June 22, 1965 S. KLEINHANS 3,191,094

STATIC ELECTRICITY DISCHARGER

Filed July 27, 1962

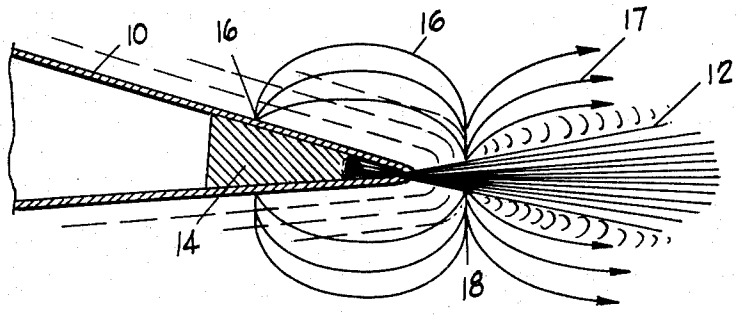


Fig. 1

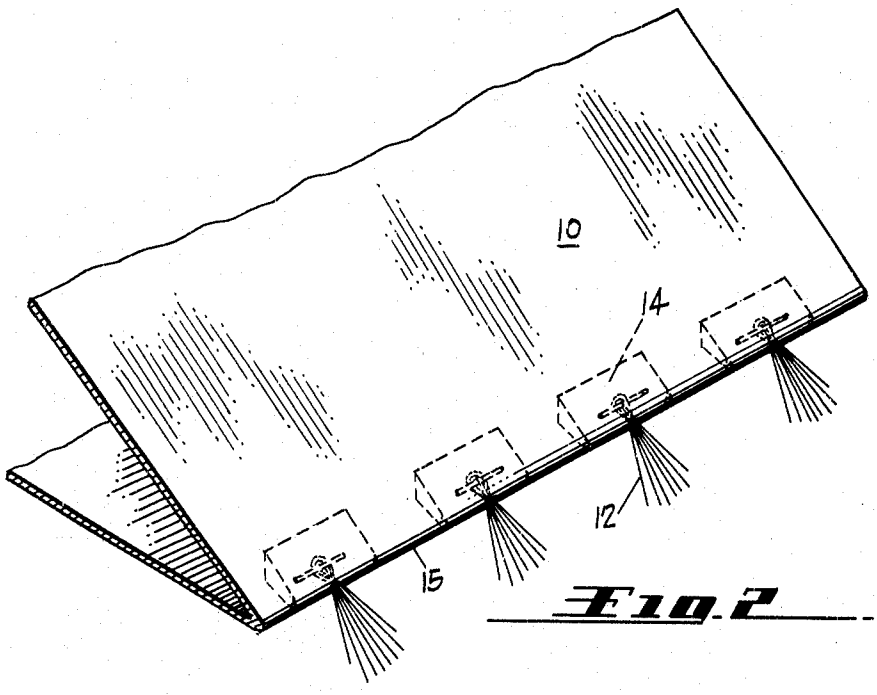


Fig. 2

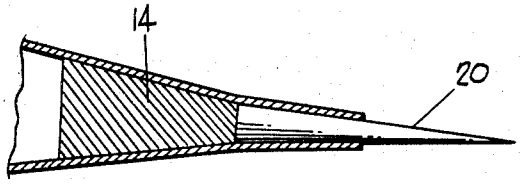


Fig. 3

INVENTOR.
SCHUYLER KLEINHANS
BY
R C Rasch
-ATTORNEY-

United States Patent Office 3,191,094 Patented June 22, 1965

3,191,094

STATIC ELECTRICITY DISCHARGER

Schuyler Kleinhans, Santa Monica, Calif., assignor to Douglas Aircraft Company, Inc., Santa Monica, Calif.

Filed July 27, 1962, Ser. No. 212,846
6 Claims. (Cl. 317—2)

This invention relates to aircraft and is particularly concerned with obviating the detrimental effects of the accumulation and discharge of static electrical charges, at the aircraft's surfaces, on the navigational equipment, radio apparatus, the ignition system and other systems of the propulsion plant, upon the fuel contents of the craft and sometimes even upon the structural integrity of the airframe. These static electrical charges are generated on the surfaces of all-metal aircraft by the friction-creating movement of the craft through the atmosphere or by charges deposited by meteorological precipitation, such as hail, snow and rain, with consequent triboelectrical phenomena pertaining thereto, resulting in D.C. electrical discharge-potentialities if the charge builds up to a triggering voltage of about 200,000 volts.

The fact should be here taken into account that such charges can, and often do, attain a magnitude of several hundred thousand volts, the charge having, as the particular case may be, either a positive or negative polarity. Usually the charged body is of negative polarity, and the particles in the airstream sweeping the body are of positive polarity. The sudden D.C. discharge of this high-voltage charge may well injure the carried personnel, in addition to having the other well-known detrimental effects on the radio, radar, and ignition, etc., systems of the craft. These factors considered, the topicality and seriousness of the conditions alleviated and of the problems solved by the present invention can well be appreciated.

Proposals are of record approaching these situations with a view to their alleviation. Some of them have alleviated one or more aspects of these situations by use of primitive "trailing wire" dischargers, "antistatic coatings," equally obsolete "needle points" at the tail cone apex and the wing tips; the use of triboelectric particles of quartz, and combinations of trailing edge wicks and capacitative means cooperating therewith to trigger the discharge at a somewhat, but insufficiently, lowered voltage, the latter constituting the most effective means developed to this date.

It was discovered, however, in connection with all these proposals, that among other inadequacies, (1) a certain minimum potential difference, usually of the order of several hundreds of thousands of volts, must build up on the body in order to trigger discharge and such discharge is detrimental, as aforesaid; and (2) the discharge is intermittent, rather than continuous.

Concisely stated, the present invention solves these problems by incorporating in, or adjacent, the trailing edge portion of all or a portion of the major components, including lift surfaces, stabilizing surfaces and control surfaces, of an aircraft or other body having relative movement with respect to a meteorological medium, a combination including radioactive means for (1) preventing the build-up, or incremental accumulation, on the surfaces or faces of the components of the craft, of the aforementioned ultra-high voltage static charges and a plurality of discharge wicks. In solving these problems the invention effectuates a continuous discharge of increments of charge out through these wicks and this it does substantially as soon as they are generated. This means that the charge is discharged at a relatively low potential, far below the aforestated magnitudes. The radioactive means are associated with trailing-edge wicks in any

suitable structural manner and the radioactive means may be of that kind which emit alpha, or beta, or gamma rays, or all of them simultaneously. The wicks, herein assumed to be of the conventional type, have naturally a high-gradient as to their potential, and tend, even in the conventional device, to "leak off" electrons and ionize the air but only in their immediate vicinity and only at 200,000 volts. The radioactive ionized airstream ultimately combines with the wick-ionized particles in which the wicks are immersed.

One of the prototype physical embodiments incorporating the present invention is representationally shown in the accompanying drawing, forming an integral part of this disclosure. It is to be understood, however, that these drawings and the following detailed description of the construction depicted therein, are presented merely by way of example and are not to be taken as constituting the sole mode and structural means for giving effect to the invention's concepts and objectives. For, the invention contemplates any and all means, equivalent to the exemplificatory means chosen for detailing herein, that fall within the scope of the subjoined claims.

In this drawing:

FIGURE 1 is a somewhat diagrammatic, fragmentary chordwise section of a portion of an airfoil that incorporates the principles of the invention;

FIGURE 2 is a diagrammatic, fragmentary perspective view of a portion of an airfoil embodying the invention; and

FIGURE 3 is a view, similar to that of FIGURE 1, showing acuate discharge electrodes substituted for the wicks of FIGURE 1.

Referring now in general outline to the specific, but not limitative, construction shown in the drawing, the invention comprises, broadly stated, the combination with the trailing-edge portion 10 of a metallic airfoil, such as a lift-surface, a stabilizing surface or a control surface, of a plurality of wicks, tufts, or the like 12, composed of a material that is preferably, but not limitatively, only semi-conductive; and a small, but adequate, mass, capsule or block 14 of a radioactive material disposed inside the airfoil ahead of the trailing edge. Preferably this material is one of the radioactive isotopic chemical elements which emits radioactive particles, including beta particles, such as americium 242, by way of example. The invention does not exclude, however, the employment of a radioactive material which emits, among other decay-products, alpha or gamma particles, such as curium 244, radium 226, polonium 210, etc.

In either case, the function of the mass 14, is solely by the radioactivity of the isotope 14, to ionize the ambient air at the airfoil's trailing edge portion 15. The nature of this phenomenon is similar to that occurring upon passage of an electrical current through an electrolyte, whereby each of the atoms of the electrolyte has an electron added to or removed therefrom, converting the atoms into ions.

The object of ionizing the air at and aft of the trailing edge region of the airfoil is to reduce the electrical resistance of the ambient air thereat, for ionized air is of reduced resistivity and is a satisfactory medium for inducing or triggering the continuous discharge of a charge of static electricity from a moving body immersed in air. This is true whether the static charge is generated by skin friction of the airfoil with the ambient air or is created by precipitation impinging upon an airfol and the deposition of its electrical charge, or either polarity, thereupon.

The plurality of tufts, or wicks, 12, each comprises, as is conventional, a plurality of strands, filaments, or elongate pieces of either conductive, or semi-conductive material. Each wick or the like is fixedly mounted, in any

suitable manner, as indicated in FIGURE 2, to the trailing edge of the airfoil along its spanwise dimension, the wicks lying in equidistantly spaced relationship with each other. The wicks extend in chordwise attitude, and conically enlarge, or flare rearwardly. The static-electricity space charge pattern around the wicks is not of essential importance, but in order to demonstrate the novel decoupling effect of the invention on the space-field charge, a pattern is illustrated in FIGURE 1 and is described hereinafter.

The wicks or tufts may be anchored, at their inner ends, to the airfoil or other portion of the charged body in any desired, or suitable manner, as disclosed, for example, in the patent to R. Beach, No. 2,497,924. Or, they may merely be inserted between the upper and lower skins of the trailing edge before riveting these skins together, the riveting then firmly clamping the inner ends of the wicks in place, although a slight and harmless bulge at each wick anchorage may result from the employment of this technique. Preferably however, each wick is looped on itself and a wide keeper inserted through the loop. See FIGURE 2.

The wicks may, or may not, be physically directly connected to the mass 14, as desired, although direct contact is not essential. Further, if a mass 14 should happen to be located closely adjacent a human occupant of the craft, or adjacent to other organic tissue, the face of the radioactive material closest to an occupant may be suitably shielded, as shown in FIGURE 1, especially for long flights in the course of which he may otherwise be continuously exposed to and affected by, the beta, alpha or gamma particles, with obvious consequences. Such shielding may be in the form of a lead box, plate, or the like, shown in FIGURE 1, thus to exclude the possibility of damage to the occupant from the particles radiated from the radioactive material.

As shown in FIGURE 1, the space charge-fields of the airfoil's discharging locus 16 and of the electrostatic field 17 of the wicks or tufts are effectively decoupled by this arrangement. At 18 is shown a typical null region of the wick, this null locus being so positioned by this invention and so decoupled from the other field that the radio-frequency components in this electrical discharge are effectively reduced. The radio, radar, and other such apparatus in the craft are relieved of the usual interference therewith occasioned by the static charge and discharge thereof.

This effect is attributable to the fact that the usual sharp peak of the current-curve of the discharge is attenuated, or even flattened, by means of this invention. It may be found under certain conditions that, to establish absolute de-coupling, the trailing edge portion of the airfoil may be well overlaid in this portion with a plastic, or other non-conductor, the effects of such arrangement being well-known in the art.

As shown in FIGURE 3, instead of wicks, a plurality of pointed metallic electrodes, 20, depicted as being directed rearwardly, but also susceptible of orientation in an upward direction, as desired, may be employed.

It is worthy of recitation that the present invention may well incidentally serve to reduce the attraction of the body for lightning. This it does by virtue of the fact that the novel discharge arrangement maintains a relatively low potential level, but, one nonetheless higher than that of the usual "lightning attractors," on the surface of the body, thereby to reduce the body's attraction

for lightning bolts, the body also having the same polarity as that of the bolts, ordinarily. Also, there are few, if any, sharp points on the body to "attract" the bolts.

Although certain specific materials, structures and arrangements have been recited hereinabove, it is to be understood that the invention is by no means restricted in its scope and in its possible embodiments because of the recitation of the foregoing parameters and specific terminology, which are presented merely to render the concepts more concrete.

I claim:

1. In combination:
   - a body having, with a meteorological medium, relative movement, there being established on at least one face thereof a charge of static electricity by virtue of the immersion and relative movement of the body with respect to the meteorological medium; and
   - radioactive means disposed in adjacency with a trailing region of said face and emitting radioactive particles ionizing the air adjacent said region and continuously discharging said charge through the ionized air substantially instantaneously upon the generation of the charge;
   - accumulation of static electricity on said face hence failing to occur.

2. A combination in accordance with claim 1, in which said radioactive means comprises material that emits radioactive particles including alpha-particles.

3. A combination in accordance with claim 1 in which said body is an all-metal aircraft and
   - in which said face constitutes one of the external structural boundaries of an airfoil.

4. A combination according to claim 1, in which said radioactive means comprises radioactive polonium, or Po^{210}.

5. A combination in accordance with claim 1, in which said radioactive material emits radioactive particles including beta-particles.

6. In a system useful in providing a continuous low potential discharge path for static electrical charges normally accumulated on a conductive body upon relative movement between said body and a meteorological medium, the combination of:
   - passive charged-particle emitting means carried by said body for providing a supply of ions;
   - said ions serving to ionize elements of said meteorological medium; and
   - low electrical potential discharge means carried by said body; and
   - extending therefrom in substantially the direction of movement of and for intersection by said ionized elements;
   - said ionized elements defining a continuous low potential discharge path for said static electrical charges between said body and said discharge means.

References Cited by the Examiner

UNITED STATES PATENTS

2,732,517	1/56	Alabaster	317—2
2,794,118	5/57	Kiriloff	317—2
2,933,732	4/60	Tanner	317—2
2,972,680	2/61	Hicks et al.	250—44
3,106,663	10/63	Tanner	317—2

SAMUEL BERNSTEIN, *Primary Examiner.*