotting the impedances of the cabinet 3 and the loop 4, the element 11 could be moved around until best results are achieved. In fact, it may be found that slightly different locations of the points 12 and 13 may yield better results for different given frequencies. Hence, the element 11 might be in the form of a clip that can be placed at premarked positions for the various frequencies. In general, it will be found that the points 12 and 13 are near together.

Whereas the invention has been described in connection with a television receiver, it is to be understood that it has general application. Furthermore, the shape

of the cabinet need not be rectangular and may take any desired form.

While I have illustrated a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto, since various modifications, both in the circuit arrangement and in the instrumentalities, may be made and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An antenna for electronic equipment comprising a cabinet of conducting material formed to make a complete conducting loop having an opening at one end thereof and a first pair of points thereon having a predetermined impedance therebetween, a loop antenna having a pair of terminals and a second pair of points thereon remote from said terminals, said second pair of points having a conjugate impedance to said predetermined impedance between said first pair of points on said cabinet, means for mounting said loop antenna adjacent the edge of said opening, and means for electrically connecting one of said points on said cabinet with one of said points on said loop antenna.

2. An antenna for electronic equipment comprising a metallic cabinet formed to make a complete conducting loop having an opening at one end thereof and a first pair of points thereon having a predetermined impedance therebetween, a loop antenna having a pair of terminals and a second pair of points thereon remote from said terminals, said second pair of points having a conjugate impedance to said predetermined impedance between said first pair of points on said cabinet, means for mounting said loop antenna adjacent the edge of said opening, and means for electrically connecting one of said points on said cabinet with one of said points on said loop antenna.

3. An antenna for electronic equipment comprising a metallic cabinet formed to make a complete conducting loop having an opening at one end thereof and a first pair of points thereon having a predetermined impedance therebetween, a loop antenna having a pair of terminals and a second pair of points thereon remote from said terminals, said second pair of points having a conjugate impedance to said predetermined impedance between said first pair of points on said cabinet, means for mounting said loop antenna adjacent the edge of said opening, and means for electrically connecting one of said points on said cabinet with one of said points on said loop antenna which are the shortest distance apart.

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