

[54] **ULTRA HARD COMMUNICATIONS
ANTENNA**

[75] Inventor: Terry E. Carrell, Los Angeles, Calif.

[73] Assignee: The United States of America as
represented by the Secretary of the
United States Air Force,
Washington, D.C.

[22] Filed: May 11, 1966

[21] Appl. No.: 550,879

[52] U.S. Cl. 343/719, 343/770, 343/873

[51] Int. Cl. H01q 1/04

[58] Field of Search 343/719, 873, 897;
325/15

[56] References Cited

UNITED STATES PATENTS

2,980,793	4/1961	Daniel.....	343/719 X
2,992,325	7/1961	Lehan.....	343/719 X
3,216,016	1/1965	Tanner.....	343/719

3,273,152 9/1966 Earp 343/719 X

OTHER PUBLICATIONS

"Pulse", Collins Radio Company Employee Bulletin,
Vol. 6, No. 1, January, 1966, page 2.

Primary Examiner—Benjamin A. Borchelt

Assistant Examiner—Richard E. Berger

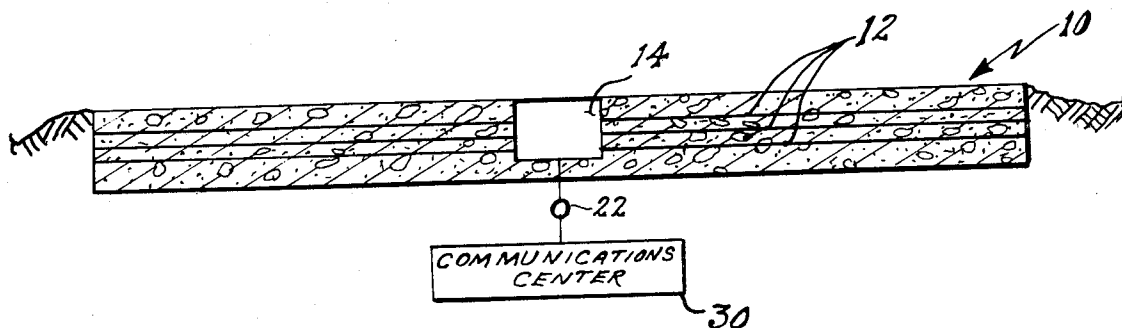
Attorney—Harry A. Herbert, Jr. and Sherman H.
Goldman

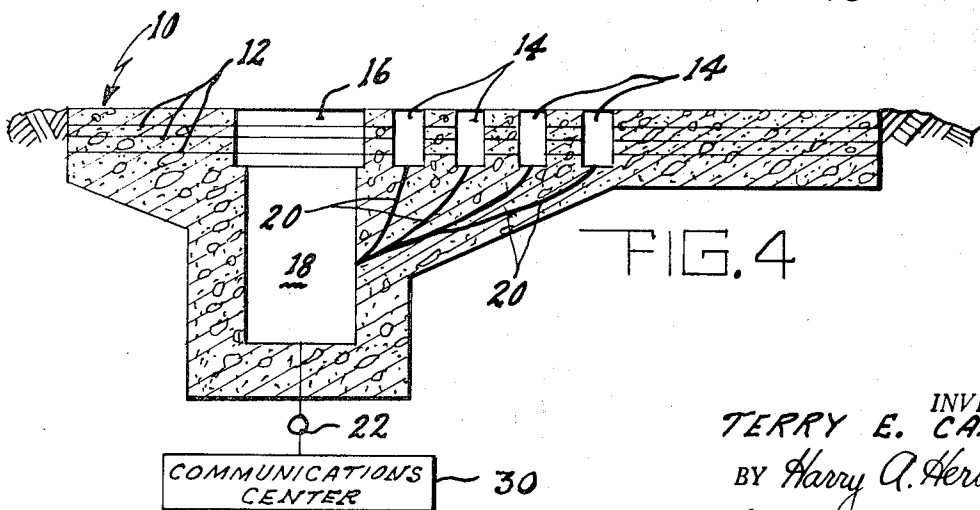
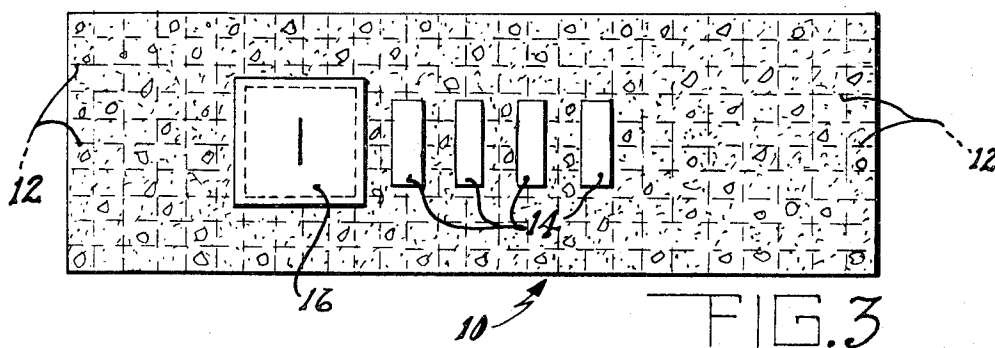
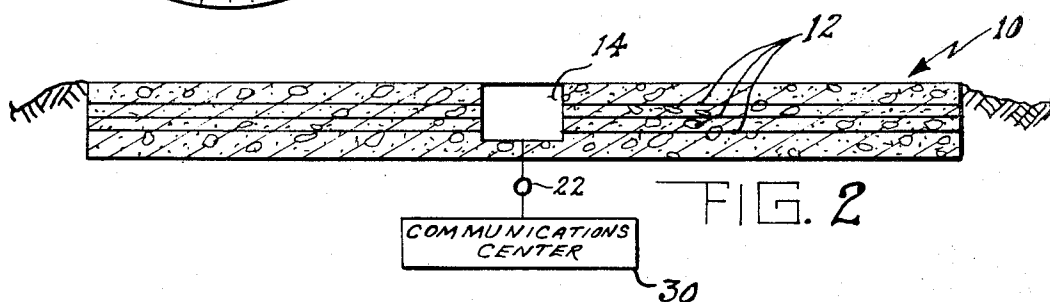
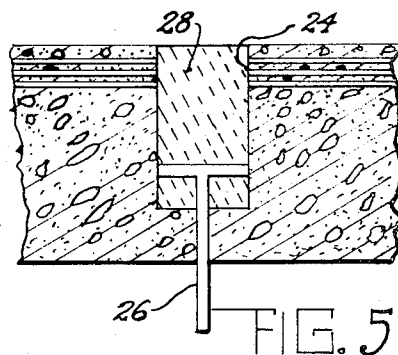
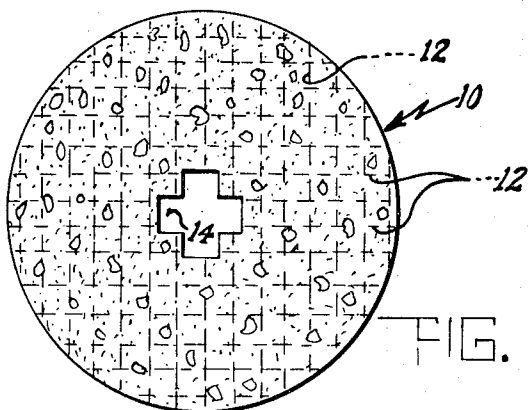
[57]

ABSTRACT

A ground-to-air antenna capable of withstanding all overpressures outside the crater of a nuclear explosion including a massive reinforced concrete block having one exposed surface flush with the surrounding terrain, copperplating the reinforcing members and placing an insulation-filled wave guide in the concrete and connecting it to a sending and receiving means, while the impedance of the wave guide is matched to that of free space.

6 Claims, 5 Drawing Figures





INVENTOR.
TERRY E. CARRELL.

BY *Harry A. Herbert Jr.*
Sherman H. Goldman
ATTORNEYS

ULTRA HARD COMMUNICATIONS ANTENNA

The invention relates generally to ground-to-air antennas and more particularly to a hard antenna capable of withstanding all overpressures outside the crater of a ground nuclear explosion.

In the event of a nuclear attack utilizing high-yield nuclear weapons the national defense system must be able to communicate in order to institute proper defensive measures.

The communication I am chiefly concerned with is communication between either an underground command post and an air-borne command post or attack aircraft.

A conventional aboveground antenna would obviously be destroyed by the effects of blast and heat caused during a nuclear explosion, therefore, any antenna constructed must be built at ground level or below in order that it may survive such effects.

While the concept of underground antennas is not entirely new the thought of an underground antenna which will withstand an overpressure of 2000 pounds per square inch (psi) and still be able to communicate with aircraft 200 miles distance is thought to be inventive. With my new structure, I provide for transmitting omni-directional radiation or unidirectional radiation and still receive in a horizontal plane.

It is therefore an object of this invention to provide a method and apparatus which will provide ground-to-air communication during and after a nuclear explosion.

It is a further object of this invention to provide an antenna which will withstand the heat and blast effects of a nuclear explosion.

It is another object of this invention to provide an antenna which is capable of withstanding an overpressure of 2,000 pounds per square inch.

It is still another object of this invention to provide a ground-to-air antenna which is mounted in a flush ground plane.

It is still a further object of this invention to provide an antenna with no vertical protruding parts which can be broken off by high winds or projectiles.

It is another object of this invention to provide an antenna for ultra high frequencies which is mounted in a hard structure capable of withstanding the effects of a nuclear explosion.

It is another object of this invention to provide an ultra high frequency antenna which will not be effected by atomic radiation of a nuclear blast.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiments in the accompanying drawings, wherein:

FIG. 1 shows a top view of a hardened omni-directional antenna structure;

FIG. 2 is a side elevation view in section of a hardened omni-directional antenna structure;

FIG. 3 is a side elevation view in section of a hardened unidirectional antenna structure embodied in this invention;

FIG. 4 is a cross sectional view of a hardened unidirectional antenna structure included in this invention; and

FIG. 5 is a cross sectional view of the T-feed utilized to excite the slots of the antennas.

Fundamentally, the antenna of my invention consists of a flush mounted slot array in which the slots have been filled with an insulating medium. The complete absence of any structure above the ground level gives the design a freedom from drag loading which other antennas cannot claim. Under most circumstances the thermal and reflected overpressure effects will be less serious than for conventional designs. At the same time, it is not forced to operate at the extremely low efficiencies of the ordinary buried antennas.

As is known in the art the slot dipole antenna is essentially the complement of the conventional dipole antenna. That is, a conventional dipole consists of a conductor of a prescribed size surrounded by an insulator (usually air) while a slot dipole consists of an insulator of the prescribed size surrounded by a conductor (usually copper). If a conventional dipole is held horizontally with respect to the earth's surface, the radiation from it is horizontally polarized. On the other hand, if a slot dipole is held horizontally with respect to the earth's surface its radiation is vertically polarized. Both, however, are efficient radiators if properly designed.

Referring now to FIG. 1 there is shown a plan view of my antenna which is a substantial omni-directional array. The circular concrete slab 10 has embedded therein welded wire fabric 12 which may be of the type commonly utilized in reinforced concrete. At least the top three layers of the wire screen 12 are copperplated. The skin effect will cause almost all of the radio frequency power to flow through the copperplated layer, hence the conductivity will be the same as if the entire screen were made of copper. Further, if the mesh spacing in this screen is smaller than about a quarter wavelength at the highest frequency to be used, the reinforcing fabric will appear to the radio frequency energy as essentially a solid sheet of copper, giving the antenna body a high electrical efficiency. The antenna feed is shown by the crossed slot 14.

The side elevation view in section, of the antenna is shown in FIG. 2, the concrete slab 10 with the copperplated wire 12 and the antenna feed at 14. In this illustration only three layers of wire mesh are shown but it is anticipated that mechanical requirements for hardness will require more layers which could be utilized as part of this antenna.

The array shown in FIGS. 1 and 2 is designed for use with a transmitter at a deep underground site. By putting the transmitter in the communications center of the subterranean command post rather than at the antenna, the shock mounting problem is largely avoided and rapid servicing is possible in the event of transmitter or receiver failure.

An item of major concern arises with this arrangement however, and that is the excessive amounts of power wasted because of the inefficiencies in transmission lines. Such a problem is overcome by mounting the radio frequency circuitry of the receiver and transmitter within the antenna as shown in FIGS. 3 and 4. The same solution may be used for the omni-directional antenna by adding an instrument silo 18 to the configuration shown in FIGS. 1 and 2. The large, heavy, and heat-generating power supply and delicate modulator will still be left at the command center to minimize shock mounting problems.

The antenna array of FIGS. 3 and 4 is substantially the same as that described with regard to FIGS. 1 and

2, the concrete slab 10, the wire fabric 12 and antenna feed 14. The antenna array of these figures is substantially unidirectional. An instrument silo 18 is located at the base of the antenna and is provided with an access door 16. A plurality of antenna feeds 14 are connected to the silo 18 by means of leads 20. The plurality of antenna feeds 14 is used to provide a shaped and steerable beam for directional communication. This is accomplished by controlling the phase relationship among the feeds 14 by using phase shifting circuits located in the instrument silo 18 or in the communications center. The power supply for the instrument silo is provided by cables 22 from the communications center 30 located some distance from the antenna structure.

The slot as shown in FIG. 5 used in this design is not the conventional boxed-in slot but is instead a section of waveguide whose characteristic impedance is matched to that of free space. The walls of the horn 24 are made from copperplated welded wire fabric and joined firmly to the copperplated reinforcing screens in the antenna body, giving electrical continuity to the entire structure. The input to the antenna feed 26 is a rugged copperplated steel bar. The input is welded to the walls of the horn and embedded in an insulating medium 28, which may be comprised of 90 percent quartz fibers with 10 percent epoxy binder. Such a material will eliminate formation of conducting carbonized surfaces. Because the antenna slot opening has no change of shape in the last foot, there will be no change in impedance or pattern of the antenna should the top foot of the antenna be eroded away as the result of a nuclear blast.

Structurally, experience has shown that there is no doubt as to the integrity of concrete housings with massive construction, even with loads caused at 2,000 psi overpressure. Furthermore, overhead detonations tend

to drive the antenna into the ground, where it is strongest.

While there may be some surface spalling, erosion of the surface and debris piled on the structure the antenna of this invention will continue to operate despite such adverse conditions.

Although the invention has been described with reference to particular embodiments, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

I claim:

1. An apparatus for sending and receiving radio waves comprising: a mass of reinforced concrete with its exposed surface flush with the earth surrounding it; a plurality of copperplated reinforcing wires embedded in said mass of concrete and disposed in a plane parallel to the earth's surface; a slot mounted in said mass, said slot being a wave guide filled with an insulating medium, the impedance of said wave guide matched to that of free space while connected both to the antenna and sending and receiving means.

2. An antenna according to claim 1 wherein the antenna is unidirectional.

3. An antenna according to claim 1 wherein the slot is a crossed slot.

4. An antenna according to claim 3 wherein the antenna is omni-directional.

5. An antenna according to claim 1 wherein containment means are provided within the antenna for radio frequency circuitry.

6. An apparatus according to claim 1 wherein said insulating medium comprises a mixture of substantially 90 percent quartz fibers with a 10 percent epoxy binder.

* * * * *

40

45

50

55

60

65