

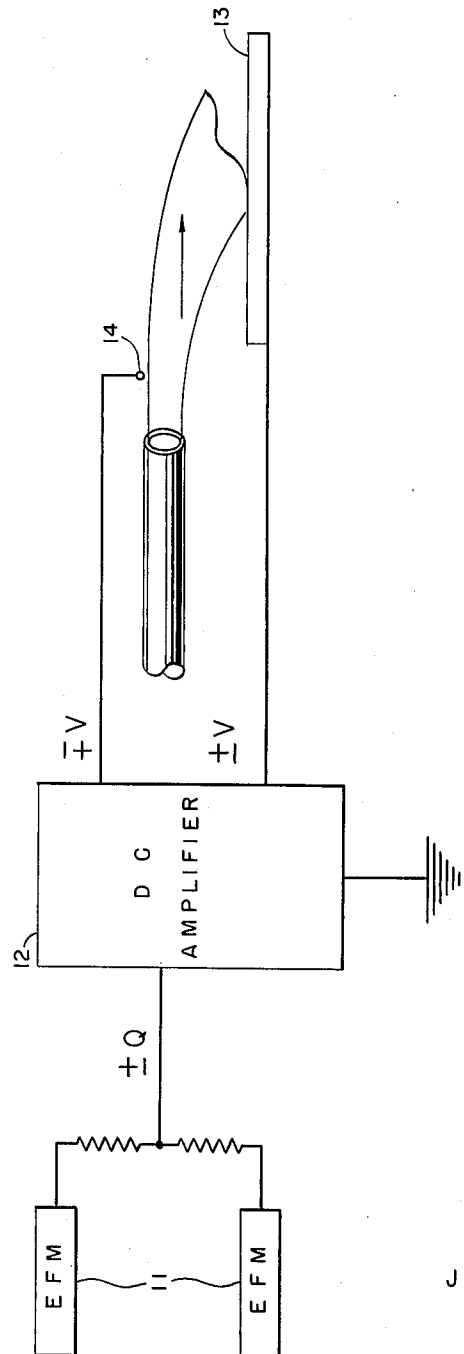
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METHOD AND APPARATUS FOR DISCHARGING AN ELECTRIC CHARGE

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**METHOD AND APPARATUS FOR DISCHARGING
AN ELECTRIC CHARGE**

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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.

The present invention relates to a method and apparatus for neutralizing charges upon charged objects and more particularly to a method and device for aircraft electric charge control.

The earth's atmosphere is a leaky dielectric of approximately 200 ohms resistance, through which flows about 1400 amperes of current. The necessary positive upper atmospheric potential of some 290 kv. relative to the earth's surface is maintained by world-wide thunderstorm activity. Thus an object moving through the atmosphere as well as stationary objects protruding into the atmosphere will become polarized.

The charge on electrified objects is commonly referred to as static electricity. It is well established that bodies moving through a medium containing aerosols may collect a static charge on electricity which discharges into the surrounding medium when the potential of the body relative to the surrounding medium becomes sufficiently great. Aircraft, when flying through precipitation or dusty areas, become charged to a potential sufficiently high with respect to the surrounding space as to cause corona discharge particularly from various projecting parts of the aircraft such as antennas and propellers. Such discharges, if permitted, cause severe radio interference which hampers and sometimes completely precludes the use of long-range radio receiver equipment on board the aircraft. The effect of electrical discharge from radio equipped aircraft is particularly critical in that it not only impairs navigation of the aircraft by rendering the radio useless, but frequently in the vicinity of thunderstorms, reaches such proportion as to actually burn holes in parts of the aircraft. It has been found that aircraft may accumulate either a negative or, more rarely, a positive charge while flying through space, depending upon atmospheric conditions and the surface composition of the aircraft. Therefore it is apparent that to be completely satisfactory from the standpoint of reducing radio interference, a static discharger should be relatively quiet when discharging potentials of either positive or negative polarity.

Heretofore, various devices have been used for removing static charge from moving bodies, and much effort has been expended in an attempt to control the removal of electro-static charges in a manner that will not interfere with the operation of radios aboard aircraft. At the present time fairly good results are obtained by using a static discharger which comprises a cotton wick extending from a metallic retaining tube. The tube is arranged so that the wick projects into the air-stream, the wick being made electrically conducting by filling it with ethylene glycol. However, this type of discharger has the disadvantage that the ethylene glycol evaporates so that the wick must be refilled from time to time thereby giving rise to a maintenance problem. Also the wick collects dirt which tends to interfere with its discharge properties. A further difficulty with this type of discharger is that while it is relatively quiet when discharging a negative potential relative to the surrounding space, it is noisy when discharging at a positive potential. In addition, it cannot function until the aircraft potential reaches the

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relatively high potential required for corona discharge at the wick tip. Other devices such as electron discharge devices have been used in the vicinity of the object affected by the static charge for the purpose of discharging the charge built up on the object. Such means have not been successful because of the inability of such apparatus to control the discharge between the electrodes so that this discharge is maintained below sparking, arcing or streamer conditions throughout continuous operation. Such streamer devices when discharging the static charge create just as much radio interference as the discharge from the plane itself and tend to produce sparks or arcs in the vicinity of the aircraft.

It has long been known that the hot exhaust gases of a powered aircraft (propeller, jet or rocket-propelled airplane, blimp, helicopter or missile) help to discharge the aircraft of a large precipitation electric charge of either polarity, and that these hot gases tend to maintain the aircraft at a small non-zero charge, usually negative, in fine weather. It has now further been determined that an electro-static field at the mouth of an exhaust stack or rocket nozzle can separate the exhaust ions so that one polarity of ions can be collected while the other is exhausted to the atmosphere. The device of the present invention overcomes the shortcomings of the prior art devices and provides an effective, inexpensive, easily controllable device for discharging an electro-static charge on an object without any noise. This is done by providing a collection probe and/or a deflection probe near the exhaust of a device for the purpose of collecting the ions of one charge from the exhaust while permitting the oppositely charged ions to pass on to the atmosphere.

An object of the present invention is to provide an electric charge control device which can be easily installed, easily operated, and yet provide a noiseless discharge device.

Another object is to provide a device for collecting ions of one charge while passing ions of another charge.

Still another object is to provide a device for controlling the charge on an aircraft which has a built up charge of either positive or negative polarity.

Yet another object is to provide a device which is automatic in operation relatively inexpensive, easily installed, and yet effective in preventing unwanted discharges from an object through the atmosphere.

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawing in which:

The drawing is a diagrammatic view illustrating the principle of the device.

In accordance with the teaching of the present invention, a device is provided at the exhaust of an aircraft for separating the positive and negatively charged ions. The device includes a collection probe which collects the ions of one charge and permits the ions of the opposite charge to be exhausted into the atmosphere. Alternatively, a deflection probe may be used to deflect ions of the same polarity as the deflection voltage to the aircraft skin; or both deflection and collection probes may be employed simultaneously. Such a system causes the potential of the aircraft to change toward the polarity of the collected ions, due to the accumulation of such ions on the surface of the aircraft.

Referring now to the drawing which is a diagrammatic view of the present invention which illustrates the various parts of the invention relative to an exhaust of any well-known exhaust type aircraft. The aircraft charge is measured by any conventional techniques such as those described in Airborne Measurement of Atmospheric Potential Gradient by John F. Clark, published in the Journal of Geophysical Research, vol. 62, No. 4, December

1957. The measured aircraft charge is directed into a proportional D.C. amplifier 12 having any suitable control means therefor for reversing the output of the amplifier in accordance to the input of the amplifier. The output from the D.C. proportional amplifier is directed to a collection probe 13 and/or a deflection probe 14, each of which are positioned near the exhaust of any suitable aircraft. The collection probe has a relatively large surface in comparison to the deflection probe.

In operation of the device in order to minimize the aircraft net charge Q, if the charge Q determined by the charge measuring device is negative, a positive voltage is applied through the amplifier to the deflection probe and a negative voltage is applied to the collection probe. Since the exhaust gases of an aircraft include both positive and negative ions, the negatively charged collection probe will collect the positive ions from the exhaust. Since the deflection probe has a positive charge thereon the deflection probe will tend to force the positively charged ions toward the collection probe and since the surface of the deflection probe is small there will be very little if any collection of negatively charged ions on the deflection probe. Thus, the negatively charged ions will be exhausted into the atmosphere. This discharge is noise-free because the applied potentials are maintained at a level less than that required for electrical breakdown in the form of corona, arc, or spark. Since the collection probe is collecting the positively charged ions and since the aircraft itself has a negative charge thereon, the positive charges are directed to the aircraft frame through a common ground, tending to bring the aircraft charge to a much smaller but non-zero negative charge. Thus a small equilibrium charge Q will result, which becomes smaller as a gain of the D.C. amplifier is increased. If the charge Q on the aircraft is positive then the voltages applied to the deflection and collection probes will be reversed and the negative ions from the exhaust gases will be collected in order to bring the aircraft back to a small equilibrium positive charge.

It has been determined that the aircraft charge Q can be changed in a matter of seconds from a large negative value equivalent to a potential such as 1,000,000 volts to a large positive potential of similar magnitude. Thus applicant's device is automatic in operation to change the voltage on the probes in accordance to the determined charge on the aircraft. However, it is possible for a human operator to substitute for the D.C. amplifier wherein the operator can observe the charge and adjust the voltages on the probes in accordance to the observed charge on the aircraft, but more slowly. The human operator would replace some equipment, however, the automatic operation is preferred.

The present invention can be adapted to be used on propeller driven aircraft, jet or rocket propelled aircraft, blimps, helicopters or missiles. Thus the installation of such a discharge device on a helicopter or blimp would facilitate ground crew handling for safety purposes during refueling operations, etc.

The present invention provides a simple inexpensive and yet effective device for preventing radio interference on aircraft and also for providing safety devices for various operations. The operation of the device is such that there are no breakdown discharges in the atmosphere around the device; therefore, no noises develop, and there are no sparking, arcing or streamering conditions throughout the continuous operation thereof, such as are found in other devices.

It is not necessary in carrying out the teaching of the present invention to use both a deflection probe and a collection probe in the vicinity of the exhaust of the aircraft. It is possible to provide only either the collection plate or the deflection probe at the exhaust exit and obtain good results; however, the system would not work as efficiently as with both probes.

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 system for controlling the static-charge of an aircraft which comprises static-charge determining means adapted to be secured to said aircraft, current receiving means adapted to be connected with said static-charge determining means to receive a current therefrom, an ion collection probe and an ion deflection probe adapted to be secured directly opposite each other on opposite sides of an exhaust stream of said aircraft and electrically connected to said current receiving means, said current receiving means adapted to apply a voltage to said collection probe of the same polarity as the static-charge on said aircraft and to apply a voltage to said deflection probe of the opposite polarity from the static-charge on said aircraft, whereby said collection probe collects ions of a polarity opposite to that of the aircraft and said deflection probe forces said ions toward said collection probe.

2. A system as claimed in claim 1 wherein the surface area of said collection probe is large in comparison to the surface area of said deflection probe.

3. A system for controlling the static-charge of an aircraft which comprises a static-charge determining means adapted to be secured to said aircraft, an amplifier means connected with said static-charge determining means to receive a current therefrom and provide a voltage output of the same polarity as the static-charge, an ion collection probe and an ion deflection probe adapted to be electrically secured to said amplifier means and to receive the voltage output therefrom, said amplifier means adapted to apply a voltage to said collection probe of the same polarity as the static-charge of said aircraft and to apply a voltage to said deflection probe opposite in polarity to the static-charge of said aircraft, said collection and deflection probes being positioned directly opposite each other on opposite sides of an exhaust stream from said aircraft whereby said collection probe collects ions in the aircraft exhaust of opposite polarity from that on the collection probe and said deflection probe forces said ions toward said collection probe and the ions of the same polarity as said deflection probe are exhausted to the surrounding air.

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