

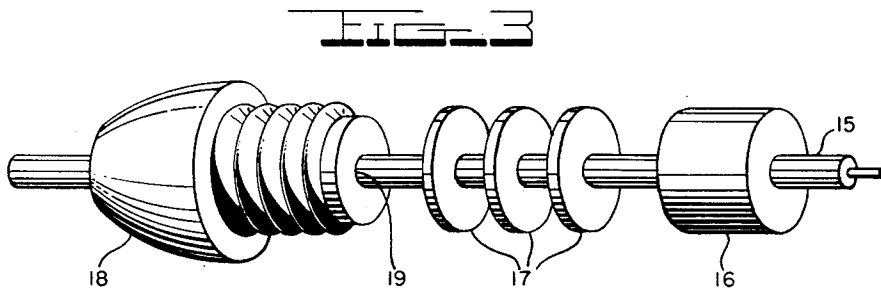
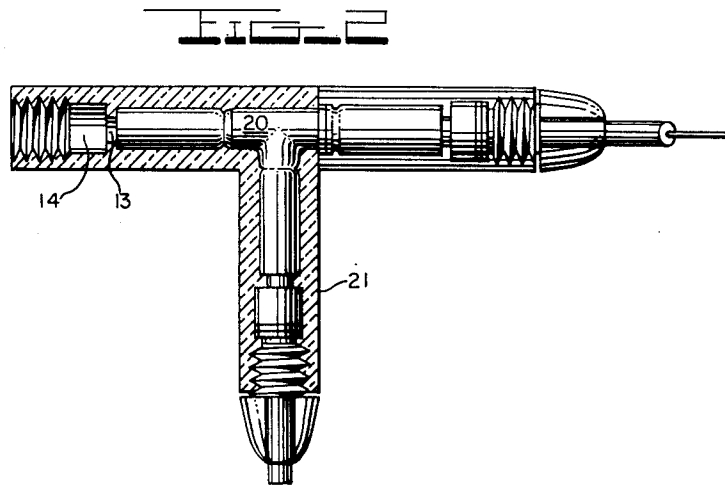
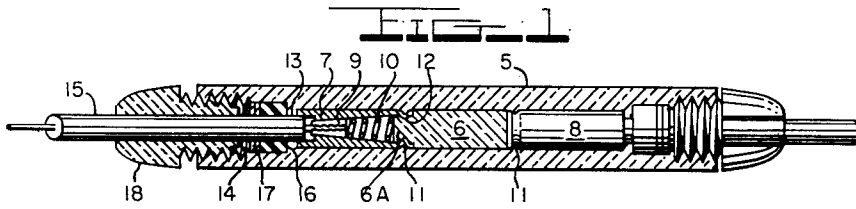
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STRAIN INSULATOR

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STRAIN INSULATOR

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This invention relates generally to strain insulator assemblies and more particularly to strain insulators for insulated wire aircraft antennas.

In general, a strain insulator will fulfill its purpose if it provides an insulated mechanical link between two wires with sufficient insulation to prevent breakdown at the potential difference of the wires and sufficient mechanical strength to withstand the stresses introduced by the weight of the wires and any additional mechanical stresses to which the antenna may be subject. However, strain insulators designed in accordance with these prior art considerations are frequent sources of corona discharge under certain atmospheric conditions. Corona discharge from the metal parts of an airplane and particularly from the antenna itself cause intense radio interference known as precipitation static.

Conventional wire antenna fittings, including strain insulators, expose wire ends and small metal parts which are more susceptible to corona discharge than the wire itself. Insulated wire antennas with large cumbersome insulated fittings capable of withstanding the order of 100,000 volts have been tried but the fittings still remained the weakest part electrically and mechanically of the antenna assembly.

In particular these fittings were inadequate because of the lack of a high voltage seal where the insulated wire terminated in a fitting. It was found that the slightest pinhole or minute break in the antenna covering would make the entire covering useless.

To insure against precipitation static, the entire antenna should be capable of withstanding direct voltages of the order of 240,000 volts. An antenna mast suitable for this purpose is disclosed in the copending application of W. U. Matson and W. K. Barrett, filed December 14, 1949, Serial No. 132,964, Patent No. 2,647,941, August 4, 1953, and a lead through insulator is disclosed in the copending application of W. A. Von Wald and T. E. Marshall, filed June 17, 1949, Serial No. 99,823, Patent No. 2,668,187, February 2, 1954.

It is an object of this invention to provide a strain insulator which is not subject to corona discharge.

It is another object of this invention to provide a strain insulator for insulated wire antennas which is no larger or heavier than conventional exposed wire insulators but which is as resistant to mechanical or electrical failure as the antenna wire.

It is another object of this invention to provide in a strain insulator for insulated wire antennas, a high voltage seal between the antenna wire and the insulator body which is totally contained within the latter and includes a resilient sleeve, a series of thrust washers and threaded cap bearing thereon for forcing the sleeve against the wire insulation and the insulator body.

It is another object of this invention to provide in a strain insulator for insulated wire antennas having an internal high voltage seal between the wire and the insulator, means for inspecting the condition of an assembled high voltage seal.

Other objects and advantages of this invention will be apparent from the following description and accompanying drawings, wherein similar characters of reference indicate similar parts throughout the several views.

In the drawings,

Fig. 1 is a longitudinal view partly in section of a preferred embodiment of this invention;

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Fig. 2 is another partial sectional view of a modification of this invention; and

Fig. 3 is an exploded elevational view of portions of Figs. 1 and 2.

Briefly, this invention provides strain insulators of reduced size and increased mechanical and dielectric strength attained by a combination of improved parts and materials. This strain insulator grips the wire portion of an insulated wire without sharp bends in the wire or exposure of the wire or any metal parts to the atmosphere. The mechanical portion of the strain insulator consists of a pair of insertion type connectors affixed to opposite ends of a length of reinforced high-dielectric rod, to provide a strain insulator having an outer diameter scarcely larger than that of the insulated wire. A transparent plastic sheath is molded over the basic strain insulator portion, entirely covering same and of sufficiently greater length to provide a sealing cavity at each end of the insulator and a wire sized inspection cavity between each sealing cavity and its respective wire connector. A resilient sleeve, a series of dielectric thrust washers, and a threaded seal cap are inserted into the sealing cavity in the order named to complete the high voltage insulation feature of this invention.

Referring now to the drawings in greater detail, the partial sectional view in Fig. 1 shows the external insulator body portion 5, in longitudinal cross section. Likewise the insulator spacer 6, the left wire gripping chuck 7, and its associated seal components are shown in cross section. The right wire gripping chuck 8 and its associated seal components, which are identical to those at the left, are shown in elevation.

In a preferred embodiment the insulator spacer 6 is made from a one $\frac{1}{16}$ inch length of $\frac{3}{32}$ inch diameter rod made of glass cloth impregnated with phenol-formaldehyde to provide high mechanical strength and to withstand the radio frequency voltages from aircraft transmitters.

Each end of the insulator spacer 6 is terminated in a portion of smaller diameter indicated at 6A. This smaller portion is circumscribed by an annular V-shaped groove 12. The wire gripping chucks 7 and 8 are machined from brass rod to provide an opening at each end and internal taper therebetween. A pair of steel jaws 9 are forced against the taper by a small spring 10 which is held in position after assembly by the small diameter end 6A of the insulator spacer 6. The spring end of each chuck has an opening large enough to receive an end 6A of the spacer 6. The chuck and spacer are fastened together by a rolled or swaged joint 11 made with the V-shaped annular groove 12. The V-shape of the annular groove was found particularly suitable for mechanical strength and permits a satisfactory joining of the chuck and spacer with only a single swaged joint. Since the spacer is smaller at each end to fit into the chucks, the chucks and spacer have substantially the same outer diameter. The opening at the jaw end of the chucks should be just large enough to receive the insulated antenna wire 15, which in a preferred antenna assembly is 50 mil copper-weld wire covered by a polyethylene sheath $\frac{3}{16}$ inch in outer diameter. The overall length of each chuck is about one inch.

It will be seen therefore that the preferred embodiment of this invention provides a very small and compact strain insulator assembly, thus providing the advantages of less weight on the antenna wire and lower material cost in manufacture. Although this invention utilizes smaller diameter and shorter length chucks and spacer and smaller and shorter jaws than any known to the prior art (these dimensions are in fact not more than half those of the smallest known insulator), the assembly is stronger than the wire itself. It has been found that the antenna wire breaks before it can be pulled out of the chuck jaws.

In a preferred embodiment the body portion 5 is a transparent methyl methacrylate sheath of $\frac{3}{8}$ inch outer diameter molded over the chucks and spacer. The sheath is formed in a cylindrical mold of suitable length and shape to provide a pair of tubular extensions beyond each chuck. The smaller extension 13 is molded between the large extension 14 and the chuck. The extension 13 is of

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diameter large enough to pass the insulated wire 15 and is disposed to register with the chuck. Its length should be at least $\frac{1}{32}$ of an inch and because it is formed of transparent material, it provides an inspection window to observe the entry of the wire into the chuck. The larger extension 14 is substantially $\frac{3}{4}$ of an inch in length and $\frac{5}{16}$ of an inch in diameter and disposed coaxial with the window extension and the chucks.

In molding the sheath, the jaw ends of the chucks must be covered to keep the methyl methacrylate out, the swaged joint 11 will keep the material from entering the spring end of the chuck. After molding, the jaw end of each chuck opens into the tubular interiors of its respective extensions. The tubular interiors provide access for inserting antenna wire into the chuck and the larger extension 14 provides the sealing cavity. Access to the chucks is provided in the form of a cavity rather than just an opening in order that the high voltage seal between the wire and the strain insulators may be entirely contained within the molded sheath body.

The polyethylene covering on the wire is adequate to withstand the desired voltage test of 240,000 volts, so is the plastic sheath molded over the chucks. It remains then to seal the open ends of the sheath and seal the wire covering to the sheath at 240,000 volts test. By providing a sealing cavity within the sheath, each of these points can be sealed by a single high voltage seal which, by sealing the wire insulation to the inside of the sheath, also blocks the breakdown path between the chuck and the atmosphere.

In Fig. 1 an insulated wire 15 is shown engaged in the jaws 9 of chuck 7. It will be seen that the portion of seal cavity extension 14 not occupied by the insulated wire 15 is filled by three different dielectric members forming a packing gland type of seal. A resilient sleeve 16 preferably of soft silicone rubber fills about half the cavity from its center to the end of the chuck 7. A series of thin polyethylene thrust washers 17 are just to the left of the sleeve. These washers are preferably very thin, enough washers are used to occupy about the space indicated by the two washers 17 which are shown in exaggerated thickness. Three washers are normally used for each seal.

A transparent seal cap 18 also molded of methyl methacrylate closes off the end of the cavity 14. The seal cavity extension 14 is provided with internal threads for substantially the outer half of its length. The molded seal caps 18 are provided with corresponding external threads and an axial bore large enough to accommodate the wire 15. In Fig. 1, seal cap 18 is shown partially turned into the seal cavity extension 14. By further turning the cap 18 into the cavity the cap may be made to bear against washers 17 causing them to compress the sleeve 16 against the interior of the sheath and the insulated wire 15, thus providing a complete seal between the wire and the atmosphere and maintaining considerable thickness between the atmosphere and the termination of wire 15. The thrust washers 17 serve a two-fold purpose in that they prevent the turning of cap 18 from damaging the soft rubber sleeve 16 and also in keeping moisture away from the sleeve.

For the seal cavity and antenna wire described above it is preferred to use a seal of .320 inch outer diameter, .185 inch inner diameter, and .281 inch in length all within a tolerance of $\pm .005$ inch. The thrust washers should preferably have a .320 inch outer diameter $+.002-0$, a .185 inch inner diameter $-.002+0$, and a .020 inch thickness $+.002-0$. Both the washers and the seals may be cut from flat stock by a suitably adapted circle cutter and a drill press. Although this seal has only about half the length of the smallest known to the prior art it has improved the insulation from less than 100,000 volts to 240,000 volts.

The seal for chuck 8 at the right of Fig. 1 is identical to that described above for chuck 7 but the component parts are shown in elevation. Here the seal cap is turned in against the washers showing how the resilient sleeve completely seals the antenna wire to the inside of the sheath between the washers and the window extension 13. Since the seal is completed on a portion of the wire lying between the washers and the window extension, and although the insulation must be bared from the end of the wire entering the chuck, if the antenna wire is observed to be covered by its insulating sheath looking in through the window extension 13 and the end cap is

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turned up snugly against the washers and sleeve, then a perfect high voltage seal is assured. The window extension therefore provides a most convenient means for inspecting the seal after assembly of the wire in the insulator and for periodically inspecting the condition of the seal. It will be noted that sufficient clearance is allowed between the seal cap 18 and the sheath 5 so that the sleeve may be expected to seal before the cap is turned against the end of the sheath.

In assembling an antenna to the strain insulator, the seal cap 18, then the thrust washers 17, followed by the sleeve 16, are placed on the antenna wire by insertion of the wire through the center hole in each as shown by the enlarged and exploded view in Fig. 3. The insulation is removed from the end of the wire 15 and its bared end is inserted through the extension 14 and 13 into the jaws 9 of the desired chuck. This is shown in detail with respect to chuck 7 in Fig. 1. The wire should be inserted sufficiently far into the chuck so that its insulation will enter the mouth of the chuck as determined by viewing the insulation through the window extension 13. The sleeve and the washers are moved along the wire into the cavity and the seal cap threaded into the cavity. Assembly of the fitting is then completed by tightening the end cap to perfect the seal. The seal may be improved by lubricating the sleeve with silicone oil.

As shown in Fig. 2, the principles of this invention may readily be modified to provide a corona free T connection which is desired for such application as lead in wires. To effect this modification the insulator spacer 6 is replaced with a T shaped spacer 20 of brass or other conducting material. As in the strain insulator, the wire gripping chucks are joined to the spacer by a rolled or swaged joint. A modified mold is required to provide a sheath 21 for the leg of the T. The branch sheath 21 is in all respects similar to either half of the molded body sheath 5 of Fig. 1.

The T-shaped embodiment of Fig. 2 shows an elevational view of an assembled end of the insulation, this is shown at the right. It will be noted that all internal parts as viewed through the transparent sheath are magnified because of the cylindrical outer shape of the insulator body. This is useful in inspecting the condition of the seal by means of the window extension 13 and facilitates inspection of the sleeve 16, washers 17 and their disposition with respect to the cap 18 and seal cavity extension 14.

The strain insulator of this invention will withstand the most severe electrical and mechanical conditions which can be expected. The preferred embodiment described has been found to withstand more than 250 pounds' pull, which is the breaking point of the 50 mil wire, without breaking or releasing the wire. It will also withstand 240,000 volts between the wire and chucks and the exterior of the sheath which is as good as the voltage rating of the dielectric covering for the antenna wire. Accordingly, an antenna system constructed with the strain insulator of this invention will be as good as the wire used and will not find the strain insulator as a limiting factor electrically or mechanically. Furthermore, the insulated strain insulator of this invention is not large with respect to conventional exposed wire strain insulators.

Although certain specific embodiments of this invention have been herein disclosed and described, it is to be understood that they are merely illustrative of this invention and modifications may, of course, be made without departing from the spirit and scope of the invention as defined in the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A strain insulator for preserving a continuously insulated exterior in insulated wire antenna systems comprising, a pair of wire gripping chucks, an elongated insulator spacer separating said chucks and rigidly attached to each, an elongated insulating sheath formed around said chucks and spacer to form an extended portion beyond each chuck, the extended portions of said sheath being similarly recessed to expose an end of the adjacent chuck, each of said recesses comprising a sealing cavity including a resilient insulating sleeve coaxially disposed

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within said recess at the chuck end thereof, a series of dielectric thrust washers disposed within said recess and bearing against said sleeve, an internally threaded portion at the outer end of said recess, and a sealing cap threaded to engage said internal threads and operative to force the washers against the sleeve to form a seal, said cap having a bore coaxial with said sleeve.

2. A strain insulator for preserving a continuously insulated exterior in insulated wire antenna systems comprising, a pair of wire gripping chucks, an elongated insulator spacer separating said chucks and rigidly attached to each, an elongated insulating sheath formed around said chucks and spacer to form an extended portion beyond each chuck, each extended portion having substantially one third the length of the remaining portion of the sheath, the extended portions of said sheath being similarly recessed to expose one end of the adjacent chuck, each recess including a resilient insulating sleeve coaxially disposed within said recess at the chuck end thereof, a series of dielectric thrust washers disposed within said recess and bearing against said sleeve, an insulating seal cap threadably engaging said recess operative to force said washers against said sleeve to form a high voltage seal, said cap having a bore coaxial with said sleeve.

3. A strain insulator for preserving a continuously insulated exterior in insulated wire antenna systems comprising, a pair of wire gripping chucks, an elongated insulator spacer separating said chucks and rigidly attached to each, an elongated transparent dielectric sheath formed around said chucks and spacer to form an extended portion beyond each chuck, the extended portions of said sheath being similarly recessed to expose an end of the adjacent chuck, each of said recesses comprising a sealing cavity and an inspection cavity, said inspection cavity being disposed between the sealing cavity and the adjacent chuck, a resilient sleeve of diameter larger than the inspection cavity, said sleeve coaxially disposed within said sealing cavity at the inspection cavity end thereof, and a dielectric seal cap operative to compress said sleeve, said cap having a bore coaxial with said sleeve.

4. A strain insulator for preserving a continuously insulated exterior in insulated wire antenna systems comprising, a pair of wire gripping chucks, an elongated insulator spacer separating said chucks and rigidly attached to each, an elongated transparent dielectric sheath formed around said chucks and spacer to form an extended portion beyond each chuck, each of said extended portions being similarly recessed to expose an end of the adjacent chuck, each of said recesses comprising a first cylindrical portion having a predetermined inner diameter, and a second cylindrical portion disposed between said first portion and the adjacent chucks and having an inner diameter smaller than that of said first portion.

5. A strain insulator for preserving a continuously insulated exterior for insulated wire antenna systems comprising, a pair of wire gripping chucks, an elongated insulator spacer separating said chucks and rigidly attached to each, a transparent dielectric sheath formed around said chucks and spacer, said sheath being elongated to form an extended portion beyond each chuck, each of said extended portions being similarly recessed to form first and second cylindrical cavities through which the adjacent chuck is accessible, each second cavity being disposed between its respective first cavity and adjacent chuck and being smaller in diameter than its respective first cavity, a resilient insulating sleeve having substantially the same diameter as and coaxially disposed within each first cavity, a series of dielectric thrust washers disposed within each first cavity to bear against the sleeve therein, an internally threaded portion at the outer end of each extended portion, a sealing cap for each first cavity threaded to engage the threaded extended portions and operative to force a series of washers against their respective sleeve and form a seal, each of said sealing caps having a bore for coaxial alignment with its respective sleeve.

6. In a connection for preserving a continuously insulated exterior in insulating wire antenna systems, the

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combination of a wire gripping chuck, an elongated transparent insulating sheath formed around said chuck and including an extended portion beyond said chuck, said extended portion being recessed to provide access to the jaws of said chuck by the bare end of said wire, said recess having a reduced cylindrical portion adjacent said chuck, a non-conducting cap member threadably positioned on said extended portion and having an opening therein aligned with said recess, and a resilient insulating sleeve in said recess for compression between said cap and said reduced portion to provide a seal about the insulated wire.

7. A connection for preserving a continuously insulated exterior in insulated wire antenna systems comprising a spacer of conducting material, a plurality of wire gripping chucks attached to the ends of said spacer, an elongated transparent insulating sheath formed about said spacer and said chucks and including extended portions beyond each chuck, said extended portions of said sheath being recessed to provide access to the jaws of the adjacent chuck, each of said recesses comprising a sealing cavity and an inspection cavity, said inspection cavity being disposed between the sealing cavity and the adjacent chuck, resilient insulating sleeves of larger diameter than the inspection cavities and coaxially disposed within said sealing cavities adjacent said inspection cavities, and non-conducting cap members threadably positioned on said extended portions and having openings therein aligned with the adjacent said sealing cavities for passage of an insulated wire, said cap members being operative to compress said sleeves against said inspection cavities within said sealing cavities to form a high voltage seal about the insulated wire.

8. A T connection for preserving a continuously insulated exterior in insulated wire antenna systems comprising a T-shaped spacer of conducting material, a plurality of wire gripping chucks joined to the respective ends of said spacer, an elongated transparent insulating sheath formed about said spacer and said chucks and including extended portions beyond each chuck, said extended portions of said sheath being recessed to provide access to the jaws of the adjacent chuck, each of said recesses comprising a sealing cavity and an inspection cavity, said inspection cavity being disposed between the sealing cavity and the adjacent chuck, resilient insulating sleeves of larger diameter than the inspection cavities and coaxially disposed within said sealing cavities adjacent said inspection cavities, and non-conducting cap members threadably positioned on said extended portions and having openings therein aligned with the adjacent said sealing cavities for passage of an insulated wire, said cap members being operative to compress said sleeves against said inspection cavities within said sealing cavities to form a high voltage seal about the insulated wire.

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