United States Patent

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[72] Inventor **Anthony Nicholas Schmitz**
Moorestown, N.J.

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[73] Assignee **RCA Corporation**
a corporation of Delaware

[54] **COAXIAL TRANSMISSION LINE**
5 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **174/16,** 174/28, 174/99, 174/110
[51] **Int. Cl.** **H01b 7/34**
[50] **Field of Search** ..... 174/28, 29, 16, 16B, 15, HS, 15C, 36, 99B, 88B, 70B, 71B, 72B, 110.4, 110.6, 110.7

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Primary Examiner—Lewis H. Myers
Assistant Examiner—A. T. Grimley
Attorney—Edward J. Norton

ABSTRACT: A coaxial transmission line having an increased average power rating compared to known lines is provided. This increased power rating is achieved by improving radiant heat transfer from the inner conductor to the outer conductor.

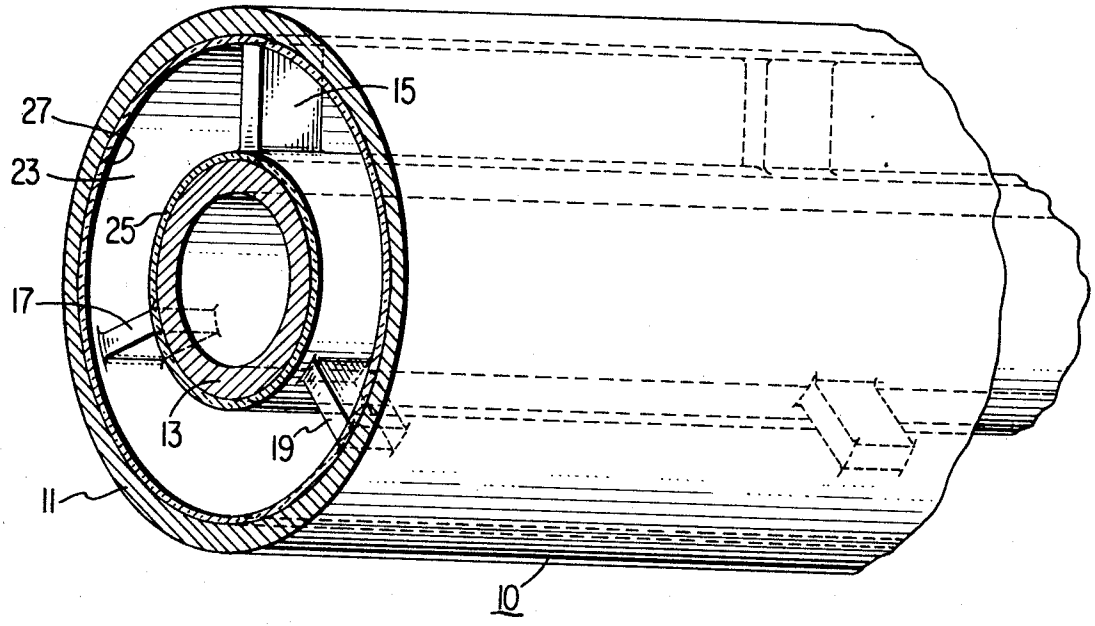
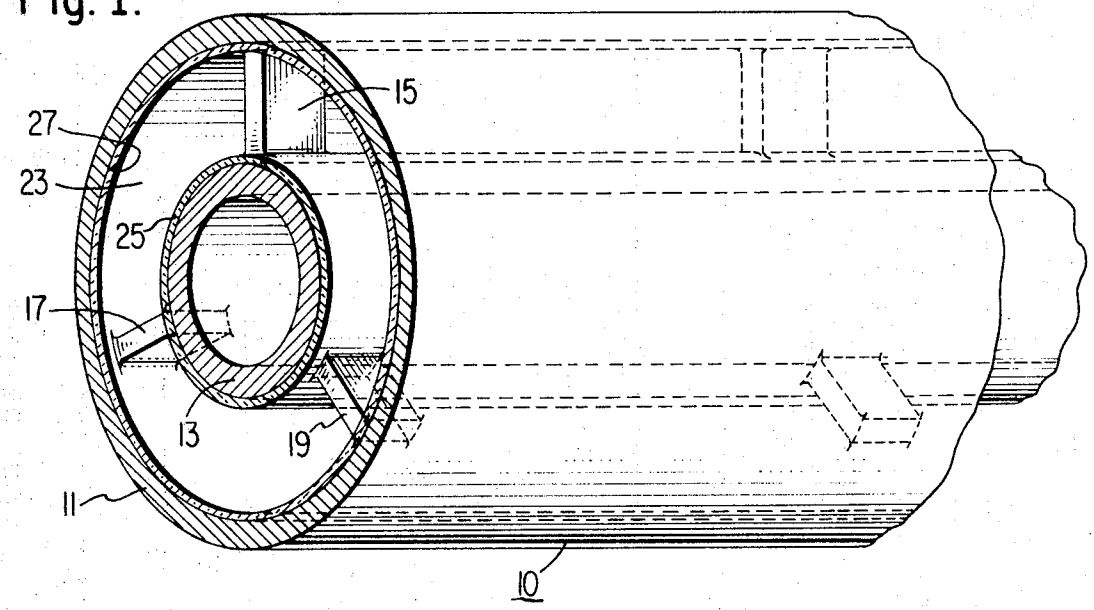


Fig. 1.



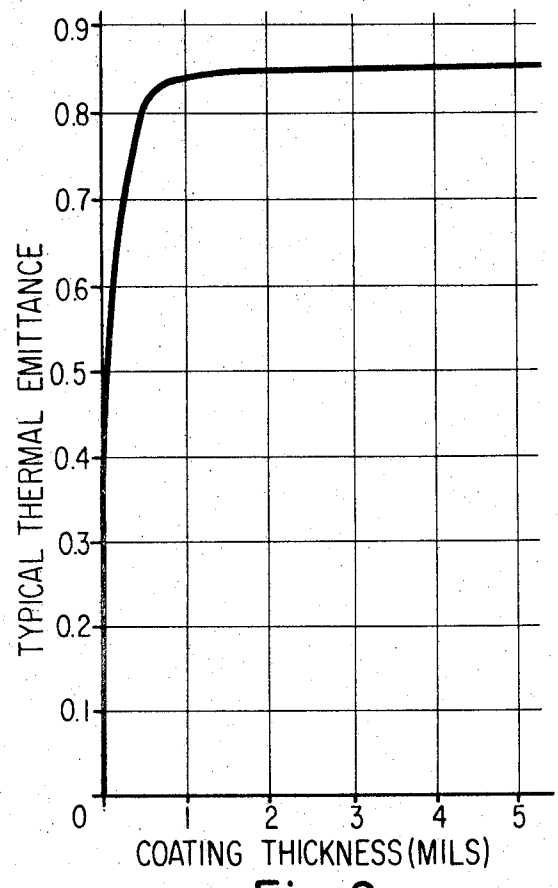


Fig. 2.

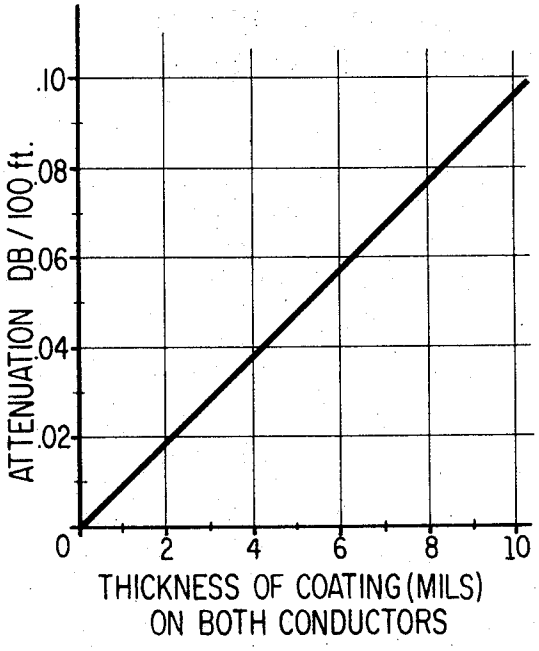


Fig. 3.

INVENTOR.
Anthony N. Schmitz
BY
Robert L. Troike
ATTORNEY

COAXIAL TRANSMISSION LINE

This invention relates to a coaxial transmission line and more particularly to a coaxial transmission line having increased average power handling capability.

The maximum average power a coaxial transmission line can handle is limited by the temperature of its inner conductor. If the temperature becomes too high, oxidation will occur increasing the losses. The result is further heating, causing still greater oxidation and heating and eventual thermal runaway failure of the transmission line.

It is an object of the present invention to provide an improved coaxial transmission line having improved radiant heat transfer from the inner conductor to the outer conductor, consequently increasing the average power handling capability of the coaxial transmission line.

Briefly, this and other objects of the present invention are provided by a coaxial transmission line having an inner and outer conductor of conductive material, a thin layer of low loss dielectric material on the inner surface of the outer conductor and a thin layer of low loss dielectric material on the outer surface of the inner conductor.

A detailed description follows in conjunction with the following drawings wherein:

FIG. **1** is a perspective view of a coaxial line in accordance with one embodiment of applicant's invention;

FIG. **2** illustrates typical thermal emissivity vs. thickness for a thin film of glass; and

FIG. **3** illustrates the comparison of attenuation (DB) for 100 ft. of transmission line vs. thickness of coating of glass or similar material on both the inner and outer conductor of the coaxial transmission line.

Heat generated in the inner conductor of a coaxial line must be transferred from the inner conductor to the outer conductor and thence to the surrounding air or environment. The satisfactory performance of the line requires transfer of heat from the smaller surface area of the inner conductor to the much larger surface area of the outer conductor. The heat is transferred by radiation and convection. Convection is a function of the geometry, temperature and properties of the surrounding medium. Little can be done with this unless forced cooling is utilized, and this is undesirable.

The ability of a material to absorb or radiate compared to a black body at the same temperature and with the same area is termed the emissivity of the material. The emissivity of polished copper which is conventionally used to form the inner and outer conductor of a coaxial transmission line is about 0.06. Most on nonconductors have an emissivity of 0.9 at normal temperatures. The placement of a thin, low loss coating of dielectric material having an emissivity of about 0.9 on the outside area of the inner conductor and the inside area of the outer conductor can serve to increase the heat transfer from the inner conductor to the outer conductor by radiation by 18.5 times and consequently increase the power handling capability over 2 ½times the average power handling capability of an untreated copper line.

Referring now to FIG. **1**, there is shown a coaxial line **10** having a outer conductor **11** made, for example, of polished copper and a hollow inner conductor **13** of polished copper. Means are provided for spacing and supporting the center conductor **13** from the outer conductor **11**. In the illustrated example, this means is provided by low loss dielectric posts **15**, **17** and **19** placed at discrete points along the length of the coaxial line **10**. Ceramic discs or any other well known means may be used for so supporting and spacing the inner and outer conductors. The less the number of posts or discs the better

the performance of the line due to the attendant attenuation associated with the use of such spacing means. A thin film **25** of low loss dielectric material having an emissivity greater than that of polished copper such as 0.9, for example, covers the outer surface of the inner conductor **13**. A second thin film **27** of similar low loss dielectric material **27** having similar greater emissivity covers the inner surface of the outer conductor **11**. The thickness of the dielectric material **25** or **27** is made less than about 10 mils. Typical thickness for low loss is in the range of 0.5 mils to 2 mils. The material selected should be low conductive loss material, having high emissivity and be able to withstand heat. Since the thickness of the material forming the films **25**, **27** is made so thin, the heat conduction of the material is satisfactory for the desired application even though the material itself may be a poor thermal conductor. Examples of materials usable are silicone, rubber, plastics, resin, Teflon, (polytetraflouroethylene), glass and lacquer. Selection of thicknesses in the order of 0.5 to 2 mils provides high emissivity with the least amount of attenuation due to the presence of the dielectric material.

FIG. **2** shows a typical curve of thermal emissivity vs. thickness for a single layer of glass on a conductor. An increase in the thickness beyond 2 mils results in no appreciable further increase in emissivity. By maintaining the thickness thin in the order described, the added attenuation as illustrated in FIG. **3** is negligible, and there is better thermal conduction through the material.

Thus, it can be seen that the film **25** on the outer surface of the inner conductor **13** by radiating heat as a function of its higher emissivity in the direction of the outer conductor **13** enhances the transfer of heat between the conductors. Further, the film **27** on the inner surface of the outer conductor **10** by absorbing heat again as a function of its higher emissivity enhances the heat transfer. The presence of the films **25**, **27** provides additional heat transfer from the smaller surface area of the inner conductor to the much larger surface area of the outer conductor, the surface of the outer conductor being located in the ambient. In this manner, the transmission line is able to handle more average power with the same inner conductor temperature.

I claim:

1. A coaxial transmission line comprising:
an inner conductor;
an outer conductor spaced from said inner conductor in a manner such as to leave air spaces between said conductors; and
a layer of low loss dielectric material having a thickness less than 10 mils covering substantially all of the outer surface of said inner conductor.

2. A coaxial transmission line comprising:
an inner conductor;
an outer conductor spaced from said inner conductor in a manner such as to leave air spaces between said conductors;
a thin cover of low loss dielectric material covering the outer surface of said inner conductor; and
a thin cover of low loss dielectric material covering the inner surface of the outer conductor.

3. The combination as claimed in claim **1** wherein said thin cover is less than 10 mils.

4. The combination as claimed in claim **2** wherein said thin cover is in the range between 0.5 and 2 mils.

5. The combination as claimed in claim **1** wherein said dielectric material has an emissivity of about 0.9 at ordinary temperatures and is able to withstand heat to 250° F. without deteriorating.