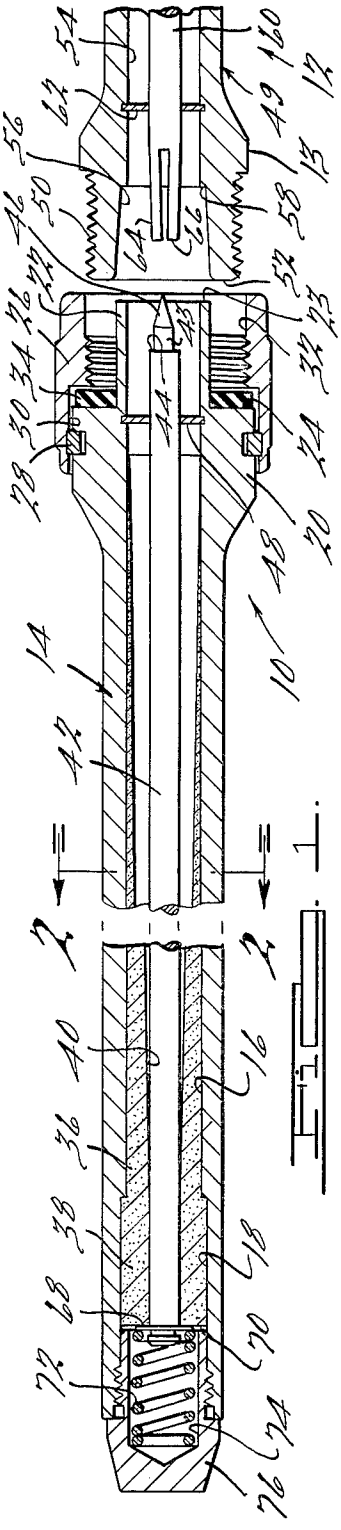
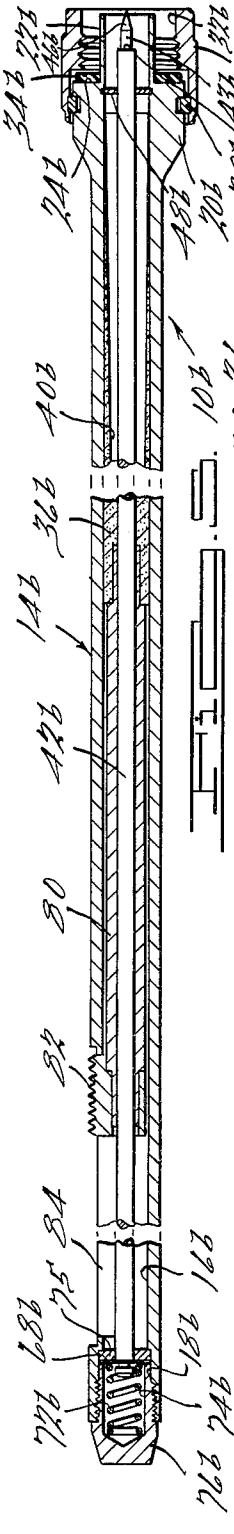
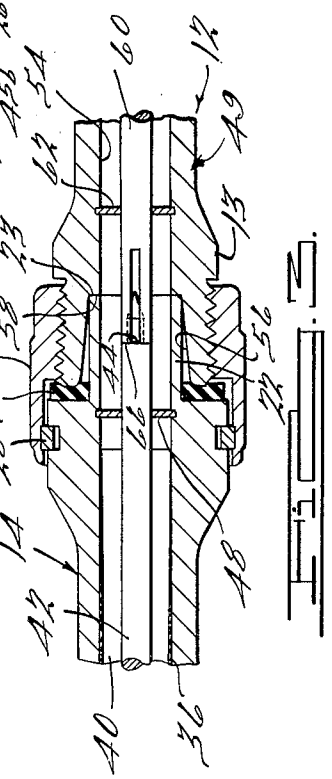
May 31, 1966 V. J. McHENRY 3,254,316

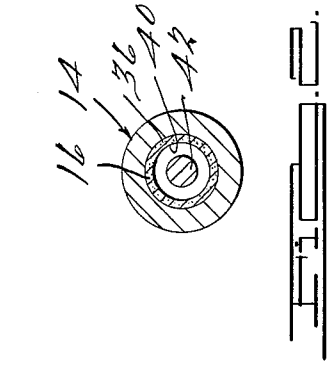
RESISTIVE TERMINATION WHEREIN COAXIAL INNER CONDUCTOR IS MOVABLE TO IMPROVE CONNECTION TO COAXIAL LINE

Filed Oct. 2, 1963 2 Sheets-Sheet 1









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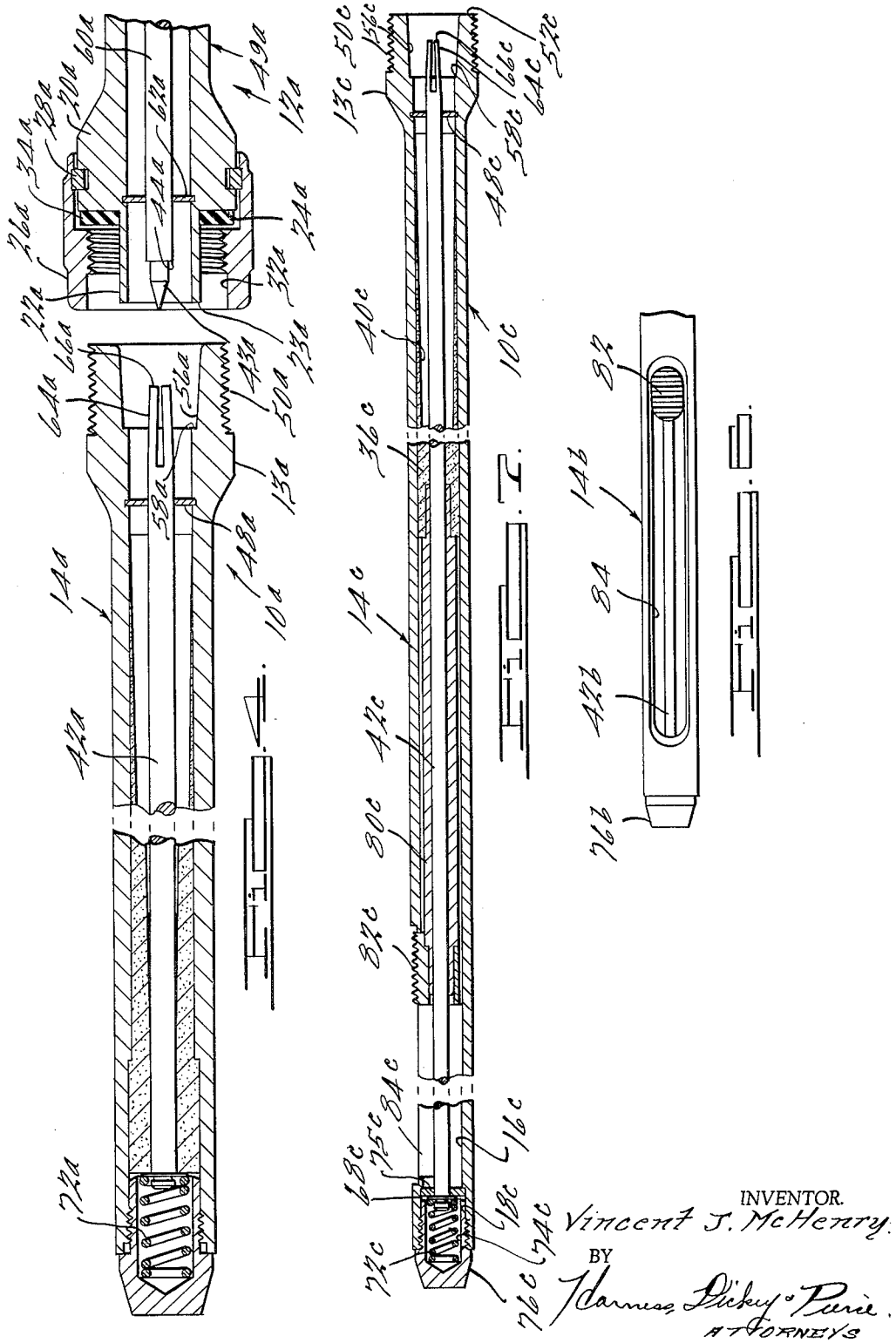

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RESISTIVE TERMINATION WHEREIN COAXIAL INNER CONDUCTOR IS MOVABLE TO IMPROVE CONNECTION TO COAXIAL LINE

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This invention relates to electrical connectors and more particularly to coaxial microwave terminations.

One problem in coaxial microwave terminations is in mating its connector with another connector without gaps or discontinuities existing between center conductors or outer shields. The present invention eliminates this problem. Therefore it is an object of this invention to provide a novel coaxial microwave termination construction having a connector for interconnection with a mating connector on a coaxial microwave line in which gaps or discontinuities are eliminated from the center conductors and outer shields of the termination and line when their respective connectors are interconnected.

It is a general object of this invention to provide a novel construction for an electrical connector.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a longitudinal, sectional view of a preferred embodiment of a fixed coaxial microwave termination having a male connector portion shown in disassembled relationship with a female connector for a coaxial line, only partially shown;

FIGURE 2 is a cross-sectional view of the termination of FIGURE 1 taken substantially along the line 2—2 in FIGURE 1;

FIGURE 3 is a fragmentary, longitudinal, sectional view of the termination and coaxial line connector of FIGURE 1 shown in assembled relationship;

FIGURE 4 is a longitudinal, sectional view similar to FIGURE 1 but in which the termination has a female connector portion and the coaxial line has a male connector;

FIGURE 5 is a longitudinal sectional view of a sliding termination having a male connector portion;

FIGURE 6 is a plan view of the end portion opposite the connector portion of the termination of FIGURE 5; and

FIGURE 7 is a longitudinal, sectional view similar to FIGURE 5 but in which the sliding termination has a female connector portion.

Looking now to FIGURE 1, a fixed, coaxial termination 10 having a male connector section is shown relative to a coaxial line 12 (only partially shown) to be terminated having a female connector portion 13. The termination 10 has an elongated tubular body or outer shield 14 having a through bore 16 terminating in a counterbore 18 at the rearward end of the body 14. The forward end of the body 14 terminates in an enlarged diameter head portion 20 which has a reduced diameter tubular portion 22 extending axially forwardly. A radial, flat shoulder 24 is defined at the juncture of the head portion 20 and tubular portion 22. For a purpose to be presently understood the tubular portion 22 has its forwardly terminating face 23 located forwardly from the shoulder 24 a selected distance. A coupling nut 26 is rotatably supported on the enlarged head portion 20 by means of a snap ring 28 located in concentric, annular grooves in a counterbore 30 in the nut 26 and in the head portion 20. A reduced diameter bore 32 at the forward end of the coupling nut 26 is partially threaded

and extends concentrically with and is radially spaced from the tubular portion 22. The counterbore 30 extends partially forwardly beyond the shoulder 24 and defines a cavity therewith. An annular sealing washer 34 is located in that cavity and fits snugly over the tubular portion 22 and is engageable with the shoulder 24. An elongated, tubular core member 36 for absorbing microwave energy is matably located within the bore 16 and has at its rearward end an enlarged diameter portion 38 matable within the forward end of the counterbore 18. The forward end of the core member 36 terminates within bore 16 short of the forward end of the body 14. The core member 36 has a central bore 40 tapering radially outwardly from its rearward to its forward end. The core member 36 can be made of pressed carbon, a ferro magnetic loss material or some other type of lossy material well known in the art. By tapering the bore 40 the microwave traveling through the termination 10 is gradually, progressively, increasingly exposed to the lossy material of the core 36 thereby providing good impedance matching characteristics and minimizing reflections.

A center conductor 42 of a male construction is located coaxially within the bore 40 of the core member 36 and is of a generally uniform diameter substantially equal to the minimum diameter of the tapered bore 40 at the enlarged diameter end portion 38. The forward end 43 of the conductor 42 is of a reduced diameter and defines thereby a radial, flat shoulder 44 and the tip 46 of the forward end 43 has a conical shape to facilitate engagement with a similar female conductor. The center conductor 42 which is supported at its rearward end within enlarged diameter end portion 38 is also supported near its forward end by an annular guide disc 48. The disc 48 is held in an annular slot in bore 16 and has a central opening of a diameter to snugly receive the center conductor 42 with the opening located coaxially in the bore 16.

In operation, the termination 10 is connected to a female connector portion 13 of an elongated tubular body or outer shield 49 of a coaxial line 12 to be terminated. The connector portion 13 has an externally threaded end portion 50 which is engageable with the threaded portion of the bore 32 of coupling nut 26. The end portion 50 can be extended completely into bore 32 until its terminating surface 52 engages and partly compresses the sealing washer 34 against the shoulder 24 and a weather-tight connection is made (see FIGURE 3). A bore 54 extends through the coaxial line 12 and terminates in a counterbore 56 in the end portion 50. The counterbore 56 tapers slightly outwardly and at its inner end defines with the bore 54 a radial, flat shoulder 58. The bore 54 of line 12 and bore 16 of termination 10 are of substantially the same diameter and the minimum diameter of the tapered bore 56 in end portion 50 is substantially equal to the outside diameter of the tubular portion 22 of the body 14. The distance from the face 23 on tubular portion 22 to the shoulder 24 is selected relative to the distance from the terminating surface 52 of end portion 50 to shoulder 58 such that upon connection of the coupling nut 26 to the connector portion 13, with the washer 34 slightly compressed by surface 52, the face 23 engages the shoulder 58. With such mating connection, no discontinuities are present in the electrical circuit through the outer shields 14 and 49, thereby eliminating unwanted reflections, etc.

A center conductor 60 of a female construction is located coaxially within bore 54 and is supported by a supporting disc 62. The end portion 64 of conductor 60 terminates in a flat end face 66 within counterbore 56 and has an axial bore therein. The end portion 64 is diametrically slotted in a pair of transverse planes and the

resultant finger portions are crimped to converge towards each other to partially close the bore. The conductor 60 is substantially of the same diameter as the center conductor 42 in termination 10 and its end bore is substantially equal to the diameter of the forward end 43 of conductor 42. Upon connection of the termination 10 and the connector portion 13, in the manner previously described, the forward end 43 of conductor 42 is inserted into the bore in the end portion 64 of conductor 60 until the shoulder 44 engages the flat end face 66. With such a mating connection, no discontinuities are present in the electrical circuit through the center conductors 42 and 60. The conical tip 46 facilitates insertion in the bore with the slotted construction at the end portion 64 causing the forward end 43 to be gripped, thereby insuring good electrical contact.

In the coaxial line 12, the center conductor 60 is fixed relative to the shield 49. In past termination constructions the center conductor and shield are likewise fixed. With such constructions it is literally impossible to get concomitant engagement between mating surfaces of outer shields, such as face 23 and shoulder 58 on shields 14 and 49, and mating surfaces of center conductors such as shoulder 44 and end face 66 on conductors 42 and 60, respectively. A gap, however, between either set of mating surfaces results in a discontinuity and its consequent undesirable effects on the transmitted microwave.

To correct the above problem, the surface 23 is located a distance from shoulder 24 whereby contact with shoulder 58 is insured. This can be readily done by taking into account the dimensional tolerance limits between the shoulder 58 and terminating surface 52 of the connector portion 13. Some variance is allowable here through the resilience of the sealing washer 34. The center conductor 42 has its shoulder 44 located at a point sufficiently forwardly such that the shoulder 44 contacts the end face 66 before the surface 23 engages the shoulder 58. The center conductor 42, however, is movably mounted within the bore 40 and hence, after the shoulder 44 and end face 66 have engaged, the conductor 42 is moved rearwardly as the tubular portion 22 advances into the bore 46 of the connector portion 13. Upon completion of the assembly the face 23 engages the shoulder 58 and the shoulder 44 engages the end face 66 thus assuring that no discontinuities exist either in the circuit of the outer shields 14 and 49 or in the circuit of the center conductors 42 and 60.

To permit movement of the center conductor 42 and the resultant advantages obtained therefrom the center conductor 42 is slidably supported by the guide 48 and the rearward end of the core member 36. An enlarged diameter snap ring 68 is fixed to the rearward end of conductor 42 and is engageable with end surface 70 of the core member 36. A coil spring 72 is located in a bore 74 in an end cap 76 which is threaded into the rearward portion of the counterbore 18 of the body 14. One end of the spring 72 engages the rearward termination of the bore 74 in the cap 76 while its other end engages the snap ring 68. As assembled the spring 72 is under a preload and urges the snap ring 68 against the surface 70 of the core member 36 biasing the center conductor 42 to its forwardmost position. At this position the shoulder 44 is assured of engaging the end face 66 prior to engagement of face 23 with shoulder 58. As the assembly is completed the center conductor 42 is moved rearwardly against the bias of the spring 72 until the various mating surfaces described above are in engagement, thus providing circuits with no discontinuities. The preload of the spring 72 is selected to be of a magnitude such that complete mating engagement of forward end 43 of center conductor 42 within the bore in the end portion 64 of the center conductor 60, and hence engagement of shoulder 44 and face 66, occurs prior to rearward movement of the center conductor 42.

The invention as shown and described in FIGURES 1–3 is equally applicable to a construction in which the termination has a female connector portion and the coaxial line to be terminated has a male connector section. Such a construction is shown in FIGURE 4 where components serving similar functions as like components in FIGURES 1–3 have been given the same number with the suffix "*a*." Thus the termination 10*a* has an outer shield 14*a* which terminates in a female connector portion 13*a* and has a movable center conductor 42*a* which terminates in an end portion 64*a*; the female connector portion 13*a* and end portion 64*a* are identical to their similarly numbered counterparts in FIGURES 1–3.

The termination 10*a* is used to terminate a coaxial line 12*a* having a male connector section. The line 12*a* has an outer shield 49*a* terminating in an enlarged diameter head portion 20*a* having a reduced diameter tubular portion 22*a* extending axially forwardly therefrom. A coupling nut 26*a* is rotatably supported on head portion 20*a* and a sealing washer 34*a* is located over the tubular portion 22*a*. A fixed center conductor 60*a* terminates in a conically tipped forward end 43*a*. The male connector section of coaxial line 12*a* is substantially identical to the male connector section of termination 10 of FIGURES 1–3 and hence head portion 20*a*, tubular portion 22*a*, coupling nut 26*a*, sealing washer 34*a* and forward end 43*a* are identical to their similarly numbered counterparts in FIGURES 1–3. The movable center conductor 42*a* is forwardly biased by a spring 72*a* and the female connector portion 13*a*, end portion 64*a*, head portion 20*a*, tubular portion 22*a*, coupling nut 26*a*, sealing washer 34*a* and forward end 43*a* cooperate together in a similar manner as their similarly numbered counterparts in FIGURES 1–3. The end face 66*a* of movable center conductor 42*a* is located forwardly relative to shoulder 58*a* such that engagement of end face 66*a* with shoulder 44*a* of fixed conductor 60*a* occurs prior to engagement of shoulder 58*a* of connector portion 13*a* with terminating face 23*a* of shield 49*a*. Thus upon connection of the termination 10*a* to the line 12*a* the various mating surfaces between the shields 14*a* and 49*a* and center conductors 42*a* and 60*a* are in engagement thereby providing circuits with no discontinuities in the same manner as described in the discussion of the embodiment of FIGURES 1–3.

In FIGURES 1–3 the invention is shown for a fixed termination. The principles of the invention, however, are equally applicable to a sliding termination. Such a construction is shown in FIGURES 5 and 6, where components serving similar functions as like components in FIGURES 1–3 have been given the same number with the suffix "*b*." The essential difference between the sliding termination 10*b* of FIGURE 5 and the fixed termination 10 of FIGURES 1–3 is that a movable core member 36*b* is used rather than the fixed core member 36. Thus core member 36*b* is slidably located within central bore 16*b* of outer shield 14*b* and has a bushing 80 fixed to its rearward end. The bushing 80 extends concentrically about center conductor 42*b* and has fixed at its rearward end a serrated gripping member 82 which extends eccentrically outwardly through a longitudinal slot 84 near the rearward end of outer shield 14*b* (see FIGURE 6). Thus the core member 36b can be moved longitudinally within bore 16*a* via bushing 80 and gripping member 82 whereby optimum absorption can be obtained for various microwave frequencies.

The termination 10*b* can be calibrated and markings can be provided along the slot 84 indicating the positions at which optimum absorption for various frequencies can be obtained. The center conductor 42*b* is slidably supported at its rearward end by a washer 75 which is located at the forward end of the counter bore 18*b*. The center conductor 42*b* is axially restrained at its forwardmost position by the washer 75. Except for the above differences, the sliding termination 10*b* is identical to fixed termination 10 and has an identical male connector section which is similarly matable with the female con-

nector portion **13** of the coaxial line **12** to provide circuits having no discontinuities.

In FIGURE 7 is shown a sliding termination **10***c* which is similar to the fixed termination **10***a* with the primary difference being in that a slidable core member **36***c* is used rather than a fixed core member such as member **36***a*. As to the construction permitting the core member **36***c* to be slidable, the construction of sliding termination **10***c* in this regard is identical to that of sliding termination **10***b* with similarly numbered components serving similar functions. Identically with the fixed termination **10***b*, the sliding termination **10***c* has a female connector construction which is matable with a male connector section, such as that shown for line **12***a* in FIGURE 4, with no discontinuities between the connected electrical circuits.

For the purpose of simplicity in the discussion of the various embodiments of FIGURES 4–7 only those components and portions necessary to understand those embodiments were discussed; the remaining components and portions, however, have been numbered in these figures with the appropriate subscripts with the description and function of those components or portions being the same as the corresponding components or portions bearing the original number.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A coaxial line termination for connection to a coaxial line having an outer shield and a central conductor comprising: a tubular shield member, a center conductor member adapted to engage the central conductor and located coaxially within said shield member, means for absorbing microwave energy located between said center conductor member and said shield member, and means holding said center conductor and shield members together and allowing axial movement of said center conductor and shield members relative to each other whereby said center conductor can engage the central conductor substantially without discontinuities therebetween.

2. For connection to a mating connector for a coaxial line with the mating connector having an outer shield and a central conductor, a coaxial line termination comprising: a tubular shield member having connector portion means at one end for connecting said shield member to the outer shield of the mating connector, a center conductor member located coaxially within said shield member, means for absorbing microwave energy located between said center conductor member and said shield member, and means for supporting said center conductor member for movement relative to said shield member and for urging said center conductor member axially toward said one end for engagement with the central conductor of the mating connector.

3. For connection to a mating connector for an electrical circuit with the mating connector having one member having a mating surface and another member having a mating surface, an electrical connector comprising: a first member electrically connectible with the one member of the mating connector and having a first surface matable with the mating surface of the one member, a second member electrically connectible with the other member of the mating connector and having a second surface matable with the mating surface of the other member, means for supporting said first and second members with said second surface movable relative to said first surface with said movement being limited between a first and a second position and means for resiliently urging said second surface toward said first position and into engagement with the mating surface of the other member.

4. A coaxial line termination for connection to a coaxial line having an outer shield and a central conductor comprising: a tubular shield member having a planar mating surface at one end, a center conductor member adapted to engage the central conductor and located coaxially within said shield member and having a planar mating surface at said one end, means holding said members together with one of said mating surfaces being axially movable relative to the other and with said one of said mating surfaces being resiliently urged toward said one end whereby said center conductor can engage the central conductor substantially without discontinuities therebetween.

5. A coaxial line termination for connection to a coaxial line having an outer shield and a central conductor comprising: an elongated, axially extending tubular shield member having an annular, transverse, planar mating surface at one end, a center conductor member adapted to engage the central conductor and located coaxially within said shield member and having a radial, transverse, planar mating surface at said one end, means holding said members together with one of said members being axially movable relative to the other and with said one of said members being resiliently urged toward said one end whereby said center conductor can engage the central conductor substantially without discontinuities therebetween.

6. A coaxial line termination for connection to a coaxial line having an outer shield and a central conductor comprising: an elongated axially extending tubular shield member having a radial, transverse, planar mating surface at one end, a center conductor member adapted to engage the central conductor and located coaxially within said shield member and having a radial, transverse, planar mating surface at said one end, means supporting said center conductor within said shield member for axial movement relative to said shield member and resiliently urging said center conductor toward said one end whereby said center conductor can engage the central conductor substantially without discontinuities therebetween.

7. For connection to a mating connector for a coaxial line with the mating connector including an outer shield having a plane surface and a central conductor having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member having a radial, transverse, planar mating surface at one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and resiliently urging said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield.

8. For connection to a mating connector for a coaxial line with the mating connector including an outer shield having a plane surface and a central conductor having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member having a radial, transverse, planar mating surface at one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the

plane surface of the center conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member.

9. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a female construction and having a plane surface and a central conductor terminating in a female construction and having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member terminating at one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member.

10. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a male construction and having a plane surface and a central conductor terminating in a male construction and having a plane surface, a coaxial line termination comprising: an elongated axially extending, tubular shield member terminating at one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member.

11. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a female construction and having a plane surface and a central conductor terminating in a female construction and having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member terminating at one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member and supported for selective axial movement whereby the absorption of selected frequency components can be maximized.

12. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a male construction and having a plane surface and a central conductor terminating in a male construction and having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member terminating at one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member and supported for selective axial movement whereby the absorption of selected frequency components can be maximized.

13. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a female construction and having a plane surface and a central conductor terminating in a female construction and having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member terminating at one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a male construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface

of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member, and a locking nut rotatably supported on said shield member at said one end and engageable with an externally threaded portion on the outer shield of the mating connector for securing said coaxial line termination to the mating connector of the coaxial line.

14. For connection to a mating connector for a coaxial line with the mating connector including an outer shield terminating in a male construction and having a plane surface and a central conductor terminating in a male construction and having a plane surface, a coaxial line termination comprising: an elongated, axially extending, tubular shield member terminating at one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the outer shield, a center conductor member located coaxially within said shield member and terminating at said one end in a female construction and having a radial, transverse, planar mating surface at said one end engageable with the plane surface of the central conductor, means supporting said center conductor member within said shield member for axial movement relative to said shield member and for limiting axial movement of said center conductor member toward said one end

to a position at which said mating surface of said center conductor member engages the plane surface of the central conductor before engagement of said mating surface of said shield member with the plane surface of the outer shield, a spring member located in said shield member under a compressive preload and operatively connected to said center conductor member for resiliently urging said center conductor member toward said one end, and means for absorbing microwave energy located between said center conductor member and said shield member, said shield member having an externally threaded portion at said one end engageable with a locking nut rotatably supported on the outer shield of the mating connector whereby said coaxial line termination can be secured to the mating connector of the coaxial line.

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