

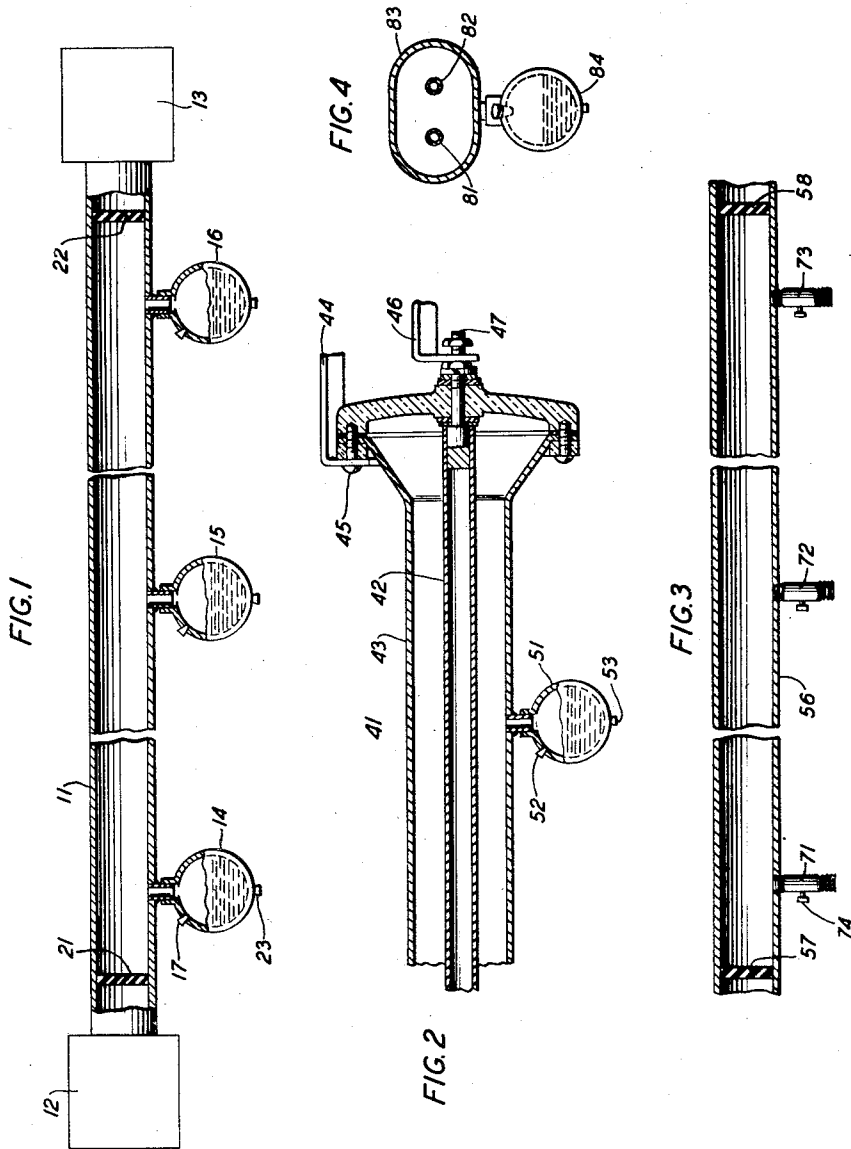
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WAVE GUIDE DIELECTRIC PROTECTION

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WAVE GUIDE DIELECTRIC PROTECTION

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1

This invention relates to wave transmission and more particularly to the transmission of ultra-high frequency waves by means of hollow conductors such as a dielectric wave guide in the form of a metallic pipe containing a gaseous dielectric or a shielded conductor or coaxial cable with a gaseous dielectric occupying the space between the inner and outer conductors.

An object of the invention is to improve the operation of hollow conductors in the transmission of ultra-high frequency waves.

A more specific object of the invention is to lessen the likelihood of the occurrence of dielectric breakdown within a hollow conductor that is being used in ultra-high frequency transmission.

Another specific object of the invention is to substantially raise the breakdown voltage point of the gaseous dielectric within a hollow conductor being used in ultra-high frequency transmission.

It has been recognized, heretofore, that, when ultra-high frequency waves are being transmitted over a hollow conductor, such, for example, as a dielectric wave guide in the form of a metallic pipe containing a gaseous dielectric, such as air, there is the possibility of "breakdown" of the dielectric within the guide. Such breakdown, with resulting sparking within the guide, interferes with efficient transmission and is, of course, highly undesirable. It follows that any feasible expedient for reducing the likelihood of such breakdown would be valuable and it is obvious that the value of such expedient would be much greater if the introduction thereof could be made without interference with the normal operation of the conductor and without any major change in the design of said conductor.

The theories of breakdown and sparking are somewhat complicated and there is not complete agreement on the part of all authorities with respect to some of the points involved. There is no occasion in the present instance for a detailed discussion of any of the theories or for expression of an opinion with respect to any of the unresolved questions. It may be of value in furthering understanding of the invention, however, if a few basic points be set forth at this time.

In general, the first step in any breakdown is an electron "avalanche." This results when an electron is liberated by cosmic rays or some other agency. The liberated electron moves along and collides with molecules thereby producing a number of new electrons and an equal number of

2

positive ions; each new electron does this same thing. If this avalanche is to develop into a spark, it must in some way produce more electrons to sustain the process; that is a continuous supply of electrons must be generated. In the case of direct current transmission, this generation may be accomplished by secondary emission resulting from the collision of positive ions with the cathode. In the case of high frequency alternating current transmission, with which the present invention is concerned, the electrons may be produced photoelectrically in the body of the gas by radiation, mostly ultra-violet, sent out from the initial avalanche and the succeeding discharge.

In accordance with a feature of the present invention, the gaseous dielectric within a hollow conductor is so modified in make-up that the breakdown voltage point of the dielectric is raised substantially.

A further feature of the present invention resides in means whereby the make-up of the dielectric may be modified at desired time intervals without interfering with the normal operation of the conductor.

In accordance with a specific embodiment of the invention, a wave guide comprises a hollow metallic pipe, a gaseous dielectric (air) being enclosed within the pipe. Means are provided at spaced intervals along the pipe for supplying a polyatomic gas (alcohol vapor) to the interior of the pipe where it mixes with the air dielectric. As will be discussed in greater detail subsequently, applicant has discovered that the addition of this polyatomic gas to the gaseous dielectric results in raising the breakdown voltage point of the dielectric substantially thereby reducing the likelihood of failure of the wave guide when being used for the transmission of ultra-high frequencies.

The expression "polyatomic gas" as used herein means that each molecule of the gas referred to comprises a plurality of atoms. The expression "alcohol" is intended to mean "ordinary" or ethyl alcohol (C_2H_5OH).

A complete understanding of the arrangements contemplated by the present invention, their operation and the advantageous features thereof may be gained from consideration of the following detailed description and the annexed drawings in which:

Fig. 1 is a longitudinal section of a circular, metallic, wave guide connecting two translating devices and provided with means for adding a polyatomic gas to the gaseous dielectric in ac-

cordance with features of the present invention;

Fig. 2 is a longitudinal section of a terminal end of a coaxial cable provided with means for adding a polyatomic gas to the gaseous dielectric enclosed within the outer conductor of the cable;

Fig. 3 is a longitudinal section of a modified form of the wave guide of Fig. 1; and

Fig. 4 is an end sectional view of a further type of transmission element provided with means for adding a polyatomic gas to the gaseous dielectric.

Referring now to the drawings, and first to Fig. 1, there is shown a circular, metallic wave guide 11 connecting translating device 12 and load device 13; translating device 12 may be, for example, an ultra-high frequency radio transmitter and load device 13 may be, by way of example, an antenna such as a dielectric polyrod, a parabolic reflector or any similar device. A gaseous dielectric, specifically air in this illustrative example, is enclosed by the wave guide.

Wave guides of this and other types and their operation have been described in detail heretofore in various publications, for example, in such patents as 2,129,711, 2,129,712 and 2,129,714, all issued September 13, 1938, to G. C. Southworth; 2,147,717, issued February 21, 1939, to S. A. Schelkunoff and in the papers by J. R. Carson et al. and S. A. Schelkunoff appearing in the April 1936, issue of Bell System Technical Journal.

When a wave guide, such as wave guide 11 is used for the transmission of ultra-high frequency waves, there is the possibility, as pointed out above, of breakdown of the gaseous dielectric within the wave guide. As also set forth above, this breakdown, in the instance of high frequency alternating current transmission with which the present invention is concerned, if it is to reach the damaging sparking magnitude, involves the production of electrons photoelectrically in the body of the gaseous dielectric by radiation, mostly ultra-violet.

In order to reduce the probability of occurrence of breakdown within wave guide 11, vessels or containers 14, 15 and 16 are provided at properly spaced intervals along the wave guide, the interior of each container communicating with the interior of wave guide 11 through a gas-tight connection. Each container holds a quantity of alcohol, removable plugs, as plug 17, being provided in each container to permit the liquid to be poured into the containers. The alcohol vapor, a polyatomic gas, which rises from the alcohol, passes from the respective containers through the gas-tight connections to the interior of the wave guide where it mixes with the gaseous dielectric (air) thereof. Vapor seals, as seals 21 and 22, are provided adjacent to devices 12 and 13 respectively as well as at other suitable points in the wave guide. In some instances, particularly when the wave guide terminates in a power device, there will be a tight seal to the glass vessel of a vacuum tube and no additional vapor seal will be required.

Applicant has discovered that this addition of the alcohol vapor to the air dielectric within the wave guide is effective in substantially raising the breakdown voltage point of the dielectric thereby reducing the chance of the failure of the wave guide during transmission. It was pointed out above that under the conditions prevailing during the use of wave guide 11, that is for the transmission of alternating current at high frequency, the establishment of a breakdown of the dielectric of a magnitude to result in sparking

would involve continuous generation of electrons photoelectrically in the body of the air dielectric by radiation, mostly ultra-violet. Now it is applicant's theory that the addition of the polyatomic gas to the dielectric within the wave guide in accordance with the features of the present invention is effective in raising the breakdown voltage point of the dielectric because of the photo-ionization referred to is prevented by absorption of the ultra-violet radiation. The energy of the radiation is used up in decomposing the polyatomic molecules.

The alcohol within containers 14, 15 and 16 should be replaced periodically in order to maintain the effectiveness of the arrangement. To facilitate draining, each of the containers is provided with a suitable drainage plug, as plug 23.

Ethyl alcohol is particularly applicable to the arrangement of the present invention as it has the property of being able to absorb ultra-violet radiation and has a relatively high volatility thereby assuring entry of the vapor into the wave guide. Other polyatomic gases having these characteristics may also be used, for example, methane or ammonia.

Referring now to Fig. 2, the arrangement of the present invention is illustrated as applied to a coaxial cable 41. Cable 41 may be of the general type described in detail in Patent 2,376,725, issued May 22, 1945, to L. W. Richardson, deceased (M. M. Richardson, administratrix) and Mr. M. W. Scheldorf and may comprise an inner tubular conductor 42 and an outer tubular conductor 43, the space between said two conductors being filled with a gaseous dielectric, specifically air. One end terminal of the cable is illustrated and it will be observed that the terminal is of a gas-tight type. It will be assumed that the other end of the cable is similarly terminated.

Conductor 43 may be electrically connected to local lead 44 by screw 45 and conductor 42 may be electrically connected to local lead 46 through extension bolt 47.

In accordance with features of the present invention, alcohol vapor is supplied from alcohol container 51 to the space between conductors 42 and 43 and mixes with the air dielectric which occupies such space. Container 51 is provided with a refill plug 52 and a drain plug 53.

The purpose of supplying the polyatomic gas to the interior of cable 41 where it mixes with the gaseous dielectric of the cable and the theory advanced for the advantageous effect of such action are the same as those discussed above in reference to wave guide 11. The addition of the polyatomic gas is effective to substantially raise the breakdown voltage of the air dielectric thereby lessening the danger of such breakdown with the resulting sparking at the outer surface of conductor 42 and the inner surface of conductor 43.

It is contemplated that other methods of adding the polyatomic gas to the dielectric may be followed as well as the general method described above in the discussion of Figs. 1 and 2. For example, it is contemplated that on occasion it may be found preferable to mix the proper proportion of vapor with the gaseous dielectric at the time of construction of the conductor after which the interior of the conductor is sealed off. By way of illustration of this method there is shown in Fig. 3, wave guide 56, the structure of which is similar generally to that of wave guide 11 of Fig. 1. In the instance of wave guide 56, however, alcohol vapor in proper proportion was mixed with the air dielectric within the wave guide, at

5

the time of manufacture, after which the interior of the wave guide was sealed-off to the passage of gases. Vapor seals, as seals 57 and 58, are provided where necessary in the wave guide.

In order that alcohol vapor may be added to the mixture within the wave guide when necessary, gas-tight couplings, such as couplings 71, 72 and 73, are provided at proper intervals along the wave guide. On occasion, a container of alcohol may be positioned on the projecting end of a coupling, the hand-operated cut-off valve provided in each coupling (as valve 74) opened and the alcohol vapor supplied to the interior of the wave guide for addition to the mixture of alcohol vapor and air therein.

Referring now to Fig. 4 there is illustrated a transmission element comprising two conductors 81 and 82 positioned within a sheath 83. The area between and surrounding, conductors 81 and 82 is filled with a gaseous dielectric (air); sheath 83 provides a gas-tight enclosure although it need not be electrically insulating. As indicated, alcohol vapor is supplied from alcohol container 84 to the space with sheath 83 where it mixes with the air dielectric therein. The addition of the alcohol vapor to the dielectric is effective to substantially raise the breakdown voltage of the air dielectric thereby lessening the chance of such breakdown with resulting sparking at the surfaces of conductors 81 and 82.

It will be apparent that the general arrangement of the present invention offers the particular advantage that its introduction interferes in no way with the normal operation of the conductor and necessitates no change in the basic structure thereof.

While certain specific embodiments of the invention have been selected for detailed description, the invention is not, of course, limited in its application to such embodiments. For example, while the application of a specific polyatomic gas (alcohol vapor) to a specific gaseous dielectric (air) has been described, it will be understood that the use of other polyatomic gases having the required characteristics referred to and the application of the polyatomic gas utilized to gaseous dielectrics other than air are contemplated. Application of the features of the invention to other types of conductors than those illustrated, for example to electromagnetic cavity resonators, is also contemplated. In short the embodiments de-

6

scribed should be taken as illustrative of the invention and not as restrictive thereof.

What is claimed is:

1. In combination, a hollow conductive transmission line for transmitting ultra-high frequency waves inclosing a gaseous dielectric at substantially atmospheric pressure and means for absorbing ultra-violet radiation originating in the dielectric during an incipient discharge without material ionization resulting from such absorption, said means comprising a second gas which is polyatomic having the property of absorbing radiation energy of a frequency in the ultra-violet range and having a relatively high volatility supplied to the interior of said hollow line and mixed with the said gaseous dielectric.

2. In combination, a hollow conductive transmission line for transmitting ultra-high frequency waves inclosing air as a dielectric at substantially atmospheric pressure and means for absorbing ultra-violet radiation originating in the dielectric during an incipient discharge without material ionization resulting from such absorption, said means comprising alcohol vapor having the property of absorbing radiation energy of a frequency in the ultra-violet range and supplied to the interior of said hollow line and mixed with the air therein.

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