Jan. 21, 1947. H. E. WEBBER 2,414,499

BARRETER WIRE UNIT

Filed Dec. 13, 1943

Fig. 1.

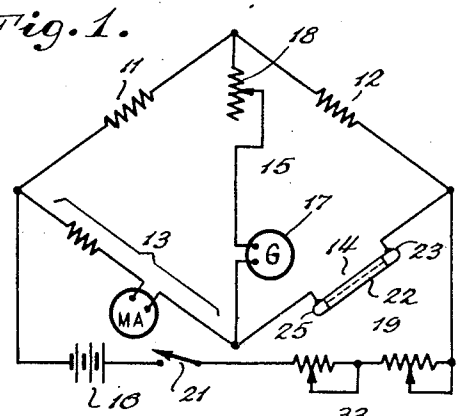


Fig. 2.

Fig. 3.

Fig. 4.

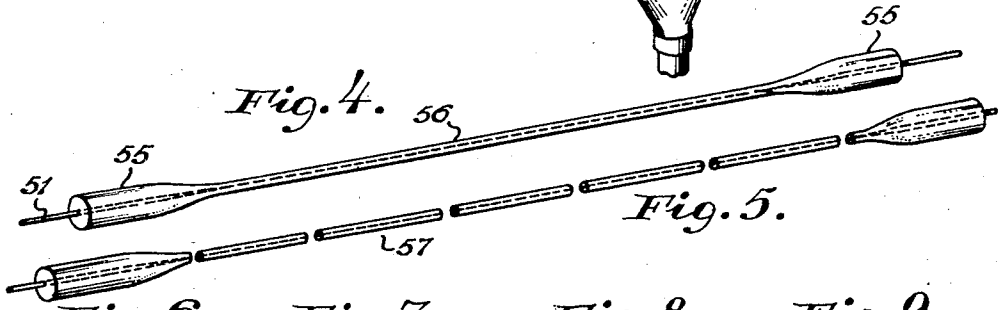


Fig. 5.

Fig. 6.

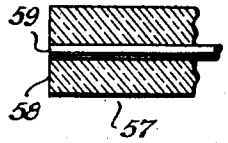


Fig. 7.

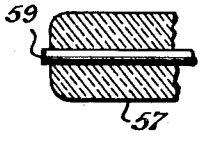


Fig. 8.

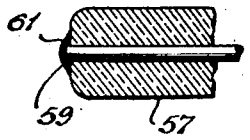


Fig. 9.

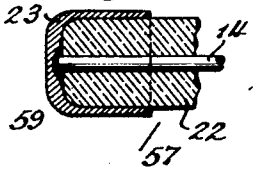


Fig. 10.



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BARRETER WIRE UNIT

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Application December 13, 1943, Serial No. 514,108

8 Claims. (Cl. 201—64)

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The present application is a continuation-in-part of my copending application, Serial No. 513,164, filed December 6, 1943.

The present invention relates to alternating current power-measuring apparatus, and concerns particularly Barreter wire units for microwave wattmeters and methods for producing the same.

It is an object of my invention to provide an improved, sturdy, durable wholly-enclosed resistance wire unit which may be used as a Barreter wire in microwave apparatus.

Another object of the invention is to provide a simplified, inexpensive, expeditious method of producing enclosed resistance, wire units.

Still another object of the invention is to provide insulated-body wire units having low-loss at high frequencies.

Other and further objects and advantages will become apparent as the description proceeds.

In carrying out the invention in its preferred form, resistance wire composed of a suitable material such as platinum is inserted in a length of fine-bore tubing or vitreous insulating material, such as glass or quartz, for example, and the tubing and wire core are together drawn out to form a fine resistance wire enclosed in the insulating tubing substantially fused to the wire. The drawn tubing is then cut into pieces of appropriate lengths, and metallic terminals are formed at the ends of the pieces to form Barreter wire units.

To form a microwave wattmeter, a holder is provided for holding such a unit in the field produced by microwave energy to be measured, and direct current is simultaneously supplied to the Barreter wire unit. The direct current strength is varied to maintain constant power consumption and resistance of the Barreter wire. The microwave power is determined by measuring the variation in direct current power required to maintain constant power dissipation.

A better understanding of the invention will be afforded by the following detailed description considered in conjunction with the accompanying drawing in which:

Fig. 1 is a schematic diagram of a bridge circuit which may be employed in conjunction with an alternating current wattmeter of the Barreter wire type;

Fig. 2 is a side view partially in section of a form of wire holder which may be employed for measuring microwave power by means of a Barreter wire;

Fig. 3 is a perspective view illustrating a step

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in the process of producing a Barreter wire unit in accordance with my invention;

Fig. 4 is a perspective view representing a further step in the process of forming the Barreter wire unit;

Fig. 5 is a perspective view illustrating a more advanced step in the process of forming the Barreter wire unit;

Fig. 6 is a fragmentary sectional view showing the end of the Barreter wire unit in its condition as represented in the step of the process in Fig. 5;

Fig. 7 is a view corresponding to Fig. 6, illustrating the appearance of the unit after an additional step in the preparation of the unit;

Fig. 8 is a view corresponding to Fig. 7, illustrating the condition after the end of the wire has been coated;

Fig. 9 is a view corresponding to Fig. 8, illustrating the condition of the unit after the end of the unit has been coated to form an end terminal or ferrule; and

Fig. 10 is a side view of Barreter wire unit in its completed form.

Like reference characters are utilized throughout the drawing to designate like parts.

As described in greater detail in my above mentioned parent application, a direct-current bridge such as shown in Fig. 1 may be employed for maintaining constant the resistance of a Barreter ware under varying conditions of microwave power input for the purpose of measuring the microwave power by measuring variations in the direct current powers. Summarizing, such a bridge comprises four bridge arms 11, 12, 13 and 14, with a diagonal arm 15 and a direct current power supply source 16. The arms 11 and 12 may be standard resistors, the arm 13 includes a resistor and a current-responsive instrument such as a milliammeter in series forming a single arm of the bridge, and the arm 14 comprises a Barreter wire unit, an improved form of which will be described in greater detail hereinafter in the specification. This unit is characterized by the fact that it has a high change in resistance for a change in temperature.

The arm 15 includes a null galvanometer 17 and a sensitivity adjuster rheostat 18 connected in series. For controlling the direct current power input to the bridge, rheostats 19 and a switch 21 are connected in series with the direct current supply source 16.

The actual resistance constituting the arm 14 of the bridge consists of a length of wire or filament composed of suitable material such as platinum mounted and enclosed within a protect-

ing and insulating body such as a tube 22 composed of a vitreous material such as glass or quartz, preferably the latter, where low power circuits are to be measured and loss is to be avoided.

The ends of the tube 22 are sealed to the wire 14 and conducting end terminals or ferrules 23 are provided which are in electrical contact with the ends of the wire 14. The Barreter wire with its enclosing tube and end terminals forms a removable and interchangeable Barreter wire unit 24, which may be so mounted as to absorb power from the microwave field, or to conduct ultra high frequency current without producing reflections in the field. For so mounting the Barreter wire unit, suitable wire holders are provided, for example, a wire holder of one of the types disclosed in my copending applications Serial No. 513,164, filed December 6, 1943, or Serial No. 514,111, filed December 13, 1943.

Where the microwave power to be measured is supplied through a wave guide type of transmission line, the wire holder may take the form illustrated in Fig. 2, for example.

The wire holder of Fig. 2 comprises a wave guide 26 open at the lefthand end with a choke coupling 27 mounted thereon, adapted to make connection with an input wave guide (not shown) having a similar choke coupling to be attached to the choke coupling 27. Suitable sockets 28 and 29 are provided for holding the unit 24 athwart the wave guide 26 and making electrical connections to a bridge, such as that shown in Fig. 1.

For tuning the line and matching the impedance of the wave guide transmission line 26 to that of the Barreter wire 14, a line-length-adjusting mechanism 31, and an adjustable stub line 32 are provided. The line-adjusting mechanism 31 comprises a rotatable screw 33 carrying at its inner end a shorting plug (not shown) the longitudinal position of which within the line 26 is adjusted by the screw 33.

Although my invention is not limited to the use of Barreter wires in a particular type of wave guide, it is assumed for the sake of illustration that the wave guide shown in Fig. 2 is a rectangular hollow pipe type having the wide transverse dimensions perpendicular to the plane of the drawing and the narrow transverse dimension in the plane of the drawing.

The stub line 32 as illustrated is of the coaxial type having an outer hollow right-circular cylinder 34 joined to the edges of an opening formed in the top surface of the wave guide 26 and a center rod 35. The stub line 32 includes a suitable screw-threaded adjusting mechanism having a knurled adjusting head 36 for adjusting the axial position within the tube 32 of a short-circuiting plug 37. The lower end of the post 35, which extends to a point flush with the top inner surface of the wave guide 26 is drilled to form the socket 28 and may be provided with saw cuts (not visible) for forming a spring socket to hold the upper conducting terminal 23 of the unit 24.

The socket 29 consists of a metallic rod drilled in a similar manner to form a socket for the lower end of the unit 24, but insulated from the wave guide 26. An opening is formed in the lower wall of the wave guide 26 to receive the socket 29 and the opening is made of sufficient size to leave an annular clearance space 38. Preferably a quarter-wave trap is mounted around the clearance opening 38. Such a trap may be formed by a flanged tubular member 39 having a flange 41 fitted into the lower wall of the wave guide 26 and a tubular-extending portion 42, the length of which is substantially a quarter-wave of the wave length for which the wave guide 26 is designed.

The socket connector rod 29 is provided with a flange 43 for supporting the rod 29 centrally of the tube 42, and a connector housing 44 is provided containing a pair of annular insulators 45 and 46 between which the connector flange 43 is clamped to support the connector rod 29. For making direct current connections to the wire 14, pins 47 and 48 are provided. The pin 47 is connected to the post 29 through a conductor 49 and the pin 48 is grounded to the wave guide 26 so as to provide a circuit to the upper end of the wire 14 through the stub line members 34 and 35.

For forming the Barreter wire unit 24, a length of wire 51 (Fig. 3) is passed through the bore of a fine-bore vitreous tube 52. The tube 52 may be of suitable material such as glass or quartz, preferably the latter, for forming low-loss microwave wattmeters and the tubing is heated to the point of softening by suitable means. Such means are represented schematically by a fish-tail burner 53 producing an elongated flame 54, but it will be understood that for softening quartz sufficiently, an oxyhydrogen blowpipe will be required.

When the tubing material has been softened by the heat of the flame 54, the ends of the tube 52 and the wire 51 are simultaneously drawn apart so as to draw down the wire and the center portion of the tubing simultaneously to form the elongated length shown in Fig. 4.

It will be understood that the relationship between the diameter of the wire 51 and the bore of the tubing 52 will remain substantially the same after drawing, but if desired the ends 55 of the tubing stock may be separated a little further after the wire 51 has been drawn down to the desired diameter so as to cause the quartz tubing 55 to tend to fuse to the wire 51.

After the wire 51 and tubing 52 have cooled, the reduced diameter portion 56 of the tubing is cut into a plurality of short lengths 57 as shown in Fig. 5. One end of such a length is shown drawn to a large scale and in a longitudinal sectional view in Fig. 6. It will be observed that a relatively straight fracture occurs, forming the square end 58. In order to provide for making good electrical contact with the end 59 of the wire, the end 58 of the quartz is preferably etched away to form the end shape shown in Fig. 7. This may be accomplished by dipping the end of the piece 57 in a suitable reagent reacting more quickly upon the quartz than the wire 59, such as a mixture of hydrofluoric acid and nitric acid, for example, in proportions of approximately 70% and 30%.

Preferably the tip 59 is coated with a high-conductivity electric-conducting material such as silver or copper to form an end coat 61 as illustrated in Fig. 8. However, if desired, a layer of platinum may be coated on the end 59. The coating 61 may be deposited in any desired manner by electro-deposition in an electro-plating cell (not shown).

After the wire end coating 61 has been deposited, a heavier conducting coating of suitable material is preferably deposited on the end of the tubing 22 to form the unit terminal or ferrule 23.

The ferrule or deposited coating 23 may be placed on the tubing 22 in any desired manner, for example, the end of the quartz may first be dipped into a suitable mucilaginous material

such as Bakelite varnish, dusted with graphite, and then placed in an electro-plating cell for a sufficient length of time to form the coating 23 which is in electrical contact with the wire end coating 59.

It will be understood that while the coating 23 is being deposited at one end of the unit, the wire end coating such as 59 at the other end of the wire 14 may be utilized for making the requisite electrical connections for the electro-plating process.

After the first end has been fully coated, the coating 23 at one end will, of course, serve as the electrical connections for causing electrodeposition of the coating 23 at the other end, so that the finished unit 24 has coated terminals 23 at both ends, as shown in Fig. 10.

In accordance with the provisions of the patent statutes a specific form of apparatus embodying the invention and an illustrative method of producing apparatus in accordance with the invention have been described, but it is to be understood that the arrangements described are only illustrative and that the invention is not limited to the specific apparatus and method described and illustrated.

What is claimed is:

1. A Barreter wire unit, comprising a length of drawn fine-bore tubing of insulating material, a wire drawn within said tubing, the ends of the tubing being sealed to the wire, conducting coatings on the ends of the wire, and terminals deposited at the ends of the tubing making electrical contact with the coatings at the ends of the wire.

2. A method of forming a Barreter wire unit which comprises enclosing a length of resistance wire in a length of tubing, softening and drawing down the tubing and enclosed wire, cutting the drawn tubing and wire into shorter lengths, and capping the ends of the shorter lengths with conducting material making electrical contact with the ends of the wire in each shorter length of tubing.

3. A method of forming a Barreter wire unit which comprises the steps of drawing a length of insulating tubing with a metallic core to a reduced diameter, cutting off the ends of the tubing to form a unit with substantially squared ends, etching away the ends of the length of tubing to expose the ends of the wire, and coating the ends of the tubing in contact with the ends of the wire to form terminals for the resistance wire unit.

4. A method of forming a resistance wire unit which comprises surrounding a length of resistance wire with a length of insulating tubing, and simultaneously drawing both said wire and said tubing.

5. A method of forming a resistance wire unit which comprises surrounding a length of resistance wire with a length of insulating tubing, simultaneously drawing both said wire and said tubing until said wire has a desired diameter, and then drawing only said tubing to fit said wire.

6. A method of forming a fine electric current-conducting wire unit which comprises the steps of enclosing a length of metal wire in a length of tubing, heating said tubing and enclosed wire, and deforming said tubing and wire to increased length and decreased diameter.

7. A method of forming a fine wire unit which comprises the steps of enclosing a length of wire of a first material in a length of tubing of a second material, plasticizing said tubing, and deforming said tubing to increased length and decreased diameter to provide radial compression and deformation and increased length of said wire.

8. A method of forming a fine wire unit which comprises the steps of enclosing a length of wire of a first material in a length of tubing of a second material, softening said tubing and wire, and deforming said tubing and wire conformally to provide increased length and reduced diameter of said tubing and wire.

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