

[54] **COAXIAL CABLE LOOP ANTENNA WITH UNIDIRECTIONAL CURRENT AMPLIFIER OPPOSITE THE OUTPUT**

[76] Inventor: **Clarence W. Fowler**, 1400 Valley View, Mesquite, Tex.

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[63] Continuation of Ser. No. 22,594, March 25, 1970, abandoned.

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[58] Field of Search **325/1, 8, 374, 375; 343/701, 734, 738**

[56] **References Cited**

UNITED STATES PATENTS

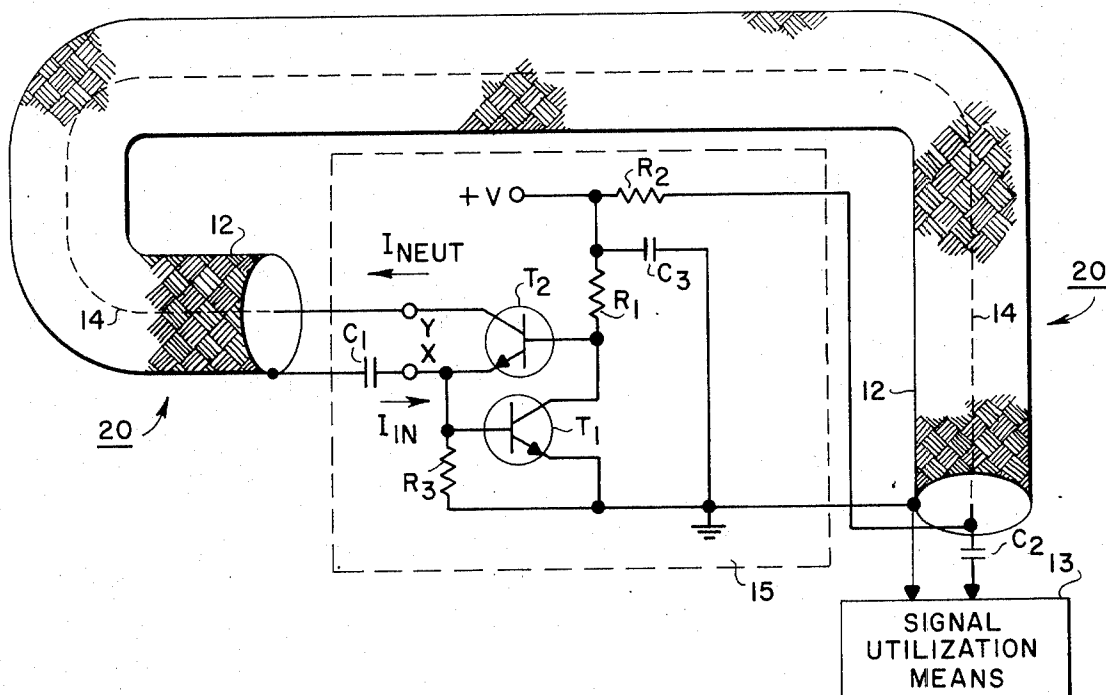
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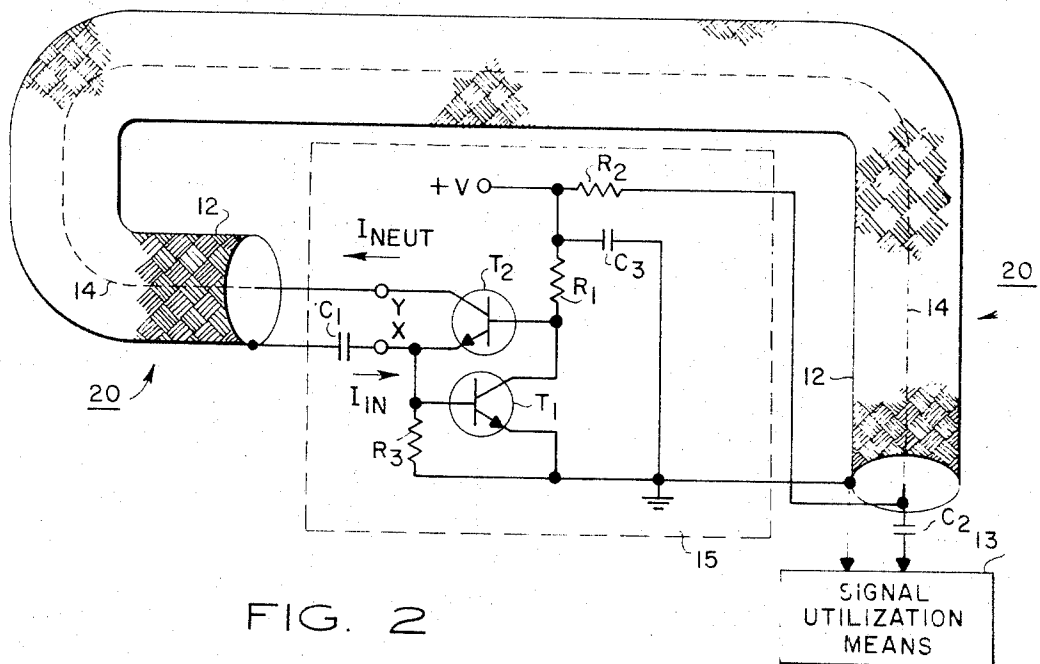
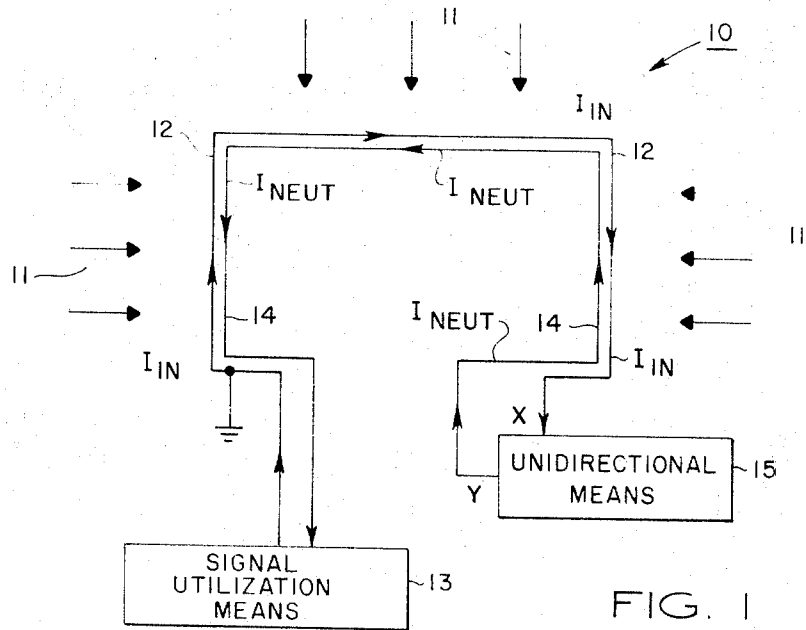
Primary Examiner—Eli Lieberman
Attorney—Kenneth R. Glaser

[57] **ABSTRACT**

Disclosed is an antenna system having a second loop disposed immediately adjacent and coupled to the primary field detecting or transmitting loop for neutralizing inductive reactance through the primary loop. Unidirectional current means which is disclosed as a low input impedance, high output impedance, unity gain current amplifier couples the primary and secondary loop for preventing significant current flow through the secondary loop except in a direction opposite that of the current flow through the primary loop, the primary and secondary loop, respectively, being the shield and center conductor of a coaxial cable, the center conductor coupled to signal utilization or transmitting means for processing or generating electromagnetic signal waves.

2 Claims, 2 Drawing Figures





INVENTOR
CLARENCE W. FOWLER

KENNETH R. GLASER
ATTORNEY

COAXIAL CABLE LOOP ANTENNA WITH UNIDIRECTIONAL CURRENT AMPLIFIER OPPOSITE THE OUTPUT

This is a continuation of application Ser. No. 22,594, filed Mar. 25, 1970, now abandoned.

The invention relates generally to antenna systems, more particularly to antenna receiving systems, and even more particularly to improved means for coupling the signals received from loop antennas to the signal utilization means.

Conventional loop antennas are often employed in high frequency directional receiving systems whereby the signals supplied to the signal utilization means (receiver) are a maximum when the source of received signals lie in the plane of the loop, and are a minimum when the axis of the loop is directed at the source of received signals. The effectiveness of these systems requires the adequate coupling of the power from these antennas to the receiver with a minimum of distortion as well as loss of signal strength. Extreme difficulty in this regard is encountered when power is to be coupled out of loops having extremely small diameters (generally less than one-tenth of the signal wavelength being received) due to the comparatively large inductive reactance relative to the low loop radiation resistance presented to the incoming signal. This large inductive reactance thus prevents sufficient power transference to the receiver.

A number of techniques have been heretofore attempted to overcome this problem, one common solution being to tune out the inductive reactance with the insertion of a parallel capacitor. Among the disadvantages associated with the solution, however, are the remote tuning problems present when the apparatus is located some distance from the control station (as, for example, in space exploration); the need for an excessively large number of capacitors when a broad range of frequencies are to be received; and the undesirably slow response time of the tuning cycle when the antenna is used for certain transmitting and direction finding applications.

It is therefore a primary object of the invention to provide a new and improved antenna system utilizing a loop antenna as the signal receiving and transmitting means;

It is a further object of the invention to provide a new and unique means and method for coupling the signals received by a loop antenna to the signal utilization means or receiver of the antenna system;

It is an even further object of the invention to provide a new and improved technique for substantially eliminating the detrimental loss of power in a small loop antenna due to the inductive reactance presented by such loop.

In accordance with these and other objects, features, and advantages, the present invention is directed to the disposition of a second loop immediately adjacent the primary loop of the antenna, the primary loop serving as the conventional electromagnetic radiation receiving or transmitting element, the second loop serving as an inductive reactance neutralization conductor in the manner subsequently described. The significant current flow through the neutralization loop is substantially equal to, but in a direction opposite that of, the significant current flow through the immediately adjacent section of the primary loop. A preferred embodiment

of the invention accomplishes this objective by having one end of the primary loop coupled by way of unidirectional current means to the neutralization conductor, which is thereafter coupled to the signal utilization means.

Other features, advantages, and objects of the invention will become more readily understood from the following detailed description taken in conjunction with the attached drawings, wherein:

FIG. 1 is a diagrammatic illustration of the antenna coupling technique in accordance with the principles of the invention; and

FIG. 2 is a partial circuit schematic of a preferred embodiment of the loop antenna receiving system of the invention utilizing a coaxial cable as the antenna loops in conjunction with a low input impedance, high output impedance amplifier as the unidirectional current means depicted in FIG. 1.

Referring now to FIG. 1, there is illustrated an antenna receiving system 10 for receiving electromagnetic waves 11. The system comprises the conventional primary loop antenna 12 in which the input signal current I_{in} is induced, and the signal utilization means 13, which may be a conventional radio receiver for processing the incoming signals. While the primary loop antenna 12 is illustrated as being of a single turn, this antenna may also be of multiple turns, all as known in the art. In the conventional loop antenna systems presently known in the art, the primary loop 12 would be directly coupled to the signal utilization means 13 and, as previously discussed, due to the comparatively large inductive reactance represented by the loop, would present difficulties in coupling sufficient power to the receiver 13, particularly if the diameter of the loop 12 is less than one-tenth of the wavelength of the received electromagnetic signals 11.

In accordance with the primary feature of the invention, therefore, a second loop 14 is disposed immediately adjacent the primary loop 12 so that the two loops are mutually inductively coupled. When a current I_{neut} substantially equal to the current I_{in} flows through the loop 14 in a direction opposite to that of the current flow in loop 12, as shown in the drawing, the inductive reactance of the two loops is neutralized, and the impedance of the antenna is essentially limited to the resistance of these conductors.

These conditions are met by the embodiment illustrated in FIG. 1 by the employment of unidirectional current means 15 which couples one end of the primary loop 12 to one end of the neutralization loop 14. The means 15 has a significantly low (preferably zero) input impedance at the input terminal X and a significantly high output impedance at the output terminal Y; as a result, the external field 11 does not cause a significant current flow in the inner loop 14, and the resulting current I_{neut} is thus generated in response to, but in the opposite direction of, the current I_{in} in the primary loop 12. The other end of the neutralization conductor loop 14 is then coupled to the signal utilization means 13, as illustrated in FIG. 1.

While various circuit arrangements may be utilized for the conductor loops 12 and 14, as well as for the unidirectional means 15, a preferred embodiment of the invention employs a properly terminated coaxial cable 20 for the antenna loops 12 and 14, and a non-inverting unity gain, current amplifier for the unidirectional means 15, one such amplifier depicted in FIG. 2.

Accordingly, the outer shield of the coaxial cable 20 serves as the field detecting antenna loop 12 which is coupled through the DC blocking capacitor C_1 to the pair of transistors T_1 and T_2 at the input terminal X of the amplifier arrangement 15, the center conductor of the cable 20 serving as the neutralization loop 14 and coupled to the output terminal Y. The input impedance at the input terminal X and the output impedance at the terminal Y are respectively minimum and maximum so that current flow through the center conductor 14 is confined to the output current I_{neut} from the amplifier, as shown.

Various types and values of circuit components and coaxial cables may be utilized in the circuit arrangement illustrated in FIG. 2, an example of such types and values being as follows:

Coaxial cable 20	RG 59
Transistors T_1 and T_2	2N 718
Resistor R_1	1.2 K ohms
Resistor R_2	75 ohms
Resistor R_3	100 ohms
Capacitors C_1 , C_2 and C_3	1 μ f

It is to be specifically pointed out that various modifications of the disclosed embodiment may be made consistent with the essential underlying concept of the invention, that is the provision of a closely spaced inductive reactance neutralization loop immediately adjacent the primary field detecting loop of the antenna; and means for preventing any significant current through the neutralization loop except in response to, but in a direction opposite that of, the current flow through the adjacent section of the field detecting loop. Thus, for example, rather than utilizing unidirectional means 15 for coupling the antenna loops 12 and 14 together, the ends of the loops 12 and 14 may be directly connected together, and the inner neutralization loop 14 surrounded by a shield for effectively isolating it from the effects of the external field 11. Thus the current flow through the inner conductor 14 would be equal to, but in an opposite direction from, the current flow through the outer field loop 12.

In addition, while FIGS. 1 and 2 have illustrated the system 10 as a receiving antenna, it would be also possible

to utilize this configuration in a transmitting antenna system. In this event, the means 13 would actually be a conventional transmitter, and the input impedance at the terminal Y of the unidirectional current means 15 would be a minimum, while the output impedance at the terminal X would be maximized. Thus current flow through adjacent loops 14 and 12 would be maintained in respectively opposite directions, thereby neutralizing the inductive reactance presented by said loops.

Various other modifications of the disclosed embodiments, as well as additional embodiments, may become apparent to one skilled in the art without departing from the spirit and scope of the invention as depicted by the appended claims.

What is claimed is:

1. A loop antenna receiving system, comprising:

- a. a coaxial cable composed of an outer shield providing a primary loop antenna for receiving externally generated electromagnetic signals and a center conductor disposed adjacent to said outer shield for providing a secondary conductive loop, said primary and secondary loops having opposite end portions,
- b. unidirectional current means coupling said outer shield to said center conductor at one end portion of said loops for preventing any significant current flow through said secondary loop except in a direction opposite the direction of current flow through said primary loop, whereby the inductive reactance associated with said primary loop conductor is effectively neutralized at a current flow through said secondary loop, said unidirectional current means being a low input impedance, high output impedance, unity gain current amplifier, and
- c. signal utilization means at the opposite end portion of said loops coupled to said center conductor of said coaxial cable for processing the said received externally generated electromagnetic signals.

2. The system as described in claim 1 wherein said amplifier has its input coupled to said outer shield and its output coupled to said center conductor.

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