April 1, 1952 H. A. WHEELER 2,591,484

ARRANGEMENT FOR DESENSITIZING HIGH-FREQUENCY ELECTRICAL-WAVE APPARATUS

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FIG. 1

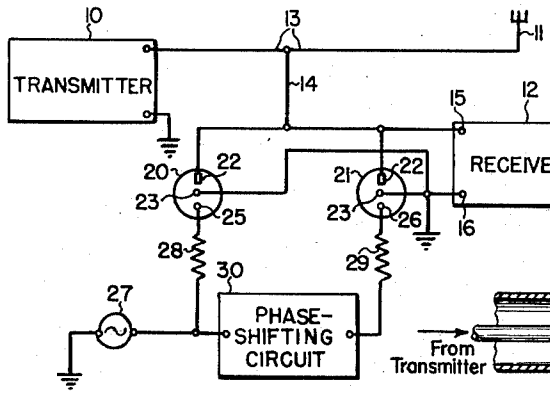


FIG. 4

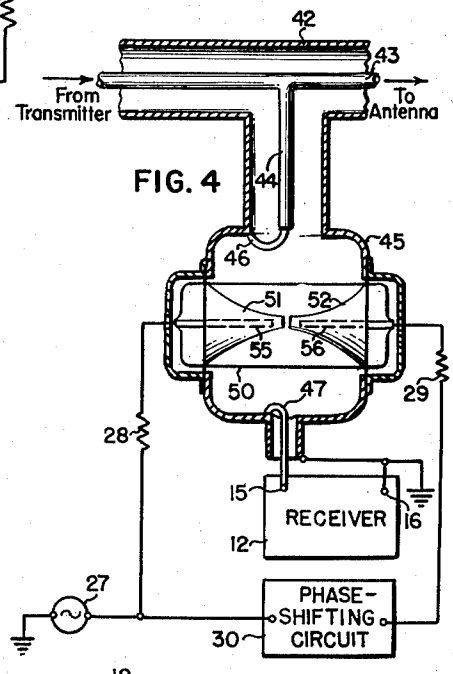


FIG. 3

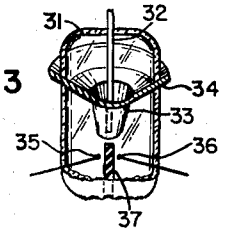
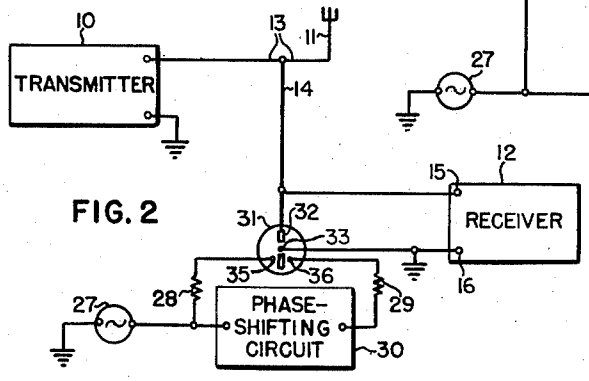


FIG. 2



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ARRANGEMENT FOR DESENSITIZING HIGH-FREQUENCY ELECTRICAL-WAVE APPARATUS

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11 Claims. (Cl. 250—13)

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This invention relates to an improved arrangement for desensitizing electrical-wave apparatus upon application to the apparatus of excessive wave energy of a type to which the apparatus is ordinarily sensitive. While this invention finds use in many systems involving electrical-wave apparatus which is subject at times to excessive input or overload, the invention is especially suited for use in a radio transmitter-receiver system and will be particularly described in that connection.

In many radio systems it is desirable to use the same antenna or neighboring antenas for transmission and reception at approximately the same wave lengths; this applies particularly to systems in which pulses of wave energy are transmitted and corresponding pulses received shortly thereafter. Such systems include receivers highly sensitive to wave energy of the wave lengths used in the system, and the input circuit and other circuits of such receivers may be damaged, or the operation of the receivers may be impaired, if power generated by the transmitter is permitted to enter the receiver circuits. One arrangement, which has been used prior to the present invention to protect the receiver, includes a vapor-filled tube having electrodes connected across the input circuit of the receiver. Surges of high voltage from the transmitter appear at times across the electrodes of this tube. If an arc-discharge path, composed of numerous ions of the vapor in the tube, breaks down under this voltage, the tube presents practically a short circuit to the receiver and hence prevents any substantial voltage from appearing in the input circuits of the receiver.

Various types of vapor-filled tubes are known having the desirable property of rapidly initiating and breaking off the arc discharge when a supply of ions is available within the tube. It has been found, however, that such tubes often do not display this desirable property after an arc discharge has ceased and the vapor has become deionized. To overcome this difficulty one prior arrangement includes an additional electrode in the tube, known as a keep-alive electrode. A suitable voltage is applied between this additional keep-alive electrode and one of the other electrodes, so that small currents flow and an incipient discharge condition is maintained in the tube. This results in a supply of ions in the tube available for the immediate formation of an arc whenever sufficient voltage appears across the arc-discharge electrodes.

When a direct voltage is applied between the

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additional electrode and another electrode in a tube of the type just mentioned, a satisfactory reservoir of ions may be maintained at all times. It is often more convenient, nevertheless, to apply voltage to the additional electrode from a source of alternating rather than direct voltage. However, it has been discovered that an alternating voltage often does not maintain ionization at a sufficiently high level during those intervals in the cycle of alternation during which the voltage is much less than its peak value.

Accordingly, it is an object of this invention to provide a new and improved arrangement for desensitizing electrical-wave apparatus which substantially avoids one or more limitations of the described prior arrangements.

It is also an object of this invention to provide a new and improved vapor-filled discharge device for rapidly desensitizing and protecting electrical-wave apparatus upon application thereto at any time of excessive wave energy.

It is a further object of this invention to provide a new and improved vapor-filled discharge device in which a supply of ions may be maintained without applying a direct and continuous keep-alive voltage to the device.

In accordance with the invention, an arrangement for desensitizing high-frequency electrical-wave apparatus upon application to it of excessive wave energy of a type to which the apparatus is ordinarily sensitive comprises an input circuit of the apparatus to which the wave energy may be applied and ionic-discharge short-circuiting means coupled with the input circuit. The arrangement further comprises two auxiliary ionic-discharge means coupled with said short-circuiting means to form auxiliary ionic-discharge paths and means for exciting one of these two auxiliary means with an alternating voltage to supply ions for the ionic-discharge short-circuiting means during intervals when such alternating voltage has a sufficient instantaneous value, and also includes means for exciting the other of the two auxiliary means with an alternating voltage which is phase-displaced from the first-mentioned alternating voltage by an amount other than integral multiple of 180° to supply ions for the short-circuiting means during intervals when the first-mentioned alternating voltage has a value much less than its peak value.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accom-

panying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a schematic circuit diagram of a complete transmitter-receiver system including an arrangement embodying the present invention; Fig. 2 is a schematic circuit diagram of a similar system including another embodiment of the present invention; Fig. 3 is a sectional view of an ionic-discharge short-circuiting tube which may be used in the system of Fig. 2; and Fig. 4 is a sectional view, partly schematic, of an arrangement in accordance with the present invention and suitable for use in the system of Fig. 2 to couple a common antenna to a transmitter and to a receiver.

Referring to Fig. 1 of the drawing, there is shown a circuit diagram including a schematic representation of a transmitter 10, an antenna 11 and an electrical wave apparatus in the form of a receiver 12. Transmitter 10 is coupled to antenna 11 by a transmission line including a conductor 13. Receiver 12 is coupled to transmission-line conductor 13 and hence to antenna 11 by a transmission line including a conductor 14, this coupling being effected by suitable connections to the terminals of an input circuit 15, 16 of the receiver.

The transmitter-receiver system including the common antenna 11 may take any of numerous forms known in the radio art and a detailed description of these parts of the complete system is considered unnecessary. The operation of one system of this kind, utilizing pulse modulation, will be briefly described. In such a system it is frequently desired to transmit a pulse and shortly thereafter to receive a pulse containing information related to the transmitted pulse. Accordingly, suitable triggering circuits in the transmitter cause a powerful pulse of wave energy to appear at its output circuit and to travel along the conductor 13 to antenna 11. Shortly thereafter a very much weaker pulse of wave energy of approximately the same wave length is induced in antenna 11. This received pulse is fed by transmission-line conductors 13 and 14 to the input circuit of receiver 12, in which suitable circuits, not shown in detail, derive and present to the operator information carried by the pulses mentioned.

Referring now more particularly to the parts of Fig. 1 involving the present invention, there is shown schematically ionic-discharge short-circuiting means comprising two short-circuiting tubes 20 and 21, each having a plurality of electrodes including two ionic-discharge electrodes 22 and 23. The ionic-discharge electrodes of each tube are connected across the input circuit 15, 16 of receiver 12 so as to be effectively coupled with the input circuit. The tubes 20 and 21 contain vapors, preferably including water vapor, at low pressures known to be suitable for rapid initiation of ionic discharges across the ionic-discharge paths between electrodes 22 and 23 in each tube.

Inside the tubes 20 and 21 are disposed two additional electrodes, an electrode 25 and an electrode 26 being provided in the tubes respectively comprising means coupled with the short-circuiting means of tubes 20 and 21 to form auxiliary ionic-discharge paths. As shown, the terminal 16 of the receiver input circuit is connected to the ionic-discharge electrode 23 in each tube and is grounded. An alternating-current generator 27 is provided, with one terminal also grounded. The other terminal of alternator 27 is connected

through a current-limiting resistor 28 to the additional electrode 25 of tube 20. Alternator 27 thus comprises a means for applying an alternating voltage between one pair of electrodes, specifically electrode 25 of the two additional electrodes and the corresponding grounded ionic-discharge electrode 23 in the tube 20. Another current-limiting resistor 29 is provided for the additional electrode 26 of tube 21. Instead of being connected directly to the source 27 of an alternating voltage, however, resistor 29 is connected to a means, including a phase-shifting circuit 30, for applying, between another pair of the above-mentioned plurality of electrodes, specifically between the other electrode 26 of the two additional electrodes and its corresponding grounded ionic-discharge electrode 23 in the other tube 21, an alternating voltage which is phase-displaced from the above-mentioned alternating voltage by an amount other than an integral multiple of 180° applied to tube 20.

The tubes 20 and 21, the alternator 27, and phase-shifting circuit 30 act upon the input circuit 15, 16 of receiver 12 so as to provide an arrangement for desensitizing the receiver upon application thereto of excessive wave energy from transmitter 10. The wave energy is of the type to which the receiver is ordinarily sensitive, that is, pulses of wave energy of the wave length of the system, as described hereinabove. Since this wave energy may be applied with little attenuation from the transmitter to at least one input circuit of the receiver, it is often so excessive as to damage the sensitive circuits of the receiver, or to impair the operation thereof, unless the receiver is protected by desensitizing one of these circuits quickly.

In the operation of the arrangement of Fig. 1, an alternating voltage, generated by alternator 27, is impressed between electrodes 25 and 23 of tube 20. This voltage is preferably of the order of 1000 volts in amplitude for a short-circuiting tube containing water vapor and in any case has a crest value amply sufficient for making the electrodes 23, 25 effective to supply ions inside the tube 20. There then exists an auxiliary ionic-discharge path between electrodes 25 and 23 in tube 20. When excited with a sufficient voltage applied by means including alternator 27 between these two electrodes, that path ionizes and carries an incipient ionic discharge. Due to the proximity to this auxiliary path of the space in tube 20 between electrodes 22 and 23, the active part of the short-circuiting means embodied in that space is exposed to the auxiliary path and is supplied with ions from that path. Current-limiting resistor 28 prevents generator 27 from causing a large ionic discharge or an arc discharge in the auxiliary path, which might affect the active ionic-discharge path between electrodes 22 and 23 so as to cause premature short-circuiting of the receiver.

A transmitted pulse traveling from transmitter 10 through transmission-line conductors 13 and 14 and reaching an input circuit of receiver 12 is impressed between the ionic-discharge electrodes 22 and 23 of tube 20. If this transmitted pulse arrives at the receiver during an interval when the alternating voltage applied between electrodes 25 and 23 by alternator 27 has a sufficient instantaneous value, that is, at any time other than in an interval during which this alternating voltage is quite low or actually reversing in polarity, there is a sufficient supply of ions in tube 20 to ensure immediate breakdown of the ionic-discharge path

between the electrodes 22 and 23 of tube 20. If, however, the transmitted pulse arrives at the receiver in the interval of time during which the alternating voltage has a value much less than its peak value, the supply of ions in tube 20 may drop to the point at which initiation of an ionic-discharge is seriously delayed. In this event the receiver circuits might be damaged, or their operation impaired, by the powerful wave energy from the transmitter were it not for the presence of ionic-discharge tube 21.

An additional electrode 26 being provided in tube 21, as well as the electrode 25 in tube 20, each of these electrodes is effective to supply ions in its tube during the times when a voltage is maintained between it and its corresponding other electrode 23 in the respective tube. Accordingly electrodes 26 and 23 in tube 21 provide a second auxiliary ionic-discharge path, to which the active part of the short-circuiting means in the space between electrodes 22 and 23 in tube 21 is exposed, and which is excited with the alternating voltage supplied by means of generator 27 and phase-shifting circuit 30 in order to supply ions from this other auxiliary path to that active part of the short-circuiting means. Tube 21 thus operates in a fashion similar to tube 20, except that the phase-shifting circuit 30, which of course comprises effectively either an inductive reactance or a capacitive reactance, causes the voltage applied to additional electrode 26 to be phase-displaced from the voltage applied to additional electrode 25 of tube 20. In a preferred form of the arrangement of the present invention, well-known phase-shifting means are employed to produce a voltage on electrode 26 with respect to its corresponding grounded electrode 23 almost 90 degrees out of phase with the voltage on electrode 25. Since the two voltages are then substantially in phase quadrature with each other, a condition obtains in which, at the instant when the voltage on electrode 25 reaches a minimum, the voltage on electrode 26 approaches a maximum. Electrode 26 is effective at that instant to supply ions to tube 21, and thus to activate an alternate short-circuiting path available during the intervals when a discharge through tube 20 cannot be relied upon.

Likewise, during the intervals when the alternating voltage between the additional electrode 26 and its corresponding grounded electrode 23 of tube 21 is reversing, tube 20 is available similarly to provide a very low impedance at the input terminals 15, 16 of the receiver, if at that time a pulse should arrive there directly from transmitter 10. Thus, considering the two additional electrodes 25 and 26 together, there is always at least a certain minimum voltage to the corresponding grounded electrodes, although the voltage on either one of the additional electrodes passes through zero periodically. It is preferable that this minimum voltage be maintained a large fraction, preferably over three-fifths, of the maximum voltage between an additional electrode and its corresponding electrode.

In the schematic circuit diagram of Fig. 2, there is shown a similar arrangement including an electrical-wave receiver 12 having a transmission-line conductor 14 connected to its input circuit at terminals 15 and 16. As in the arrangement of Fig. 1, receiver 12 is ordinarily sensitive to wave energy of a wave length generated by a transmitter 10, and associated with receiver 12 there is a system including a source of wave energy excessive to the receiver, this

wave energy originating from transmission-line conductor 13 which is supplied by the transmitter 10. The associated system also includes an antenna means 11 for both radiating and receiving wave energy, and both transmitted wave energy from transmitter 10 and received wave energy from antenna 11 may be conducted by line conductors 13 and 14 to the receiver.

In the arrangement of Fig. 2, an ionic-discharge short-circuiting means comprises a single short-circuiting tube 31, having two ionic-discharge electrodes 32, 33 connected across the input circuit 15, 16 of receiver 12, and containing vapors, similar to those in tubes 20 and 21 of Fig.1, to serve as a source of ions. Two additional electrodes 35, 36 are provided in tube 31. As in Fig. 1, voltage from an alternator 27 is applied through a current-limiting resistor 28 between the additional electrode 35 and grounded electrode 33, while the same alternator supplies, through a phase-shifting circuit 30 and current-limiting resistor 29, a phase-displaced alternating voltage between the other additional electrode 36 and the grounded electrode.

In the operation of the arrangement of Fig. 2, each of the two additional electrodes 35 and 36 is effective to supply ions when the above-mentioned voltage difference is maintained between that electrode and the corresponding electrode 33 in tube 31. Due to the presence of the phase-shifting circuit, a sufficient voltage difference is maintained at all time between one of the two electrodes 35 and 36 and the electrode 33 to supply the ions necessary for ensuring an ionic discharge immediately upon the arrival of excessive wave energy at terminals 15 and 16.

In Fig. 3 is shown a sectional view of a tube suitable for use as the short-circuiting tube with keep-alive electrodes in the arrangement of Fig. 2. Similar reference numerals are used to designate the parts of the ionic-discharge tube 31. Thus, the tube is provided with a rod-shaped ionic-discharge electrode 32 which extends into a cupped arc-discharge electrode 33 open at top and bottom. The electrode 33 is provided with a skirt or disc 34, which may extend through the walls of the tube around the entire perimeter of the tube. Placed symmetrically near electrode 33 are two additional electrodes 35 and 36, similar to each other. Between these electrodes there is provided an insulating barrier 37, which may suitably be of a material such as mica. The insulating barrier suppresses discharges which might otherwise take place between the additional electrodes 35 and 36, between which substantial voltages appear because of the phase change occurring across phase-shifting circuit 30. In this way incipient or glow discharges between electrode 33 and either one of the additional electrodes maintain a supply of ions in the region of tube 31 constituting an ionic-discharge path between electrodes 32 and 33. The funnel-shaped ionic-discharge electrode 33 may be used advantageously as one or more of the ionic-discharge electrodes shown schematically in Figs. 1 and 2.

Fig. 4 illustrates an embodiment of the invention suitable for incorporation in the arrangement of Fig. 2. A transmission line having an outer conductor 42 and an inner conductor 43 couples a transmitter to an antenna used for both radiating and receiving signals. Another section of transmission line including an inner conductor 44 has one end connected to the system which includes a source of wave energy and

the antenna, the connection being made to the inner conductor 43. The other end of the section of transmission line including conductor 44 is connected across the input circuit 15, 16 of the receiver 12 through an interposed cavity resonator 45, which is coupled to the source of wave energy by means of a connection between conductor 44 and an input loop 46. An output loop 47 couples resonator 45 to the input circuit 15, 16, making the resonator part of the input circuit of the receiver. As in Fig. 2, there is provided an alternator 27 with one terminal connected to ground, and the terminal 16 of the receiver input circuit is also grounded.

Associated with resonator 45 is an ionic-discharge tube 50 inside of which are two generally conical or funnel-shaped ionic-discharge electrodes 51 and 52, the bases of these cones having skirt portions protruding through the glass envelope of the tube 50 and forming parts of two opposite walls of the resonator 45. Resonator 45 is designed in association with tube 50 to be resonant at substantially the wave length of the system. When coupled by means of loop 46 to the source of wave energy, the resonator is excited so as to develop, across a region therein located midway between coupling loops 46 and 47, a voltage relatively high in comparison to the voltage coupled into the resonator by loop 46. As shown, the ionic-discharge electrodes 51 and 52 are fastened to the walls of the resonator at opposite sides of this high-voltage region, and are disposed in large part within the active part of the cavity resonator. Accordingly, the electrodes 51 and 52, being connected across the resonator, also are connected across the input circuit of the receiver.

Two additional electrodes 55 and 56 extend from within the conical arc-discharge electrodes 51 and 52, respectively, and pass through the glass envelope of the tube. Additional electrode 55 is in circuit with current-limiting resistor 28 and alternator 27, while additional electrode 56 is in circuit with current-limiting resistor 29, phase-shifting circuit 30, and the same alternator.

During reception the operation of the arrangement of Fig. 4 is similar to that of the arrangement of Fig. 2. Received signals from the antenna travel to input loop 46 of resonator 45, inducing relatively low voltage in the resonator and corresponding voltages on output loop 47. The signals from the resonator thus pass through input circuit 15, 16 to receiver 12. In a pulse-modulation system, voltages of radio-frequency energy corresponding to the received pulses and insufficient to cause an arc discharge, appear between arc-discharge electrodes 51 and 52. However, as regards the lower frequency voltages generated by alternator 27, the arc-discharge electrodes 51 and 52 are both at ground potential by virtue of the connection from terminal 16 to ground, since resonant voltages appear across resonator 45 only as it is excited with energy having approximately the wave length of the pulse signals in the transmitter-receiver system. Accordingly, the voltages applied from the alternator to additional electrode 55 and, through phase-shifting circuit 30, to additional electrode 56 maintain an incipient or glow discharge between these electrodes and the grounded arc-discharge electrodes 51 and 52, respectively. Each of the electrodes 55 and 56 is effective to maintain a supply of ions in the tube 50 during the intervals when the other is undergoing a reversal of voltage.

It is particularly advantageous in the arrangement described that the transmission line which includes conductor 44 have an effective electrical length approximately equal to an odd integral multiple of one quarter of the wave length of the transmitter-receiver system. The section of the transmission line 42, 43 between the transmitter and the junction of that line with the conductor 44 advantageously may have an impedance characteristic which co-operates with the impedance characteristic of the transmitter itself so as to have the effect of disconnecting that section of line 42, 43 from the system when the transmitter is not in operation, leaving only the receiver and cavity resonator effectively coupled to the antenna. If now, however, the transmitter should commence operation, the first surge of high-intensity wave energy from it excites the resonator 45. Since, as pointed out above, the short-circuiting tube 50 and its ionic-discharge electrodes 51 and 52 are connected across a region of the resonator which develops relatively high voltages in comparison with the voltages at the pickup loops 46 and 47, an ionic discharge of high intensity occurs between these electrodes. This discharge causes a very low impedance or effectively short-circuited condition at input loop 46, which is reflected to the junction of the transmission line as a very high impedance because of the resonant length of conductor 44. In this way the conductor 44 and hence the entire receiver system are effectively disconnected from transmission line 42, 43, which now functions only to carry energy from the transmitter to the antenna. When the transmitter ceases to deliver energy to the line, the transmitting section of the line is effectively disconnected as before, and the receiver again responds to signals carried through conductors 43 and 44 and the resonator 45. Consequently, the receiver is protected during intervals of transmission without the necessity of maintaining a high direct-current voltage on an electrode in the discharge tube. The alternator 27, of course, may be replaced by any source of alternating current, preferably an easily available source of low frequency energy. Since the current drawn by the additional electrodes is very small, a small transformer usually suffices to provide the proper voltage on the additional electrodes to maintain a glow discharge.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An arrangement for desensitizing high-frequency electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, ionic-discharge short-circuiting means coupled with said input circuit, two auxiliary ionic-discharge means coupled with said short-circuiting means to form auxiliary ionic-discharge paths, means for exciting one of said two auxiliary means with an alternating voltage to supply ions for said ionic-discharge short-circuiting means during intervals when said alternating voltage has a sufficient instantaneous value, and means for exciting the

other of said two auxiliary means with an alternating voltage which is phase-displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180° to supply ions for said short-circuiting means during intervals when said first-mentioned alternating voltage has a value much less than its peak value.

2. An arrangement for desensitizing high-frequency electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus in ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, ionic-discharge short-circuiting means coupled with said input circuit, two auxiliary ionic-discharge means coupled with said short-circuiting means to form auxiliary ionic-discharge paths, means for exciting one of said two auxiliary means with an alternating voltage to supply ions for said ionic-discharge short-circuiting means during intervals when said alternating voltage has a sufficient instantaneous value, and means for exciting the other of said two auxiliary means with an alternating voltage which is substantially in phase quadrature with said first-mentioned alternating voltage to supply ions for said short-circuiting means during intervals when said first-mentioned alternating voltage has a value much less than its peak value.

3. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, ionic-discharge short-circuiting means coupled with said input circuit, a plurality of electrodes in said means at least pairs of which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, means for applying an alternating voltage between one pair of said electrodes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180 degrees between another pair of said electrodes.

4. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, short-circuiting means having ionic-discharge electrodes connected across said input circuit, a plurality of additional electrodes in said means, individual ones of said additional electrodes in combination with other individual ones of said additional electrodes and said ionic-discharge electrodes forming pairs of electrodes which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, means for applying an alternating voltage between one pair of said electrodes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180 degrees between another pair of said electrodes.

5. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, at least one input circuit of said apparatus to which said wave energy may be applied, two short-circuiting tubes, each having ionic-discharge electrodes connected across one of said input circuits, a pair of electrodes in each of said tubes which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, means for applying an alternating voltage between one pair of said electrodes in one of said tubes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180 degrees between another pair of said electrodes in the other of said tubes.

6. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, a short-circuiting tube having ionic-discharge electrodes connected across said input circuit, a plurality of electrodes in said tube at least pairs of which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, means for applying an alternating voltage between one pair of said electrodes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180 degrees between another pair of said electrodes.

7. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising, an input circuit of said apparatus to which said wave energy may be applied, a short-circuiting tube having ionic-discharge electrodes connected across said input circuit, a plurality of electrodes in said tube at least pairs of which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, an insulating barrier between one electrode of one of said pairs of electrodes and another electrode of another of said pairs of electrodes, means for applying an alternating voltage between said one pair of said electrodes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than integral multiple of 180 degrees between said other pair of said electrodes.

8. An arrangement for desensitizing electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus to which said wave energy may be applied, a short-circuiting tube having ionic-discharge electrodes connected across said input circuit, two additional electrodes in said tube, each of which is effective to supply ions when a voltage is maintained between it and one of said ionic-discharge electrodes, an insulating barrier between said two additional electrodes, means for applying an alternating voltage between one of said two additional electrodes and one of said ionic-discharge electrodes, and means for applying an alternating voltage which is phase-displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180° between the other of said two additional electrodes and one of said ionic-discharge electrodes.

9. An arrangement for desensitizing a high-frequency electrical-wave receiver upon application to an input circuit thereof of excessive wave energy of a wave length to which said receiver is ordinarily sensitive comprising, a transmission line, a cavity resonator coupled to said transmis-

sion line and resonant at substantially said wave length, said input circuit of said receiver being coupled to said cavity resonator, ionic-discharge short-circuiting means disposed in large part within said cavity resonator across a region thereof which develops relatively high voltages, two auxiliary ionic-discharge means coupled with said short-circuiting means to form auxiliary ionic-discharge paths, means for exciting one of said two auxiliary means with an alternating voltage to supply ions for said ionic-discharge short-circuiting means during intervals when said alternating voltage has a substantial instantaneous value, and means for exciting the other of said two auxiliary means with an alternating voltage which is phase-displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180° to supply ions for said short-circuiting means during intervals when said first-mentioned alternating voltage has a value much less than its peak value.

10. An arrangement for desensitizing a high-frequency electrical-wave receiver upon application to an input circuit thereof of excessive wave energy of a wave length to which said receiver is ordinarily sensitive comprising: a transmission line having an effective electrical length approximately equal to an odd integral multiple of one-quarter of said wave length and having coupling means at one end thereof for applying said wave energy and coupling means at another end thereof for coupling said receiver thereto; ionic-discharge short-circuiting means connected across said other end of said transmission line; a plurality of electrodes in said means at least pairs of which are effective to maintain a flow of ions therebetween when a voltage is maintained therebetween, means for applying an alternating voltage between one pair of said electrodes, and means for applying an alternating voltage which is phase displaced from said first-mentioned alternating voltage by an amount other than an integral multiple of 180 degrees between another pair of said electrodes.

11. An arrangement for desensitizing high-frequency electrical-wave apparatus upon application thereto of excessive wave energy of a type to which said apparatus is ordinarily sensitive comprising: an input circuit of said apparatus to which said wave energy may be applied; ionic-discharge short-circuiting means coupled with said input circuit; a plurality of auxiliary ionic-discharge means coupled with said short-circuiting means to form auxiliary ionic-discharge paths; means for exciting one of said plurality of auxiliary means with an alternating voltage to supply ions for said short-circuiting means during intervals when said alternating voltage has a predetermined instantaneous value; and means for exciting other ones of said plurality of auxiliary means with an alternating voltage which is phase displaced from said first-mentioned alternating voltage by amounts other than an integral multiple of 180° to supply ions for said short-circuiting means during intervals when said first-mentioned alternating voltage has a value less than its peak value.

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