United States Patent [19]

St. Amand et al.

[11] **3,788,543**

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[54] **UNIFORM SIZE PARTICLE GENERATOR**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

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[21] Appl. No.: **289,202**

[52] **U.S. Cl.** ..... **239/2 R,** 239/14, 239/102, 239/136

[51] **Int. Cl.** **A01g 15/00**

[58] **Field of Search** 239/2, 14, 102, 136, 142

[56] **References Cited**

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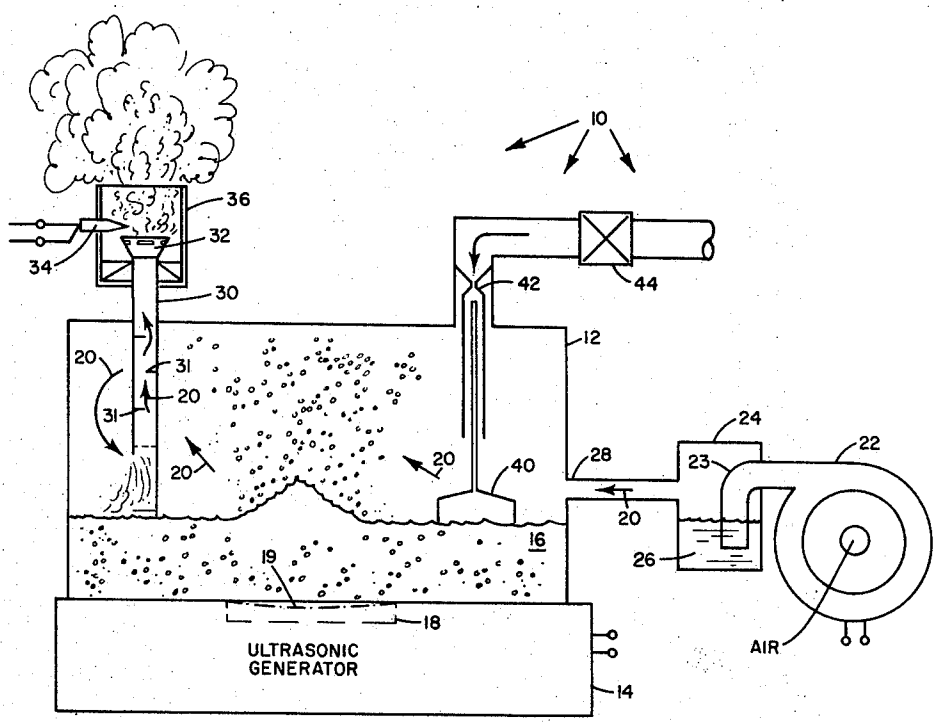
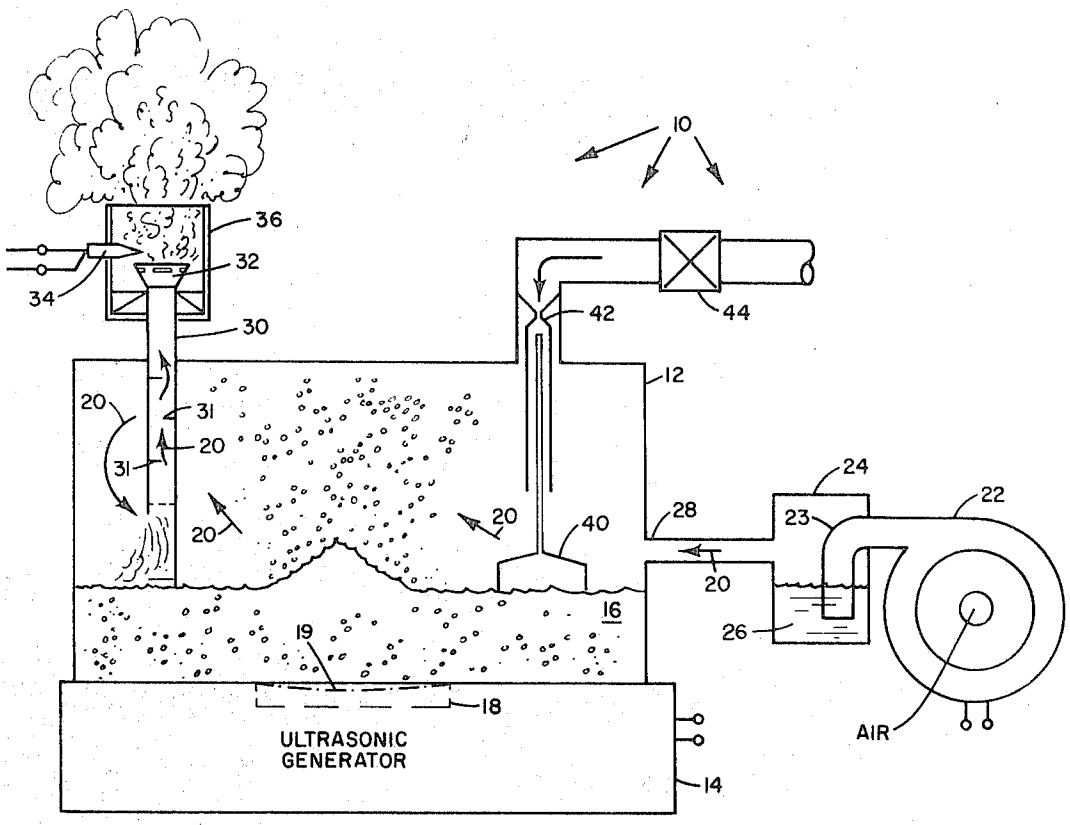
[57] **ABSTRACT**

A method and apparatus is disclosed for generation of fine particles, for example of silver iodide, from a nebulizer for cloud seeding. The nebulizer comprises a large container in which is maintained a constant level of a combustible or highly volatile solution such as an acetone solution of silver iodide. An ultra-sonic generator in the base of the container produces micron size droplets of the solution in the airspace above the solution. The droplets are forced out of the container by a stream of solvent laden air into a burner or vent which burns or evaporates the solvent. Fine particles of the solute silver iodide remain for the cloud seeding operation.

10 Claims, 2 Drawing Figures

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ULTRASONIC
GENERATOR
14
AIR

Fig. 1

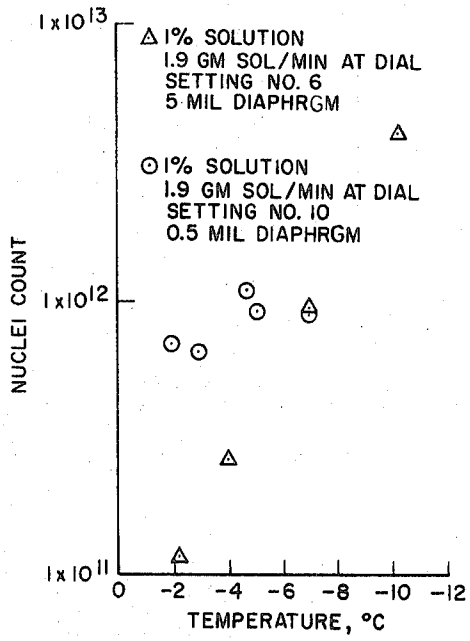
1 x 10 13
△ 1% SOLUTION
1.9 GM SOL/MIN AT DIAL
SETTING NO. 6
5 MIL DIAPHRGM
⊙ 1% SOLUTION
1.9 GM SOL/MIN AT DIAL
SETTING NO. 10
0.5 MIL DIAPHRGM
NUCLEI COUNT
1 x 10 12
1 x 10 11
0 -2 -4 -6 -8 -10 -12
TEMPERATURE, °C

Fig. 2

UNIFORM SIZE PARTICLE GENERATOR

BACKGROUND OF THE INVENTION

This invention relates generally to weather modification and more particularly to the seeding of clouds using ice-nucleating particles, for example silver iodide. Cloud seeding using crystals of silver iodide for example, has been accomplished by a combustion process of vaporizing silver iodide at a high temperature and causing it to recrystallize or by spraying into the atmosphere a solution of silver iodide in ammonia or by burning a solution of silver iodide in acetone.

These procedures, with variation, have been tested and used over a period of years with varying degrees of success depending upon the cloud conditions. It has been found, however, that these prior attempts at weather modification were erratic and unpredictable.

On the theory that control of particle size would result in more efficient and predictable cloud seedings, an apparatus according to the present invention was developed to provide minute particles of uniform size. These particles of controlled size and specific material can be used as cloud seeding nuclei to freeze supercooled water droplets at desired freezing temperatures within a particle cloud with greater realiability and predictability.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a plan view of a uniform particle size generator according to the invention; and

FIG. 2 is a graphic illustration of test data obtained from two test of an apparatus according to FIG. 1.

DESCRIPTION AND OPERATION

The particle sizing process according the invention involves the use of an ultrasonic nebulizer, one form of which is generally indicated by numeral **10** in FIG. **1.** The nebulizer **10** comprises a neublizing chamber **12** mounted on a base **14.** A combustible or highly volatile solution **16** of desired solute concentration is shown within the chamber **12.** A piezoelectric crystal **18,** for example is located at the bottom of the nebulizing chamber and separated therefrom by a plastic energy transfer diaphragm **19.** Acutation of said crystal generates sufficient ultrasonic energy to cause relatively uniform droplets to form from the solution. The micron size droplets thus generated in the nebulizing chamber, form a continuous cloud that is continually removed from the chamber by the movement of solvent saturated air indicated by arrows **20.** For this purpose a blower **22** is provided having a discharge nozzle **23** below the surface of solution **26** in container **24.** Container **24** connects with the chamber **12** through tube **28.** During operation, this solvent saturated air moves the cloud of droplets out of chamber **12** through a vent **30** having a plurality of buffers **31** and terminating at its outer end in a burner **32,** for example, where the cloud of solvent etc. may be ignited by a glow plug or other igniter **34.**

Burner **32** is shown surrounded by a structure **36** which may be closed by a sized screen that would further refine the segregation of large and small drops. As the solvent burns or evaporates, the solute residue remains in the form of dry particles of a predetermined uniform size. The size of the particles is controlled primarily by the concentration of the solute in the solvent and secondarily by nebulizing parameters including solution level, input energy to the ultrasonic generator, solution viscosity, etc.

PRELIMINARY ICE NUCLEI ACTIVITY TESTS

Two initial nuclei activity tests were conducted in a 24 cubic meter cold chamber. The first was performed without a liquid leveler in the nebulizing chamber and a 1-mil thick plastic (Mylar) energy transfer diaphram. A minimum power setting was used. The subsequent test utilized a constant liquid level system **40, 42, 44** and a 5-mil thick Mylar diaphram **19.** A medium power setting was used. Data obtained from the two tests are presented in FIG. **2.** The data of the latter test indicate that the size of the nuclei is an important factor with regard to nuclei freezing threshold.

Although the above method and apparatus has been described in terms only with respect to cloud seeding with silver iodide, obviously many other solutions may be utilized in the nebulizer not only for weather modification and fog dispersal but also for medication and other commercial application.

We claim:

1. A process for the seeding of clouds using ice nucleating particles including the steps of:

dissolving a salt in a combustible solvent to form a solution;

ultrasonically agitating said solution to provide an airborn collection of irregular droplets;

forcibly moving a stream of solvent laden air to create an airborn stream of said irregular droplets away from said solution;

separating and returning the larger droplets from said stream to said solution such that the resulting droplet stream comprises a narrow size spectrum of fine droplets of said solution;

dissipating the solvent from said resulting stream of fine droplets; and dispensing the resulting particles of solute into the atmosphere.

2. The process of claim **1** wherein the solvent is dissipated by evaporation.

3. The process of claim **2** wherein the salt used is silver iodide.

4. The process of claim **1** wherein the solvent is dissipated by burning.

5. The process of claim **4** wherein the salt used is silver iodide.

6. Means for producing uniform particles comprising:

a first enclosed container;

a salt solution in said container;

ultrasonic means agitating said solution in said container to produce a cloud of airborn droplets of solution;

a second container communicating with said first container and being partially filled with solvent;

forced air circulating means causing movement of said cloud of droplets by means of a stream of air forced through said solvent;

a vent defining a passageway for said cloud of droplets out of said container;

a plurality of baffles in said vent causing removal and return of larger droplets from said cloud of droplets; and means external of said vent and in the path of said cloud of droplets for dissipating said solvent.

7. The apparatus of claim 6 wherein said solution comprises a volatile solvent and said means for dissipating is a burner.

8. The apparatus of claim 6 wherein said solution comprises a combustible solvent and said dissipating means serves to ignite said solvent in said cloud of droplets.

9. The apparatus of claim 8 wherein said solution consists of silver iodide and acetone.

10. The apparatus of claim 6 wherein said solution comprises silver iodide.

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