United States Patent

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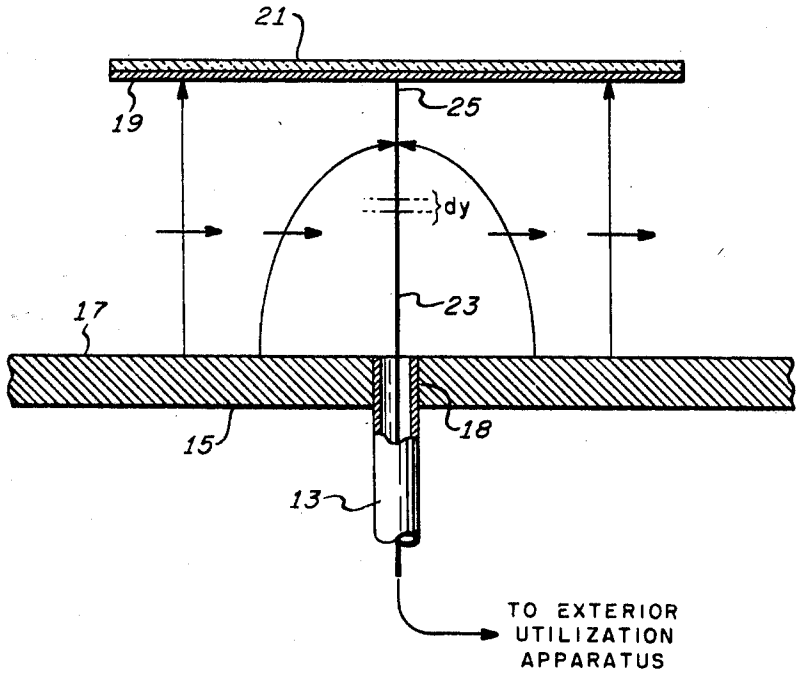
[54] **TIME LIMITED IMPULSE RESPONSE ANTENNA**
8 Claims, 2 Drawing Figs.

[52] U.S. Cl. 343/739, 343/830, 343/899
[51] Int. Cl. H01q 9/36
[50] Field of Search 343/739, 752, 825, 828, 829, 830, 846, 908

[56] **References Cited**
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ABSTRACT: An antenna for producing an output pulse of desired duration in response to an impulsive wave front includes a resistive plate mounted above a ground plane. A coaxial transmission line projects through the ground plane so that its center conductor contacts the resistive plate and its outer conductor terminates flush with the ground plane. The resistive plate consists of a submicron film of resistive material deposited on a dielectric backing and is spaced from the ground plane at a distance approximating the distance travelled by an electromagnetic wave in a time equal to the desired pulse duration.



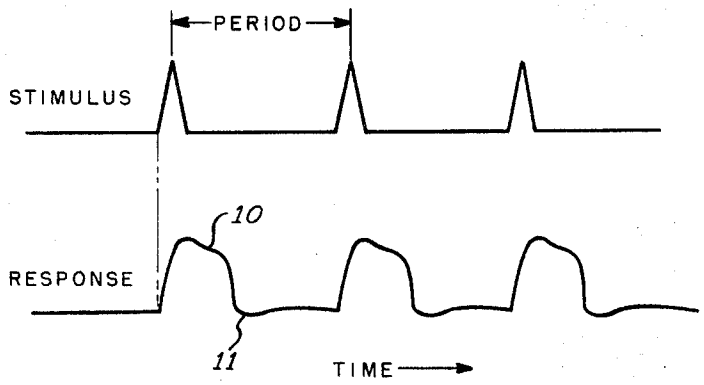


FIG. 1.

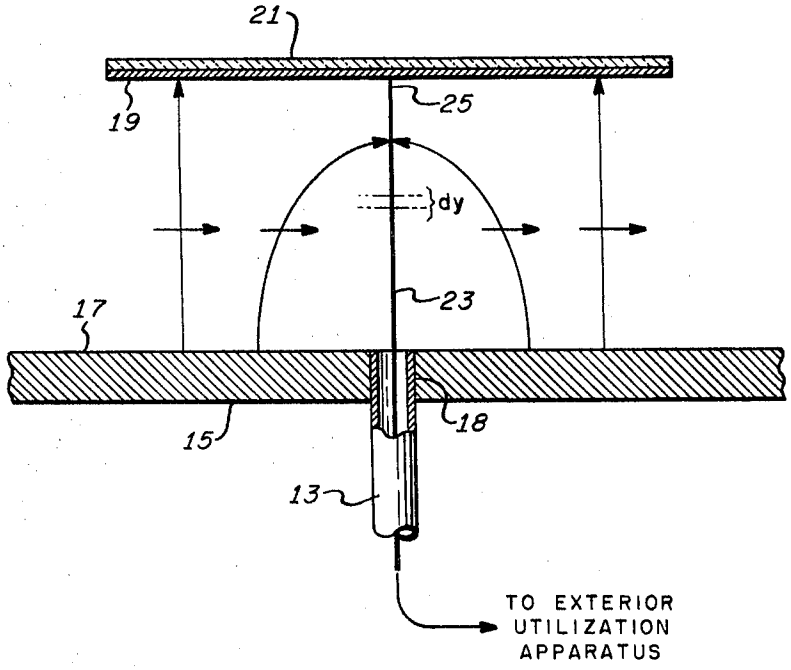


FIG. 2.

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TIME LIMITED IMPULSE RESPONSE ANTENNA

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to microwave antennas and more specifically to antennas capable of responding to electrical impulses.

2. Description of the Prior Art

Wideband communication systems now being developed require antenna elements that effectively respond to individual pulses of electromagnetic energy having a spectral content ranging from the VHF band through the X band.

Various types of antennas have been suggested for such systems. For instance, arbitrarily scaled antennas whose form can be specified entirely by angles have been developed for use over a wide frequency band. Conical and equiangular antennas are examples of this type of "frequency independent" antenna.

Similarly, log-periodic antennas having a structure that causes the electrical properties to repeat periodically with the logarithm of the frequency are operable over a wide range of frequencies.

Although these antennas respond to signals over a wide range of frequencies, they involve the use of narrow band signals. The structures are difficult to fabricate and they tend to produce dispersion when short bursts of energy having a wide spectral content are involved because they inherently produce phase distortion.

SUMMARY OF THE INVENTION

A monopole receiving antenna for producing a pulse of desired duration has a length such that a voltage induced at its tip travels to its base in a time equal to the duration of the desired pulse. The monopole extends between an apertured ground plane and a thin resistive "top hat" having a surface resistivity substantially equal to the impedance of free space and a radius at least equal to the length of the monopole so as to provide an essentially reflectionless termination for the monopole and a minimum of distortion to the received electromagnetic wave.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a drawing illustrating waveshapes of the type encountered with the present invention; and

FIG. 2 is a schematic diagram illustrating the construction of the presently preferred form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, a train of baseband electromagnetic impulselike stimulus pulses includes individual positive-going pulses occurring at a specified period. These "impulselike" pulses have extremely short, but finite durations as indicated. Typically, they have a duration of 200 picoseconds measured at the base line.

The response pulses **10** produced by the receiving antenna have a duration somewhat longer than the original stimulus. The response pulse is followed by a slight oscillatory portion **11**. The response of the present antenna is essentially time-limited, however, in that the response wave becomes zero substantially before the following stimulus pulse occurs. In this way, relatively distortionless individual response pulses can be detected at the antenna output. Prior art antennas, when subjected to the same kind of stimulus train produce significant ringing. Although the antenna may be excited over waveforms, the buildup time or decay time of the envelope in such waveforms cannot exceed the duration of the time-limited impulse response.

Typical response curves associated with the prior art antennas display a positive-going response pulse similar to that displayed by the present invention. However, these positive-going pulses are followed by a negative-going pulse of almost equal amplitude and a train of several oscillations having a typical exponential envelope decay.

Thus, the response of these prior art antennas contains distortion components sufficiently long so as to mask succeeding stimulus signals.

FIG. 2 illustrates the construction of an antenna constructed according to the present invention. A coaxial transmission line **13** has its outer conductor electrically bonded to a conducting plate **15** whose upper surface **17** forms a ground plane. The outer conductor of the coaxial transmission line is inserted in an aperture **18** in the conducting plate and terminates flush with the ground plane **17**. A resistive plate **19** in the nature of a "top hat" is positioned above and parallel to the ground plane **17**. This resistive plate is typically a disc formed from a thin resistive member coated on a substrate **21** formed from glass or other suitable insulating material.

The center conductor of the coaxial line **13** forms a monopole antenna element **23** which extends up to the resistive plate **19**. The monopole element is bonded to this resistive plate at a point **25**. The resistive plate **19** is ordinarily constructed in the form of a flat disc having a radius approximately equal to the length of the monopole element **23**.

The resistive plate **19** may be formed from any convenient material. It has a surface resistivity of approximately 377 ohms per square so as to match the impedance of free space.

In a typical antenna, the transmission line **13** may be conveniently formed from RG–9 coaxial cable. The height of the monopole antenna element **23** is typically in the order of 6 inches. The main consideration in selecting the height of this element is that it must be relatively long with respect to the diameter of the aperture in the ground plane **17**. The element, however, should be short with respect to the buildup time of incident nonbaseband pulses.

Similarly, the radius of the resistive plate must be chosen so that it is very large with respect to the diameter of the monopole element **23** but comparable to the height of the monopole element. Typically, the resistive plate **19** has a radius at least 100 times the diameter of the monopole element.

As presently preferred, the resistive plate **19** is formed from a submicron thick film of chromium deposited on a glass substrate.

The operation of the antenna can be understood by assuming that a plane polarized wave, oriented so that its electric vectors are parallel to the monopole element, impinges on the antenna from the left of the drawing.

As the wave reaches the antenna, voltages are established between the ground plane and the resistive plate. These voltages may be represented by vectors that initially enter the region with a vertical orientation.

When the wave first reaches the monopole element, it induces an impulsive current in each infinitesimal length, dy, of a current in this element. The current induced in each infinitesimal length flows downward towards the coaxial transmission line. Current is also induced in this monopole element such that it flows upward toward the resistive plate **19**. The downward flowing current passes to the transmission line where it can be essentially absorbed by the choice of a proper impedance coaxial line **13**, and detected by exterior utilization apparatus. The upward-flowing current is essentially absorbed in the resistive plate.

Because the upward-flowing current is absorbed by the resistive plate, it cannot be reflected downward into the transmission line. Therefore, the ringing that would ordinarily occur because of this reflected component is eliminated.

Because of the nonsinusoidal waveshapes employed, the various signals contain frequency components extending over a wide band of frequencies. Because of skin effect, each of these components would penetrate a conductor to a different depth. By making the resistive plate extremely thin, however, each of the frequency components is absorbed to a comparable degree so that this resistive plate becomes essentially frequency insensitive.

The output signal passing to the exterior utilization apparatus will persist from the time that current is first induced near the base of the monopole element until the current which

was first induced near the tip of the monopole element flows downward through this element. Thus, in the case of the vertically polarized wave indicated, the duration of the output pulse will be dependent upon the height of the monopole element and approximately equal to the height of this element in terms of the velocity of electromagnetic radiation.

Experiments have shown that the height of the monopole element **23** should be at least about 4 inches.

Measurements have indicated that the maximum deflection of the negative-going portion **11** of the response curve is typically less than about 10 percent of the maximum deflection of the desired pulse **10**. Similar measurements on prior art antennas have indicated the comparable secondary pulse to be as much as 95 percent of the desired pulse amplitude.

In practice, the resistive plate **19** and the substrate may be supported in any convenient manner. Polyfoam struts, for instance, have been used successfully for this purpose.

Although the antenna has been described as operating in the receive mode, it will be apparent to those skilled in the art that the antenna may be operated in the transmit mode as well. In transmission, the antenna radiates the derivative of the electrical signal or essentially two impulses of opposite polarity separated by the desired duration.

While the invention has been described in its preferred embodiment, it is to be understood that the words which have been used are words of description rather than limitation and that changes may be made without departing from the true scope and spirit of the invention in its broader aspects.

I claim:

1. An antenna for providing a pulse having a desired time duration comprising a flat ground plane having an aperture therein, a flat resistive member disposed parallel to said ground plane and supported at a predetermined distance from said ground plane, a coaxial transmission line extending into said aperture, an outer conductor on said transmission line terminating in said ground plane and electrically connected to said ground plane, an inner conductor extending through the region between said ground plane and said resistive member, said inner conductor being electrically connected to said resistive member, said resistive member having a surface resistivity substantially equal to the impedance of free space, said predetermined distance being substantially equal to the distance travelled by an electromagnetic wave in a time equal to the desired pulse duration.

2. The antenna of claim **1** wherein said predetermined distance is large with respect to the transverse dimension of said aperture.

3. The antenna of claim **2** wherein the flat resistive member is a disc having a radius at least 100 times as great as the diameter of said inner conductor.

4. The antenna of claim **3** wherein said predetermined distance is comparable to the radius of said resistive member.

5. The antenna of claim **4** wherein said resistive member includes a thin resistive film formed on an insulating substrate.

6. The antenna of claim **5** wherein said resistive film is a submicron thick film of chromium deposited on a glass substrate.

7. The antenna of claim **6** wherein the inner conductor is normal to said ground plane.

8. The antenna of claim **7** wherein said coaxial transmission line is formed from RG–9 coaxial cable and said predetermined height is approximately 6 inches.