

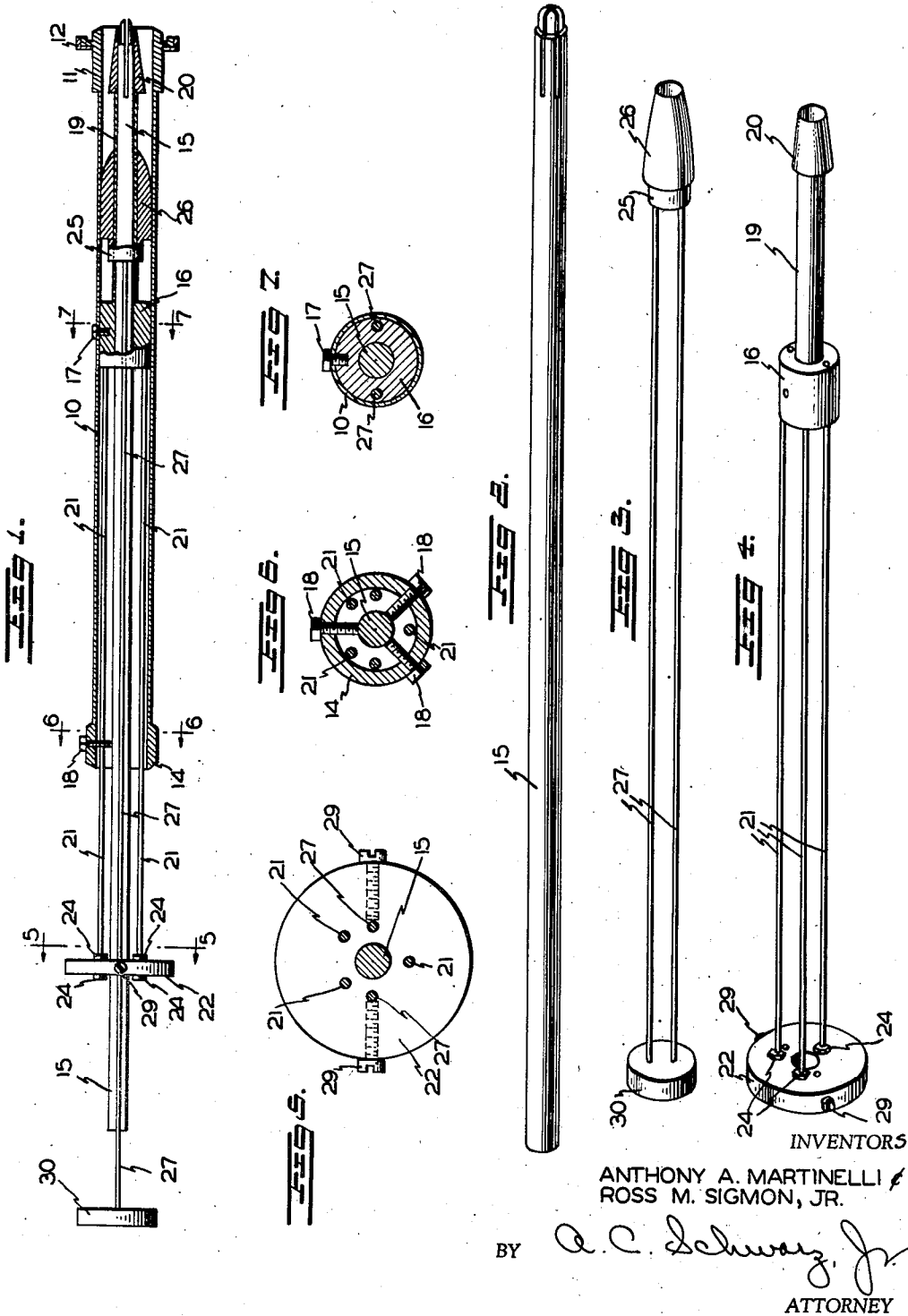
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TUNABLE COAXIAL TERMINATION

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TUNABLE COAXIAL TERMINATION

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1 Claim. (Cl. 333-22)

This invention relates to terminations for transmission lines and more particularly to a high frequency coaxial termination which is tunable over a wide range of frequencies.

It is often desirable to terminate a high frequency transmission line with a substantially perfectly matching termination that will not reflect energy back to the line. Other situations arise where it is desirable to terminate the line so that some definite value of standing wave will be set up in the line. Terminations that have been heretofore developed to solve the former problem have, for the most part, been limited in that they can be adapted to systems of only a single frequency. Even those that are tunable fail to solve the latter problem in that they may be adapted to present a matching impedance to the line over a range of frequencies, but the same termination cannot be adapted to terminate the line in some definite value of standing wave over such range.

Accordingly, one object of this invention is to provide a termination that can be tuned to the characteristic impedance of systems over a wide range of frequencies.

Another object is to provide a termination that can reflect back to the system a variable amount of energy to set up in the system variable values of standing waves over a wide range of frequencies.

Still another object is to provide a termination by which the coefficient of reflection of the termination can be evaluated by a very simple test procedure.

With these and other objects in view, one embodiment of the invention comprises an inner and an outer conductor which may be fixedly secured to a system to be terminated and between which a pair of attenuators of resistive material are slidably mounted at different points along the axis of the conductors. Means are provided to move the attenuators relative to one another to present a substantially perfect matching impedance or to introduce variable values of standing waves to the system to which the termination is connected. Means are also provided to secure the attenuators against relative movement but to allow their joint movement relative to the inner and outer conductors in order that the coefficient of reflection of the termination might be evaluated.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, wherein:

Fig. 1 is an elevational view partially in section of the termination embodying the invention;

Fig. 2 is a perspective view of the inner conductor of the termination of Fig. 1;

Fig. 3 is a perspective view of the back attenuator of the termination of Fig. 1 connected to tuning rods and a tuning knob;

Fig. 4 is a perspective view of the front attenuator of the termination of Fig. 1 connected to a termination mount, adjusting rods, and a support for the controlling rods;

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Fig. 5 is an enlarged cross-sectional view taken along the lines 5-5 of Fig. 1 showing the support for the control rods;

Fig. 6 is an enlarged cross-sectional view taken along the lines 6-6 of Fig. 1 showing means to secure the outer conductor to the inner conductor, and

Fig. 7 is an enlarged cross-sectional view taken along the lines 7-7 of Fig. 1 showing means to secure the front termination mount to the outer conductor.

Referring now to the drawings, wherein like reference numerals designate the same elements throughout the several views, the numeral 10 designates an outer conductor of a high frequency coaxial termination. To the right in Fig. 1, which shall be termed the front end of the termination, a ring 11 of conducting material is secured to or integral with the outer conductor 10. Depending from the ring 11 is a flange 12 of any appropriate size and shape and through which there may be apertures, or in which there may be threads (neither shown) to firmly secure the flange 12 to a system to be terminated. To the back end of the termination, a ring 14 is secured to or integral with the outer conductor 10.

An inner conductor of the coaxial termination is designated by the numeral 15. The inner conductor 15 is supported at one portion thereof within a cylindrical member 16 which member is slidable on the inner conductor 15 and slidable within the outer conductor 10. The cylindrical member 16 may be secured to the outer conductor 10 by a screw 17. The screw 17 may either enter a transverse, threaded bore in the cylindrical member 16 as shown in Fig. 1, or be tightened down against the side of the cylindrical member if the threaded bore is not in alignment therewith. The inner conductor 15 is fixedly secured to the outer conductor by a plurality of screws 18 which are threaded through the ring 14 at the back end of the termination (Figs. 1 and 6). The screws 18 prevent any relative movement between the two conductors 10 and 15. The right end of the inner conductor 15, as viewed in Fig. 2, is slotted so that it can be inserted into a cooperating inner conductor of a coaxial line from the system to be terminated.

Secured to the cylindrical member 16 at the front end thereof is a sleeve 19 to which a front attenuator 20 is connected. The front attenuator may be made of carbon and iron filings molded under pressure. The cylindrical member 16, the sleeve 19, and the front attenuator 20, therefore, are connected together and all make a sliding fit with the inner conductor 15.

Secured to the back end of the cylindrical member 16 are a plurality of adjusting rods 21 (Figs. 1 and 4) which are threaded at their other extremity and secured to a control rod supporting member 22 by a plurality of nuts 24.

Slidably mounted on the sleeve 19 is an attenuator support 25 to which a back attenuator 26 is secured, which back attenuator also makes a sliding fit with the sleeve 19. The back attenuator 26 may be made of the same material as the front attenuator 20. Connected to the support 25 are a plurality of tuning rods 27 which make a sliding fit through apertures in the supporting member 22 (Fig. 5) and which can be secured relative to the supporting member 22 by screws 29 which are threaded into the member 22 radially. The inner conductor 15 also makes a sliding fit within a center aperture of the supporting member 22. A tuning knob 30 is connected to the left ends of the tuning rods 27.

It can readily be seen from the above description that when the screws 29 and screw 17 are loosened thereby permitting the tuning rods 27 to slide within their corresponding apertures in the supporting member 22, that either the front attenuator 20 is movable longitudinally

dinally of the conductors 10 and 15 by manually moving the supporting member 22 or the back attenuator 26 is longitudinally movable by moving the tuning knob 30. If, however, the screws 29 are turned down so that the tuning rods 27 are secured to the supporting member 22, then relative movement between the front attenuator 20 and the back attenuator 26 is prevented, but both attenuators are jointly movable longitudinally with respect to the conductors 10 and 15.

When it is desired to terminate a system, the termination of the present invention may be connected to the system through a standing wave ratio test line. This test line is common in the art and usually consists of a slotted section through which a probe is inserted. The probe picks up a sampling of energy, detects it and passes it to an indicator. The indicator may be of a type that simply indicates the amount of energy at the probe from which indication the standing wave ratio can be computed from the maximum and minimum readings of voltage or current or it may be calibrated to read the standing wave ratio directly. For the purposes of this invention it will be assumed that the latter type of instrument is used.

Whether it is desirable to terminate the system in its characteristic impedance or in some predetermined amount of standing waves, the adjustment and evaluation procedure will be the same. The screw 17 is removed, and the screws 29 are loosened so as to permit free movement of the attenuators 20 and 26 relative to one another and relative to the system. The distance between the attenuators 20 and 26 is then set to some arbitrary value by moving the tuning knob 30 and the screws 29 are tightened against the rods 27 to prevent any further relative movement between the attenuators 20 and 26. Since neither of the attenuators 20 or 26 is a perfect termination, each will reflect energy of specific amplitude and phase, the addition of which will produce a resultant reflection. By varying the distance between attenuators 20 and 26 the relative phases of the two reflections are changed and when the proper phase relation is attained, the two reflections will combine to produce a resultant reflection as desired. In the case of introducing a standing wave, the resultant reflection will be adjusted to the value required. With the test probe held stationary, the attenuators 20 and 26 are jointly moved longitudinally along the termination by the tuning knob 30 through a distance of one wave length or more, and the standing wave ratio of the termination is read directly on the standing wave indicator (or computed from the maximum and minimum readings as discussed above). If this indicated value is other than that desired, the spacing between the attenuators 20 and 26 is changed slightly and the measuring procedure repeated until the proper value of standing wave ratio introduced into the system by the termination is obtained (either unity, in the case of a perfectly matched termination, or some specific value as desired).

It should be pointed out that it is important to leave screws 29 securely tightened when the desired result has been attained, since any further relative movement between attenuators 20 and 26 will introduce error. It is not necessary, however, to secure screw 17 in the case of adjustment for a perfectly matched termination, since the position of the terminating assembly is immaterial where the standing wave ratio is at or near unity. Nevertheless, in the case of a matched termination, the transverse, threaded slot should be aligned with the screw 17 which should be threaded therein for mechanical stability. Where a predetermined amount of standing waves is to be introduced into the system and the transverse, threaded bore in the cylindrical member 16 is not in alignment with the screw 17, the screw 17 may be tightened against the side of the cylindrical member.

It will be readily appreciated that when the termination of the present invention is placed in a system, nothing in the system need be changed in order to either terminate the system in its characteristic impedance or develop therein some value of standing wave. Also, with the termination of the instant invention, it is a simple matter to evaluate the coefficient of reflection of the termination. It can be determined by a simple computation when the indication of the standing wave ratio is observed on the standing wave ratio indicator above described. As disclosed above, when it is desired to evaluate the coefficient of reflection of the termination, the attenuators 20 and 26 are secured against relative movement and moved along the conductors 10 and 15 for a distance of approximately one wave length. When the attenuators are moved over such distance, the termination vector is varied in phase relative to the standing wave vector of any system mismatch which is present. That such mismatch be present is a necessary requirement in order to evaluate the termination of this invention, but this condition is easily obtained since it would be highly improbable that a random combination of line components would be perfectly matched to the characteristics of the system. Since the test probe is held stationary, the phase of the system vector remains constant with respect to the probe while the phase of the termination vector changes. The probe therefore picks up a resultant vector which varies between the sum and difference of the system and termination vectors. But since the termination vector is the rotating component the indication on the standing wave indicator is a direct measure of the standing wave of the termination, and hence by a simple computation (standing wave ratio minus 1 divided by standing wave ratio plus 1), the coefficient of reflection of the termination can be calculated.

In cases where it is merely desirable to tune a line to its characteristic impedance, the evaluation of the coefficient of reflection of the termination has no application. However, in the cases where it is desirable to have a termination which presents a purely resistive load and which, when connected to a system, will not disturb the standing wave (or impedance) conditions of the system, it is necessary to have a termination which has a coefficient of reflection equal to or closely approximating zero. A situation of this type would arise in testing where, after initial conditions are established, other components are inserted between the termination and the rest of the system. In this case, the termination is effectively moved some unknown electrical length further along the line, and therefore its phase relative to the initial conditions of the system has been changed. It can easily be seen, then, that if the termination had an appreciably high coefficient of reflection, the operation of the system would be completely disrupted and the termination would thereby subject any subsequent measurements to excessive error; however, with the termination of the instant invention, adjustment of the attenuators 20 and 26 with respect to each other would overcome any high coefficient of reflection.

As discussed above, the termination of the instant invention can be readily adapted to systems where these requirements are desired as well as situations where it is desirable to terminate the line in some definite value of standing wave, again irrespective of other conditions in the system.

It is to be understood that the above-described arrangements are merely illustrative of the application of the principles of the invention, and numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

A high frequency coaxial termination to terminate systems having a wide range of frequencies in either their

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characteristic impedance or some value of impedance that will introduce a variable amount of standing waves in said system, which comprises an outer conductor and an inner conductor having a common axis, a coupling member for connecting said conductors to the system to be terminated, a cylindrical member designed to hold said conductors in spaced relation and slidably mounted therebetween, a first attenuator slidably mounted on said inner conductor, means for connecting said first attenuator to said cylindrical member, a plurality of adjusting rods secured to said cylindrical member at one end and designed to protrude from said outer conductor, a supporting member having a plurality of apertures therein located externally of said outer conductor to which the other ends of said adjusting rods are connected, a second attenuator slidably mounted between said two conductors at a point along the axis thereof different from said first attenuator, a plurality of tuning rods connected at one

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end to said second attenuator, a tuning knob, said plurality of tuning rods being slidably mounted in said plurality of apertures in said supporting member and connected at their other ends to said tuning knob, and a plurality of screws threaded into said supporting member and adapted to secure said tuning rods against movement relative to said supporting member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,270,949	Hulster	Jan. 27, 1942
2,701,861	Andrews	Feb. 8, 1955
2,775,741	Corbell	Dec. 25, 1956

FOREIGN PATENTS

951,066	France	Apr. 4, 1949
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