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MICROWAVE CALORIMETRIC WATTMETER

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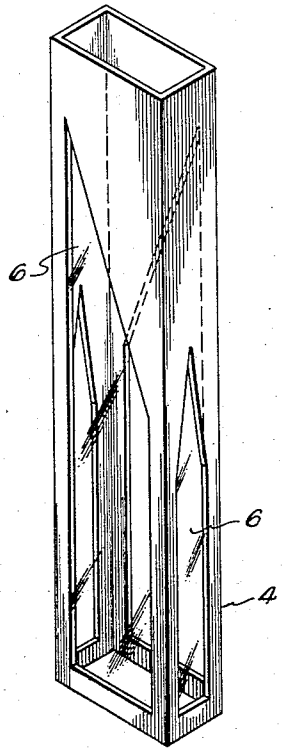


Fig. 2

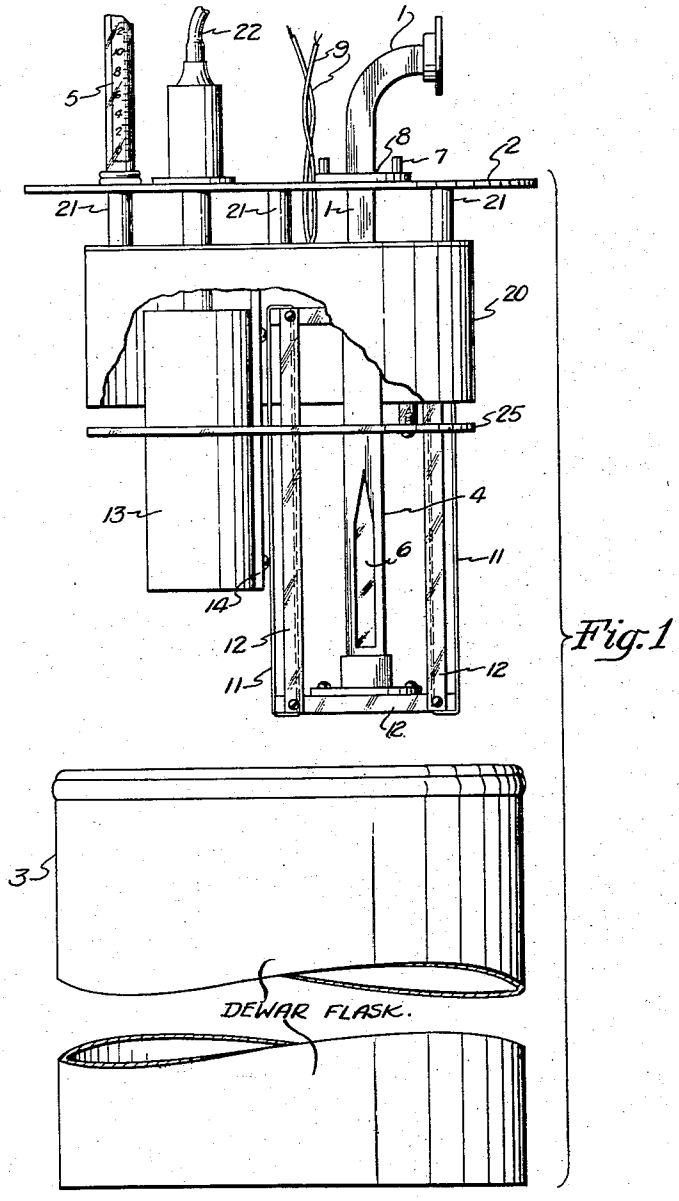


Fig. 1

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MICROWAVE CALORIMETRIC WATTMETER

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2 Claims. (Cl. 324—95)

This invention relates to wattmeters and is more particularly concerned with a microwave high-power calorimetric wattmeter.

Various systems for measuring high average power in waveguides are known to the prior art, one of the most common being what might be called a water-flow system. An example of such a system is disclosed in U. S. Patent 2,398,606 to C. C. Wang. However, such systems are not extremely accurate from a calorimetric point of view because of many factors the magnitudes of which are extremely difficult or impossible to calculate. In addition, the prior art systems are not very sensitive to small changes in power since the flowing water is only heated for a short time. Also the majority of these systems require rather bulky and expensive equipment.

The present invention overcomes the above-named difficulties by providing relatively simple inexpensive equipment in which the waveguide is terminated in a dewar container filled with water. With proper stirring the microwave power uniformly heats the water and the resulting temperature rise can be calibrated by heating the water with a known amount of D. C. power. The dewar waveguide termination tends to minimize heat loss while the water remains in the calorimeter and can be heated by microwave energy for any desired period of time.

It is accordingly one object of the invention to provide an improved microwave calorimeter wattmeter requiring only simple inexpensive equipment.

Another object of the invention is to provide an improved microwave wattmeter having a minimum of heat loss.

A further object of this invention is to provide an improved calorimeter wattmeter having increased sensitivity.

An additional object of this invention is to provide an improved calorimeter wattmeter having improved accuracy.

A still further object of this invention is to provide an improved microwave power measuring device utilizing simple basic calorimetric principles.

Other uses and advantages of the invention will become apparent upon reference to the specification and drawings in which,

Fig. 1 shows the microwave calorimetric wattmeter of the instant invention, and

Fig. 2 shows an enlarged view of the waveguide termination of Fig. 1.

Referring to Fig. 1, at 1 is shown a section of waveguide for supplying the microwave power to be measured. Waveguide 1 passes through a closure member or top plate 2 adapted to fit over a dewar container 3 which is filled with any suitable heat load fluid, preferably water. Waveguide 1 also passes through a copper heat shield 20 shown partly broken away and is terminated at 4 by means of windows 6 which allow the microwave energy in waveguide 1 to pass into the fluid of container 3 while preventing the fluid from entering the waveguide. Heat

shield 20 which serves to minimize convection losses from the surface of the fluid and also tends to reduce evaporation is supported from plate 2 by posts 21. Windows 6 are positioned and shaped to provide maximum energy transfer to the fluid and may be made of any suitabl material transparent to micro-wave energy, an example being mica. Waveguide 1 is secured to plate 2 by flange bolts 7 secured to flange 8. The entire junction may be covered by a tarry fluid sealing material (not shown) which is relatively transparent to microwaves if desired.

Also shown are leads 9 which pass through plate 2 and shield 20 and supply D. C. energy to heater wires indicated at 11 positioned adjacent the waveguide. Wires 11 are supported by an insulated plastic frame 12 which is secured to shield 20, the terminal end of waveguide 1 likewise being supported by frame 12.

A cylindrical shield 13 open at both ends and supported by bracket 14 secured to heat shield 20 houses an electric stirrer for agitating the fluid and evenly distributing the heat throughout the interior of container 3. Cable 22 serves as a means for supplying electric power to stirrer 13. At 5 is shown a thermometer which extends a short distance into container 3 for reading the temperature inside the container. A plastic ring 25 serves to position the entire unit inside dewar container 3.

In operation the device is closed and the beginning temperature read from thermometer 5. After this reading is recorded and with the stirrer in cylinder 13 agitating the fluid, microwave energy to be measured is supplied to waveguide 1. This energy passes out through the windows 6 in the terminating end 4 of waveguide 1 and is dissipated in the fluid in container 3. The temperature rise of the fluid over a predetermined period of time is determined by the use of thermometer 5.

Ideally the container may now be opened and the liquid cooled to its original temperature or the water may be removed and a like amount of water as first placed in the container may be substituted therefor.

If it is desirable to sacrifice accuracy slightly for time the original fluid may be left in the container and the subsequent or second measuring step can be made utilizing the fluid temperature at the end of the application of microwave energy as the base or starting temperature. The second measurement involves the application of a known amount of D. C. energy to heater wires 11 via leads 9 over a suitable time period to produce a temperature rise in the fluid corresponding to the previous temperature rise evidenced with the application of microwave energy to waveguide 1. The D. C. power is then a measurement of the microwave energy.

Fig. 2 shows an enlarged view of the terminating end 4 of waveguide 1. Incorporated in the termination are four waveguide windows 6 positioned and shaped as shown to provide a maximum of energy transfer from the waveguide into the fluid. The windows 6 may be made of any suitable material transparent to microwave energy the most common material being mica. The windows on opposite sides of the guide are similar, with those on the broader faces of the waveguide substantially larger than the windows on the narrow sides of the waveguide. The particular termination provides a maximum of energy transfer from a matched source with a minimum of reflection within the guide. Power maximum energy transfer is important, with minor changes in the shape and size of the windows 6 tending to reduce the accuracy of the measurement. While the window termination shown is preferred the particular termination is not critical and other window type waveguide terminations (which must be experimentally determined) may be utilized.

The present invention provides a simple, basic calorimetric device for measuring microwave power with increased sensitivity at a minimum of expense.

It will be apparent that the embodiment shown is only exemplary and that various modifications can be made in construction and arrangement within the scope of invention as defined in the appended claims.

What is claimed is:

1. A microwave wattmeter comprising a dewar flask containing a fluid to be heated, a removable closure member for said flask, a section of rectangular waveguide passing through said closure member and projecting into said flask, a heat shield supported from said closure member, an insulating frame affixed to said heat shield supporting the terminal end of said waveguide section, the sides of said waveguide section within said flask including microwave transparent windows having a tapered configuration in a direction away from said terminal end, a plurality of heater wires supported on said frame with a connecting lead passing through said closure member, thermometer means passing through said closure member having a temperature-sensitive element projecting into said flask and an indicating element external of said flask, and stirrer means within said flask supported from said shield.

2. A wattmeter as defined in claim 1 in which said fluid is water.

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