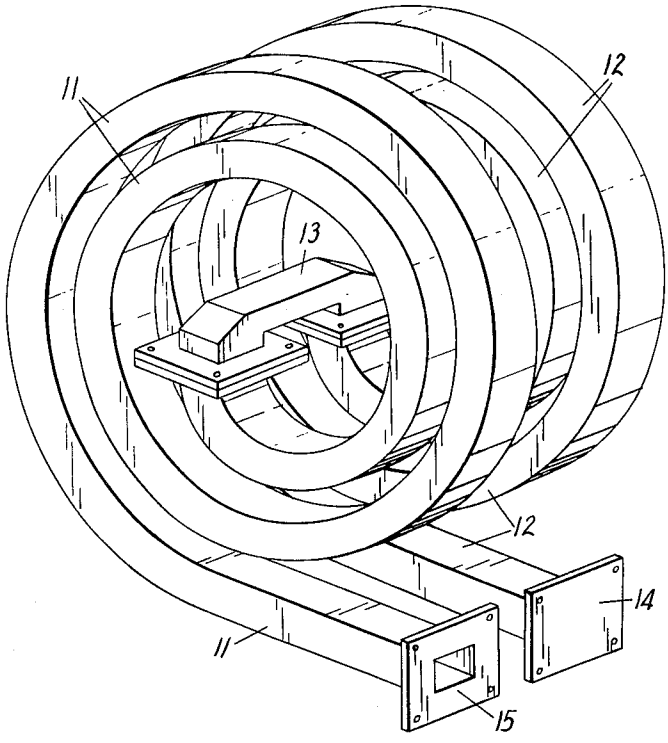
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WAVEGUIDE TERMINATION WITH MAGNETIC METAL WALLS WHEREIN THE CURIE TEMPERATURE THEREOF IS EXCEEDED DURING OPERATION

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WAVEGUIDE TERMINATION WITH MAGNETIC METAL WALLS WHEREIN THE CURIE TEMPERATURE THEREOF IS EXCEEDED DURING OPERATION

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This invention relates to waveguide systems and specifically to dissipative loads for them.

Dissipative loads are available in a variety of forms and may be required to absorb the total output power of a radio or radar transmitter when it is undesirable to radiate the power from an aerial. These conditions arise, for example, when setting up and adjusting a transmitter to its proper frequency and maximum power output.

Most of the available forms of dissipative load, however, have disadvantages when used in this way. For example, the so-called water load, in which a flow of water is maintained through a dielectric tube located within a section of waveguide, can be used to absorb high-power energy, but its use depends on a plentiful water supply or requires a closed water-flow circuit including a heat exchanger. Moreover, the arrangement is fragile and the escape of water into the waveguide system could be disastrous.

Loads in which the power is absorbed in lossy dielectric wedges located inside the waveguide in contact with the walls are limited in power-handling capacity because of poor heat transfer from the ceramic dielectric to the metal. These arrangements are also fragile.

A lossy ceramic material has been used to form a thick-walled waveguide with an internal taper for impedance matching purposes, energy being absorbed by the ceramic mass and radiated as heat. These also are mechanically weak both as regards the material itself, which is frangible, and as regards the junction between the material and the metal flange which secures it to the waveguide system. This junction is liable to be broken by stresses due to differential expansion. Such material is porous and water absorbed by it may be released as steam to damage the structure when the system is in operation. The material may be shielded from the atmosphere by a metal cover but this cover must be in good thermal contact with the material and the risk of breakage through differential expansion is increased.

In order to dissipate high power radio frequency with such devices it is necessary to use a number of load structures and a power-dividing network in order to share the power amongst the loads. The cost and complexity of the installation is therefore increased.

An object of the invention is accordingly to provide for a waveguide system a high-power dissipative load which is to a large extent free from the disadvantages above set forth.

In accordance with the present invention, a high-power dissipative load for a waveguide system includes a length of dissipative waveguide short-circuited at one end and made of magnetic metal material which has an electrical resistance such that energy introduced at the other end thereof during operation is sufficiently attenuated by the time it is received back at said other end after reflection at the short-circuited end.

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

In carrying out the invention in accordance with one form by way of example, a dissipative load for a waveguide system includes a length of rectangular waveguide having the sectional dimensions appropriate to the system. In order to occupy a convenient space the guide is coiled to form two flat helical coils **11** and **12**, see the accompanying drawing, secured side by side on a frame, omitted from the drawing for clarity, which includes spacers between adjacent turns of each coil and, if necessary, is fitted with radiating fins to provide the necessary degree of heat dissipation.

The inner ends of the coils are coupled together by a short portion of waveguide **13**. The outer ends of the respective coils thus form the ends of the dissipative guide as a whole. One of these outer ends—that of coil **12**, say—is short-circuited as indicated at **14** to reflect without appreciable loss at the point of reflection the energy reaching this end of the guide. The other end **15** is flanged for coupling to the waveguide system.

The material of the guide is a magnetic nickel-iron alloy having an appreciable electrical resistance and a Curie temperature the values of which will be indicated shortly.

In operation, the energy entering the guide from the system at end **15** gives rise to currents which, being at a high frequency, are confined by the skin effect to flow mainly in the interior surface regions of the guide walls. The skin depth and hence the cross section available for current flow is inversely dependent on the magnetic permeability of the guide material—that is, the skin depth is smaller with a magnetic material than with a non-magnetic. Hence the use for the guide walls of magnetic material of appreciable permeability instead of the usual non-magnetic material of unity permeability, together with the appreciable electrical resistance of the material, and possibly other magnetic loss mechanisms such as hysteresis, imparts a heavy resistive loss to the energy throughout its double journey along the guide to the short circuit at **14** and back to the end **15**. The resistance of the material is chosen such that, at the frequency concerned, this overall resistive loss has effected the required degree of attenuation by the time the energy is returned from the guide to the system.

The energy dissipated appears as heat in the waveguide wall and the temperature reached at any point along the length of the guide depends on the power level at that point. Since the power level is being attenuated progressively along the guide a temperature gradient is produced. As the temperature coefficient of resistance of most suitable waveguide materials is positive, the resistivity of the hotter parts of the guide becomes higher than the resistivity of the cooler parts. The temperature gradient is therefore increased, since proportionately more power is now being dissipated in the hot parts near the entrance to the dissipative load.

In a load of conventional construction this effect would be overcome, and a more uniform temperature distribution and power adsorption achieved, by grading the resistivity or the dimensions of the lossy material. A somewhat similar effect may be achieved in a load constructed according to the invention by making use of the change in the magnetic properties of the material at the Curie temperature.

The material is chosen to have a Curie temperature which is reached through the resistive heating of the guide walls in dissipating energy above a predetermined power level. This power level is passed near the input end of the waveguide load but not over the whole length. The effect of reaching this temperature is to reduce the permeability of the guide material substantially to unity, thereby removing the source of magnetic losses; thus the attenuation over this part of the waveguide load is lowered and more power is transmitted to more distant cooler

parts of the guide. The temperature in these more distant parts is increased, but beyond a certain distance the power level is so attenuated that the Curie temperature is not reached. In this way a more uniform temperature distribution is achieved and in particular the temperature near the input end of the waveguide load is prevented. from becoming so high as to encourage arcing of the radio frequency power across the guide due to ionised particles provided by burnt dust, etc.

In a particular construction the nickel-iron alloy of the guide material has an electrical conductivity of approximately 16,000 mhos per centimetre cube and a magnetic permeability of approximately 2 at room temperature and at the working frequency of 10,000 mc./s., the Curie point being 360° C. A dissipative guide of that material suitable for input powers of 2 or 3 kw. at the above frequency has a length of about 27 feet. The cold loss is about 0.5 db per foot and the hot loss 0.3 db per foot for parts of the guide where the temperature is above the Curie level.

It is usually desirable to design the supporting frame to allow for the differential expansion of the coiled guide caused by the large temperature gradients along it when in operation, otherwise parts of the guide may be overstressed, in particular at the points where it is attached to the frame.

In addition to possessing the advantages of being of robust construction and inexpensive to manufacture, a dissipative load in accordance with the invention is free from the disadvantage of the known kind in which the energy is absorbed in interior dielectric wedges and as a consequence there is poor heat transfer to the metal.

What I claim is:

1. A high-power dissipative load for a waveguide system including a length of dissipative waveguide short-circuited at one end and having walls made of continuous magnetic metal material having a Curie temperature considerably above the ambient temperature, whereby parts of said walls are subject to a change in magnetic properties through resistive heating thereof to a temperature above the Curie temperature during normal operation.

2. Apparatus as claimed in claim **1** wherein the material is a magnetic nickel-iron alloy.

3. Apparatus as claimed in claim **1** wherein the dissipative waveguide is coiled to form two flat helical coils secured side by side and coupled together at their inner ends by a portion of waveguide extending parallel to the common axis of the coils, the said one end which is short-circuited being one of the outer ends.

4. A high-power dissipative load for a waveguide system including a length of dissipative waveguide short-circuited at one end and having walls of uniform cross section made entirely of a magnetic nickel-iron alloy which has an electrical resistance such that energy introduced at the other end thereof during operation is sufficiently attenuated by the time it is received back at said other end after reflection at the short-circuited end, said electrical resistance being such that the resistive heating of said walls during normal operation is effective to raise the temperature of a part of the dissipative waveguide above the Curie temperature of said nickel-iron alloy, whereby said rise in temperature serves to change the magnetic properties of said part of the waveguide.

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