

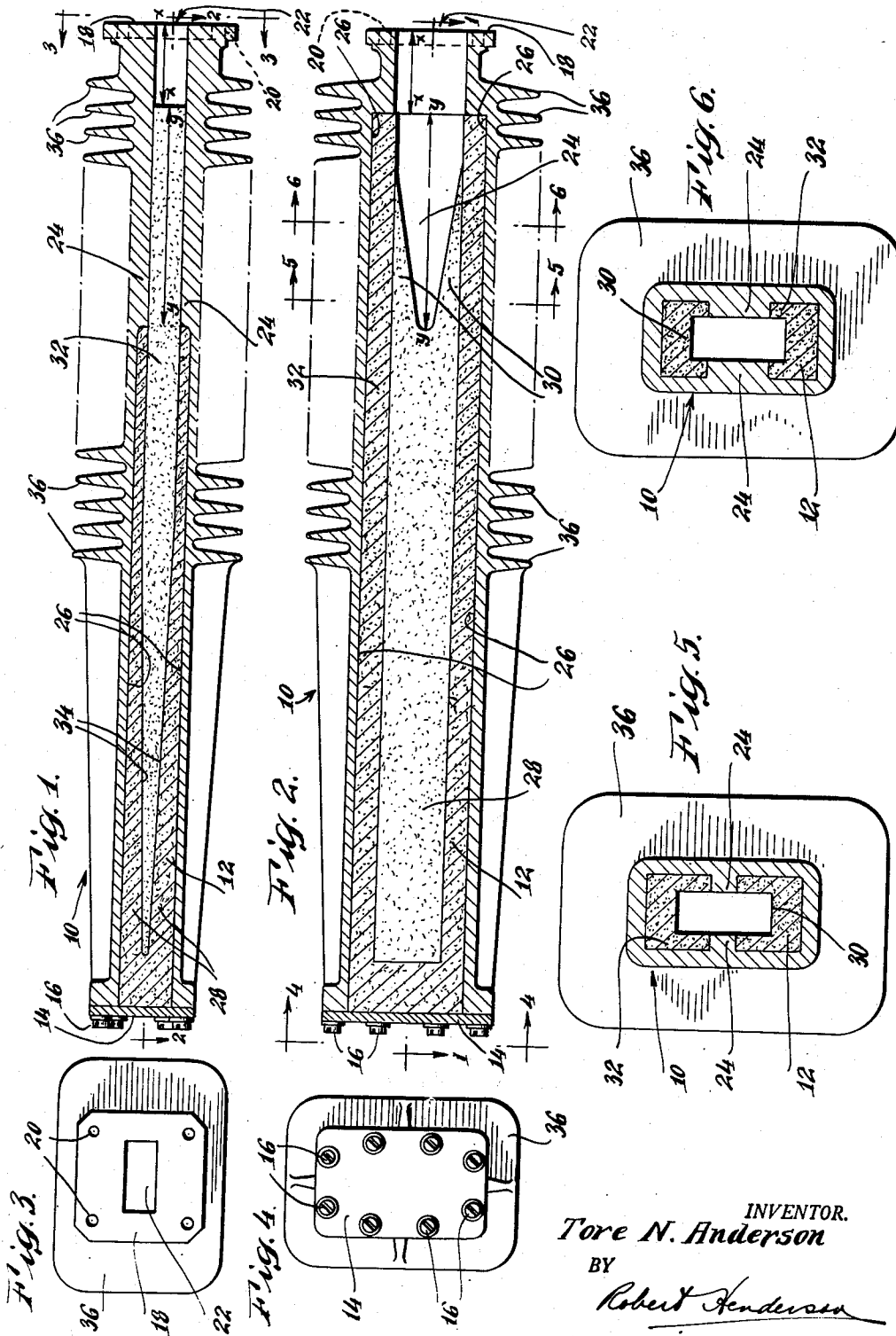
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HIGH-FREQUENCY POWER DISSIPATING TERMINATION

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HIGH-FREQUENCY POWER DISSIPATING
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This invention relates to high frequency power dissipating terminations wherein electrical energy is converted into thermal energy for dissipation, and, more particularly, relates to provisions in such terminations for causing the dissipation of electrical energy to be substantially uniformly effected along a longitudinal dimension of the device.

Such terminations have heretofore been provided both for coaxial cables and for wave guides to permit testing of power and other factors in electronic systems. In such devices, it is common to employ, within a closed-end cable or wave-guide termination section, a lining of suitable dissipative material, usually a ceramic material, to absorb and convert the electrical energy therein into thermal energy; the resultant heat being carried off through the walls of the termination section. Such linings have commonly been applied to the entire interior of the termination section and radiation fins, also, have been provided throughout the entire length of the exterior of such a termination section to facilitate the dissipation of the heat.

Terminations of the character just described have not been entirely satisfactory for several reasons. Apparently because of the abruptness with which the electrical energy is received in the termination by the latter's dissipative material at a sharp transverse line where the dissipative material adjoins a connected metal conductor, the conversion to heat becomes considerably accentuated in the region of the said junction, causing relatively quick structural breakdown of the dissipative material and failure of the device at that location. With such prior structures, also, it has been difficult to minimize reflection of energy back into the conductor, thereby giving rise to an objectionably high standing wave ratio with decreased power in the related electronic system and test results which are not adequately dependable. The mentioned disadvantages become more pronounced with the much higher power now being employed in such electronic systems.

Accordingly, an important object of this invention is the provision of a novel and improved dissipating termination capable of efficiently converting electrical energy to another form of energy for dissipation.

Another important object is the provision, in such a termination, of improved means for effecting such conversion of energy quite uniformly throughout the termination's length.

Another important object is the provision of such a termination wherein the electrical energy

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is converted to thermal energy quite uniformly along the length of the termination, thereby minimizing the total heat developed and avoiding hot spots which might cause quick breakdown of the dissipative material.

Another important object is the provision of such a termination which may operate at increased peak power and which is capable of substantially completely dissipating whatever electrical energy is flowing through the system without material development of reflections or standing waves.

Although the present invention may be useful in other forms of conductors, it is particularly useful in wave guides which have greater pulse power capacity than cables and are more suitable than cables for conducting the shorter wave lengths in the microwave region. The present trend to higher power in such shorter wave lengths serves to point up the importance of the stated objectives in relation to wave guides and, therefore, the present disclosure of this invention is made with respect to wave guides without, however, limiting the invention except as specified in the claims hereinafter set forth.

As applied to wave guides, the stated objects are accomplished by a termination which has smooth, uninterrupted, internal surfaces forming direct continuations of internal surfaces of a wave guide connected thereto, said surfaces, in the vicinity of the input end of the termination, being inter-tapering surfaces of bodies of conductive metal and of dissipative material, the metal surfaces being at opposite sides of the device as continuations of the interior, conductive surfaces of the related wave guide and tapering away, in the form of a wedge, to non-existence in the direction of the closed or terminal end of the termination. In the same input vicinity, the dissipative material is shaped complementally to said wedge to complete the internal walls in which the wedges are located. The metal wedge maintains a diminishing conductivity of the device in the same longitudinal area thereof where the dissipative material effects an increasing dissipation of the electrical energy so that dissipation is relatively gradual and heat concentration is substantially avoided.

More particularly, the present invention is illustrated in the accompanying drawing in only one of numerous possible embodiments thereof without, however, limiting the invention to that particular embodiment.

In the drawing:

Figure 1 is a central, longitudinal, sectional view of a termination according to a preferred

embodiment of this invention substantially on the line 1—1 of Fig. 2, i. e., at a plane extending through the broader opposite sides thereof;

Fig. 2 is a central, longitudinal, sectional view on the line 2—2 of Fig. 1, i. e., at a plane extending through the narrower opposite sides thereof;

Fig. 3 is an end elevational view of the termination as seen from the right end of Figs. 1 and 2;

Fig. 4 is an end elevational view of the termination as seen from the left end of Figs. 1 and 2; and

Figs. 5 and 6 are transverse, sectional views, respectively, on the lines 5—5 and 6—6 of Fig. 2.

The illustrated termination consists fundamentally of three parts; a tubular casing 10 which may be cast of suitable metal such as an aluminum alloy, an inlay 12 of dissipative material, and an end or cover plate 14 held upon the terminal end of the casing by screws 16.

At its input end, its right end as viewed in Figs. 1 and 2, the device is provided with a preferably integral connection flange 13 having screw holes 20 to receive screws (not shown) by which the device may be connected to a rectangular wave guide or other conducting component in related electronic apparatus. Either by special connection or by a suitable switching arrangement, the termination device may be substituted, for test purposes, for a power output assembly, as, for example, an antenna circuit.

The termination is formed with what might be termed a conduction-dissipation passage 22 extending from the input end, almost to the opposite or terminal end of the device. This passage, in the illustrated structure, is rectangular in shape in cross-section substantially throughout its length, preferably being of the same size and shape, at the input end, as the interior of the wave guide or other component to which it is connected. The broader diameter of this passage is preferably of uniform dimension throughout the length of the passage, as may best be understood from Fig. 2, while the narrower diameter of the passage is preferably of uniform dimension only to an intermediate location in the device and, as shown in Fig. 1, tapers from that intermediate location to substantial nonexistence at a location near the terminal end of the device.

The passage 22 has flat surfaces of metal on all four sides thereof in the vicinity of the input end to the longitudinal extent indicated by double-headed arrows $x-x$ in Figs. 1 and 2, the metal thereof being the metal of which the casing 10 is cast. The mentioned flat surfaces of metal on the opposite broader sides of said passage are coplanar continued in the form of internal metal wedges 24, which preferably, are integrally cast as a part of the casing 10. These wedges may advantageously be of the approximate longitudinal extent indicated by double-headed arrows $y-y$ in Figs. 1 and 2 and are like internal lands defining therearound the areas occupied by the inlay 12.

The inlay area is in the nature of an elongate, internal, rectangular recess 26 which has broader and narrower diameters which are greater, respectively, than corresponding broader and narrower diameters of the passage 22 at the input end of the device. Thus, the dissipative inlay 12 which fills the recess 26 is substantially rectangular in shape, with gradually thickened broad wall portions 28 toward its terminal end and having its broad walls acutely bifurcated by the wedges 24 toward the input

end of the termination to form acute angular wings 30, 30 which taper off to non-existence at points near the input end of narrow walls 32 of the inlay which may be of uniform thickness throughout their length. In the illustrated embodiment, the broader internal surfaces of the inlay and of the wedges defining the passage 22 are coplanar throughout approximately the input half of the device and the said broader surfaces, which are entirely inlay surfaces throughout approximately the terminal half of the device, are continuations of said coplanar surface portions and converge toward the terminal end as indicated at 34 in Fig. 1. The inner surfaces of the wedges 24, preferably, are broached during manufacture to render them smooth, thereby offsetting in the corresponding end of the device, some undesirable effects arising from the relative roughness of the surfaces of the inlay 12, particularly at the wings 30.

The casing 10 is suitably fitted or formed with a plurality of integral peripheral fins 36 to facilitate the transfer of heat from said casing to the surrounding air. These fins may be provided, as shown in Figs. 1 and 2, only toward the input end of the device. If they extend from a point toward the right of the input end of the inlay 12 to a point well beyond the wedges, as shown in the drawing, the fins function adequately adjacent to the area where greatest heat generation occurs; and the remaining portion of the casing suffices without such peripheral fins to transfer, to ambient atmosphere, the heat developed toward the terminal end of the device.

The dissipative inlay 12 may be of any suitable material for absorbing electrical energy and converting it to thermal energy and should be capable of withstanding the high temperature developed by the absorption of the high power in a related wave guide. It may advantageously be a composition formed by intermixing and ball-milling two parts, by weight, of flaked graphite and three parts of lumnite cement and by then admixing water only in a quantity sufficient to form a plastic cement which is workable as hereinafter indicated.

In making the device, the casing 10 is first cast to its desired shape, after which the surfaces of the wedges 24 are broached smooth. A core or mandrel corresponding in shape to the desired shape of the passage 22 and coated with suitable anti-adhesion material, is extended into the input end of the casing and suitably held fixedly therein. Then, with the casing held in a vibrating device in an upright position with its terminal end uppermost, the previously prepared dissipative material is poured very slowly into the then-open terminal end of the device and permitted to gravitate into the inlay space until the latter is filled; the vibration of the device, meanwhile, functioning to free any air bubbles from the dissipative mix. After the mix has set, the setting time usually being an hour or more, the mandrel is removed and the device is subjected to a week, more or less, of curing in air and then suitably baked. The baking, where the inlay mix is of the general character suggested herein, may advantageously be at approximately 275° F. for about twenty-four hours; and then at about 700° F. for about eight hours; the oven being permitted to cool to about 200° F. before the termination is removed therefrom.

After completion of the baking step, the device is filled with an impregnating solution of

about 90% silicone resin and 10% toluol (by vol-

ume) and subjected to a vacuum while thus filled until bubbling from the dissipative inlay substantially ceases, after which the excess of this solution is drained off and wiped from all exposed metal inner and outer surfaces. Thereafter, the device is again baked, first at about 275° F. for about twenty-two hours and then at about 500° F. for about eight hours. The inlay, thus, is fixedly impregnated and coated to minimize moisture absorption in the presence of humidity.

In operation, the electrical energy entering the device, at its input end, in the form of waves, apparently moves between the wedges 24 with the peak of the waves following the center line of the wedges while the wave's opposite fringes undergo gradually increasing absorption from the gradually enlarging areas of the wings 30 of dissipative material. This fringe absorption causes absorption, also, at the wave peaks so that upon reaching the ends of the wedges the electrical energy has been converted, to such an extent, to thermal energy that, in the remainder of the device, the dissipative material alone suffices to complete the absorption of the electrical energy and the resultant heat in said remainder of the device may be carried off adequately through the non-finned portion of the casing 10. Thus, the heat generated is not unduly localized at any one point and the total heat generated is minimized, leading to long life for the inlay 12.

It has been found, also, that terminations according to this invention may operate at increased peak powers, apparently because of the avoidance of hot spots, and that reflection of energy is minimized with a resulting minimum in standing wave ratio. In addition, it appears that as there is no development of excessive heat at any point in the inlay, steaming of the inlay is minimized, thereby substantially obviating the passage of steam vapor into a related wave guide and the undesirable condensation of such vapor which could adversely affect the wave guide's transmission characteristics.

Without attempting to recite herein all the possible variations of this invention, it may be noted that the wedges 24 may be of various relative dimensions; that the broad concept of using such wedges as herein described may also be varied by disposing the wedges in the narrower walls rather than in the broader walls of a rectangular termination for use with a rectangular wave guide; and that such wedges may be used, in the manner and for the purposes stated, in circular wave-guide terminations. In circular wave-guide terminations, the bases of the metal wedges should preferably be spaced from each other much as the bases of the wedges 24 in the accompanying drawing are spaced from each other by the dissipative material in the narrower walls of the termination.

As the present inventive concept obviously could be utilized in means other than disclosed herein, the scope of this improvement should not be limited except as set forth in the following claims.

What I claim is:

1. A power dissipating termination comprising a tubular body of dissipative material, closed at a terminal end thereof and of a cross-sectional, inside size and shape toward the opposite, input end of said body, substantially similar to a recess opening in a conducting element to which the termination is adapted for connection, and 75

a wedge of conductive material extending into the input end of a wall of said body and having its interior surface directly continuous with adjacent surfaces of the dissipative body.

2. A power dissipating termination comprising an elongate, hollow body of dissipative material, closed at a terminal end thereof and interiorly of rectangular shape in cross-section, and a pair of conductive wedge-shaped members fixedly associated with and extending into said dissipative body toward the latter's opposite, input end with wedge points thereof directed toward the terminal end of the said body and with opposed inner faces of the wedge-shaped members coplanar with corresponding inner faces of adjacent portions of said dissipative body.

3. A power dissipating termination comprising a casing of conductive metal and a lining therein of dissipative material defining therewithin an electrical energy-dissipating passage of rectangular shape in transverse section, and wedge-shaped, conductive, metallic portions integral with said casing at opposite sides thereof toward an input end of the casing and directed toward the opposite end of the casing and extending into the dissipative material at corresponding opposite sides of said passage, thereby forming dissipative wings at opposite sides of said wedge-shaped portions; the latter having substantially flat inside surface which are substantially coplanar and continuous with respect to adjacent inside surfaces of dissipative lining material at said corresponding opposite sides of said passage.

4. A power dissipating termination according to claim 3, further characterized in that the said passage is non-equilaterally rectangular in transverse sectional shape and the said wedge-shaped portions are in partially embedded relationship with respect to the dissipative lining material at the broader sides of said passage.

5. A power dissipating termination according to claim 3, further characterized in including plural radiation fins at the exterior of the casing in a longitudinal region of the latter corresponding substantially to the longitudinal region wherein the said wedge-shaped portions are located.

6. A power dissipating termination according to claim 3, further characterized in that the said inside surfaces of the wedge-shaped conductive portions are substantially smooth.

7. A power dissipating termination according to claim 3, further characterized in that said lining includes moisture-resistant material on its exposed surfaces.

8. A power dissipating termination according to claim 3, further characterized in that the said passage extends toward the terminal end of the device substantially beyond the said wedge-shaped portions and in that the lining walls defining the sides of the said extended portion of the passage which are continuations of the sides having the wedge-shaped portions therein converge and come together to close the terminal end of said passage.

9. A power dissipating termination according to claim 8, further characterized in that the said converging lining walls increase in thickness toward their terminal ends substantially in proportion to the convergence of said converging walls.

10. A power dissipating termination comprising a tubular body of dissipative material, closed at a terminal end thereof and of a cross-sectional, inside size and shape toward the opposite, input end of said body, substantially similar to a recess

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opening in a conducting element to which the termination is adapted for connection, and a pair of opposed wedges of conductive material extending into the input end of said body at opposite sides thereof with their converging sides directed generally toward the termination's terminal end and having their interior surfaces directly continuous with adjacent surfaces of the dissipative body.

11. A power dissipating termination according to

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to claim 10, further characterized in that said wedges are spaced from each other.

12. A power dissipating termination according to claim 10, further characterized in that the said wedges extend only into an input-end portion of the termination which, with said wedges therein, is of uniform diameter throughout its length.

No references cited.