

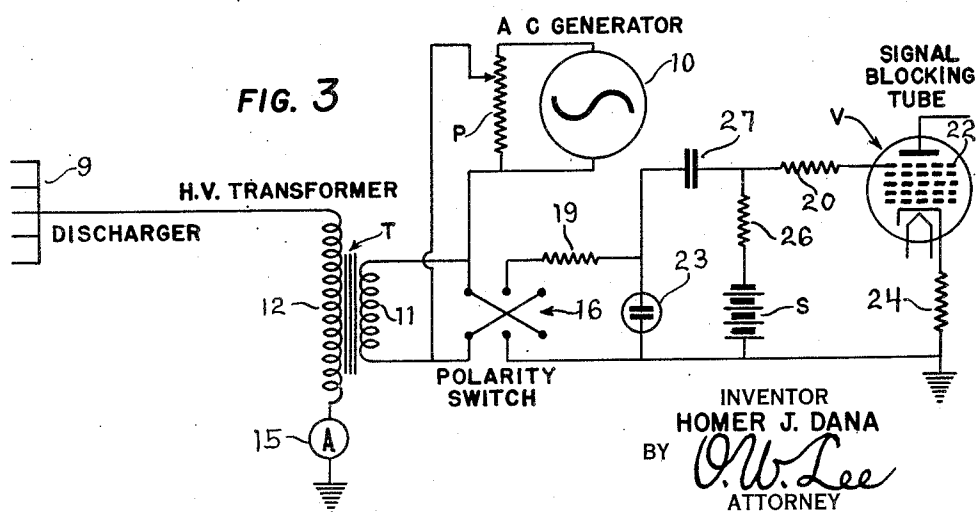
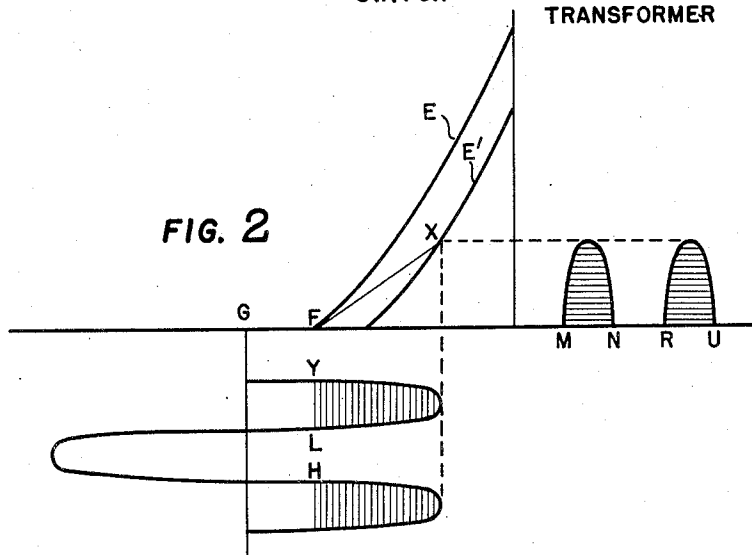
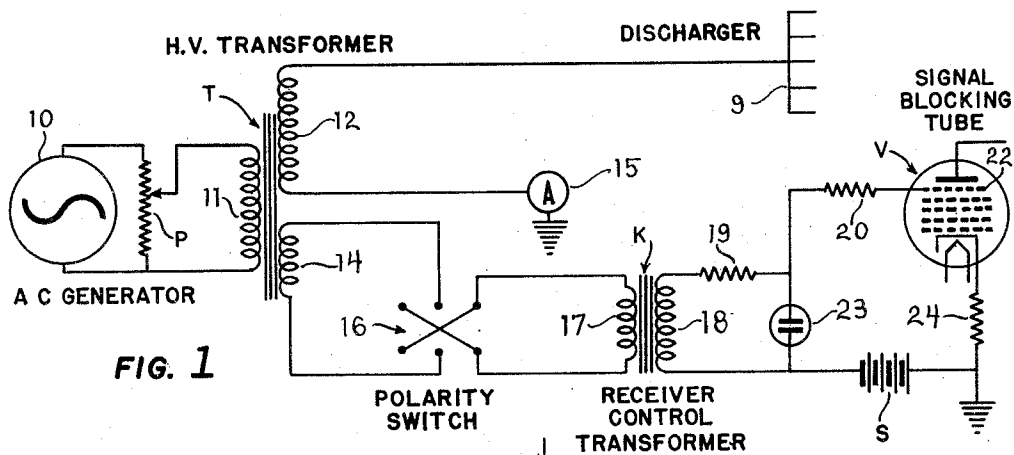
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PRECIPITATION STATIC CONTROL FOR AIRPLANES

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PRECIPITATION STATIC CONTROL FOR AIRPLANES

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The present invention relates to certain new and useful improvements in precipitation static control for airplanes and is particularly directed to alternately accelerating and decelerating a corona discharge from the airplane and automatically blocking the radio receiver during each of the accelerating periods so that the radio receiver functions only during the decelerated periods when the corona discharge is sufficiently low to cause no objectionable interference with the radio signal.

When an airplane flies through precipitation such as rain, snow, frost, sleet, etc., an electrostatic charge accumulates on the surface of the airplane. This electrostatic potential continues to build up until some sharp edge or corner emits a corona discharge to atmosphere. Thereafter the rate of corona discharge balances the rate of charge unless the charging rate exceeds the capacity of this original discharging point, whereupon other less sharp portions of the airplane will then emit additional corona discharge arcs. Whenever this corona discharge reaches a current density of about 35 to 50 microamperes it will usually produce considerable radio noise which greatly interferes with radio reception on the airplane. On the larger and faster airplanes, the corona discharge may range from 150 to 600 microamperes or more, and thus render the radio receiver entirely useless because the extreme noise which the corona discharge produces in the radio receiver drowns out all intelligible sounds.

The size of the airplane and its speed are important factors, because the electrostatic charging rate is directly proportional to the area bombarded by moisture particles, and to the cube of the true air speed. Thus it will be seen that the electrostatic charge on the plane may reach a gigantic amount and give rise to considerable difficulties. For these reasons, the capacity of any noiseless type of discharger is not sufficient to adequately discharge the static encountered on the larger and faster type of airplanes.

The present invention provides for discharging the static at a rate far above that which would be noiseless, and it is thus possible to momentarily dissipate the charge at a faster rate than it is accumulating on the airplane. This accelerated discharging is done at high frequency and with the radio receiver automatically turned off during each accelerated discharge period, so that the radio receiver is in operation only during the intervals between these accelerated discharge periods.

The present invention localizes all of the corona discharge, and also modulates that dis-

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charge so as to provide recurring periods of noiseless reception interspersed between high potential discharge periods which would be totally unsuited for radio reception. For this purpose, a high capacity discharger with a low corona starting voltage characteristic, is employed, so that it will have a wide range of capacity to meet the various requirements encountered in actual practice. The noise making characteristics of the discharger are a matter of no consequence in the present invention which intends an extremely noisy period of corona discharge during each momentarily inoperative period of the radio receiver. The invention may be properly termed a "block and squirter" system, wherein the radio receiver is first blocked and then the electrostatic charge is squirted from the airplane through the discharger and into the atmosphere as a corona discharge, and thereupon the radio receiver is momentarily turned on for a listening period while the corona discharge is sufficiently low that there is no objectionable interference with the radio signal. The interval between the listening periods is made sufficiently short that the interruptions are imperceptible and the signal has the same sound as though it were continuous.

The nature and principle of the invention will be best understood by reference to the accompanying drawing.

Fig. 1 is a circuit diagram of the invention.

Fig. 2 diagrammatically illustrates the operation of the signal blocking vacuum tube which is used as an automatic switch for the radio receiver.

Fig. 3 shows a simplification of Fig. 1.

The discharger 9 is suitably mounted on the exterior of the airplane and may take various forms such as any device which has an edge or a pointed end of very small radius, and efficiency may be enhanced by multiple points from which several corona arcs may be simultaneously discharged. As shown in Fig. 1 this discharger 9 is grounded to the plane through the secondary 12 of the high voltage transformer T, the primary 11 of which is energized by the A. C. generator 10, the potentiometer P or other suitable means being employed to vary the output of the generator 10. As here shown, an ammeter 15 is included in the circuit of the secondary 12 so as to indicate the amount and polarity of the corona current flowing from the airplane to the discharger 9, and thus afford information as to the amount of A. C. voltage necessary to effectually control the corona discharge.

To alternately block and open the signal flow

through the radio receiver used on the airplane, one of the vacuum tubes V of the radio receiver is used as an automatic valve to alternately open and close the circuit at the frequency of the A. C. potential supplied to the discharger 9. This signal blocking tube V may be the mixer tube conventional in superheterodynes, leaving this mixer tube to also serve its usual purpose even though it is used as a signal blocking tube or automatic valve. Some other receiver tube such as the R. F. tube or I. F. tube may be used for this purpose, or it is also feasible to provide a separate tube suitably interposed between the antenna and the receiver.

This signal blocking tube V has one of its grids biased beyond cutoff by the bias source S which is here shown as connected to the suppressor grid 22 through the secondary 18 of the receiver control transformer K which has its primary 17 energized by the A. C. generator 10 as for instance through the secondary 14 as here shown. This receiver control transformer K is employed so as to utilize low voltage from the secondary 14 and thus avoid undue transmission losses, after which this receiver control transformer affords the increased voltage necessary to modulate the grid bias on the signal blocking tube V. The polarity switch 16 is provided so as to reverse the polarity in accordance with the polarity of the corona discharge which may be either negative or positive, dependent upon atmospheric conditions.

To provide a regulated A. C. potential to the grid 22 of the signal blocking tube V the voltage regulator tube 23 and resistor 19 are connected in series across the secondary 18 of the receiver control transformer K. As a precautionary measure to limit the positive grid current, the resistor 20 is connected between the voltage regulator tube 23 and the grid 22. The cathode resistor 24 is employed to afford self bias of the control grid of the signal blocking tube V, this resistor and the bias source each being connected to ground as shown.

Fig. 3 shows a simplified diagram which affords essentially the same function and control as Fig. 1. In Fig. 3 the potentiometer P of the A. C. generator 10 is connected direct to the polarity switch 16 which is connected direct to the receiver control circuit, thus eliminating the need for the previously described secondary 14 and the receiver control transformer K which are needed only when the signal blocking tube V is situated remote from the high voltage transformer so that power losses need to be overcome.

In the simplified embodiment shown in Fig. 3 the signal blocking tube V has one of its grids biased beyond cut-off by the bias source S which is here shown as connected to the suppressor grid 22 through the filter resistor 26 and current limiting resistor 20. The cathode resistor 24 is employed to afford self bias of the control grid of the signal blocking tube V, this resistor 24 and the bias source S each being connected to ground as shown. The condenser 27 couples this described suppressor grid circuit to the voltage regulator tube 23 which is connected in series with the resistor 19 to opposite sides of the polarity switch 16, which is connected in parallel with the A. C. generator 10 which is also connected to the primary 11 of the high voltage transformer T the secondary 12 of which connects the discharger 9 to ground as previously described. The voltage regulating tube 23 and corresponding side

of the polarity switch 16 are connected to ground, as shown.

In the operation of the invention, it is of course understood that the A. C. generator 10 and high voltage transformer T are of a capacity to afford sufficiently high voltage to modulate the corona discharge to a noiseless level. It is then a simple matter for the operator to regulate the potentiometer P to whatever output is necessary for modulating the corona discharge sufficiently to afford noiseless reception on the radio receiver. The ammeter 15 may be used as a guide for this purpose so as to facilitate regulating the modulation according to the requirements of the corona discharge. It is only necessary that the modulating potential be sufficiently high to effectually decelerate the corona discharge to a current value which is sufficiently noiseless that it will not produce objectionable radio interference.

The grid 22 of the signal blocking tube V is biased beyond cut-off, and this bias is modulated by an A. C. potential of the same frequency as used for modulating the corona discharge. The phase relation between these two modulating potentials is either in phase or else 180 degrees out of phase, depending upon the polarity of the electrostatic charge, the polarity switch 16 being employed to accomplish the necessary phase shift.

The voltage regulating tube 23 affords a constant modulating potential on the grid 22 of the tube V irrespective of variations in the output of the A. C. generator 10 necessary to meet the requirements of proper modulation of the corona discharge.

The signal blocking tube V having its grid biased beyond cut-off, will not pass any signal until the modulating potential reduces the negative bias sufficiently to render the tube radio-conductive. This radio-conductive period occurs during the decelerated period of the corona discharge, and is less than a half cycle, due to the fact that the grid is biased beyond cut-off.

Fig. 2 shows a typical example of the relation between the plate current and grid voltage of the signal blocking tube V. As here shown, the curves E and E' show typical changes in plate current affected by modulation of the grid bias. The line F—X represents the actual variation of plate current with grid bias modulation. Here the grid bias is shown at the point G beyond cut-off. The A. C. modulation renders the tube radio-conductive over that portion Y—L of the modulation cycle which is above cut-off and the incoming signal will pass thru the tube in recurring pulses as shown at M—N and R—U. It will be noted that the interval between pulses is longer than the pulse interval and this is necessary where the noiseless period of corona discharge is less than a half cycle which is the condition usually encountered in actual practice.

I claim as my invention:

1. A method of controlling precipitation static of an air-lane radio receiver having electron discharge tubes with grids anode and cathode, which comprises discharging the accumulated electrostatic potential as a localized corona discharge, modulating said corona discharge by applying thereto a high voltage alternating current potential sufficient to alternately accelerate and then decelerate the corona discharge to a noiseless value, applying to a grid of one of the tubes of the radio receiver a negative bias potential sufficient to bias the plate current of that tube beyond cut-off, modulating that grid bias at the

same frequency as said modulated corona discharge and phased according to the polarity thereof, whereby the radio receiver will pass signals only during that portion of the decelerated half cycle when the corona discharge is below the noisy value.

2. A method of controlling precipitation static of an airplane radio receiver wherein the transmission periods are governed by an electron discharge tube having a cathode an anode and a grid biased beyond cut-off, which comprises discharging the accumulated electrostatic potential as a localized corona discharge, modulating said corona discharge by applying thereto a high voltage alternating current potential sufficient to alternately accelerate and then decelerate the corona discharge to a noiseless value, modulating the grid bias by applying thereto an alternating current potential of the same frequency as the modulated corona discharge and phased according to the polarity thereof, whereby the radio receiver will pass radio signals only during that portion of the decelerated half cycle when the corona discharge is below the noisy value.

3. A method of controlling precipitation static of an airplane radio receiver which comprises discharging the accumulated electrostatic potential as a localized corona discharge, modulating said corona discharge by applying thereto a high voltage alternating current potential sufficient to alternately accelerate and then decelerate the corona discharge to a noiseless value, electronically switching the radio receiver on and off at the same frequency as the aforesaid modulated corona discharge and in corresponding phase relation therewith, so that the radio receiver is operative only during the noiseless portion of each decelerated period of corona discharge.

4. A precipitation static control for an airplane radio receiver, comprising a corona discharger, means for applying a high voltage alternating current potential to said discharger to modulate the corona discharge therefrom, a vacuum tube for controlling the transmission periods of the radio receiver, means whereby a grid of said tube is biased beyond cut-off, means for applying to said biased grid a modulating potential of the same frequency as the aforesaid corona modulating potential and phased according to the polarity of the corona discharge, so that said tube will automatically turn off said radio receiver each time the bias exceeds cut-off.

5. In a device of the class described wherein there is an airplane radio receiver having electron discharge tubes with grids anode and cathode, a precipitation static control comprising a corona discharger, means for applying a high voltage alternating current potential to said discharger to modulate the corona discharge there-

from, means whereby a grid of a selected tube of the radio receiver is biased beyond cut-off, means for applying to said grid an alternating current potential of the same frequency as said modulating potential and phased according to the polarity of the corona discharge whereby said tube will automatically turn off said radio receiver each time the bias exceeds cut-off.

6. A precipitation static control for an airplane radio receiver, comprising a corona discharger, a vacuum tube having a grid biased beyond cut-off, means to modulate said biased grid and the corona discharge from said discharger at the same frequency and relative polarity, whereby said tube can be used as an electronic switch for the radio receiver and thus provide recurring periods for signal transmission in timed relation with the modulated corona discharge.

7. A precipitation static control for an airplane radio receiver, comprising a corona discharger, a high voltage transformer having a secondary winding in series between said discharger and the airplane, an alternating current generator energizing the primary of said transformer, a vacuum tube having a grid biased beyond cut-off and in circuit with the radio receiver, means for applying portion of the output of said generator to said biased grid to modulate said biased grid and the corona discharge at the same frequency, and a polarity reversing switch for changing the phase of the modulated grid bias according to the polarity of the corona discharge.

8. An aircraft radio system including, on board an aircraft, a radio receiver, means for cyclically discharging said aircraft to approximately the potential of the surrounding atmosphere, and means for cyclically disabling said receiver in synchronism with said discharge.

9. An aircraft radio system including, on board an aircraft, a radio receiver, an antenna, and control voltage responsive electronic switch means connected between said antenna and said receiver; a discharge wire, and source of cyclically repeated high voltage pulses connected to said discharge wire and to the body of said craft, and means for applying pulses from said source as a control voltage to said switch means to effectively disconnect said receiver from said antenna cyclically in synchronism with said pulses.

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