Sept. 20, 1966 N. R. NELSON 3,274,447

COAXIAL CABLE LIGHTNING ARRESTER

Filed March 14, 1963

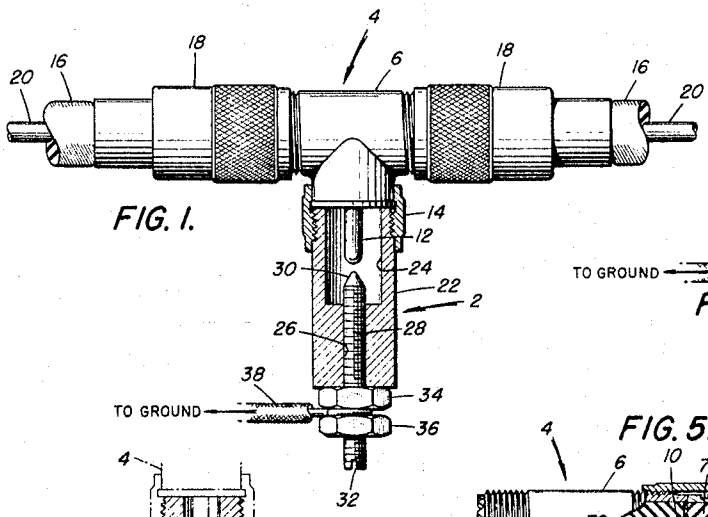


FIG. 1.

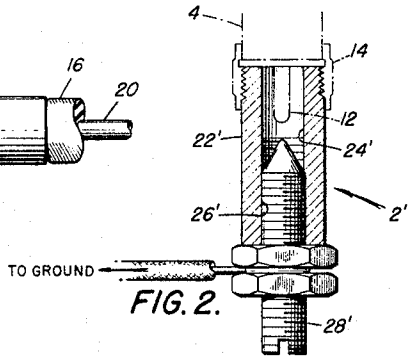


FIG. 2.

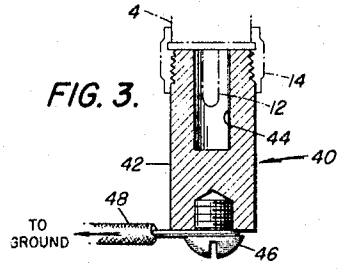


FIG. 3.

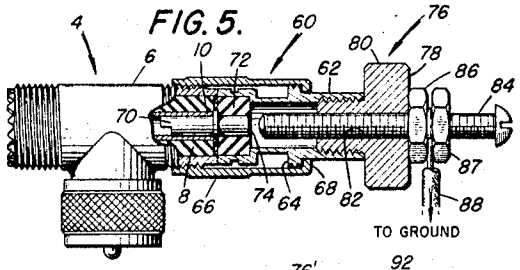


FIG. 5.

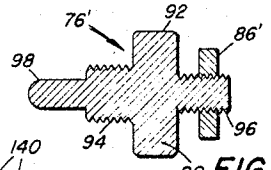


FIG. 6.

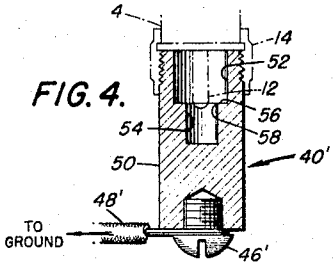


FIG. 4.

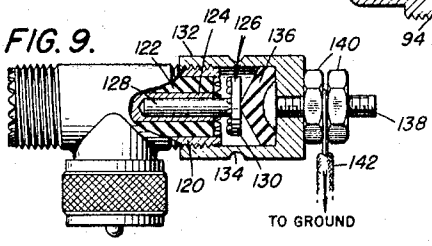


FIG. 9.

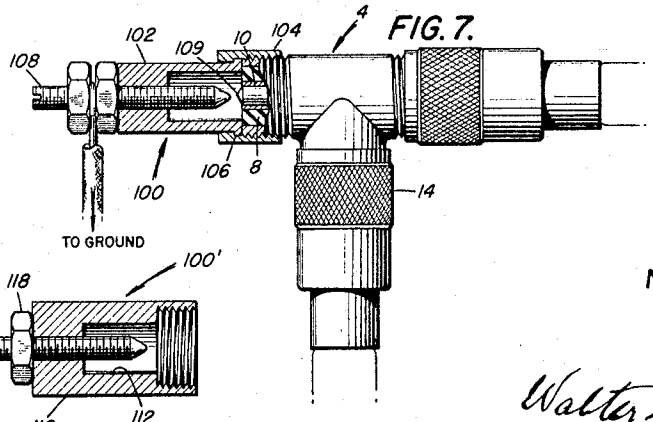


FIG. 7.

FIG. 8.

NOEL R. NELSON
INVENTOR

Walter J. Paul

BY

ATTORNEY

United States Patent Office

3,274,447

Patented Sept. 20, 1966

3,274,447

COAXIAL CABLE LIGHTNING ARRESTER

Noel R. Nelson, 12813 Camellia Drive, Takoma Park, Md.

Filed Mar. 14, 1963, Ser. No. 265,191
12 Claims. (Cl. 317—61)

This invention relates generally to lightning arrestors for use with coaxial cables, and more particularly to an improved, economical to construct lightning arrester for protecting equipment connected to a coaxial cable against damage from surges of static electricity and from lightning striking the cable or striking an antenna or other equipment connected thereto.

The need has long been recognized for the use of lightning arresters in electrical energy transmission lines of the coaxial type, and many such arresters have been devised. An arrester for use with coaxial cable should introduce a minimum of losses into the transmission line, especially when high frequency equipment is being utilized, and should not adversely affect the standing wave ratio. Further, it is desirable that the arrester device be constructed for easy assembly into a coaxial line, and that it be highly economical to construct.

Previous lightning arresters for coaxial cables have usually failed to satisfy one or more of the above-recited desirable characteristics. The arrester of the subject invention, however, satisfactorily meets all of these desirabilities, and in addition provides an arrester which may be easily adjusted and which is impervious to weather. Further, the subject arrester is constructed for ready installation into an assembled coaxial line, and thus requires a minimum of time and inconvenience to install, adjust and remove.

It is an object of this invention to provide a lightning arrester for use with coaxial cable, so constructed as to provide effective protection for said cable and equipment connected thereto while simultaneously introducing substantially no added losses, and while not adversely affecting the standing wave ratio of the cable, particularly in applications where the frequency is 150 megacycles or below.

A further object of the present invention is to provide a coaxial cable lightning arrester constructed for use with conventional coaxial cable components, and which may thus be readily installed and removed in an assembled coaxial line.

It is also an object of the subject invention to provide a coaxial cable lightning arrester having an adjustable air gap, and so constructed as to drain off to ground surges of static electricity in a coaxial line in which it is connected, and to provide a direct path to ground in the event of a lightning strike.

Another object of this invention is to provide an air gap type coaxial cable lightning arrester constructed to be substantially impervious to weather and to permit ready inspection of the spark gap.

It is also an important object of the present invention to provide a lightning arrester for use with coaxial cable which may be economically constructed and installed, and which may be easily replaced at nominal cost in the event of serious damage thereto.

Other objects and many of the attendant advantages of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is an elevational view, partially in section, of a first embodiment of the lightning arrester of the present

invention, showing the embodiment installed on the center leg of a conventional coaxial cable branched T connector,

FIG. 2 is a sectional view of a modification of the embodiment of FIG. 1, the T connector being indicated by phantom lines,

FIG. 3 is an axial section of a second embodiment of the present invention, the center leg of a conventional T connector being indicated by phantom lines,

FIG. 4 is an axial section showing a modification of the embodiment of FIG. 3,

FIG. 5 is a broken-away elevational view, partly in section, showing a third embodiment of the subject arrester installed in a conventional coaxial cable screw thimble connector and attached to a conventional coaxial cable T connector,

FIG. 6 is a view in axial section of a modification of the lightning arrester of FIG. 5,

FIG. 7 is an axial section of another embodiment of the present invention, shown connected to one end of a conventional coaxial cable T connector,

FIG. 8 is an axial section of a modification of the lightning arrester embodiment shown in FIG. 7, and

FIG. 9 is an axial section of another embodiment of the invention.

The lightning arrester of the present invention is intended for in-the-line use with conventional coaxial cable connectors and the like, and comprises a body member which, together with the center conductor of the coaxial cable connector, defines an air gap, the arrester body being connected to ground. In one principal embodiment of the invention the arrester body is provided with a threaded contact, which contact defines the air gap and is adjustable over a wide range; in a second principal embodiment of the invention the body has a cylindrical recess therein, within which a portion of the center conductor of the coaxial cable is received to thereby define the air gap. In certain embodiments utilizing the threaded contact the body may be made of a clear insulating material to permit ready inspection of the air gap without disassembly.

Referring now to the drawings, a first embodiment of the subject lightning arrester is indicated at **2** in FIG. 1, and is connected to the center leg of a branched coaxial T connector **4**, the branched connector **4** in FIG. 1 being identical in construction to the like-numbered connectors illustrated in the other figures. The T connectors **4** are of conventional construction, and hence will not be described in detail herein; briefly, they each comprise an outer, cylindrical in cross-section, T-shaped body **6** having a T-shaped inner conductor supported concentrically therewithin by dielectric material **8**, as may be seen in FIGURE 5. The ends **10** of the inner conductor exposed at the opposite ends of the connector **4** are hollow for the reception of male connection portions of the center conductors of coaxial cables connected thereto, and the center leg of the inner conductor terminates in a projecting male portion **12** having a rounded tip. A screw thimble **14** is secured by a flange to the center leg of the body **6** and surrounds the male portion **12** of the inner conductor, said male portion projecting slightly beyond the plane containing the end face of said screw thimble **14**; the opposite ends of the body **6** are externally threaded for connection into a coaxial cable line.

The T connector **4** in FIG. 1 has a pair of coaxial cables **16** connected to the opposite ends thereof by screw thimbles **18**, each cable **16** including an inner conductor **20** and a flexible outer conductor shell with insulation material between them. The outer shell has a rigid

terminal collar 17 providing a shoulder for cooperation with the securing flange of the thimble 18 in securing cable 16 to one of the branches of the T connector. It is understood that one of the cables 16 may be connected with an antenna or the like, and the other to receiving, transmitting, or other electronic RF equipment. It is again emphasized that the T connector utilized with the arrester of the invention is of conventional construction, and that it is merely inserted into the coaxial line at any convenient position.

The lightning arrester 2 comprises a body 22 having a cylindrical chamber 24 of uniform diameter therein, the diameter of said chamber preferably corresponding to the inner diameter of the center leg of the connector body 6 to which it is to be attached, whereby the radial distance between the inner conductor male portion 12 and the wall of said chamber 24 will be substantially identical to the radial distance between said portion and the surrounding inner wall of body 6; by properly relating the diameter of the chamber 24 to that of said center leg it is possible to obtain substantially constant impedance. The chamber 24 has a length sufficient so that the bottom thereof is spaced a substantial distance from the tip of conductor portion 12, and a threaded bore 26 is provided in the body 22 in position to confront and be aligned with said portion 12.

A threaded cylindrical conductor post 28 having a diameter corresponding approximately to the diameter of the conductor portion 12 is received within the bore 26, and has a tapered nose 30 thereon terminating in a rounded tip. The outer end of the conductor post 28 is provided with a slot 32 to facilitate manipulation thereof, and a lock nut 34 and a binding nut 36 are threaded thereon. The lock nut 34 is threaded against the body 22 to secure the conductor post in position, and the end of a ground lead 38 is secured to said conductor post by the binding nut 36.

It is readily apparent from FIG. 1 how the embodiment of the lightning arrester shown therein functions. The air gap between the opposed tips of the conductor portion 12 and the conductor post 28 is first set to the desired spacing, after which ground lead 38 is secured in position to said post 28 and grounded. When the voltage between the two opposed tips reaches a predetermined value, determined by the distance therebetween, the spark gap will be breached and the charge conducted to ground. Thus, heavy surges of static electricity are readily drained off from the coaxial cable line, and in the event of a lightning strike a lead to ground is provided; in the latter instance the voltage may well be sufficient to weld the opposing tips together, which will then provide a direct low resistance path to ground. If the conductor post should become damaged, it is readily seen that the conductor post or even the entire lightning arrester unit may be easily replaced at a very nominal cost.

In certain instances it may be desirable to provide for visual inspection of the spark gap of the lightning arrester, both to insure that it is in functioning order and to determine whether the gap is properly set. This may be readily accomplished in the arrester of FIG. 1 by constructing the body 22 of a clear, transparent plastic material; while such a normally dielectric material may somewhat affect the performance of the cable over that obtainable when the body 22 is constructed from the same material as the body 6, this may be allowable in some instances.

A modification of the arrester embodiment of FIG. 1 is shown at 2' in FIG. 2, and comprises a body 22' having a chamber 24' therein, said chamber 24' being identical in diameter to the chamber 24. The body 22' has a threaded bore 26' therein of a diameter corresponding to that of chamber 24', and a conductor post 28' is threaded therein. For certain applications the construction of FIG. 2 has an advantage of that of FIG. 1 in that the conductor post 28' therein may be substantially larger in diameter than the post 28; this provides relatively heavy conductive material leading to ground, and thus increases the amount of current or surge that may be handled with safety.

The embodiments of the invention shown in FIGS. 1 and 2 provide an adjustable air gap, which may not be necessary nor desirable for some applications. Referring now to FIG. 3, another principal embodiment of a lightning arrester constructed according to the invention is shown at 40, said arrester being externally threaded for connection to the center leg of a conventional T coupler 4 in the same manner as the arresters 2 and 2'.

The arrester 40 comprises a body 42 of conductive material and having a cylindrical blind bore 44 therein of constant diameter throughout. The bore 44 is substantially larger than the projecting inner conductor portion 12, and has a diameter relative to the diameter of said conductor such that the radial spacing between the opposed cylindrical surface of said conductor portion and the wall defining said bore corresponds to the desired value for the air gap. The outer end of the body 42 is drilled and tapped for reception of a terminal screw 46, which screw functions to attach the terminal end of a ground lead 48 to the arrester.

The lightning arrester of FIG. 3 functions in an analogous manner to those of FIGS. 1 and 2, voltage above a predetermined level causing electricity to jump from the conductor portion 12 to the annular conductor surface on the body 42, from which body it is carried to ground.

The annular cavity air gap provided by the conductor surface in the arrester 40 is ideal for some application, but may provide a path too high in resistance for effectively bleeding off static electricity. Accordingly, a modification of the arrester 40 is indicated at 40' in FIG. 4, said arrester including a conductive body 50 having a pair of aligned, concentrically disposed bores 52 and 54 therein. The bores 52 and 54 are separated by a radially-directed, annular face 56, which face defines a relatively sharp peripheral conductor edge 58. The conductor edge 58 is positioned to surround the rounded tip of the inner conductor portion 12, and thus defines a relatively low impedance annular air gap therewith which is highly effective in draining off static discharges from the coaxial line. A ground lead 48' is connected to the body 50 by a lead screw 46', and provides a path to ground.

The lightning arresters of FIGS. 1–4 are all adapted for connection to the leg of a conventional coaxial connector having a male center conductor projecting therefrom. In some applications it is desirable to connect an arrester to the leg of a connector containing a non-projecting center conductor, an embodiment of the subject invention suitable for such use being illustrated in FIG. 5.

Referring to FIG. 5, a conventional screw thimble coaxial cable connector 60 is shown secured to a conventional T connector 4, and comprises a sleeve 62 internally threaded at its outer end to threadably receive an end of a coaxial cable, and having a thread-bearing flange 64 thereon. A thimble 66 having internal threads at its forward end of a diameter and pitch to mesh with the threads on flange 64 and body threads, is threaded onto the connector 4, and the flange 68 thereof abuts against the rear face of said flange 64. A male connector pin 70 is supported concentrically within sleeve 62 by a dielectric element 72, and has its projecting forward portion received within the bore 10. The rear or outer end 74 of the connector pin 70 is thus exposed within the sleeve 62. The structure just described, as was referred to above, is conventional for coaxial cable connectors.

Threadably received within the outer end of the sleeve 62 is a lightning arrester 76, said arrester comprising a body 78 having an externally knurled flange 80 thereon. The body may be constructed of brass, and has a con-

centrically-disposed threaded bore **82** therethrough positioned to confront connector pin end **74**. A threaded conductor post **84**, having a rounded tip thereon, is threaded into bore **82** and has a pair of binding nuts **86** and **87** received thereon for clamping the terminal end of a ground lead **88**.

A modification of the arrester **76** is illustrated at **76'** in FIG. 6, for use in instances where an adjustable spark gap is not desired. The arrester **76'** is of unitary construction, and comprises a body **90** having a flange **92** thereon and threaded externally at **94** and **96** for reception of sleeve **62** and a binding nut **86'**, respectively. A rounded conductor post **98** projects forwardly from the body **90**, and functions to define one terminal of a spark gap when installed in the sleeve **62**.

The lighting arresters **76** and **76'** are both very economical to construct, and when utilized with conventional, coaxial cable screw thimble connectors **60** provide effective in-line protection for transmitters and like apparatus connected to the center leg of T connector **4**. A slightly more expensive lightning arrester embodiment for similar use is illustrated at **100** in FIG. 7. The arrester **100** is actually nearly identical in construction to the arrester **2** shown in FIG. 1, save that the body **102** thereof is connected to the threaded end of a fitting **4** by a screw thimble **104** retained thereon by a flange **106**. The threaded conductor post **108** thereof defines an air gap with a pin **109** press belted into the inner conductor of said connector **4**, and the arrester **100** functions in the same manner as the previously described embodiments. A modification of the lightning arrester **100** is shown at **100'** in FIG. 8; the arrester **100'** eliminates the screw thimble **104**, and comprises a body **110** having a cylindrical chamber **112** therein threaded at its forward end for reception of the threaded end of a T connector **4**. A conductor post **114** is mounted concentrically thereof within a threaded bore therein, and has a pair of nuts **116** and **118** thereon.

Another embodiment of the invention is illustrated in FIG. 9 attached to one leg of a T-fitting, which leg incorporates an outer conductor **120** and a concentric inner conductor **124** separated by insulation **122**. The inner conductor **124** is conventional, and has a bore therein within which is received the leg **128** of a pin **126**, said pin having a circular head **130** thereon. The leg **128** seats against the bottom of the bore in the inner conductor, whereby to determine precisely the spacing between said conductor and the head of the pin.

The head **130** has a diameter a little less than the inside diameter of the conductor **120**, and has a plurality of radially-extending ribs on the rear face thereof, which ribs confront the serrated end of the conductor **120**. A thimble **132**, having an annular groove **134** therein, is threaded on the conductor **120**, and contains a frustoconical body of insulation **136** that engages the pin **126** to urge it to seat fully within the inner conductor bore.

The end wall of the thimble **132** has a bore therethrough, and a bolt **138** extends therethrough to define a conductor post. A lead **142** to ground is secured on the post **138** by a pair of nuts **140**.

In operation, electricity will jump from the opposed serrations on the pin **126** and the outer conductor to the thimble **132**, and will then flow to ground. If lightning should strike this line, the resulting sudden gas expansion in the thimble **132** will cause it to break along the frangible bottom of groove **134** preventing any damage to the coaxial cable connector.

It is now seen that an economical, easily installed and replaced lightning arrester has been provided by the present invention, which arrester is utilized with conventional coaxial cable fittings to provide in-the-line protection against surges of static electricity and lightning strikes. The arrester of the present invention, in its various embodiments, cooperates with the center conductor of a coaxial fitting to provide a gap, and is so constructed as to normally cause minimal interference with the desirable electrical characteristics of the coaxial cable line.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A lightning arrester fitting adapted for connection to one leg of a branched coaxial cable connector said leg having a center conductor extending therefrom, said arrester fitting comprising a body, means for securing said body to said connector leg, conductor means within said body forming an air gap with said center conductor, and means on the outside of said body for connecting said conductor means with ground.

2. A lightning arrester fitting as recited in claim **1**, wherein said body includes a cylindrical chamber mounted in spaced relation over said center conductor, and wherein said conductor means includes a conductor post within said chamber positioned in alignment with and spaced from the tip of said center conductor to form said gap.

3. A lightning arrester fitting as recited in claim **2**, wherein said conductor post is adjustable relative to said body toward and away from said tip.

4. A lightning arrester fitting as recited in claim **1**, wherein said body is of conductive material and has a cylindrical bore therein disposed concentrically about and in alignment with the longitudinal axis of said center conductor, the end portion of said center conductor being received within said bore, whereby the cylindrical wall defining said bore forms an annular gap with said conductor means.

5. A lightning arrester fitting as recited in claim **4**, including additionally a headed pin received within said center conductor, the head of said pin facing said conductor having radial serrations thereon.

6. A lightning arrester fitting as recited in claim **1**, wherein said body is of conductive material having therein a first, relatively large bore in the end face thereof terminating in an annular shoulder and a second, relatively smaller bore extending from said shoulder in axial alignment with said first bore, and wherein said conductor means is formed by the inner edge of said annular shoulder, the tip of said center conductor extending into said bores to a point adjacent said conductor shoulder.

7. A lightning arrester fitting adapted for connection to one leg of a branched coaxial cable connector, said connector leg having a center conductor therein disposed concentrically within an outer conductor and terminating in a tip, said arrested fitting comprising a body having a cylindrical bore therein mounted over said center conductor and positioned concentrically about the longitudinal axis thereof, means for detachably securing said body to said leg, the outer end of said body having a threaded bore therethrough axially aligned with said longitudinal axis, a threaded conductor post received within said threaded bore and having a tip portion which together with the outer end of said inner conductor defines an air gap, and means for connecting a ground lead to said conductor post.

8. A lightning arrester fitting as recited in claim **7**, wherein said cylindrical bore has a uniform diameter substantially identical to the inner diameter of said outer conductor of said leg, whereby to maintain substantially constant impedance.

9. A lightning arrester fitting as recited in claim **7**, wherein said body is made from a transparent material, whereby said air gap may be visually inspected.

10. In a coaxial cable line, a branched coaxial cable connector, said connector including a center conductor

concentrically disposed within an outer conductor, a connector sleeve secured to one leg of said branched connector, said sleeve having an internal thread in its outer end, said one leg including a connector pin supported concentrically therein, and extending from said center conductor and having its outer end exposed within said sleeve, a lightning arrester fitting including an externally threaded body, said body being threaded into said threaded end of said sleeve, a conductor post carried by said body and positioned concentrically thereof, said conductor post defining with the exposed end of said pin an air gap, and means for attaching a ground lead to said conductor post.

11. The combination as recited in claim **10**, wherein said conductor post is integral with said body.

12. The combination as recited in claim **10**, wherein said arrester fitting body has a threaded bore therethrough, and wherein said conductor post comprises a threaded bolt element received within said threaded bore.

References Cited by the Examiner

UNITED STATES PATENTS

1,194,195	8/1916	Jackson	317—61.5 X
2,735,040	2/1956	Opsahl	317—15 X
3,111,606	11/1963	Schultz et al.	317—70

FOREIGN PATENTS

210,014	1/1924	Great Britain.

OTHER REFERENCES

German published application 1,153,114, 8/1963.

MILTON O. HIRSHFIELD, *Primary Examiner.*

LEE T. HIX, *Examiner.*

J. A. SILVERMAN, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,274,447 September 20, 1966

Noel R. Nelson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 3, for "Takoma Park" read -- Wheaton --.

Signed and sealed this 22nd day of August 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents