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RADIO FREQUENCY LOAD
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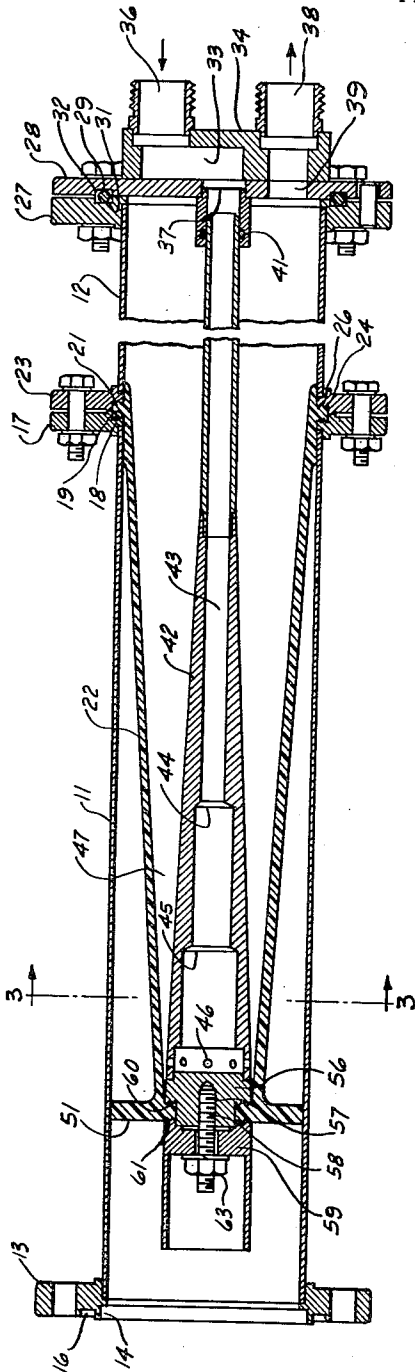


Fig. 1

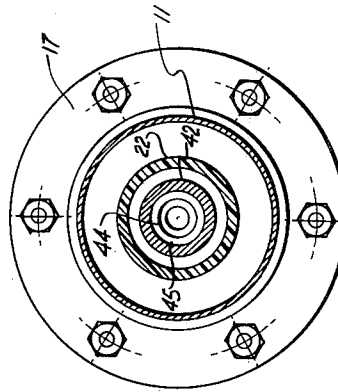


Fig. 2

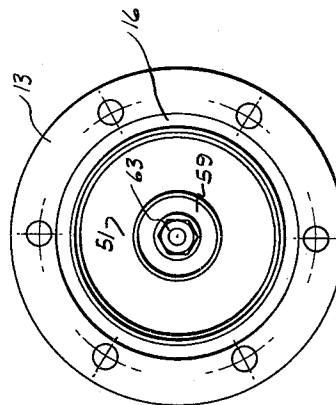


Fig. 3

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1

2

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RADIO FREQUENCY LOAD

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This invention relates generally to a radio frequency load and more particularly to a load for dissipating electromagnetic energy.

Water loads are often employed where it is required to absorb electromagnetic energy. Difficulties are experienced in sealing the loads against water leakage and in causing the water to circulate uniformly. As is well known, R-F loads should have relatively low voltage standing wave ratios (VSWR).

It is a general object of the present invention to provide an improved R-F load.

It is another object of the present invention to provide an R-F load in which fluid leakage is minimized and in which the fluid is uniformly circulated.

It is another object of the present invention to provide an R-F load in which a tapered cone fed at its small end confines the circulating fluid.

It is a further object of the present invention to provide an R-F load which is formed as a compact assembly having improved fluid circulation and electrical characteristics.

These and other objects of the invention will become more clearly apparent from the following description when taken in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 is a sectional elevational view of an R-F load in accordance with the invention;

FIGURE 2 is an end view of the R-F load shown in FIGURE 1; and

FIGURE 3 is a sectional view taken along the line 3-3 of FIGURE 1.

Referring to the drawings, the load comprises first and second sections 11 and 12 of a coaxial transmission line. One end of the outer conductor of section 11 is provided with a flange 13 which is suitably secured thereto, as for example, by brazing. The flange 13 provides means for connecting the load to an associated coaxial transmission system. The flange includes an annular recess 14 for receiving the adjacent end portion of the outer conductor of an associated coaxial transmission line. An annular groove 16 is formed on the face of the flange and cooperates with the flange of the associated guide to receive an O ring for sealing the system whereby it may be pressurized, if desired.

A seal flange 17 is suitably secured to the other end of the outer conductor of the first section. The face of the flange is provided with annular grooves 18 which form a plurality of ridges 19 for receiving the annular sealing member 21 formed on the large end of the tapered member 22, to be presently described. The adjacent end of the outer conductor of section 12 carries a flange 23 which is adapted to cooperate with the flange 17 and which likewise includes a plurality of grooves 24 forming ridges 26. The member 21 is clamped or held between the flanges 17 and 23 with the grooves and ridges biting into the annular shoulder 21 to form a fluid-tight connection.

The other end of the outer conductor of section 12 carries a flange 27 which is suitably secured thereto, as for example, by brazing. The flange 27 receives the end plate 28. An O-ring 29 is carried in the grooves 31 and

32 formed in the opposed faces of the flange 27 and plate 28 and provides a fluid-tight seal.

An inlet chamber 33 defined by the walls 34 is carried by the plate 28. An inlet connection 36 communicates with the chamber. The chamber also communicates with the central opening 37 formed in the plate. An outlet 38 communicates with the opening 39 formed in the plate.

A sleeve 41 slidably connects a tapered metallic member 42 with plate 28 and the opening 37. Suitable gasket means as shown ensure fluid-tightness of the union between sleeve 41 and member 42 while permitting relative movement in response to thermal expansion and contraction of the parts. The member 42 forms the inner conductor of the coaxial transmission line sections. The member 42 is tapered towards the rear to provide transmission of R-F energy towards the plate 28. The member 42 includes a central bore 43 whose diameter increases toward the enlarged end. The diameter may increase gradually or may be increased in steps as shown at 44 and 45.

The end of the tapered member is provided with a plurality of radial openings or passageways 46 which extend outwardly and communicate with the space 47 defined by the tapered member 22, the wall 12, the plate 28 and the tapered member 42. Thus, the fluid which absorbs the R-F energy, for example, water, flows axially along the member 43, outwardly through the spaced radial openings 46 into the space 47. It then flows towards the back and out through the outlet 38. The spacing and location of the openings 46 near the apex of the truncated tapered member provides a uniform distribution of the fluid. It is observed that the fluid flows more rapidly at the end of the tapered member 22 where there is less volume than towards the back of the load. It has been observed that most of the R-F energy is absorbed in this region. Thus, the maximum flow of fluid is created at the point where the most power is absorbed. This minimizes the rise in temperature and preserves the heat exchange rate in this region.

The tapered member 22 may be made of any suitable dielectric material. We prefer to employ a Teflon insert which has good dielectric characteristics and which is somewhat flexible and can withstand relatively high temperatures. The taper is selected to provide an impedance match between the load and associated coaxial transmission line. The tapered member 22 is provided at one end with the annular member 21 which is secured between the flanges 17 and 23 to form an effective water seal, as previously described. The small end of the dielectric member 22 includes an outwardly extending integral flange 51 slidably engaging the inner periphery of the outer conductor and which serves to center and slidably support the end of the tapered member 42 within the load. Thermal expansion and contraction of the parts may therefore occur without imposing destructive stresses on the elements of the combination.

A metallic sealing member 56 is suitably brazed to the tapered member 43. The member 56 is drilled and tapped 57 to receive the stud 58. The member 56 includes a shoulder 60 having grooves and ridges. A cup-shaped member 59 having an end face 61 which includes grooves and ridges is received by the stud. A nut 63 is threaded to the stud and tightened to clamp the inner edges of the flange 51 between the members 56 and 59. The cup-shaped member 59 also serves to provide a socket for receiving the center conductor of an associated coaxial transmission line system. It is apparent that the flange 51 will introduce an impedance change in the system which may give rise to reflections. The annular groove formed by the members 56 and 59 compensates for the impedance change and minimizes reflections. Thus, the

members serve the dual function of providing a water seal and an impedance match.

Thus, it is seen that a relatively compact and easy to construct R-F load assembly is provided. The various members form improved fluid-tight seals to confine the flow of fluid. The load includes improved means for preventing reflection. The circulation of fluid is such as to produce a better distribution of the transfer of energy into the fluid.

We claim:

1. A radio frequency load comprising a coaxial transmission line section having relatively movable inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said section between the outer and inner conductors with the small end extending towards the associated coaxial transmission line system and being movable with said inner conductor relative to the outer conductor, means forming a fluid-tight seal between the outer conductor and the enlarged end of the dielectric member, means forming a fluid-tight seal between the small end of said member and the inner conductor, an end plate secured to the other end of said coaxial transmission section, said plate and dielectric member serving to form a tapered fluid-tight chamber, means for supplying a fluid into said chamber near the small end thereof, and means for removing said fluid from the large end of said chamber.

2. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said section with the small end extending towards the associated coaxial transmission line system, means forming a fluid-tight seal between the outer conductor and the enlarged end of the tapered dielectric member and fixing said enlarged end with respect to the outer conductor, a plate secured to the other end of said coaxial transmission line section and forming a fluid-tight seal, said plate and dielectric member serving to form a fluid-tight tapered chamber, means slidably engaging the inner periphery of the outer conductor for supporting the small end of said hollow tapered dielectric member coaxially within said coaxial transmission line section, means for supplying a fluid into said chamber at the small end of said chamber, and means for removing said fluid from the large end of said chamber.

3. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said section with the small end extending toward the associated coaxial transmission line system, means including a radially extending integral flange on said dielectric member and a pair of juxtaposed flanges on said outer conductor clamped on said integral dielectric flange to form a fluid-tight seal between the outer conductor of said section and the enlarged end of the tapered dielectric member, an end plate detachably secured to the other end of said coaxial transmission line section, said end plate and dielectric member serving to form a tapered fluid-tight chamber, said inner conductor having an axial opening, a plurality of radially extending circumferentially spaced passageways formed adjacent one end of said inner conductor and serving to communicate between the opening and the small end of the chamber, whereby fluid may be forced along the opening to the small end of the chamber, and means for removing liquid from the large end of said chamber.

4. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said section with the small end extending toward the associated coaxial transmission line system, means for supporting the small end of said tapered dielectric member coaxially within said section, means forming a detachable union and a fluid-tight seal between the outer conductor and the enlarged end of the tapered dielectric member, an end plate detachably secured to the other end of said coaxial transmission line section, said end plate and dielectric member serving to form a tapered fluid-tight chamber, said inner conductor having one end slidably supported on the plate and having an axial opening, a plurality of radially extending spaced passageways formed at the other end of said inner conductor and serving to communicate between the opening and the small end of the chamber, whereby fluid may be forced along the opening to the small end of the chamber, and means in said end plate for removing liquid from the other end of said chamber.

5. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for detachably connecting both inner and outer conductors of the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said outer conductor with the small end extending toward the associated coaxial transmission line system, a radially outwardly extending flange formed on the small end of said dielectric member cooperating with the outer conductor to maintain the small end of said dielectric member centered within the same, means forming a fluid-tight seal between the enlarged end of the dielectric member and the outer conductor section, an end plate, means including a cylindrical inwardly extending sleeve forming a fluid-tight connection between the end plate and the coaxial transmission line section, said end plate and dielectric member serving to form a tapered fluid-tight chamber, said inner conductor having one end secured to said plate and having an axial opening, a plurality of radially extending passageways formed at the other end of said conductor and communicating between the axial opening and the small end of the tapered chamber, means in said end plate for supplying fluid to said one end of said inner conductor, means for removing fluid from the enlarged end of said chamber, and means cooperating with said flange on the small end of said member and serving to support the other end of said inner conductor on and to form a fluid-tight seal with the dielectric member.

6. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said section with the small end extending toward the associated coaxial transmission line system, a flange formed on the small end of said dielectric member cooperating with the outer conductor to maintain the small end of said dielectric member centered within the same, means forming a fluid-tight seal between the enlarged end of the dielectric member and the outer conductor, an end plate, means forming a fluid-tight connection between the end plate and the coaxial transmission line section, said end plate and dielectric member serving to form a tapered fluid-tight chamber, said inner conductor having one end movably mounted on said plate and having an axial opening, a plurality of radially extending passageways formed at the other end of said inner

5

conductor communicating between the opening and the small end of the tapered chamber, means for supplying fluid to said one end of said inner conductor, means in said end plate for removing fluid from the enlarged end of said chamber, means cooperating with said flange on the small end of said member and serving to support the other end of said inner conductor on and to form a fluid-tight seal with the dielectric member, said last named means including a radially inwardly extending flange detachably secured to the inner conductor and serving to minimize reflection of microwave energy.

7. A radio frequency load comprising first and second coaxial transmission line sections each having an inner and outer conductor, means carried at one end of said first section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially coaxial interior and exterior conical surfaces, said member carried parallel within said sections with the small end extending towards the associated coaxial transmission line system, means carried by associated ends of the outer conductors of said first and second sections to detachably bind the enlarged end of the tapered member and said associated ends to form a fluid-tight seal therebetween, an end plate forming a fluid-tight seal with the other end of the outer conductor of the second section, said dielectric member, outer conductor of the second section and plate serving to form a tapered chamber, an inner conductor extending between said plate and the small end of said dielectric member, said inner conductor having an axial opening, means for supplying fluid to the axial opening at the plate end of said load, a plurality of radially disposed passageways formed at the other end of said inner conductor serving to communicate between the opening and the small end of the chamber, and means disposed at the large end of said chamber for removing liquid therefrom.

8. A radio frequency load comprising a coaxial transmission line section having relatively movable inner and outer conductors detachably connected together at one end by an end plate, means carried at the other end of said section for detachably connecting the load to an associated coaxial transmission line system, an annular dielectric member disposed between said inner and outer conductors to form a fluid-tight chamber in cooperation with said end plate, and inner conductor, said inner conductor having an exterior tapered surface within said chamber with said one end being of smaller diameter and said other end being of larger diameter and sealed within said dielectric member, means including an axial bore in said inner conductor for supplying a fluid into said chamber near the larger diameter end of the inner conductor, and means for removing fluid from said chamber.

9. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors, means carried at one end of said section for connecting the load to an associated coaxial transmission line system, a hollow tapered dielectric member having substantially parallel interior and exterior conical wall surfaces, said member carried coaxially within said section with the small end extending toward the associated coaxial transmission line system, a flange formed on the small end of said dielectric member cooperating with the outer conductor to maintain the small end of said dielectric member centered within the same, means forming a fluid-tight seal between the enlarged end of the dielectric member and the outer conductor, an end plate, means forming a fixed fluid-tight connection between the end plate and the outer conductor of the coaxial transmission line section and forming slidable fluid-tight connection between the end plate and the inner conductor of the

6

transmission line section, said end plate and dielectric member with said inner conductor serving to form a tapered fluid-tight expansible chamber, said inner conductor having a tapered exterior surface within said chamber with the smaller diameter end supported on said end plate and larger diameter end sealed to said dielectric member, said inner conductor having an axial bore, a plurality of radially extending passageways formed at the large diameter end of said inner conductor communicating between the bore and the small end of the chamber, means for supplying fluid to said smaller diameter end of said inner conductor, means for removing fluid from the enlarged end of said chamber, and means cooperating with said flange on the small end of said member and serving to support the larger diameter end of said inner conductor on and to form a fluid-tight seal with the dielectric member.

10. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors connected together at one end by an end plate, means carried at the other end of said section for connecting the load to an associated coaxial transmission line system, an annular dielectric member disposed between said inner and outer conductors to form a fluid-tight chamber in cooperation with said end plate and inner conductor, said means for connecting the load to an associated coaxial transmission line system including a shoulder formed on said other end of said inner conductor, said dielectric member having an inwardly extending flange disposed to abut said shoulder, and an apertured metallic member bolted to said other end of said inner conductor and abutting the inwardly extending flange on the other side thereof from said shoulder whereby said flange is releasably compressed between said apertured member and said inner conductor to form a releasable fluid-tight seal.

11. A radio frequency load comprising a coaxial transmission line section having inner and outer conductors connected together at one end by an end plate, means carried at the other end of said section for connecting the load of an associated coaxial transmission line system, an annular dielectric member disposed between said inner and outer conductor to form a fluid-tight chamber in cooperation with said end plate and inner conductor, said means for connecting the load to an associated coaxial transmission line system including a shoulder formed on said other end of said inner conductor, said dielectric member having an inwardly extending flange and an outwardly extending flange opposite thereof abutting the inner periphery of the outer conductor, said inwardly extending flange being disposed to abut said shoulder, and a detachable connector member bolted to said other end of said inner conductor and confining the flanged end of the dielectric member against movement relative to said inner conductor.

References Cited in the file of this patent

UNITED STATES PATENTS

2,399,930	Keister	May 7, 1946
2,831,047	Wadey	Apr. 15, 1958
2,881,399	Leyton	Apr. 7, 1959
2,882,502	Freundlich	Apr. 14, 1959
2,913,619	Geisler	Nov. 17, 1959

FOREIGN PATENTS

572,981	Great Britain	Nov. 1, 1945
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OTHER REFERENCES

Freedman: "Water Loads," Radio-Electronic Engineering, May 1954, pages 14, 15 and 35.