Oct. 13, 1953 O. M. WOODWARD, JR 2,655,635

TRANSMISSION LINE TERMINATION

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FIG. 1

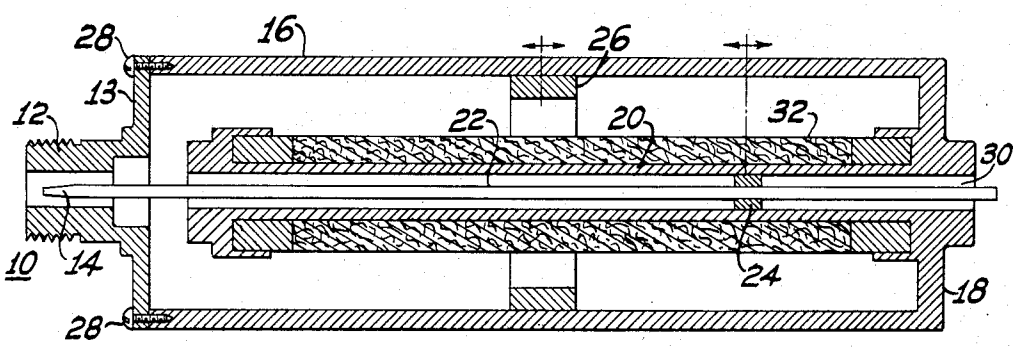
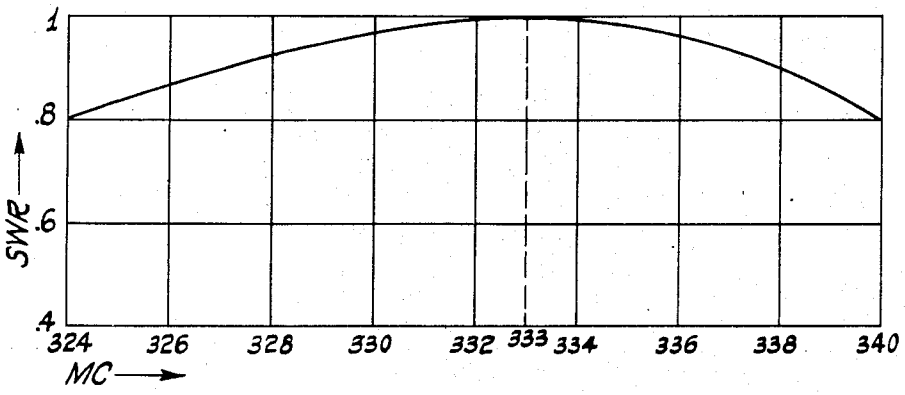


FIG. 2



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TRANSMISSION LINE TERMINATION

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9 Claims. (Cl. 333—22)

1

This invention relates to terminations for transmission lines and particularly to a tunable high frequency transmission line matched resistive termination.

It is frequently desirable to terminate a high frequency transmission line, for example, a coaxial transmission line with a substantially perfectly matching termination which will absorb substantially all of the energy transmitted through the line to the termination without the formation of reflections or standing waves. Such transmission line terminations are frequently difficult to construct, and when constructed, are often suitable for use at only one frequency. Furthermore, some of these terminations are long and consequently awkward to handle, and comparatively expensive to construct, with a special termination being required at each frequency employed.

It is an object of the present invention to improve the termination of a high frequency transmission line.

Still another object of the invention is the provision of a high frequency transmission termination which will be suitable over a wide range of frequencies.

Another object of the invention is to provide a high frequency transmission line termination which shall be compact, inexpensive, and readily constructed.

These and other objects, advantages and novel features of the invention will be more fully apparent from the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a transverse cross-sectional view of a transmission line termination in accordance with the invention; and

Fig. 2 is a plot showing the high degree of perfect matching and absorption possible with the termination of Fig. 1.

In accordance with the invention, a first length of coaxial transmission line is arranged and adapted to be connected to the coaxial transmission line to be terminated. The first length of line includes a lossy material between the conductors thereof to absorb energy from the electromagnetic field between the conductors, and a capacitive element such as a projection or protuberance is provided between the line conductors which, in effect, provides a lumped capacitance at a chosen point along the line. By suitably positioning the lumped capacitance, an impedance is

2

reflected at the connecting end of this length of transmission line having a resistive component which is equal to the impedance of the transmission line to be matched. A second transmission line is inserted in series with the first length of transmission line and which is substantially entirely reactive and of opposite sign to cancel the reactive component of the first length of transmission line. The line is thus substantially perfectly matched by the termination at any desired frequency over a relatively wide range.

Referring now to Fig. 1, an adapter 10 has an outer threaded conductor 12 and an inner tapered conductor 14. Thus means or terminals are provided for connection to the line to be matched. The adapter 10 illustrated is designed for easy connection to a standard 52 ohm characteristic impedance coaxial line. Conductor 12 is connected to a cylindrical outer conductor 16 terminating in a short-circuiting portion 18 which short-circuits conductor 16 to an inner conductor in the form of a sleeve 20 surrounded by the conductor 16. Sleeve 20 surrounds conductor 22 which is an extension of conductor 14. Sleeve 20 and conductor 22 form a coaxial line short-circuited by a shorting plug 24 longitudinally adjustable therewith. Between conductors 16 and 20 is a capacitive projection or protuberance, in this instance a ring 26 of conductive or dielectric material, as desired, connected to conductor 16. The ring may be moved longitudinally (as indicated) along conductor 16 by a longitudinal slot therein (not shown) or by removing end plate 13 from its connection with conductor 16 by taking out screws 28, and then replacing the parts. Short-circuiting plug 24 may also be slid longitudinally (as indicated) of the structure and may be reached through the inactive open end 30 of sleeve 20 at the back of the structure. Conductor 20 is surrounded by or has a heavy coating of lossy or resistive material 32 distributed along the length of line section 16, 20, as shown. In fact, the structure may be formed by taking an ordinary conventional 50 watt resistor, of tubular form, such as are in common commercial manufacture, and inserting the tubular sleeve 20 within it. The particular termination of Fig. 1 is about eight inches long overall, and about 1¾ inches in outside diameter.

In operation, the adapter 10 is inserted into a mating connection in the coaxial line. The ring 26 is moved to a suitable position, at which point there is reflected at the adapter end 10 a heavily

resistive component, due to the resistive material 32 in the electromagnetic field between conductors 16 and 20, in shunt with the capacity introduced by the ring 26. The amount of resistance thus reflected at the adapter 10 may be controlled by positioning of the ring 26. There will then be presented at adaptor 10 an impedance comprising a resistive component and a reactive component. The short-circuited length of transmission line formed by conductors 20 and 22 is effectively in series with this reflected impedance between the adapter terminals. By suitable adjustment of the shorting plug 24, the reactive component of the reflected impedance may be tuned out or balanced out by a reactance of the same magnitude but opposite in sign.

As well understood, the resistance of the material 32 will change with frequency. However, it is a simple matter to readjust the termination device to properly terminate the line at the new operating frequency.

Referring now more particularly to Fig. 2 there is shown a curve of standing wave ratio plotted against frequency for a standard 52 ohm coaxial transmission line terminated with the device of Fig. 1. This curve was derived experimentally for an adjustment of the shorting plug 24 and ring 26 of the termination of Fig. 1 for a proper termination at 333 megacycles. Similar curves may be derived with a unity standing wave ratio at other frequencies by readjustment of the plug and ring.

It will be noted that the resistive or lossy material employed may be a thick coating, and is not necessarily a thin or surface coating. Therefore, I may use standard resistors to make the line, instead of having the difficulties associated with preparing sprays and the like for forming a lossy material surface coating on conductor 20, as is necessary in some prior matching terminations. Moreover, no complicated logarithmically curved surfaces need be formed, as in some prior art terminations.

It will be apparent that I have provided a transmission line termination which may be readily and suitably adjusted for different ranges of high frequency and which is compact and economical. No separate or new construction is necessary to arrange the device to match a desired transmission line at different high frequencies, only a simply and readily made adjustment being required for that purpose.

What I claim is:

1. A termination for a first transmission line comprising a first portion having inner and outer conductors terminated for connection to said line, a second portion having an innermost conductor continued from said first portion inner conductor and having a sleeve surrounding said second portion innermost conductor and short-circuited thereto at a point distant from said first portion, said second portion having an outermost conductor extended from said first portion outer conductor, said sleeve being surrounded by said outermost conductor and short-circuited thereto at a point distant from said first portion, said second portion thereby comprising serially connected short-circuited inner and outer transmission lines each with inner and outer conductors, the said sleeve being the outer conductor of said inner line and the inner conductor of said outer line, one of said short-circuited transmission lines having an element in capacitive relationship between the conductors thereof and having a lossy material distributed along the length of said one transmission line between the conductors thereof, said short-circuited lines having cancelling reactances.

2. The termination claimed in claim 1, said lossy material being a resistance coating on one of the conductors of said one short-circuited transmission line.

3. The termination claimed in claim 1, said element being metallic and ring-shaped and connected directly to one conductor of said one short-circuited line.

4. The termination claimed in claim 1, said element being adjustable in position along said one short-circuited transmission line.

5. The termination claimed in claim 1, said one short-circuited transmission line being the outer one, the short-circuit of the other inner transmission line being adjustable whereby said other inner short-circuited transmission line is adjustable in length.

6. A termination for a first two conductor transmission line, said termination comprising an innermost conductor, an intermediate conductor surrounding said innermost conductor, and an outermost conductor surrounding said intermediate conductor to form an inner transmission line section and an outer transmission line section, said intermediate conductor serving as both the outer conductor of said inner line section and the inner conductor of said outer line section, means to connect one end of said innermost conductor to one conductor of said first line, means to connect said outermost conductor at its one end adjacent said innermost conductor one end to the other conductor of said first line, said innermost conductor at a point remote from its said one end being short-circuited to said intermediate conductor, said outermost conductor at a point remote from its said one end being short-circuited to said intermediate conductor, the said line sections being thereby serially connected, one of said line sections having a lossy material distributed along the length of the section between the conductors thereof, said one line section having a capacity element between its conductors, said line sections having cancelling reactances, thereby to present a purely resistive termination to said first line on connection thereto.

7. The termination claimed in claim 6, said line section conductors being coaxial.

8. The termination claimed in claim 6, said line section conductors being coaxial, said capacity element being a ring shaped capacity projection from one of the conductors of said one section.

9. A termination for a first two conductor transmission line, the termination comprising three conductors, the second being positioned between the first and third thereby to form two transmission line sections of which said second conductor is a conductor for each, means to connect said first conductor at one end thereof to one conductor of said first transmission line, means to connect the one end of said third conductor adjacent said one end of said first conductor to the other conductor of said first transmission line, said second conductor being short-circuited to said first at a point remote from said first conductor one end, said second conductor being short-circuited to said third conductor at a point remote from said third conductor one end, whereby said line sections are serially connected, a lossy material between those two conductors forming one of said line sections effective to absorb energy in the electromagnetic fields therebetween, said material being distributed along the

length of said one section, the line sections having cancelling reactances, thereby to present a pure resistive termination to said first line on connection thereto further comprising a shunt capacity element between the conductors of said one line section.

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