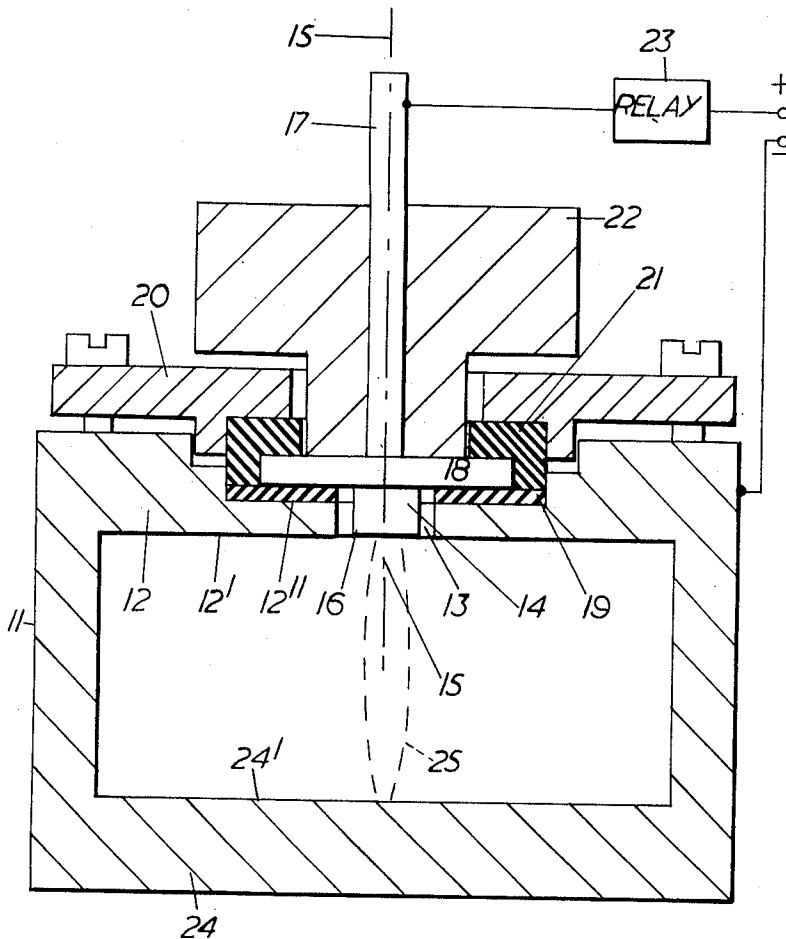


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DEVICE FOR PROTECTING A WAVEGUIDE SYSTEM AGAINST
DAMAGE CAUSED BY ARCING
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DEVICE FOR PROTECTING A WAVEGUIDE SYSTEM AGAINST DAMAGE CAUSED BY ARCING

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4 Claims. (Cl. 333-17)

This invention relates to waveguide systems and specifically to apparatus for protecting them against damage due to arcing in a guide, in particular where the energy is in the form of high power continuous waves.

Such arcing may occur in a waveguide from a variety of causes whenever the power level is sufficiently high. For example, local heating of dirt particles in the radio frequency (RF) field may cause a "hot spot" to develop which becomes a thermionic source of ions or electrons to render the air in the guide conductive. Once struck, the arc invariably travels along the guide towards the source of RF power, destroying in its passage such obstacles as dielectric windows. Where the source of power is a generator tube such as a klystron, the arc will destroy its window too.

Such an arc is not easy to detect. To begin with, it usually presents a fairly well-matched load to the generator and so cannot be detected with certainty in reliance on any unusual standing-wave ratio in the system close to the generator. Nor can the fall in output power at the output end of the system be relied on, since that may be due to some normal switching operation. Photo-electric methods of the kind in which the arc is seen by a photocell located so as to have a clear view of the interior of the guide are also unsatisfactory, since the circuitry necessary to avoid false responses due to the effects of drifting supply voltages or changes in photocell characteristics is apt to be complex and hence excessive in cost and bulk.

An object of the invention is to provide apparatus (which may conveniently be described as a detector) for the purpose stated which is both simple and reliable.

In accordance with the present invention, apparatus for protecting a waveguide system against damage caused by arcing includes for insertion in the system a section of rectangular waveguide having on the longitudinal centre line of one of the broader walls an aperture in which is located an electrode insulated from that wall and having a surface coplanar with the inner surface of that wall, no part of the electrode extending beyond that surface into the guide space, there being provided protective response means for actuation when the electrode is connected electrically to one of the walls of the waveguide section by an arc discharge occurring within the guide.

The invention relies firstly on the fact that, as already stated, arcs in a waveguide system always travel towards the generator, so that detector in accordance with the invention when mounted on the output side of a component of the system can be relied on to respond to any arc struck further along the guide towards the output end, since that arc must pass the detector before it reaches the component; second, that in such an arc the intensity of ionization and the conductance of the plasma is a maximum in the mid-plane of the guide—that is, the plane containing the center lines of the broader walls; and third, that the plasma has a relatively low D.C. resistance, values of about 1,000 ohms having been experienced in practice.

The accompanying drawing is a sectional view of one embodiment of the invention.

In carrying out the invention in accordance with one form by way of example, see the accompanying drawing, apparatus for protecting a waveguide system against damage due to arcing includes a section 11 of rectangular

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waveguide of dimensions such as to allow the guide to be inserted in the system on the output side of the component or point the protection of which is required.

One of the broader walls 12 of the guide is provided on its longitudinal centre line with an aperture 13 in which is located, clear of the aperture wall, an electrode 14 of cylindrical shape with its axis 15 normal to that wall. The inner plane circular end 16 of the electrode is coplanar with the inner surface 12¹ of the wall. The electrode may be considered as forming one end of a probe the other end of which extends as a conductive stem 17, coaxial with axis 15, outside the guide. At the junction of stem and electrode the probe carries a conductive flange 18 which extends over the outer surface 12² of a counter-sunk part of wall 12 beyond the boundary of aperture 13. A washer 19 of insulating material, preferably mica, separates the flange from the wall. The combination of flange 18 and the adjacent part of wall 12, with the insulation 19 between them, acts as a bypass capacitor to minimize leakage of RF energy from the guide through the aperture 13.

The probe is secured with electrode 14 in the correct position, out of electrical contact with wall 12, by a clamping plate 20 bolted to the wall and bearing against the outer surface of flange 18 by way of a spacing ring 21 of insulating material. It will be seen that no part of the probe projects beyond surface 16 into the guide space.

To absorb any of the waveguide energy which should happen to leak past flange 18, a plug 22 of lossy dielectric material is placed as a close fit around the stem 17 of the probe to abut against the outer surface of the flange.

Each end of waveguide section 11 is provided with a flange (not shown) or other arrangements to allow the section to be coupled into the waveguide system.

The probe is connected by way of its stem 17 to protective response means including a direct-current voltage source and a relay 23 connected in series between the outer end of the probe and the guide, the relay being arranged to control, in any convenient manner, whatever generator it is that supplies the RF energy in the guide.

In normal operation, the D.C. source maintains the probe at a steady potential with respect to the guide walls. As the probe does not project into the guide but stops short with its inner plane surface 16 flush with the inner surface 12¹ of the wall 12, and is moreover located on the longitudinal centre line of the wall, where there is minimum RF current flow, no appreciable interference is presented by it to the flow of RF energy along the guide. Under these conditions the relay circuit is unenergized, being broken at the probe, and accordingly the operation of the generator is unaffected.

Should an arc develop on the output side of the detector, the arc will traverse the detector before it can reach the component to be protected. As already explained, the arc plasma will be concentrated along the mid plane of the guide and so be at its maximum in the region of the probe. The end surface 16 of the probe will thus be connected electrically by the arc to the inner surface of one of guide walls and so will complete the relay circuit. Usually this surface is the inner surface 24¹ of the opposite broad wall 24, since the arc plasma is usually of a narrow pencil-like form extending across the guide between its broader walls, as indicated by the broken lines 25.

The relay operates by switching off the RF generator, thereby extinguishing the arc before it has gone far enough along the guide system to reach the component to be protected. Alternatively, the response of the relay may be to isolate that part of the system in which the arc was developed.

The plasma is found to provide a sufficiently low resistance connection between the probe and the wall to

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result in a definite indication of the arc's presence even with relatively simple and robust response means

The cheapness of a detector in accordance with the invention and the fact that in normal use it exerts no appreciable effect on the RF energy in the guide, except sometimes to cause a slight leakage of energy, encourage its use wherever protection is at all desirable. Hence a waveguide system may be provided with more than one detector, a separate detector being supplied and located immediately on the output side of each of a number of components the protection of which is required. In such an arrangement each detector may have its own relay, or all may share a common relay.

It is not essential to use a relay as part of the protective response means; any other apparatus may be employed which can give a protective response in dependence on the conductance between the probe and the guide wall.

The probe need not be led into the guide by way of a capacitive bypass as described, but may instead be led through a form of choke coupling which has the similar result of minimizing the effect of the aperture on the RF energy in the guide.

A special length of waveguide need not be provided where the guide at the point where the detector is required is already of rectangular section. In that case the existing guide has one of its broader walls drilled to take a probe and so provide a waveguide section in accordance with the invention.

What I claim is:

1. Apparatus for protecting a waveguide system against damage caused by arcing including for insertion in the system a section of rectangular waveguide having on the

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longitudinal center line of one of the broader walls an aperture in which is located an electrode insulated from that wall and having a surface coplanar with the inner surface of that wall, no part of the electrode extending beyond that surface into the guide space, there being provided protective response means for actuation when the electrode is connected electrically to one of the walls of the waveguide section by an arc discharge occurring within the guide.

2. Apparatus as claimed in claim 1 wherein there is secured to the electrode a flange of conductive material extending over an outer surface of said wall beyond the boundary of said aperture, thereby forming with the wall a bypass capacitor to minimize leakage of energy from the guide through the aperture.

3. Apparatus as claimed in claim 1 wherein lossy dielectric material is located outside the waveguide section to absorb energy which in operation may leak from the guide through said aperture.

4. Apparatus as claimed in claim 1 wherein said response means includes a relay connected in series with a voltage source, the said electrode, and the walls of the waveguide section.

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