

[54] **FLUSH MOUNTED ANTENNA AND
RECEIVER TANK CIRCUIT ASSEMBLY**

[75] Inventors: **Robert E. Munson; Jack K. Krutsinger; Jerry H. Polson**, all of Boulder, Colo.

[73] Assignee: **Ball Brothers Research Corporation**, Boulder, Colo.

[22] Filed: **Dec. 18, 1970**

[21] Appl. No.: **99,484**

[52] U.S. Cl. **343/792, 343/807, 343/DIG. 2**

[51] Int. Cl. **H01q 9/16**

[58] Field of Search.....343/729, 730, 792, 807, 873,
343/DIG. 2

[56] **References Cited**

UNITED STATES PATENTS

2,258,953	10/1941	Higgins.....	343/821
3,139,620	6/1964	Leidy et al.....	343/730

FOREIGN PATENTS OR APPLICATIONS

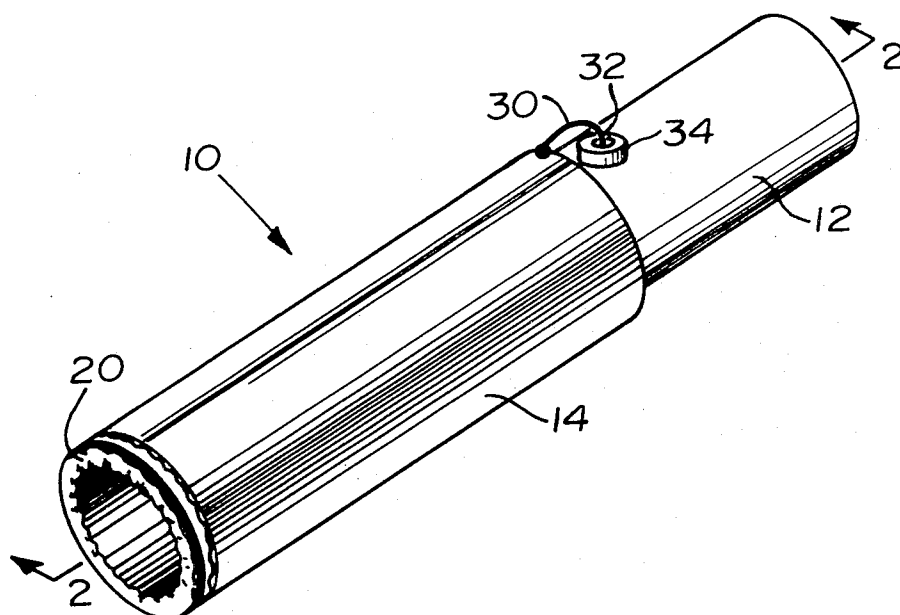
807,693	1/1959	Great Britain.....	343/813
---------	--------	--------------------	---------

Primary Examiner—Eli Lieberman
Attorney—Harris and O'Rourke

[57] **ABSTRACT**

An assembly for transmitting and receiving communication signals is disclosed and generally includes a first or inner cylindrical conductor, the length of which is substantially equal to one-half wavelength at a predetermined operating frequency and a second concentrically positioned outer cylindrical conductor, the length of which is substantially equal to one-half that of the inner conductor. The conductors are electrically connected at adjacent transverse edges so as to define a one-quarter wavelength open-ended coaxial cavity. A coaxial line, connected to the conductors at the opening of the cavity, is provided for joining the device to a transmitter or receiver. The device, constructed in this manner, electrically becomes a half-wave dipole antenna operating at the aforementioned predetermined frequency. In addition, the assembly may include a third cylindrical conductor which is also positioned concentrically about the first conductor and which operates at a second predetermined frequency as a second half-wave dipole antenna.

10 Claims, 8 Drawing Figures



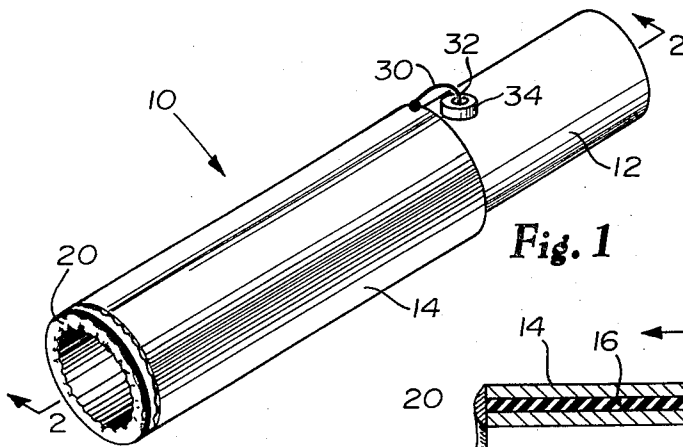


Fig. 1

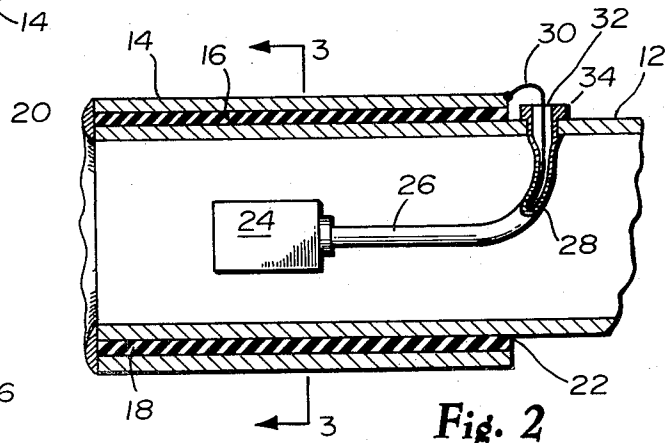


Fig. 2

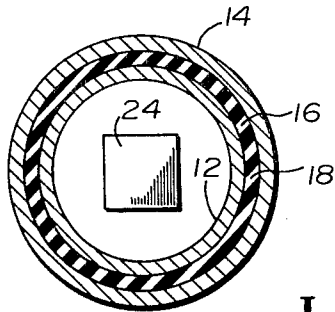


Fig. 3

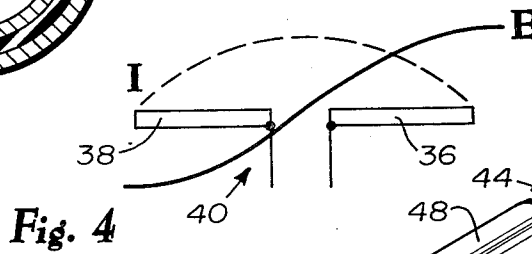


Fig. 4

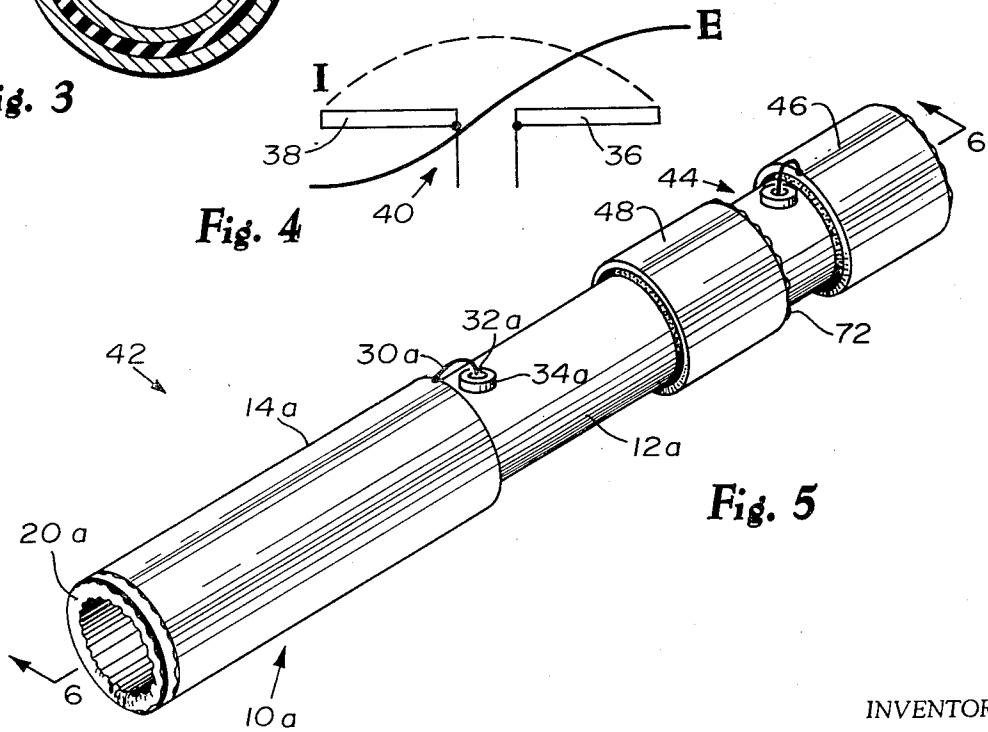


Fig. 5

INVENTORS

JACK K. KRUTSINGER
ROBERT E. MUNSON
JERRY H. POLSON

BY

Harris & O'Rourke
ATTORNEYS

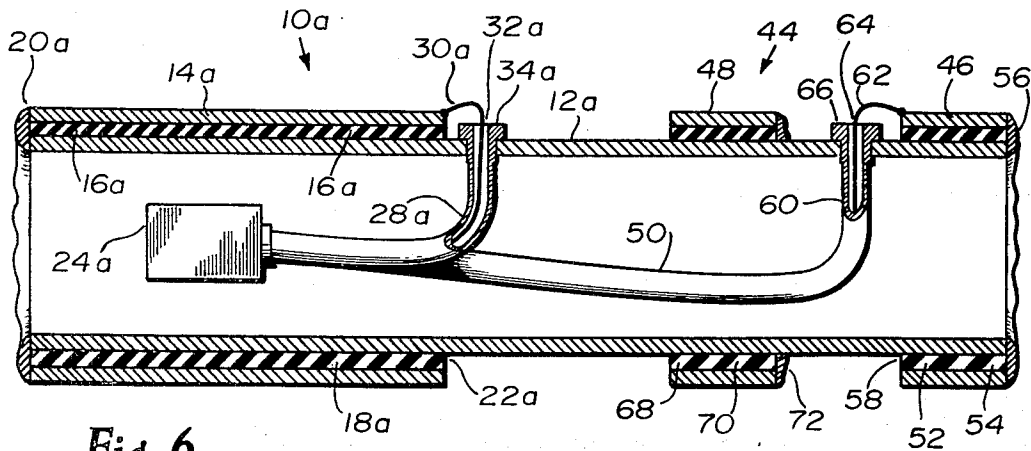


Fig. 6

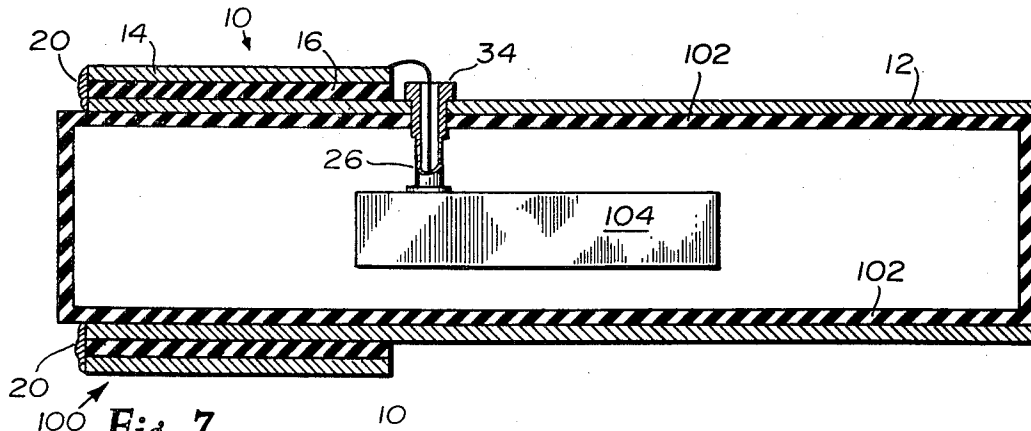


Fig. 7

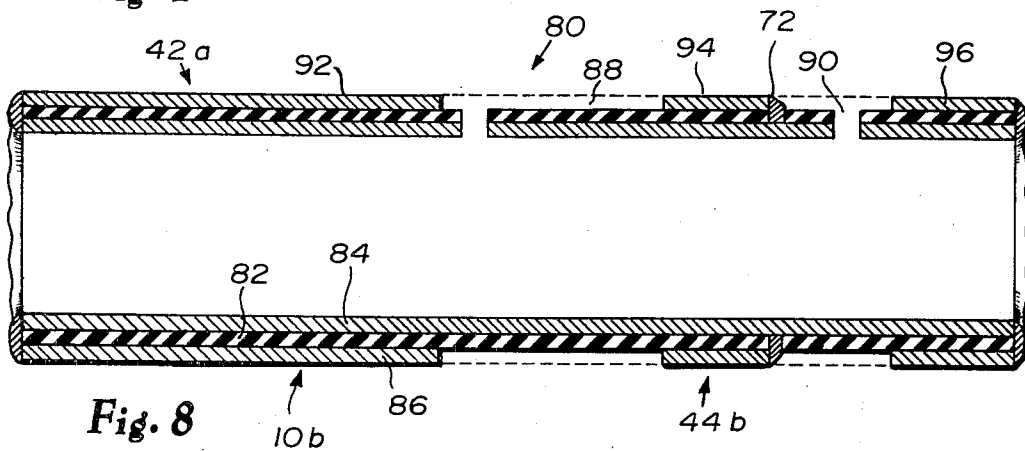


Fig. 8

INVENTORS
 JACK K. KRUTSINGER
 ROBERT E. MUNSON
 JERRY H. POLSON
 BY *Harris & O'Rourke*
 ATTORNEYS

FLUSH MOUNTED ANTENNA AND RECEIVER TANK CIRCUIT ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to antenna assemblies and, more particularly, to flush mounted symmetrical antenna devices. 2. Description of the Prior Art

The use of antenna assemblies for both transmission and reception of radio signals is well known, and such antenna assemblies have taken many diverse dimensions and/or shapes to accomplish given objectives. Among such antennas known in the art are those useful in conjunction with propelled vehicles, including missiles, and, more particularly, missiles such as the Loci-Dart which carry instrument payloads into the atmosphere where they are ejected and allowed to descend by parachute to earth. As the payloads descend, valuable data information, such as temperature data, is transmitted back to earth via UHF electromagnetic radio wave signals.

Heretofore, there have been many problems encountered in the transmission and/or reception of the aforementioned radio signals, one problem of which has been loss in communication. One reason for this problem is readily exemplified by the aforementioned payload operation. Loci-Darts or other payload carrying missiles presently use conventional whip antennas on their payloads which, upon being ejected from the carrying missile, become entangled in the shrouds of the parachute. When this happens, the antennas usually break off, thereby causing loss of communication.

In attempting to rectify the aforementioned problem, the prior art has, for example, suggested providing a conventional flush mounted half-wave dipole antenna, the type of which is often used for UHF transmission and reception. However, this type of antenna, which includes a gap between separate halves thereof, has not met with much success, due mainly to the lack of isolation (caused by the gap) between the antenna and electronic data collecting equipment within the payload. It has been found that this lack of isolation not only produces electrical interference which substantially reduces the operational quality of both the antenna and electronic equipment but, in many cases, completely shorts out the two, so as to make both completely ineffective.

Another problem encountered in the aforementioned antennas has been their inability to provide the proper frequency selectivity required in the communication of radio signals. Heretofore, the normal approach in providing for frequency selectivity has been to utilize a discrete component tank circuit at the receiver or transmitter. Such a circuit takes the general form of a parallel resonant circuit, including an auto transformer connected in parallel with a variable capacitor. It has been found, however, that at frequencies above 100 MHz this type of tank circuit becomes degraded in performance, mainly in loaded Q values attainable, because of the low load impedances normally experienced and the limitation in capacitance and reactance values realizable.

As an example, a typical tank circuit of the type described above, designed to operate at a frequency of 400 MHz and at 50 ohms input and output impedance, has a loaded Q value of 6, which, in turn, yields a 3 dB

bandwidth of 67 MHz. A bandwidth of 67 MHz is much too broad for the narrow-band receiver application required in many payload operations. While stripline components have been suggested in place of these discrete components, it should be pointed out that such components are quite large physically. Where space is at a premium, which is often the case, the stripline components cannot be used.

SUMMARY OF THE INVENTION

The present invention overcomes the aforementioned disadvantages, as well as other disadvantages, by providing an antenna which is both versatile in use and inexpensive to manufacture. As will be seen hereinafter, one embodiment of the antenna assembly according to the present invention generally comprises first and second spaced-apart conductors, the first of which is equal in length to one-half the length of the second conductor and is electrically shorted thereto. Electrically, this antenna assembly becomes a half-wave dipole antenna having a typical half-wave radiation pattern and a built-in high Q tuned circuit.

A second embodiment of the antenna assembly constructed in accordance with the present invention comprises all of the elements making up the aforescribed embodiment. In addition, however, this embodiment includes a third conductor which is also spaced from said second conductor and which operates as an independent half-wave dipole antenna operating at a different frequency than that of the first-mentioned half-wave dipole. In this way, both antenna portions can operate simultaneously and separately so as to provide greater communication coverage.

It is apparent that the above-described antennas are readily flush mountable to the exterior surface of a propelled vehicle and thereby eliminate the disadvantages characterized by the aforescribed whip antenna. In addition, since each of these antennas is structurally one continuous cylinder, as opposed to the separated halves making up the typical half-wave dipole antenna, it provides isolation between itself and the payload components and thereby substantially eliminates the possibility of electrical interference or short circuit. Further, by utilizing its own tuned circuit, the antenna can attain a higher Q and, therefore, a narrower bandwidth while simultaneously eliminating the cost of receiver or transmitter circuit parts and extra space otherwise required by such parts.

Accordingly, an object of the present invention is to provide a new and improved antenna assembly which more readily maintains communication between points of operation.

Another object of the present invention is to provide a new and improved antenna assembly which may be readily adapted for use with a cylindrical surface, such as the skin of a missile.

Yet another object of the present invention is to provide a new and improved half-wave dipole antenna assembly.

Still another object of the present invention is to provide a high Q, low power loss narrow bandwidth antenna assembly.

A further object of the present invention is to provide an antenna assembly of the above-stated type, having a built-in tuned tank circuit.

Yet a further object of the present invention is to provide a new and improved antenna assembly which is relatively inexpensive to make and which eliminates many components otherwise required by a communication system.

Still another object of the present invention is to provide an antenna assembly which includes its own built-in means for isolating itself from other electronic components.

A further object of the present invention is to provide a single assembly which is capable of transmitting and receiving signals of different frequencies.

Another object of the present invention is to provide an assembly of the last-mentioned type which includes two half-wave dipole antennas adapted to simultaneously and independently operate at different frequencies.

Still a further object of the present invention is to provide a new and improved payload structure which utilizes the aforescribed antenna.

These and other objects and advantages will be apparent to those skilled in the art from the following descriptions.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of an antenna assembly constructed in accordance with a preferred embodiment of the present invention;

FIG. 2 is a partially broken away sectional view of the antenna assembly of FIG. 1, taken generally along line 2—2 in FIG. 1;

FIG. 3 is a cross-sectional view of the antenna assembly of FIG. 1, taken generally along line 3—3 in FIG. 2;

FIG. 4 is a diagrammatic view of a typical center fed half-wave dipole;

FIG. 5 is a perspective view of an antenna assembly constructed in accordance with a second embodiment of the present invention;

FIG. 6 is a sectional view of the antenna assembly of FIG. 5, taken generally along line 6—6 of FIG. 5;

FIG. 7 is a vertical sectional view of a device for measuring and transmitting data constructed in accordance with the present invention; and

FIG. 8 is a sectional view of an antenna assembly constructed in accordance with a further embodiment of the present invention.

DETAILED DESCRIPTION

Turning now to the drawings, wherein like components are designated by like reference numerals throughout the various figures, an assembly constructed in accordance with a preferred embodiment of the present invention is illustrated in FIGS. 1, 2 and 3 and is generally designated by the reference numeral 10. As will be seen hereinafter, assembly 10 is a combination antenna, tuned-tank circuit, and part of a payload structure. However, for sake of clarity, the assembly hereinafter will be referred to only as an antenna. In addition, while the antenna may be used for both transmission and reception of communication or command signals generally, it is especially useful for transmitting UHF electromagnetic radio wave signals from a small missile. Accordingly, for purposes of description,

the antenna will be considered as transmitting such radio signals, it being readily apparent to those skilled in the art that the same may be used for reception purposes also.

Turning now to FIGS. 1, 2 and 3, antenna 10 is shown to include an elongated cylindrical inner conductor 12, the axial length of which is equal to approximately one-half wavelength at the operating resonant frequency of the antenna. The inner conductor may be constructed of any suitable conductive material, such as, for example, copper. However, as will be discussed in more detail hereinafter, inner conductor 12 is preferably an outer copper layer in a three-layer sheet of copper clad (stripline) laminate.

Antenna 10 further includes a second or outer elongated cylindrical conductor 14 which displays an axial length equal to or substantially equal to one-half that of inner conductor 12 or one-quarter wavelength at the aforementioned frequency. Conductor 14 may be constructed of any suitable conductive material, such as, for example, copper, but is preferably the opposite copper layer of the aforementioned sheet of laminate.

As illustrated in FIG. 2, outer conductor 14, which has a cross-sectional diameter greater than the cross-sectional diameter of conductor 12, is positioned concentrically about the exterior surface of conductor 12 so as to encompass approximately one-half of the latter. In this manner, a coaxial cavity 16 is provided and has a radial width equal to the difference in cross-sectional diameters between the inner and outer conductors. While the cavity can be left void of material, for ease of construction, it is preferably filled with an insulating material, such as polytetrafluoro ethylene (commercially available Teflon), for example. This can be achieved by utilizing the aforementioned sheet of copper clad laminate or by positioning a separate cylindrical insulator 18, equal in length to that of outer conductor 14, between the inner and outer conductors, as illustrated in FIG. 2. In this regard, it is to be noted that the actual length of coaxial cavity 16 must be corrected for the impedance producing effect of the dielectrical layer. This may be accomplished by resorting to the relationship of effective wavelength λ_c as a function of actual wavelength λ , which relationship is:

$$\lambda_c = \lambda / \sqrt{\Sigma R}$$

wherein λ_c is the corrected wavelength in a cavity filled with dielectric material, λ is the actual wavelength in a cavity void of material and ΣR is the dielectric constant of the cavity filled material. By utilizing the above-stated equation, the length of cavity 22 can be easily corrected so as to be "effectively" one-quarter wavelength. However, for purpose of clarity, only the term "one-quarter wavelength cavity" will be used hereinafter, it being understood that when the cavity is filled with dielectric material, such as material 18, an effective one-quarter wavelength cavity is contemplated.

The entire left-hand transverse edge (as viewed in FIG. 2) of inner conductor 12 is electrically shorted to the entire adjacent transverse edge of outer conductor 14. This can be accomplished in any suitable manner, such as, for example, by the utilization of soldering material 20. In this way, the one-quarter wavelength coaxial cavity 16 may be defined as a continuous open-

ended cavity electrically shorted at one end, that is, the soldering end 20, and having an open circuit 22 at a distance one-quarter wavelength therefrom.

Antenna 10 is coupled to a transmitter (or receiver) 24, which, for example, may be located within the shell of the antenna by a coaxial transmission line 26 having an outer conductive cable 28 and an inner conductive cable 30. The conductive cable 28 is connected to inner cylindrical conductor 12 at a point adjacent open circuit 22, or a distance of one-quarter wavelength from the shorted end of cavity 18, and conductive cable 30 is connected to outer cylindrical conductor 14 at a point equally distant from the shorted end. This may be accomplished in any suitable manner, so long as inner conductive cable 30 is appropriately insulated from inner conductor 12. In this regard, an opening 32 is provided through the inner conductor at a point adjacent open circuit 22 and is defined by an insulation gasket 34 which receives inner conductive cable 30 for connection with conductor 14, as illustrated best in FIG. 2.

With antenna 10 constructed in the aforementioned manner, attention is now directed to its operation. While the antenna physically takes the form of one continuous metal cylinder defining a one-quarter wavelength coaxial cavity, as illustrated in FIG. 1, it electrically acts as two separate halves of a center fed dipole antenna of the type illustrated diagrammatically in FIG. 4. As seen in this figure, two separate halves 36 and 38 of a typical center fed dipole antenna 40 are positioned axially adjacent to each other and are fed by individual transmission lines 42 and 44 so as to provide current I and voltage E in the manner illustrated. While both the antenna 10 and configuration 40 emit radiation in basically the same manner, that is, as a center fed one-half wave dipole, it is readily apparent that the structures making up the two are quite different. It is this continuous metal cylinder type structure which makes half-wave dipole antenna 10 extremely convenient for use as a flush mounted antenna with all types of cylindrical bodies generally and with propelled vehicles, such as missiles, in particular.

Another important feature of antenna 10 is its ability to operate at an ultrahigh resonant frequency, within a narrow bandwidth and at a low loss high Q value without resorting to a discrete component tank circuit, which tank circuit, in any case, is inoperable at such high frequencies, as stated above. This is accomplished by utilizing the aforescribed one-quarter wavelength coaxial cavity 16 as a tuned input tank circuit, which circuit operates in the following manner.

At the input to cavity 16, the impedance of coaxial transmission line 26, which is given by the standard equation for the TEM mode of propagation, combines in parallel with the impedance of the tank circuit. This input impedance is very frequency sensitive, that is, as frequency changes about the center resonant operating frequency of the antenna, the input reactance changes from a large inductance to zero reactance and then to a large capacitance, while the input resistance remains substantially constant. As a result, cavity 16 acts typically like a low loss high Q narrow band device. The exact value of Q is dependent upon the radial width of the cavity, the shorter the radial width, the greater the Q value and, therefore, the narrower the bandwidth.

Accordingly, since a high Q is desired for antenna 10, the distance between cylindrical conductors 12 and 14 is maintained extremely small.

For purposes of example, let it be assumed that antenna 10 is to operate at a resonant frequency of 400 MHz and that coaxial transmission line 26 has an impedance of 50 ohms. Accordingly, by providing the proper length to inner and outer conductors 12 and 14 (one-half and one-quarter wavelength, respectively) and by suitably dimensioning the radial width of cavity 16, a loaded Q value of approximately 12 to 1 or higher has been attainable, yielding a narrow 3 dB bandwidth of approximately 35 MHz, as opposed to a maximum loaded Q value of approximately 6 and a 3 dB bandwidth of 67 MHz attained by the typical discrete component input tank circuit described above.

Such restrictions in realizable Q value from discrete component tank circuits points up the value of utilizing cavity 16 as a high Q input tank circuit. Since the cavity is required for proper antenna operation anyway, utilizing it additionally for the receiver input provides several economies. Firstly, for example, it eliminates the cost of receiver tank circuit parts; and, secondly, it eliminates the need for extra space in the receiver otherwise required for such a circuit.

Turning to FIGS. 5 and 6, attention is directed to an assembly 42 constructed in accordance with a second embodiment of the present invention. Assembly 42 includes all of those components making up antenna 10. The combination of these components hereinafter will be referred to as antenna portion 10a, the individual components thereof being designated by the same reference numerals as like components of antenna 10 with the suffix letter a attached therewith. Because the operation of antenna portion 10a is identical to the operation of antenna 10, reference is made to the above operational discussion of the latter for a description of the former.

In addition to antenna portion 10a which, as stated above, is adapted for transmitting or receiving electromagnetic radio wave signals of a first predetermined frequency, device 42 further includes an antenna portion 44 which, as will be seen hereinafter, operates to transmit or receive electromagnetic radio wave signals of a second predetermined frequency. Antenna portion 44 includes elongated cylindrical inner conductor 12a, outer cylindrical conductors 46 and 48, and coaxial transmission line 50, all of which structurally combine together to make up a combination antenna, tuned tank circuit, and part of a payload structure in the same manner as antenna portion 10a.

Outer cylindrical conductor 46 is preferably constructed of the same material as that of outer cylindrical conductor 14a and has an axial length substantially equal to one-quarter wavelength at the aforementioned second operating frequency. As illustrated best in FIG. 6, the conductor is concentrically positioned about the otherwise free end of inner conductor 12a and is radially spaced apart therefrom so as to define a one-quarter wavelength coaxial cavity 52. While the cavity can be left void of material, for ease of construction, it is preferably filled with an insulating material, such as polytetrafluoro ethylene, for example. This may be achieved by utilizing the aforementioned sheet of copper clad laminate or by positioning a separate cylin-

drical insulator 54, equal in axial length to that of outer conductor 46, between the outer conductor and inner conductor 12a. In this regard, the actual length of coaxial cavity 52 must be corrected for the impedance producing effect of the dielectric layer in the same manner as described with respect to cavity 16.

The entire right-hand transverse edge (as viewed in FIG. 6) of inner conductor 12a is electrically shorted to the entire adjacent transverse edge of outer conductor 46. This may be achieved in any suitable manner, such as, for example, by the utilization of soldering material 56. In this way, the one-quarter wavelength coaxial cavity 52, like cavity 16, may be defined as a continuous open-ended cavity having an electrical short at one end, that is, at the soldering end 56, and having an open circuit 58 at a distance one-quarter wavelength therefrom.

Cylindrical conductors 12a and 46 are coupled to transmitter (or receiver) 24a by coaxial transmission line 50, which transmission line includes an outer conductive cable 60 and an inner conductive cable 62. The conductive cable 60 is connected to inner cylindrical conductor 12a at a point adjacent open circuit 58, or a distance of one-quarter wavelength from the shorted end of cavity 52, and conductive cable 62 is connected to outer cylindrical conductor 46 at a point equally distant from the shorted end of the cavity. This can be provided in any suitable manner, so long as inner conductive cable 62 is appropriately insulated from inner conductor 12a. In this regard, a second opening 64 is provided through the inner conductor at a point adjacent opened circuit 58 and is defined by an insulation gasket 66 which receives inner conductor cable 62 for connection with conductor 46, as illustrated best in FIG. 6.

As seen in FIG. 6, cylindrical conductor 48, which is identical in construction to conductor 46, is concentrically positioned about the exterior surface of inner conductor 12a at a point slightly to the left of conductor 46 and defines a further one-quarter wavelength coaxial cavity 68, which cavity may be filled with insulating material 70, preferably identical to insulator 54. In addition, the right-hand transverse edge of conductor 48 is electrically shorted to inner conductor 12a in the same manner as outer conductor 46 and 14a, that is, by the utilization of solder or other such material 72.

Outer conductor 48 and the underlying portion of inner conductor 12a defining coaxial cavity 68 provide a choke for electrically isolating antenna portion 44 from antenna portion 10a. In this manner, both antenna portions may operate independently and simultaneously as half-wave dipole antennas at different frequencies, so long as their operating bandwidths do not overlap. For example, it has been found that with antenna portion 10a operating at the aforesaid frequency of 400 MHz, antenna portion 44 operates quite well at a frequency of approximately 1,680 MHz.

Antenna portion 44 operates in the same manner as antenna 10 and 10a, that is, as separate halves of a center fed half-wave dipole antenna. In addition, one-quarter wavelength coaxial cavity 52, like coaxial cavities 16 and 16a, provides a tank circuit to the antenna portion so that the latter is capable of operating within a narrow bandwidth having a low power loss high Q value at a UHF operating resonant frequency. This has

all been discussed in detail with regard to antenna 10 and reference is made thereto.

Attention is now directed to various methods of making the aforescribed devices and, particularly, device or antenna 10. One method is to wrap each of the cylindrical layers of material, that is, layers 12, 14 and 18, separately to form the coaxial layers of conductive material and insulating material. By this method, a hollow dielectric tube (not shown) can be covered with a sheet of copper foil, or other suitable electrically conductive foil, which represents the inner cylindrical conductor 12 illustrated in FIGS. 1, 2 and 3. The length of the conductive foil is approximately equal to one-half wavelength at the operating frequency of antenna 10. Thereafter, a Teflon or other suitable insulating sheet, representing insulating sheet 18, is wrapped or otherwise placed around the conductive foil cylinder, however, covering only approximately one-half of the total length thereof. Thereafter, another layer of copper or other suitable conductive foil, which is of substantially the same length as that of the insulating sheet and which is analogous to outer conductor 14, is wrapped around the cylindrical insulating layer. In this manner, coaxial cavity 16 is produced. In this regard, it should be noted that the thickness of the insulating layer is appropriately chosen so as to define the desired radial thickness of cavity 16 which, in turn, determines the Q value and bandwidth of antenna 10 at its operating resonant frequency, as stated above.

After applying the various layers in the manner described above, adjacent transverse edges of the conductive layers are shorted by a suitable method, such as by soldering. Finally, an aperture representing opening 32 may be provided through the inner conductive cylindrical layer at a point one-quarter wavelength from the soldered connection.

Device 42, illustrated in FIGS. 5 and 6, may be constructed in the same manner as that of device 10, however, including the coaxial cavities 52 and 68.

A second method of making an antenna device, which is identical in operation and substantially identical in construction to antenna 42, is illustrated in FIG. 8, the device being generally designated by the reference numeral 42a, with antenna portions identical to portions 10a and 44 of device 42, being designated by reference numerals 10b and 44b, respectively. This method utilizes a unitary laminated sheet 80, the length of which is substantially equal to one-half wavelength at the operating frequency of antenna portion 10b. Sheet 80, which is preferably copper clad (stripline) laminate, includes an intermediate layer of dielectric or insulating material 82, having electrically conductive layers 84 and 86 on opposite sides thereof.

The method includes the steps of etching or otherwise removing portions 88 and 90 of conductive layer 86, as generally indicated by dotted lines in FIG. 8, so as to define conductive layers 92, 94 and 96. Thereafter, the longitudinal edges of each layer (82, 84 and 86) are soldered or otherwise suitably connected together so as to form a single cylinder, layers 92, 94 and 96 representing respective outer conductors 14a, 48, and 46 of device 42, layer 84 representing inner conductor 12a, and layer 82 representing insulators 18a, 54 and 70.

The remaining steps required in completing device 42a are substantially identical to the aforescribed method with the exception that openings are to be provided through the insulating layer (in addition to conductive layer 84) for receiving the appropriate transmission lines (not shown). Accordingly, reference is made to the aforescribed method.

It is readily apparent that the only difference between antenna 42 and antenna 42a resides in the fact that the latter utilizes one continuous intermediate dielectric or insulating layer. From an operational point of view, this, of course, makes no difference. It is equally readily apparent that device 10 can be constructed in the same manner as device 42a, that is, by completely removing layers 94 and 96.

Directing attention to FIG. 7, a payload structure 100 is illustrated in cross-section. Structure 100 is utilized for transmitting various types of data, such as, for example, temperature data, from the earth's surrounding atmosphere. As stated above, this may be accomplished by ejecting the payload structure from a missile, the former being allowed to slowly descend back to earth by parachute. During this period of descent, the payload structure continuously transmits the data back to earth.

Payload structure 100 includes a cylindrical housing or shell 102, which is preferably constructed of a dielectric material but which may be part of antenna 10, as will be seen hereinafter. Enclosed within housing 102 is a package of appropriate conventional components, generally designated by the reference numeral 104, which takes the desired data. The data is transmitted back to earth by the aforescribed antenna 10 which is flush mounted concentrically about the exterior surface of housing 102 and connected to a transmitter making up part of the component package 104.

In accordance with the present invention, housing or shell 102 has an axial length substantially equal to one-half wavelength at the operating frequency of antenna 10. In this manner, the inner cylindrical conductor 12 of the antenna, which is of the same length, circumscribes the entire length of the housing and thereby acts as a shield, isolating the antenna from component package 104 and vice versa. Therefore, the antenna and the component package can each operate separately and simultaneously without electrical interference from the other.

It should be pointed out that the inner cylindrical conductor 12 of antenna 10 may, itself, be utilized as the housing of payload structure 100, thereby eliminating shell 102. However, in this regard, the component package 104 must be suitably insulated therefrom. In addition, it is to be understood that while payload structure 100 utilizes device 10 as its antenna, device 42 or 42a may be easily used therewith.

Although various embodiments of the present invention have been illustrated and described, it is anticipated that various changes and modifications will be apparent to those skilled in the art, and such changes may be made without departing from the scope of the invention as defined by the following claims.

What is claimed is:

1. An assembly for transmitting and receiving communication signals of differing frequencies, said assembly comprising: a common conductor of predeter-

mined length; a first conductor substantially shorter in length than said common conductor and spaced from a first portion of said common conductor; first conductive means connecting said common conductor with said first conductor; a second conductor substantially shorter in length than said common conductor and spaced from a second portion of said common conductor, said first and second portions of said common conductor being spaced with respect to one another; second conductive means connecting said common conductor with said second conductor; and first and second electrical signal transfer means one of which is connected to said first conductor and said common conductor and the second of which is connected to said second conductor and said common conductor, whereby said first conductor and said common conductor are adapted to transmit and receive communication signals at a first predetermined frequency and whereby said second conductor and said common conductor are adapted to transmit and receive communication signals at a second predetermined frequency.

2. An assembly according to claim 1, including choke means between and spaced with respect to said first and second conductors for electrically isolating said second conductor and common conductor from said first conductor and common conductor, whereby said second and common conductors operate independent of said first and common conductors.

3. An assembly according to claim 2 wherein said choke means includes a third conductor spaced from a third portion of said common conductor between said first and second portions of said common conductor, and conductive means connecting said common conductor with said third conductor.

4. An assembly according to claim 1, including first connecting means for connecting said first conductor with said first portion of said common conductor, second connecting means for connecting said second conductor with said second portion of said common conductor, and wherein said electrical signal transfer means comprises a first coaxial line having an inner cable connected to said first conductor at a point spaced from said first connecting means approximately one-quarter wavelength at said first predetermined frequency and an outer cable connected to said common conductor at a point spaced from said first connecting means approximately one-quarter wavelength at said first predetermined frequency, said electrical signal transfer means further including a second coaxial line having an inner cable connected to said second conductor at a point spaced from said second connecting means approximately one-quarter wavelength at said second predetermined frequency and an outer cable connected to said common conductor at a point spaced from said second connecting means approximately one-quarter wavelength at said second predetermined frequency.

5. An assembly according to claim 3 wherein said common conductor is in the form of an elongated cylinder and wherein said first, second and third conductors are in the form of cylinders axially spaced with respect to one another and positioned concentrically around the exterior surface of said common conductor.

6. An assembly according to claim 1 wherein said electrical signal transfer means includes a first coaxial

line, the inner conductor of which is connected to said first conductor and an outer conductor of which is connected to said common conductor; and a second coaxial line, the inner conductor of which is connected to said second conductor and the outer conductor of which is connected to said common conductor.

7. An assembly for transmitting and receiving communication signals of differing frequencies, said assembly comprising: an elongated cylindrical common conductor; a first cylindrical conductor connected with said common conductor so as to form a first coaxial cavity therewith; a second cylindrical conductor connected with said common conductor so as to form a second coaxial cavity therewith, said first and second coaxial cavities being of different lengths, and said second conductor being axially spaced from said first conductor; and electrical signal transfer means connected to said first conductor, second conductor and common conductor.

8. An assembly according to claim 7, including means for electrically isolating said coaxial cavities from each other, said isolating means including a third cylindrical conductor adjacent to said elongated cylindrical common conductor and positioned between said first and second conductors with axial spacing therebetween, said third cylindrical conductor being connected with said common conductor so as to form a third coaxial cavity therewith.

9. An assembly for transmitting and receiving communication signals of differing frequencies, said assembly comprising: a cylindrical support of insulating material; a first cylindrical conductor of conductive material supported on one side of said insulating material; a second cylindrical conductor of conductive material substantially shorter in length than said first conductor and supported on the opposite side of said insulating support; first conductive means connecting

said first and second conductors, said conductors and conductive means forming a first antenna operating at a first predetermined frequency; a third cylindrical conductor of conductive material substantially shorter in length than said first conductor and supported on said opposite side of the insulating support, said second and third cylindrical conductors being axially spaced with respect to one another; and second conductive means connecting said first and third conductors, said last-mentioned conductors and conductive means forming a second antenna operating at a second predetermined frequency.

10. An assembly for transmitting and receiving communication signals of differing frequencies, said assembly comprising: a support of insulating material; a first conductor of conductive material supported on one side of said insulating material; a second conductor of conductive material substantially shorter in length than said first conductor and supported on the opposite side of said insulating support; first conductive means connecting said first and second conductors, said conductors and conductive means forming a first antenna operating at a first predetermined frequency; a third conductor of conductive material substantially shorter in length than said first conductor and supported on said opposite side of the insulating support; second conductive means connecting said first and third conductors, said last-mentioned conductors and conductive means forming a second antenna operating at a second predetermined frequency; and means for electrically isolating said second antenna from said first antenna, said isolating means including a fourth conductor of conductive material supported on said opposite side of the insulating support and between said second and third conductors, and third conductive means for connecting said fourth conductor with said first conductor.

* * * * *

40

45

50

55

60

65

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,713,166 Dated January 23, 1973

Inventor(s) Robert E. Munson; Jack K. Krutsinger; Jerry H. Polson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 47, " $\lambda c = \lambda \sqrt{\epsilon R}$ " should be $-\lambda c = \lambda / \sqrt{\epsilon R} -$.

Signed and sealed this 10th day of July 1973.

(SEAL)
Attest;

EDWARD M. FLETCHER, JR.
Attesting Officer

Rene Tegtmeyer
Acting Commissioner of Patents