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METHOD AND APPARATUS FOR SEEDING CLOUDS

Filed Jan. 9, 1967

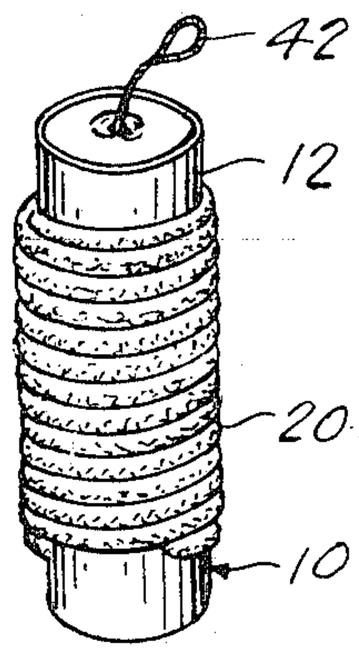


FIG. 1

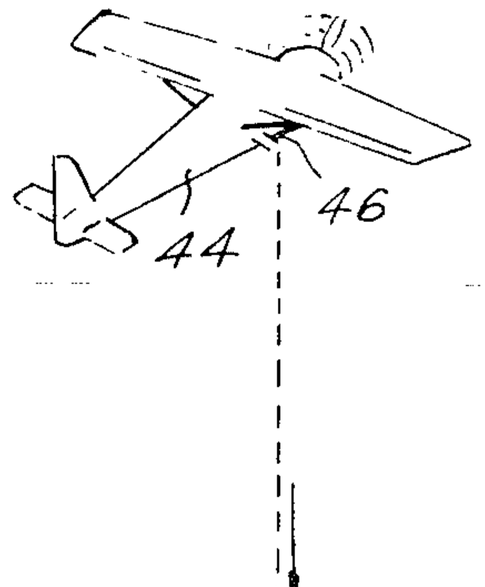


FIG. 5

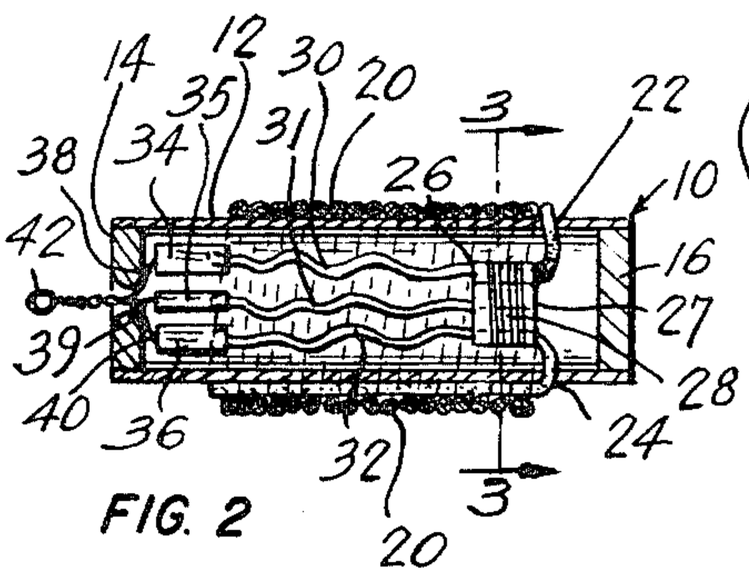
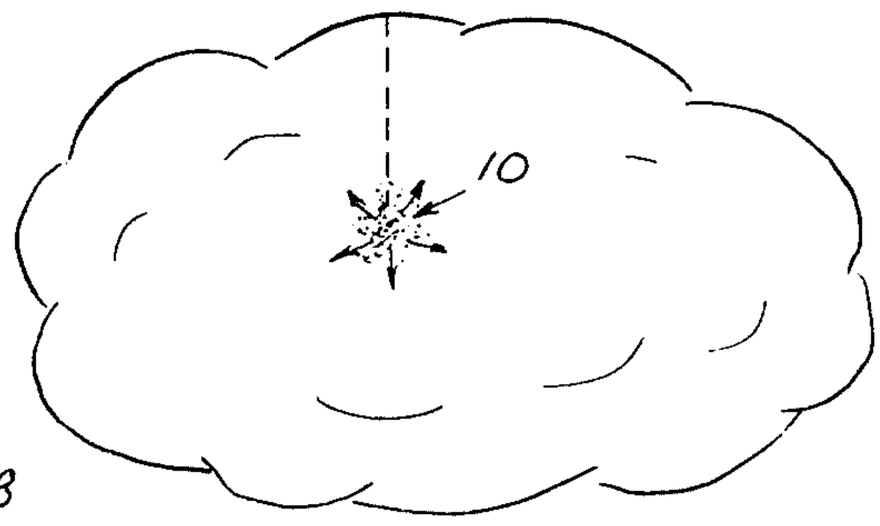


FIG. 2



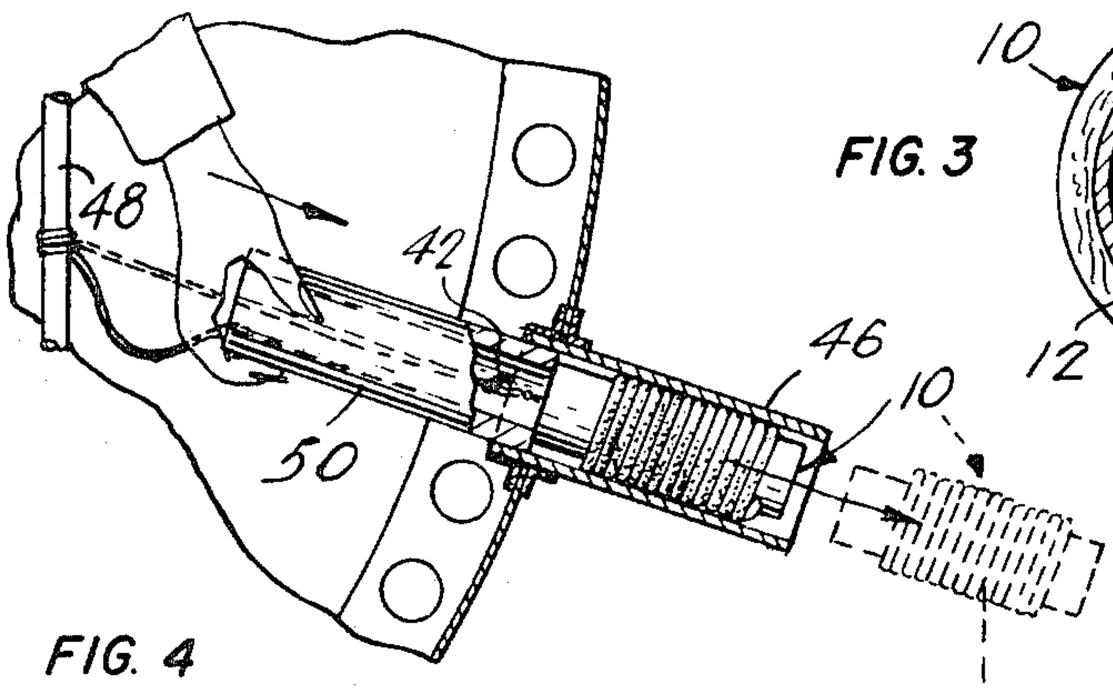


FIG. 4

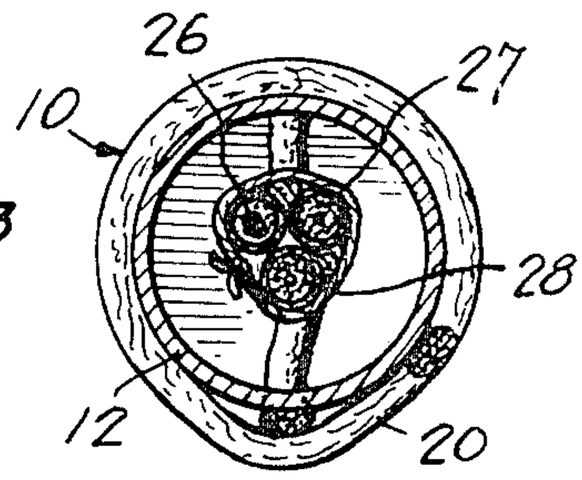


FIG. 3

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METHOD AND APPARATUS FOR SEEDING CLOUDS

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ABSTRACT OF THE DISCLOSURE

An apparatus and method for seeding clouds from an aircraft by means of a package including an explosive generator containing silver iodide. The package also includes a time fuse attached at one end to an igniter and at the other end to a detonator for setting off the fuse cord containing the silver iodide at the required height.

BACKGROUND OF THE INVENTION

The invention relates to the seeding of clouds and particularly to a safe method and apparatus for seeding clouds from an aircraft when using an ice-nucleating material generator of an explosive nature.

Since the developments of V. Schaefer and B. Vonnegut with respect to cloud seeding by introducing into the clouds, crystals of material foreign with respect to the clouds and having a space group and unit cell dimensions closely approximating those of ice crystals, which act as nuclei for the formation of ice crystals within the clouds, as disclosed in U.S. Patents 3,527,230 and 2,527,231, many attempts have been made to improve the efficiency of such cloud seeding. For instance, burner generators have been proposed, by which it is carried by aircrafts through clouds. However, the concentration of nuclei per unit volume when using such generators is very low.

On the other hand, an explosive type generator has now been developed such as is described in U.S. Patent 3,127,107, Merryweather, 1964, which has a very high concentration of AgI in a very small volume. It is noted, however, that the explosive-type generator cannot normally be handled or seeded in clouds by conventional methods.

The present invention aims to provide a method and apparatus for seeding clouds when using explosive-type generators.

In accordance with the present invention, it is proposed to drop a package containing the explosive generator from an aircraft at a predetermined distance above the target cloud. The package includes a casing, an elongated explosive cord-like member, containing dispersed silver iodide, arranged about the exterior of the casing with at least one of its ends protruding within the casing; a plurality of detonator devices attached to the end of the cord-like member, a time fuse connected to each detonator device and having a delay determined by the distance the package is to be dropped, each time fuse being provided with an igniter including an actuator extending outside the casing.

The package is ejected from an aircraft at a predetermined distance above the cloud to be seeded and simultaneously the actuator is actuated thereby igniting the time fuse and subsequently the detonating devices for detonating the explosive cord-like member.

Having thus generally described the invention, the same will be explained in more detail with reference to the accompanying drawings and in which:

FIGURE 1 is a perspective view of the package to be dropped;

FIGURE 2 is a cross-sectional view taken along the central axis;

FIGURE 3 is a cross-sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is a fragmentary view showing the package being ejected from an aircraft, and

FIGURE 5 is a diagrammatic view illustrating the seeding of clouds according to the present invention.

Referring to the drawings and specifically to FIGURES 1, 2 and 3, the package containing an explosive generator is generally identified by the numeral **10**. The package 10 includes a tubular casing **12** which in this case is made of a strong paperboard material. Each end of the tubular casing **12** is provided with a suitable cap **14** and **16**. Cap **14** is provided with a central aperture **18**.

A cord-like explosive member **20** is coiled about the exterior wall of casing **12**. The ends of the explosive member **20** pass through apertures **22** and **24** into the interior of casing **12**. The cord-like explosive member **20** is preferably of the type described in U.S. Patent 3,127,107 and contains approximately 3.2 gm. of PETN (pentaerythritol tetranitrate) and 0.8 gm. of AgI per foot of cord. It detonates at a velocity of about 18,000 ft. sec.$^{-1}$.

Three No. 6 blasting caps **26**, **27** and **28** are attached to the ends of the member **20** by a piece of string. The blasting caps **26**, **27** and **28** are connected to black powder fuses **30**, **31** and **32** respectively. The individual lengths of fuses **30**, **31** and **32** determine the delay for detonating the charge after ejection. The free ends of the fuses **30**, **31** and **32** are connected with standard pull-wire igniters **34**, **35** and **36** respectively. The pull wires **38**, **39** and **40** extend through the aperture **18** and are connected to a single lanyard **42**. It is understood that for safety purposes the detonating device including the blasting caps are only connected to the ends of the cord-like explosive member when the package **10** is being readied for ejection.

The aircraft **44** from which the package **10** is to be ejected is provided with a barrel **46** protruding through the side wall of the aircraft behind or below the wing.

When it is desired to seed a cloud from an aircraft **44** with the above-described explosive generator, the approximate height at which the aircraft will fly over the cloud is first determined and the fuses **30**, **31** and **32** are cut to a length corresponding proportionally to the time delay required for free fall at that predetermined height. The blasting caps **26**, **27** and **28** are then crimped to the end of the fuses **30**, **31** and **32** and the complete detonating device including the blasting caps, fuse and pull wire igniter is inserted within the casing **12** while at the same time attaching the blasting caps **26**, **27** and **28** to the ends of cord-like explosive member **20**. The end cap **14** is then secured to the rim of the casing **12** with pull wires **38**, **39** and **40** extending through the aperture **18** and attached to the lanyard **42**. The completed package **10** is then placed in a barrel **46** and the lanyard is attached to a fixed member **48** in the aircraft. A push member **50** of the type shown in FIGURE 4 is then applied with pressure to the end of the package **10** to eject the package **10** from the barrel **46**. The action of ejecting the package **10** causes the lanyard **42** to pull the pull wires **38**, **39** and **40** thus activating the pull wire igniters **34**, **35** and **36** in order to light the fuses **30**, **31** and **32**. As the package **10** falls freely through the air, as shown in FIGURE 5, the fuses burn until the blasting caps **26**, **27** and **28** are reached whereby the explosive charge is detonated. Thus, the silver iodide dispersed in the explosive cord-like member **20** is distributed in the cloud in order to form ice-generating nuclei.

An important safety feature of the package **10** is that at least three independent detonating devices are used.

Therefore, if one igniter, fuse or blasting cap is defective, the others can still detonate the charge. Of course, the more independent detonating arrangements used, the greater the safety factor.

Example

Height of cloud:		
Base	feet	2000
Top	do	6000
Distance of aircraft over cloud	do	1000
Length of time fuse	inches	7
Composition of explosive cord member (PETN mixed with silver iodide in the following proportions):		
Silver iodide	grains per foot	10
PETN	do	50
Length of explosive cord member	feet	25

Detonator, 3 No. 6 blasting caps.

Ground observations vertified that the detonation occurred at the proper predicted height within the cloud.

Five minutes after detonation, the top of the cloud was seen to increase in height, some 500 feet, and a changeover of the cloud composition from supercooled water droplets to ice crystals was observed visually, according to the usual visual criteria for such a change, i.e., softening in the appearance of the outline of the cloud and general fuzziness developing in the cloud mass, etc. This verified that the silver iodide released by the detonation had operated to convert the supercooled portion of the cloud to ice crystals.

We claim:

1. A method of cloud seeding comprising the steps of flying over a cloud to be seeded at a given distance from the cloud in an aircraft, placing an explosive body containing dispersed ice-nucleating materials connected to a plurality of time-detonating fuses in an ejection zone outside of the aircraft body, coordinating the time fuse to said given distance, ejecting said explosive body while simultaneously initiating the ignition of each time fuse as the explosive body is ejected from the ejection zone outside of the aircraft body thereby causing the detonation of the explosive member in said cloud to release the ice-nucleating materials in the cloud.

2. An apparatus for seeding clouds comprising an aircraft body, an ejection tube extending outwardly of the body and communicating therewith, anchor means within the aircraft adjacent said ejection tube, a tubular casing,

about which is wrapped a cord-like explosive member containing dispersed ice-nucleating materials suitable for insertion within the ejection tube; at least a portion of said cord-like explosive member extending within said casing, a plurality of detonating devices attached to the portion of the cord-like member extending within the casing, for detonating the cord-like member, a separate time fuse connected to each detonating device, a plurality of self-igniting means each attached to one of said time fuses for individually igniting the time fuses when activated, and a detachable activating means connected to each of said self-igniting means extending outward of said casing and being adapted for attachment to said anchor means when the casing is within the ejection tube, whereby the time fuses are ignited as the casing is ejected from the ejection tube.

3. An apparatus as defined in claim **2** wherein the explosive cord-like member has a core of de-sensitized pentaerythritol tetranitrate and a protective sheath about said core, said core also containing from 3.5% to about 20% by weight of silver iodide.

4. An apparatus as defined in claim **2** wherein there are three detonating devices, the detonating devices are No. 6 blasting caps and there are three time fuses, one to each blasting cap and three self-igniting means, one connected to each fuse.

5. An apparatus as defined in claim **3** wherein the time fuse is of the black powder type and there is one fuse independently connected to each blasting cap.

6. An apparatus as defined in claim **4** wherein the self-igniting means is a pull-wire igniter and there is one connected independently to each fuse, and the actuator is the pull-wire from the pull-wire igniter extending through the end of the casing and attached to a lanyard adapted to be anchored.

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239—14; 169—28, 36; 102—6; 89—1