United States Patent

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[54] **STATIC DISCHARGER WITH IONIZATION BYPASS**
7 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **317/2 E**
[51] **Int. Cl.** **B64d 45/02**
[50] **Field of Search** ..... 317/2 R, 2 E

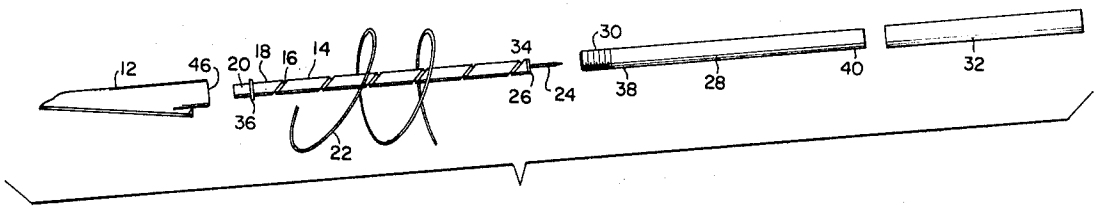
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ABSTRACT: A static discharger for use with aircraft of the internal resistive element type having the electrically conductive internal construction shielded by a nonconductive outer covering and an electrically conductive ionization bypass overfitting portions of the nonconductive outer shield.



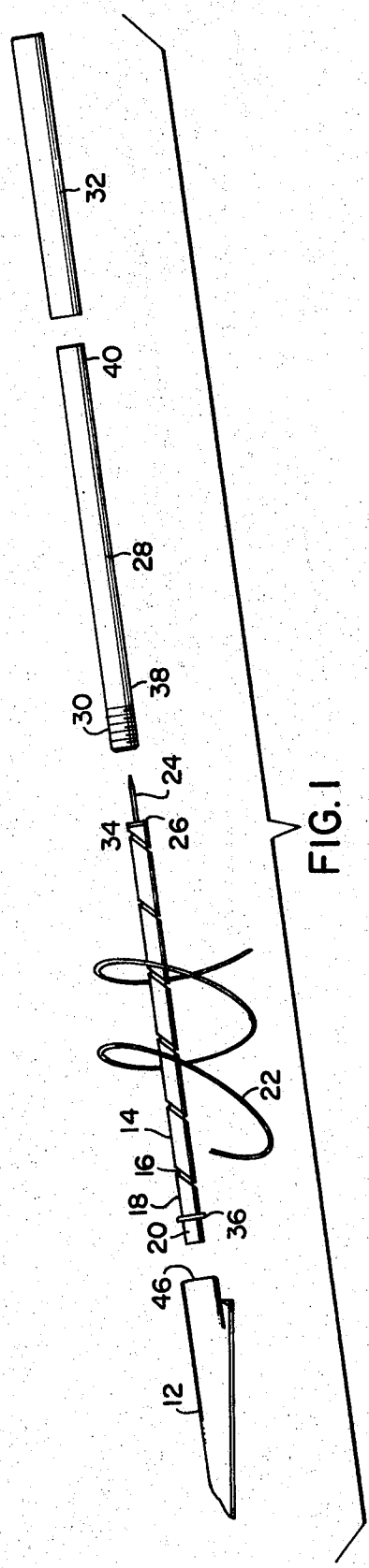


FIG. 1

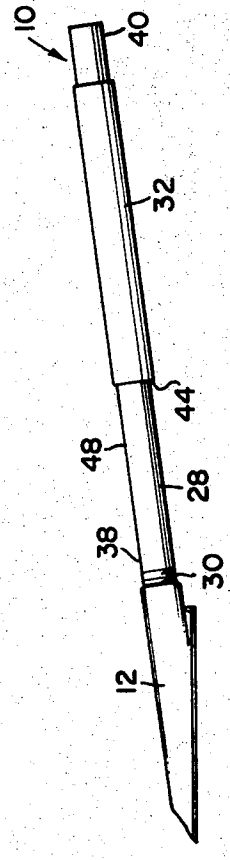


FIG. 2

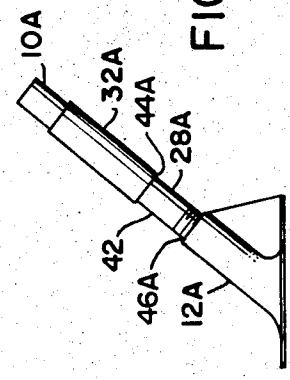


FIG. 3

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STATIC DISCHARGER WITH IONIZATION BYPASS

BACKGROUND OF THE INVENTION

The present invention relates to the general field of static dischargers and more particularly, is directed to a novel static discharger of the internal resistance type wherein the functioning parts are protected by an external ionization bypass against electrical overload.

This invention relates to the removal of static electric charges from aircraft in order to prevent corona discharge in the vicinity of radio antennae inasmuch as it has been found that the corona discharge is a source of electromagnetic interference which can disrupt the normal radio communications of the aircraft. In order to minimize these effects and the noise of corona discharge, static discharge devices have been placed at the extremities of the airframe by prior workers in the field. In particular, static dischargers are usually affixed at the trailing and lateral edges of the wings and horizontal stabilizers and at the top and trailing lateral edges of the vertical stabilizer.

Most prior art static dischargers are presently in use are either of the wick type which employ a length of graphite impregnated cotton enclosed in a plastic tube or are of the so-called null field type which include a high impedance rod having a conductive coating externally affixed thereon and which carry a tungsten static discharge pin positioned at right angles to the axis of the rod. Both prior art types function to provide a localized area where static precipitation can be leaked off by corona discharge before the charge buildup is of sufficient magnitude to cause the airframe itself to discharge by corona discharge. Since this corona discharge takes place at the extremities of the aircraft remote from the radio antennae, the effect of the corona noise on the radio communications is thereby minimized.

A static discharger of the novel internal resistive element type has recently been developed by Chester H. Miller and Arthur J. Brodersen and a complete disclosure of this type of device may be found in a pending patent application entitled Internal Resistive Element Static Discharger, Ser. No. 824,570, dated May 14, 1969. Tests have shown that the internal resistance element type of static discharger greatly improves over the previously known wick type and null field type of static dischargers. However, none of the devices heretofore available were constructed to adequately handle extremely high energies generated by lightening encountered in storm areas and as might be encountered under very high static conditions. The possibility of complete breakdown of the electrically conductive construction under such extreme conditions exists in all prior art models.

SUMMARY OF THE INVENTION

The present invention includes an outer, nonconductive rod which completely surrounds the conductive resistance element and protects the conductor from damage due to wind shear at high speeds. Further, the present mechanical design makes the installation and maintenance of the static discharger relatively simple without the need for special tools or other special devices. The outer rod, which completely surrounds the electrically conductive construction serves also to shield the sharp discharge needle to thereby completely eliminate all hazards to maintenance personnel. As fully described in U.S. Pat. application Ser. No. 824,570, all of these mechanical advantages can be obtained by utilizing the present design and at the same time, the electrical performance characteristics that can be achieved have been found to equal or surpass those of all presently known static dischargers. The present device includes the improvement of providing ionization bypass capable of handling large quantities of electrical energy without wear, deterioration or other indications of mechanical breakdown. A stainless steel sleeve overfits and affixes to outer portions of the nonconductive outer rod to provide an external, electrically conductive bypass to thereby shunt high energy about the internal resistance element when extreme electrical conditions are imposed upon the aircraft such as may be caused by lightening.

It has been found that high energy, in excess of 50,000 volts at 2,000 amperes frequently occurs in electrical storms and creates forces that can not be handled by prior art static dischargers without damage occurring to the conductive surface. The present unit functions basically the same in its method of eliminating static charges from aircraft under normal conditions as described in the previously mentioned pending U.S. Pat application Ser. No. 824,570. Additionally, the present invention includes the improvement of rendering the static discharger capable of disbursing large amounts of energy. The present unit is capable due to its improved design and construction of handling repeated high energy strikes without any visible or measurable harm or damage.

It is therefore an object of the present invention to provide an improved internal resistive element static discharger of the type set forth.

It is another object of the present invention to provide an improved internal resistive element static discharger wherein ionization bypass construction is incorporated therein.

It is another object of the present invention to provide a novel internal resistive element static discharger incorporating an ionization bypass sleeve externally affixed to the discharger construction.

It is another object of the present invention to provide a novel static discharger of the internal resistive element type equipped with an ionization bypass that is rugged in construction, inexpensive in manufacture and trouble-free when in use.

Other objects and a fuller understanding of the invention will be had by referring to the following description and claims of a preferred embodiment thereof, taken in conjunction with the accompanying drawings wherein like reference characters refer to similar parts throughout the several views and in which:

BRIEF DESCRIPTION OF THE DRAWings

FIG. 1 is an exploded, side-elevational view of a static discharger constructed in accordance with the present invention.

FIG. 2 is a side elevational view of the static discharger of FIG. 1 with the parts in assembled relation.

FIG. 3 is a side elevational view similar to FIG. 2 showing a modified short unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Although specific terms are used in the following description for the sake of clarity, these terms are intended to refer only to the particular structure of my invention selected for illustration in the drawings, and are not intended to define or limit the scope of the invention.

Referring now to the drawings, two general types of static dischargers embodying the present invention are disclosed for illustrative purposes. The long unit type **10** as exemplified by the embodiment of FIGS. **1** and **2** is designed for and is suitable for mounting upon the trailing edges of the wings and stabilizers of an aircraft. The short unit type **10***a* as exemplified by the embodiment illustrated in FIG. **3** is designed for and is suitable for installation on the tips or extremities of the wings and stabilizers of an aircraft. In accordance with well-known practice, it should be understood that the exact number and location of the internal resistive element dischargers constructed in accordance with the present invention must be determined by the configuration and characteristics of the individual aircraft being so equipped and that the static dischargers herein disclosed are equally suitable for use with all types of aircraft.

Referring now to FIGS. **1** and **2**, a long unit **10** is illustrated comprising a conductive base **12** for mounting upon the surface of the aircraft in an electrically conductive junction in accordance with the usual practice. Each unit comprises an

inner rod 14 and an outer rod 28 overfitting the inner rod 14 and which is provided with a longitudinally extending internal bore of diameter and length to overfit and protect the inner rod 14. The inner rod 14 is externally spirally grooved at 16 throughout its length to receive the resistive element 22 therein spiralled about the periphery of the inner rod 14 and contained entirely within the spiral groove 16. The resistive element 22 is sized to fit entirely within the groove 16 to thereby permit the outer rod 28 to slidingly overfit and protect the inner rod 14 without damage to the resistive element 22.

A discharge needle 24 axially extends from its mounting base 26 and affixes to the free end 34 of the inner rod 14 for corona discharge purposes as hereinafter more fully set forth. A stainless steel pin 20 affixes to a flanged base 36 which in turn secures to the connected end 18 of the inner rod 14 to thereby provide a complete, positive electrical circuit between the steel pin 20 and the conductive base 12. It should be noted that the discharge needle 24 connects to one end of the resistive element 22 through its attached mounting base 26. Similarly the stainless steel pin 20 connects to the other end of the resistive element 22 through its affixed flanged base 36 to thereby provide a complete electrically conductive circuit from the discharge needle 24 through the resistive element 22 to the stainless steel pin 20.

Accordingly, static currents generated upon the skin of the aircraft can thus flow through the base 12, the steel pin 20, the resistive element 22 for discharge at the discharge needle 24. As illustrated, it should be noted that the outer rod 28 completely covers and protects the inner rod 14, the steel pin 20 and the spirally wound resistive element 22. Additionally, the outer rod 28 extends beyond the free end 34 of the inner rod 14 and completely covers the extended portion of the discharge needle 24 to thereby prevent physical damage to the needle by physical shielding and also acts to eliminate any hazard to maintenance personnel who might otherwise inadvertently come in contact with the needle point.

A hollow, cylindrical, conductive covering 32 overfits the outer rod 28 and secures thereto intermediate its connected end 38 and free end 40. The conductive covering which may be of stainless steel, secures externally to the external surface of the outer rod 28 in well-known manner, such as by crimping, punching or otherwise in a manner that will not disturb nor interfere with the function of the resistive element 22. The connected end 38 of the outer rod 28 serves as a nonconductive gap between the conductive base 12 and the conductive bypass covering 32. Thus, upon encountering extremely high energies, such as might be generated by violent electrical storms, the conductive covering 32 serves to shunt or bypass the high energies so generated about the resistive element 22 to thereby prevent damage to the resistive element 22. In this manner it will be seen that the resistive element 22 serves to discharge corona under normal operating conditions as hereinbefore set forth. The conductive covering 32 functions as an ionization bypass to thereby shunt high energies about the internal resistive element 22 during those periods of infrequent high energy buildup such as may be generated by electrical storms. During normal periods of operation the conductive covering 32 serves no purpose and is so constructed as to not interfere with the normal static discharge path between the pin 20, the resistive element 22 and discharge needle 24.

In accordance with the teachings of the previous application Ser. No. 824,570, the outer rod 28 is provided at one end thereof with external threads 30 which threadedly engage into the threaded socket 46 of the mounting base 12 to thereby securely urge the conductive pin 20 into intimate electrical contact with the base 12 by pressing against the affixed flanged base 36. In this manner, the unit may be readily assembled by hand without requiring the use of any special tools whatsoever.

Although the conductive bypass covering 32 is illustrated in hollow cylindrical configuration, it will be appreciated that any shape of conductive construction, such as strips, may also be employed in the same application. An airgap 48 has been employed to assure that normal static charges will follow the path through the resistive element 22. Upon encountering high energies in the range of 200 joules or more the charges will jump the gap 48 for discharge along the surface of the device. This permits protection of the internal resistance device 22 from rupture due to the excessive heat that is generated.

As best seen in FIG. 2, the end 44 of the conductive covering 32 closest to the base 12 spaces from the threaded socket 46 of the conductive base 12 a distance in the range of approximately one-half inch to 3 inches to thereby provide a nonconductive gap 48 comprising the exposed portion of the nonconductive outer rod. The size of the airgap 48 may be varied in the range indicated depending on the desired performance characteristics. The longer the airgap, the higher the energies required to arc across. The limiting factor would be a gap long enough to offer such resistance to shunting charges as to force the high energies through the resistive element 22 to cause permanent damage thereto.

Experiments have proved that high energy buildup impressed upon the conductive base 12 will arc across the connected end 38 of the outer rod 28 and the gap 48 to the conductive covering 32 to thus be shunted around the conductive element 22 thus protecting the same from the imposition of current of a magnitude too great for capacity of the resistive element 22.

In FIG. 3, I show a modified construction employing a short unit 10A which is normally employed at the extremities of the wing and stabilizer tips of an aircraft. A conductive base 12A affixes to the surface of the aircraft in an electrically conductive connection to receive the threaded outer rod 28A therein in threaded engagement. A short conductive covering 32A overfits and affixes to the outer surface of the outer rod 28A in spaced relationship from the threaded socket of the conductive base 12A. An airgap 42 of approximately three-quarters of an inch is provided between the end 44A of the conductive covering 32A and to socket 46A of the conductive base 12A so that under normal operating conditions a sufficient resistance to electrical flow is presented by the exposed outer rod 28A as to encourage the flow of current directly from the base through the internal resistive element (not shown) for discharge at the discharge needle in the manner hereinbefore explained. In cases of electrical overcharge, such as might be encountered by the high energy generated during electrical storms, the high energies will jump the nonconductive space 42 and thus be shunted around the resistive element by the conductive covering 32A in the same manner of operation as hereinbefore described with regard to the long unit 10.

I claim:

1. In an internal resistive element type static discharge unit having a conductive mounting bracket for affixing to the surface of an aircraft in an electrically conductive manner, the combination of

A. an elongated nonconductive element extending from the said conductive mounting bracket;

B. a resistive element having a first end and a second end and being associated with the nonconductive element,

1. said resistive element being protected from mechanical injury by portions of the said nonconductive element;

C. connection means connecting said first end of the resistive element to the said mounting bracket;

D. discharge means connected to the second end of the resistive element,

1. said connection means, discharge means and resistive element forming a continuous electrically conductive path from the mounting bracket to the discharge means; and

E. electrically conductive bypass means providing an electrically conductive path spaced from the said resistive element and having a base end and a discharge end,

1. said base end spacing from the mounting bracket a distance sufficient to form a nonconductive gap therebetween.

2. The invention of claim 1 wherein the conductive bypass is formed to a hollow, cylindrical configuration, and the said resistive element positions within the said hollow interior of the conductive bypass.

3. The invention of claim 2 wherein the resistive element axially positions within the conductive bypass and is spaced therefrom by portions of the nonconductive element.

4. In a static discharge unit having a conductive mounting bracket for affixing to the surface of an aircraft in an electrically conductive manner, the combination of

A. an elongated resistive element extending from the said conductive mounting bracket and having a first end and a second end,
   1. said first end of the resistive element being in electrically conductive contact with the mounting bracket to permit electrical charges of less than a damage voltage to be conducted through the resistive element,
      a. said damage voltage being of a magnitude sufficient to mechanically damage the said resistive element,
   2. said resistive element offering a resistance to the flow of electricity; and

B. electrically conductive bypass means associated with the resistive element and having a length less than the length of the resistive element, said bypass means being defined between a first end and a second end,
   1. said electrically conductive bypass means having an electrical resistance which is less than the said resistance to the flow of electricity of the said resistive element,
   2. the first end of said electrically conductive bypass means being spaced from the said conductive mounting bracket a distance sufficient to provide an electrically nonconductive gap,
      a. electrical charges exceeding said damage voltage discharging across the said gap and being conducted by the said electrically conductive bypass means.

5. In a static discharge unit having a conductive mounting bracket for affixing to the surface of an aircraft in an electrically conductive manner to conduct electrical charges away from the surface of the aircraft, the combination of

A. an elongated electrically resistive element having a first end and a second end,
   1. the first end connecting to the mounting bracket in an electrically conductive junction,
   2. the second end terminating outwardly from the aircraft in electrical discharge means,
   3. said resistive element being capable of conducting electrical charges of less than a predetermined resistive element damage level from the aircraft surface to the electrical discharge means; and

B. electrically conductive bypass means affixed to the electrically resistive element in a manner to provide a nonconductive gap between the aircraft surface and the electrically conductive bypass means,
   1. said electrically conductive bypass means coextending with the electrically resistive element along an appropriate length whereby electrical charges on the aircraft surface will be discharged at the electrical discharge means if the electrical charge level does not exceed the said predetermined resistive element damage level and whereby electrical charge levels exceeding said predetermined level will discharge across the nonconductive gap and by means of said electrically conductive bypass means to shunt the high electrical charge levels around the electrically resistive element.

6. The invention of claim 4 wherein the electrically conductive bypass means are hollow cylindrical in configuration.

7. The invention of claim 6 wherein the electrically conductive bypass means are shorter in length than the said electrically resistive element.

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