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References cited :
EP-A- 0 186 483
DE-A- 2 921 225
GB-A- 2 071 424
US-A- 3 902 177
US-A- 4 012 742

References cited :
US-A- 4 260 990
PATENT ABSTRACTS OF JAPAN, vol. 1, no.
72, page 696E77, 13th juli 1977; & JP-A-528 754
(DENKI KOGYO)

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Description

This invention relates to a coil antenna device for a two frequency electromagnetic detection system, said device serving to generate an electromagnetic interrogation field for detecting responders comprised by said system.

Loop antenna coils for electromagnetic detection systems, serving to generate an interrogation field for detecting responders associated with the system are known in the art. One known antenna of this kind is, for example the single loop antenna, the antenna coil of which has the shape of an O. Another known loop antenna is eight-shaped. An eight-shaped loop antenna has the advantage over and above the O-shaped antenna that it has a minimum sensitivity to interfering external radiofrequency signals. As a consequence, the risk of picking up spurious signals is quite small. Also, with an eight-shaped antenna coil, the radiation to the so-called distant field is minute, so that there is little chance of interference with other transmitting and/or receiving set-ups.

Electromagnetic detection systems comprising an O-shaped antenna coil and an eight-shaped antenna coil has been disclosed in EP-A-0186483. US-A-4260990 further discloses various types of O-shaped and eight-shaped loop coil antennas for an electronic security system.

One disadvantage of the known loop antennas is that they are only suitable for one single pre-determined signal frequency or for a single pre-determined signal frequency range.

For two-frequency detection systems, however, it is desirable to have an antenna that is suitable for two different frequencies (or frequency ranges). Two-frequency systems are used, for example, to detect attempts at tampering with a responder. In such a system, the first signal frequency serves to detect the presence of a responder in an interrogation zone, and the second signal frequency serves to detect fraud with a responder. Such a system is described, for example, in US-A-4,742,341. It is also possible, to use a first frequency for detection purposes and a second frequency for the transfer of energy to a responder, for example, for charging a power accumulator of a responder.

According to the prior technique, antennas for two frequencies are produced by using for example two antenna coils which are alternately connected in a parallel and a non-parallel configuration for given periods of time. The field of operation of the antenna is changed periodically between two predetermined frequencies or frequency ranges.

When two frequencies are used and the system is alternately adjusted to one and the other frequency, each change in frequency (range) will cause a transitional period during which a responder cannot be detected, or fraud with a responder cannot be detected,

or a power accumulator of a responder cannot be charged. Also, special switching means are required.

It is an object of the present invention to overcome the disadvantages outlined above and, in general, to provide an effective and simple loop antenna device for a two frequency electromagnetic detection system.

For this purpose, according to the present invention, a detection system of the above kind is characterized in that the loop antenna coil device comprises a closed loop built up of four adjoining sections having substantially equal impedances, the junction between each pair of adjoining sections together with the junction between the complementary pair of adjoining sections forming a connection port so that two connection ports are provided which in operation are available for two independent signals having different frequencies.

It is noted that the term "detection system" as used herein includes identification systems, which have responders detected similarly to the responders of detection systems. The only difference between responders of an identification system and those of a detection system is in fact that the responders of an identification system when detected can additionally be individually recognized by a coded signal.

It is observed that Patent Abstracts of Japan, vol 1, no. 72, page 696 E 77, 13th July 1977 & JP-A-528754 (Denki Kogyo) discloses a cubical quad antenna for radiating various types of polarization waves. The known antenna is arranged on a boom and comprises a radiator and one or more reflectors of the same shape as the radiator. The radiator has a radiation panel comprising a square loop provided with two sets of terminals connected to the middle points of each side of the square. This known antenna however is dimensionally tuned. The sides of the square loop each have length of 1/4 of the wavelength of the frequency to be radiated or received. Thus this known antenna device is not a coil device and is only suitable for a single frequency. Therefore such an antenna cannot be used for an electromagnetic detection system.

US-A-4012742 discloses a multimode loop antenna for use as a direction finding antenna on an aerospace structure. The purpose of this prior art antenna, which comprises a square loop structure of hollow conductive material with peripheral gaps is to be able to operate in various modes providing various radiation patterns and sensitivity patterns resp.. The overall loop antenna size depends upon the lowest anticipated frequency of operation. It would seem that this known antenna is not suitable for use as an antenna device in a detection system according to the present invention. Also, two-frequency use is not suggested.

One embodiment of the invention will now be described, by way of example, with reference to the accompanying schematic drawings. In said drawings,

Fig. 1 illustrates a known O-shaped antenna coil;
Fig. 2 shows a known eight-shaped antenna coil;
and

Fig. 3 shows an embodiment of a loop antenna device according to the present invention.

Fig. 1 shows schematically an O-shaped antenna coil 1 with two terminals 2 and 3. Such an antenna coil, after being tuned with, for example, a suitable capacitor, is only suitable for a single frequency or a single frequency range. Also, an O-shaped antenna is sensitive to spurious signals.

Fig. 2 illustrates schematically an eight-shaped antenna 4 with two superimposed, substantially congruent loops 5 and 6 and two junctions 7,8 located on an axis of symmetry 9 of these loops. Such eight-shaped antennas are rather insensitive to interference by external radio signals and provide minimum radiation in the distant field. These eight-shaped antennas, however, are also only suitable, after being tuned, to function at a single pre-determined frequency or a single predetermined frequency range.

Fig. 3 shows schematically an embodiment of an antenna configuration according to the present invention. The loop antenna device shown comprises a loop 10, which is square in this example, and has four vertices A, B, C and D. From the vertices, branches 11,12,13 and 14 extend inwardly, coinciding with the diagonals of the square and terminating in two sets of connection points 31,33 and 32,34, each set of connection points forming a connection port.

From the square shown, an eight-shaped antenna can be constructed in two ways. Unlike the eight-shaped antenna of Fig. 2, there are now two axes of symmetry joining the vertices of the square. The axes of symmetry are perpendicular to each other. The two eight-shapes in the square are turned through 90° relative to each other. The first antenna consists of two halves, i.e., triangle ABC and triangle ADC, which halves are separated by axis of symmetry AC. Rotation through 90° gives the second antenna, consisting of halves BCD and BAD with axis of symmetry BD.

As will be described below, the eight-shaped antennas are not electrically coupled together. The operation of the antenna configuration is as follows. The first eight-shaped antenna is fed by connecting a source of A.C. voltage between terminals or connection points 31 and 33, which together form a connection port. Through the application of the A.C. voltage, a current I_1 will start to run. At the vertices A and C, this current will be equally distributed over branches ABC and ADC. As the impedances of the antenna sections AB, BC, AD and DC are all identical, the potentials in points B and D will be equal to each other. As a consequence, there can be no difference in voltage between connection points 32 and 34. Also, no voltage can be generated through induction. Normally, in the antenna sections formed by the conductor between connection points 32 and vertex B (branch

13) and the conductor between connection point 34 and vertex D (branch 14), a voltage would be induced by the magnetic fields which, in turn, are generated through the voltage applied between connection points 31 and 33 and the currents flowing as a consequence. However, by reason of the fact that branches 13 and 14 are located in the plane of symmetry, no voltage is induced in the antenna sections referred to.

If, similarly, a voltage is applied between connection points 32 and 34, then, as a result of the symmetrical construction, no voltage differential is formed between connection points 31 and 33. Therefore, if a voltage is applied to the four connection points, two antennas are active which, electrically, are fully uncoupled from each other.

The two antennas can generate different resonant frequencies by means, for example, of capacitors. Thus, for example, a capacitor not shown can be applied across connection point 31 and 33, as a result of which the resonance frequency of the first eight-shaped antenna will assume a value of 2 MHz, while across connection points 32 and 34 a capacitor can be provided which leads to a resonance frequency of, for example, 8 MHz of the second eight-shaped antenna. As the antennas are not electrically coupled together, the resonance frequencies can be freely selected.

Accordingly, the antenna device illustrated in Fig. 3 forms two electrically independent antennas which, however, mechanically are virtually fully integrated and essentially use the same conductors.

It is noted that, in principle, connection points 31,33 and 32,34 could be closer to vertices A,C and B,D respectively, or even coincide with them. In that case, except for the location of the connection points, the two antennas are physically fully identical.

Furthermore, sections AB, BC, CD and DA may have any curved and/or bent shape. The important feature is that the impedances of the sections should be equal, and that the magnetic fields caused by the A.C. currents which in operation flow through two successive sections (e.g. AD and DC) eliminate each other at an intermediate branch (e.g. 14,13).

These and similar modifications will readily occur to those skilled in the art after reading the above disclosure, and should be considered to fall within the scope of the present invention.

Claims

1. A coil antenna device for a two-frequency electromagnetic detection system, said device serving to generate an electromagnetic interrogation field for detecting responders comprised by said system, characterized by comprising a closed loop (10) built up of four adjoining sections

(AB,BC,CD,DA) having substantially equal impedances, the junction (A,B,C,D) between each pair of adjoining sections together with the junction between the complementary pair of adjoining sections forming a connection port so that two connection ports are provided which in operation are available for two independent signals having different frequencies.

2. An antenna device as claimed in claim 1, characterized in that the pair of junctions associated with at least one connection port are located in one and the same plane of symmetry of the closed loop. 10
3. An antenna device as claimed in claim 2, characterized in that the junctions of at least one pair of junctions located in one and the same plane of symmetry link up with antenna branches located in said plane of symmetry and forming connection points at their ends. 15
4. An antenna device as claimed in claim 3, characterized in that the antenna branches extend from the junctions to a point near the centre of the loop. 20
5. An antenna device as claimed in any of claims 2-4, characterized in that the closed loop has two planes of symmetry each containing two antenna branches extending from junctions located within the plane of symmetry to a point near the centre of the loop. 25
6. An antenna device as claimed in any of the preceding claims, characterized in that the closed loop has the shape of a square and has antenna branches extending along the diagonals to a point near the centre of the square, where the ends of the antenna branches form two connection ports. 30
7. An antenna device as claimed in any of the preceding claims, characterized in that each connection port is connected to a tuning capacitor. 35
8. A two-frequency electromagnetic detection system, characterized by an antenna device as claimed in any of claims 1-7. 40

Patentansprüche

1. Spulenantennenvorrichtung für ein elektromagnetisches Erkennungssystem mit zwei Frequenzen, wobei die Vorrichtung zur Erzeugung eines elektromagnetischen Abfragefeldes zum Erkennen von Respondern dient, die in dem System vorhanden sind, 55

dadurch gekennzeichnet, daß sie eine aus vier benachbarten Abschnitten (AB, BC, CD, DA) mit im wesentlichen gleichen Impedanzen aufgebaute geschlossene Schleife (10) aufweist, wobei der Verbindungspunkt (A,B,C,D) zwischen jedem Paar benachbarter Abschnitte zusammen mit dem Verbindungspunkt zwischen dem komplementären Paar benachbarter Abschnitte eine Anschlußstelle bildet, so daß zwei Anschlußstellen vorgesehen sind, die im Betrieb für zwei unabhängige Signale mit unterschiedlichen Frequenzen zur Verfügung stehen.

2. Antennenvorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das der mindestens einen Anschlußstelle zugeordnete Paar von Verbindungspunkten in ein und derselben Symmetrieebene der geschlossenen Schleife angeordnet ist. 15
3. Antennenvorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Verbindungspunkte mindestens eines in ein und derselben Symmetrieebene angeordneten Paares von Verbindungspunkten mit den in der Symmetrieebene angeordneten Antennenabzweigen verbunden sind und an ihren Enden Anschlußpunkte bilden. 20
4. Antennenvorrichtung nach Anspruch 3, dadurch gekennzeichnet, daß die Antennenabzweige sich von den Verbindungspunkten aus zu einem Punkt in der Nähe des Mittelpunktes der Schleife erstrecken. 25
5. Antennenvorrichtung nach einem der Ansprüche 2-4, dadurch gekennzeichnet, daß die geschlossene Schleife zwei Symmetrieebenen aufweist, die jeweils zwei Antennenabzweige enthalten, welche sich von den in der Symmetrieebene angeordneten Verbindungspunkten zu einem Punkt in der Nähe des Mittelpunktes der Schleife erstrecken. 30
6. Antennenvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die geschlossene Schleife die Form eines Quadrates hat und Antennenabzweige aufweist, die sich die Diagonalen entlang zu einem Punkt in der Nähe des Mittelpunktes des Quadrates erstrecken, wo die Enden der Antennenabzweige zwei Anschlußstellen bilden. 35

7. Antennenvorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jeder Anschlußpunkt mit einem Abstimmkondensator verbunden ist. 40
8. Elektromagnetisches Erkennungssystem mit

zwei Frequenzen, gekennzeichnet durch eine Antennenvorrichtung nach einem der Ansprüche 1-7.

Revendications

1. Dispositif d'antenne-cadre pour un système de détection électromagnétique à deux fréquences, ledit dispositif servant à générer un champ d'interrogation électromagnétique pour détecter des répondeurs inclus dans ledit système, caractérisé en ce qu'il comprend une boucle fermée (10) constituée de quatre sections se raccordant (AB, BC, CD, DA) présentant des impédances pratiquement égales, la jonction (A, B, C, D) entre chaque paire de sections voisines associée à la jonction entre la paire complémentaire de sections voisines formant un accès de connexion de sorte que deux points d'accès soient prévus, qui en fonctionnement, sont disponibles pour deux signaux indépendants présentant des fréquences différentes. 10
2. Dispositif d'antenne selon la revendication 1, caractérisé en ce que la paire des jonctions associées à au moins un accès de connexion est située dans un seul et même plan de symétrie de la boucle fermée. 15
3. Dispositif d'antenne-cadre selon la revendication 2, caractérisé en ce que les jonctions d'au moins une paire de jonctions situées dans un seul et même plan de symétrie se raccorde avec des branches d'antenne placées dans ledit plan de symétrie et forme des points de connexions à leurs extrémités. 20
4. Dispositif d'antenne selon la revendication 3, caractérisé en ce que les branches d'antenne s'étendent à partir des jonctions jusqu'à un point proche du centre de la boucle. 25
5. Dispositif d'antenne selon l'une quelconque des revendications 2 à 4, caractérisé en ce que la boucle fermée présente deux plans de symétrie contenant chacun deux branches d'antenne s'étendant à partir des jonctions situées dans le plan de symétrie en un point proche du centre de la boucle. 30
6. Dispositif d'antenne selon l'une quelconque des revendications précédentes, caractérisé en ce que la boucle fermée présente une forme en carré et comporte des branches d'antenne s'étendant suivant les diagonales à un point proche du centre du carré, où les extrémités des branches d'antenne forment deux accès de 35

connexion.

7. Dispositif d'antenne selon l'une quelconque des revendications précédentes, caractérisé en ce que chaque accès de connexion est connecté à un condensateur d'accord. 40
8. Système de détection électromagnétique à deux fréquences caractérisé par un dispositif d'antenne selon l'une quelconque des revendications 1 à 7. 45

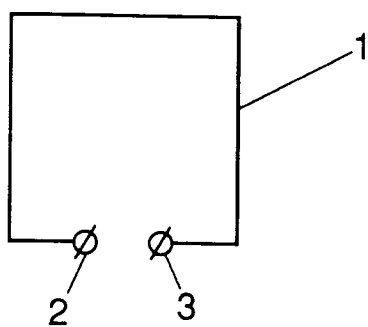


FIG. 1

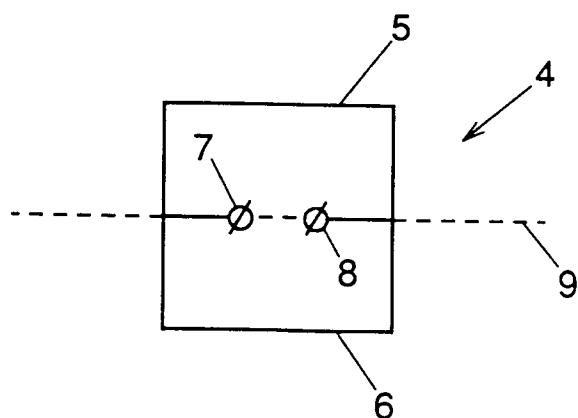


FIG. 2

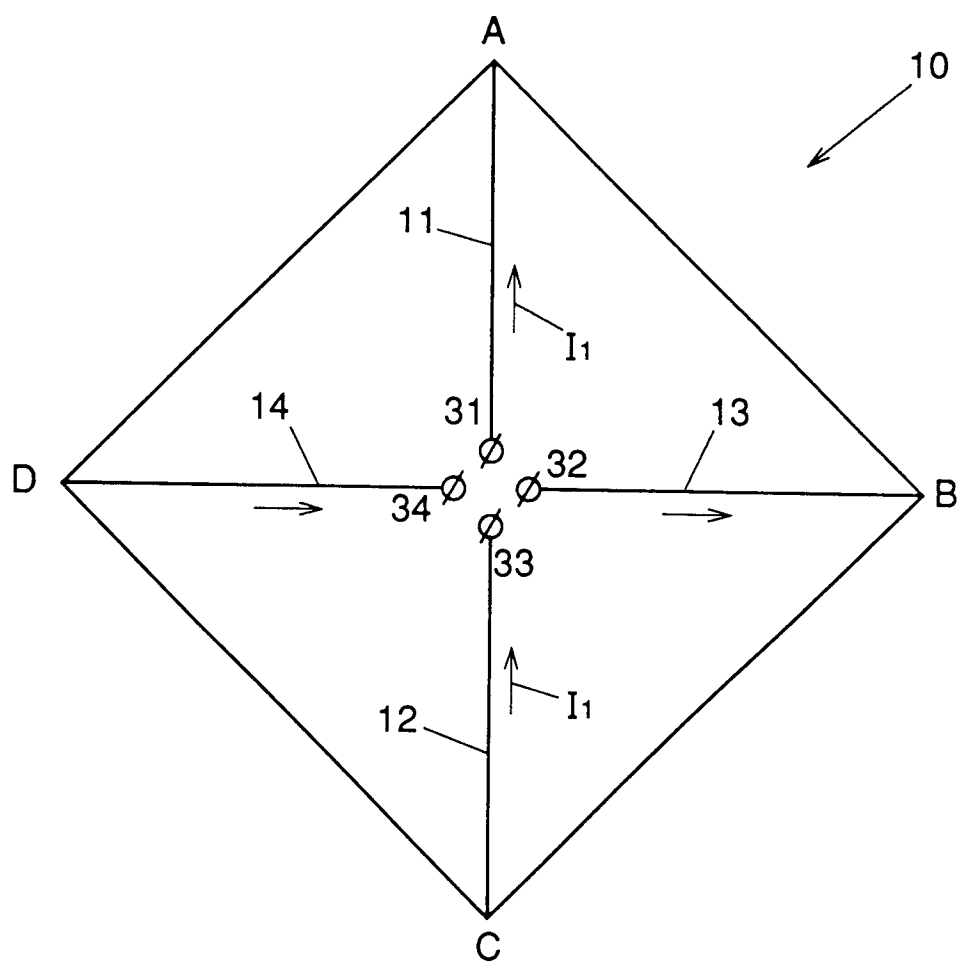


FIG. 3