SILVER IODIDE ICE NUCLEI GENERATOR STARTER TRIGGERED BY ATMOSPHERIC ELECTRIC POTENTIAL GRADIENT

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ABSTRACT

Observations on Silver Iodide Ice Nuclei Generator operations in the Andes of Northern Peru during the 1966-68 raining seasons showed continuous lack of correct compliance on given operations instructions at several installation sites; long-time generator operators began to object to AgI ice nuclei generator operations and to complain about too much precipitation shortly after beginning and during generator operations times.

Therefore, a device was developed to have generators operated by themselves fully automatic during desired time intervals using higher than normal atmospheric electric potential gradients as a starting trigger.

INTRODUCTION

According to Houghton (1968), it appears that the active liftime of a convective cell is much the same as the time required to grow precipitation particles and, therefore, that artificial nucleants should be inserted during the inception of the cell.

Assuming that an average fair-weather atmospheric electric potential gradient of 1 v cm^{-1} is enhanced about tenfold by space charge carried aloft during convection, then from sharp points located high enough above ground Corona Point Discharge will occur below such changed gradients.

It was noted frequently during the two rainy seasons in Northern Peru before 1966/67 that at different locations in the High Andes of Northern Peru the atmospheric electric potential gradients rose to such values below active cells, up to thirty minutes before rainfall occurred from those, and which formed normally above steep and narrow valleys.

AgI ice nuclei generators located at most favorable sites such as the upper portions of narrow and steep valleys at or above average cloud base levels, and started to operate by a device using higher than normal atmospheric electric potential gradients, and turned off after a preset time by means of a time-delay-relay or clock-operated switch, could well provide the necessary artificial nucleants shortly before and during the inception of growing cells.

Therefore, a generator to produce AgI-ice nuclei which could be started fully automaticwas prepared and installed near the meteorological observatory "477-Kanzel" of Compania Peruana de Servicios Meteorologicos S.A., within the upper-most portion of the Chicama Valley in Northern Peru (7^{o} 28' S - 78^{o} 21' W) at nearly 13,000 ft. MSL, and tested for four months during the 1968 rainfall season. It worked perfectly below summer convective clouds every time during the beginning and progress of overhead thunderstorms, as well as during the formation of cumulus congestus clouds, above the installation site, even if the cumulus congestus clouds did not develop into fully grown thunderstorms.

Cloud formation, thunderstorm occurrence, and generator operation were observed closely by a person who lived in a tent at the test installation site, and who made immediate reports to the author via a specially installed field telephone, during the entire test time; an extra "alert" in form of a bell connected to a heat sensitive switch inside the generators burner compartment was added to the observation system; the test generator was sealed into a metal housing, therefore manual starting and/or tampering with the test equipment was not possible.

OPERATION

The double-pole-double-throw starting switch inside a Howell string-type AgI ice nuclei generator of the "Mark-B-1" series was removed and replaced by a device as shown in Fig. 1.

Corona Point Discharge resulting during atmospheric electric potential gradients of about 10 v cm^{-1} provided the trigger impulses for proper operation of the generator. The Corona Point Discharge occurred from a sharp metal point located high above the ground. After a preset time of operation, the AgI ice nuclei generator was turned off by means of a clock-operated contact arrangement. If after turn-off time the atmospheric electric potential gradient above the generator site was still such that Corona Point Discharge took place, the cycle repeated until a normal fair-weather atmospheric electric potential gradient reigned above the area.

To obtain Corona Point Discharge early enough to effectively trigger the starter of the AgI ice nuclei generator, the "sharp point" of the device was located 30 feet above the ground, as can be seen in Fig. 2. which shows the installation in the field. This distance from the ground proved satisfactory for the test operations, but higher "sharp-point" arrangements would make the device more sensitive and would provide earlier turn-on impulses.

To prevent lightning damage to the system, a large single-layer air-core coil of bare number 6 copper wire together with a point-spark-gap was located between the sharp point and the starting device providing a short way to ground for eventual direct lightning hits.

Power for the operation of the test installation was provided by one large 6 volt battery set which was recharged by a wind-driven generator.

DISCUSSION

Really favorable AgI ice nuclei generator operation sites are often found at remote locations, and effective generator operations depend highly on responsible operators.

This automatic AgI ice nuclei generator starting device could prove satisfactory for generator installations at most favorable but remote sites without inhabitants. If higher-than-normal atmospheric electric potential gradients frequent those areas, automatic generator arrangements with sufficient supplies for long-term operations could prove most useful as artificial cloud seeding devices for such areas. It is suggested that the device be tested to start ground based AgI ice nuclei pyrotechnics and normal ground based generators, and also, that the device be tested previous to minor modification for use in remote control seeding operations, with different seeding agents used for different types of cloud seeding activities. With minor modifications it could also be tested for radio-control and/or telephone-contact operation for sites which would not provide clouds showing atmospheric electric potential gradients strong enough for self-contained operation, that is: from sites within areas from where strong advection would carry the artificial nucleants - well mixed within a large volume of air - into areas where they would be expected to become effective.

During the Northern Peruvian operation high-quality target clouds normally were not found above near-coastal areas which were dry and arid, but favorable advection towards regions where convection favored the development of those was frequently observed.

During the test time, a precipitation gage network installed downwind from the automatically started AgI ice nuclei generator showed increases up to about four miles downwind from the test site. This increase was found to be above the average increase obtained within the target area of the above mentioned project. Furthermore, during several occasions soft small diameter hail of about 3mm was found downwind of the AgI ice nuclei generator to be tested, when average cloud bases were below the test site. The small hail fell mainly onto a large plateau, located east of the test site, and about 200 to 250 feet higher in elevation. There was no hail observed at this plateau within the 10 years of continuous observation prior to the test operation, but hail was observed downwind from another AgI ice nuclei generator site located approximately at the same altitude within the projects area of Compania Peruana de Servicios Meteorologicos S.A., during those 10 years.

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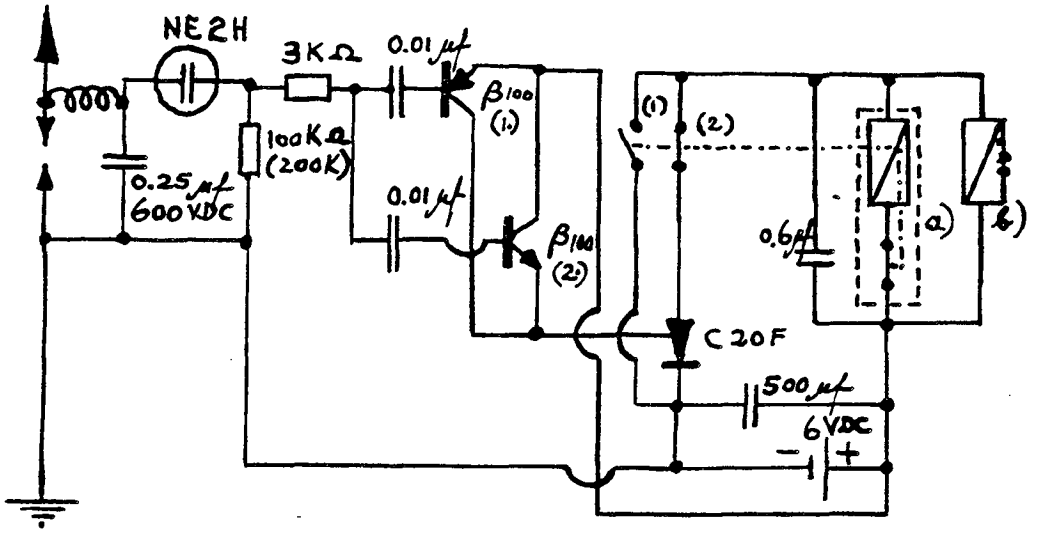


a) Electric clock operated relay or time-delay-relay

b) Relay to generator

Silicon controlled rectifier is GE C 20 F

Transistors: (1) - PNP Selenium β 100, (2) - NPN Selenium β 100

Contacts (1) and (2) are clock-operated

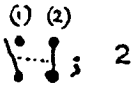
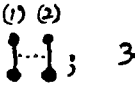
Phases of clock-operated contactsare: 1 -  ; 2 -  ; 3-  .

Fig. 1

Diagram of Silver Iodide Smoke Generator Switch operated by Atmospheric Electric Potential Gradient

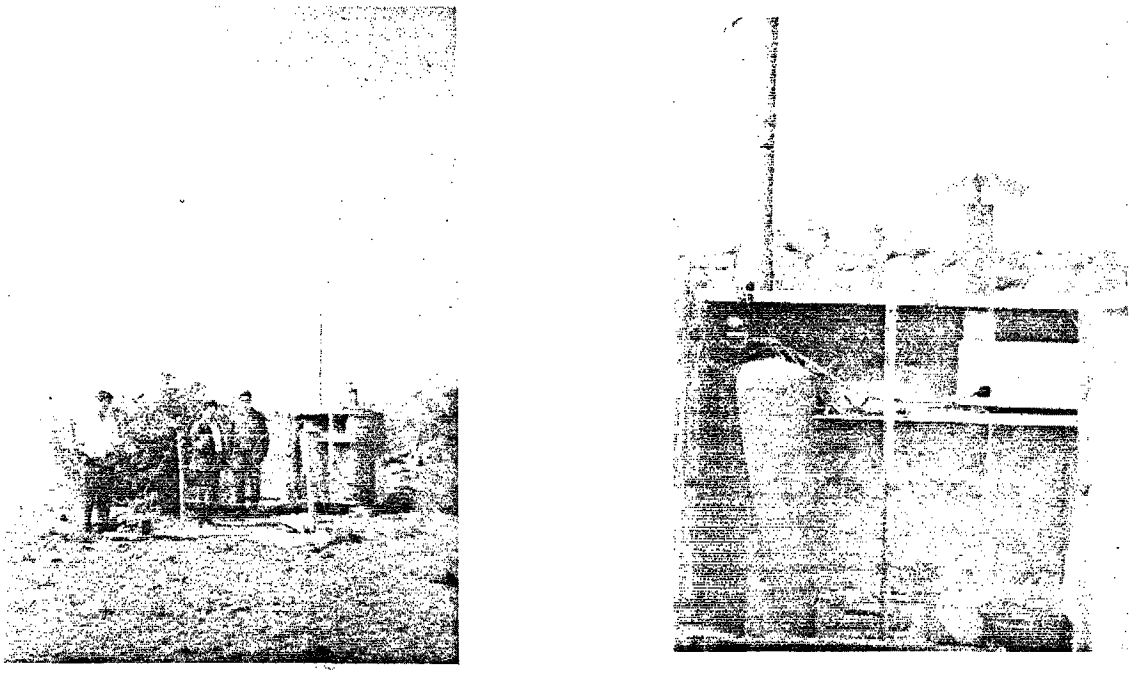


FIGURE 2.

Field installation of automatic silver iodide smoke generator operated by a starter using atmospheric electric potential gradients, near meteorological observatory "477 - Kanzel", upper Chicama Valley, Peru (7° 28' S - 78° 21' W)

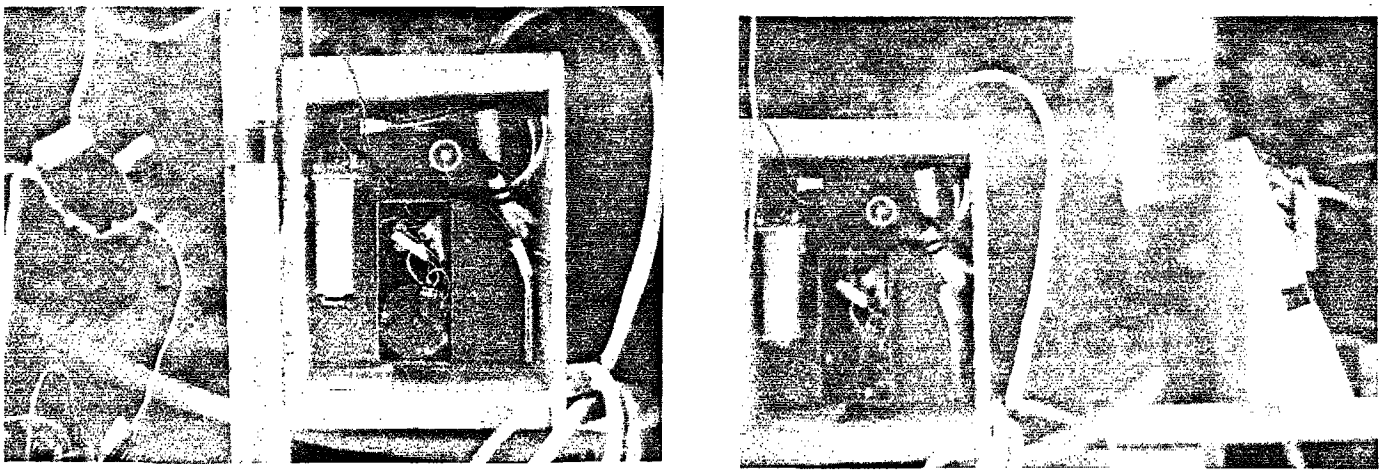


FIGURE 3.

Close-up views of the automatic generator starter, without and with part of silver iodide generator (flame vaporizing silver iodide impregnated string)