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METHOD OF ARTIFICIALLY INFLUENCING  
THE WEATHER

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1 Claim. (Cl. 239—2)

The invention relates to a method of artificially influencing the weather by turning undercooled clouds into ice particles for the purpose of generating a rainfall and of preventing the formation of hail by seeding the said clouds with ice-forming nuclei, i.e. with freezing or sublimation nuclei in finely atomized form.

The technique of seeding undercooled clouds in this manner has become known per se. In most cases the operation consisted in that undercooled clouds were turned into ice particles by the introduction of finely distributed silver iodide (AgI), whereby in certain circumstances an increase of the rainfall can be attained, or in other cases the formation of hail is made more difficult, and in circumstances even a weakening of the electric phenomena attendant a thunderstorm is attained. The silver iodide has been either atomized on the ground by means of so called ground generators and distributed in the atmosphere under the assumption that the seeding material is entrained into the range of the clouds to be seeded by updraft, or alternatively it has been ferried directly into the clouds to be seeded by means of aircraft, rockets or artillery missiles. In the direct ferrying the atomization of the seeding material is effected by means of special devices built into the aircraft, or by the explosion of an explosive charge.

The use of silver iodide as a seeding material is based on this property of acting as freezing- or sublimation-nuclei even at a relatively high temperature, namely between  $-4^{\circ}\text{C.}$  and  $-5^{\circ}\text{C.}$ , and of turning thereby undercooled clouds into ice particles. Hitherto only very few substances have become known which have nucleus properties similar to those of silver iodide, such as e.g. lead iodide ( $\text{PbI}_2$ ). These substances have not, however gained any importance in practice for this purpose owing to detrimental properties, such as being poisonous. Even silver iodide has two properties detrimental to its use as a seeding material. There is for example the danger of its having it suitability for forming freezing nuclei strongly impaired when finely distributed in the atmosphere owing to photochemical decomposition by sunlight. Moreover its use in large quantities is uneconomic. It is the main object of the invention to provide substances, which show as good a capability of forming nuclei as silver iodide, but are more stable chemically and physically, and are less expensive to obtain.

With this and other objects in view we provide a seeding material consisting of a copper compound of one of the two first elements of the main column of the sixth column of the periodic table having an atomic weight between 15 and 33 inclusive, for example copper sulphide ( $\text{CuS}$ ) and cupro oxide ( $\text{Cu}_2\text{O}$ ).

The suitability of the aforesaid substances as seeding materials for clouds has been recognized by systematic research. A great number of individual substances has been sorted out and grouped from the following two points of view:

(1) According to the crystallographic properties, such as atom distance, grid constant, type of structure, coordination number, symmetry, forms of growth and of cleavage;

(2) According to surface properties such as polarizability of the crystal constituents adsorption properties.

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On the whole, about 100 individual substances have been selected in this manner and investigated together with a series of crystallized solid solutions within the temperature intervals of  $0^{\circ}$  to  $-10^{\circ}\text{C.}$  and  $-10^{\circ}$  to  $-18^{\circ}\text{C.}$  in a cooling chamber as regards their capability of forming freezing- or sublimation-nuclei. The atomization of the substances was carried out in principle in a mortar, the powder seeded by means of an air spray diffuser into an undercooled cloud produced in a cooling chamber.

The substances investigated can be divided into the following main groups:

- (1) Crystallized inorganic substances;
  - (a) Artificially produced;
  - (b) Natural rock-forming minerals;
- (2) Crystallized organic substances (cellulose or protein bodies);
- (3) Vitreous substances.

In order to make attainment more certain, moreover a great proportion of these substances has been examined by X-ray photography.

The investigations lead to result that within the same temperature interval as silver iodide and lead iodide (which had already been known) the following substances in dispersed form act as ice forming nuclei: copper iodide ( $\text{CuI}$ ); cupro-oxide ( $\text{Cu}_2\text{O}$ ); copper sulphide ( $\text{CuS}$ ); copper selenide ( $\text{CuSe}$ ); mercury telluride ( $\text{HgTe}$ ); vanadium pentoxide ( $\text{V}_2\text{O}_5$ ); silver sulphide ( $\text{Ag}_2\text{S}$ ); silver nitrate ( $\text{AgNO}_3$ ); silver oxide ( $\text{Ag}_2\text{O}$ ) and cadmium telluride ( $\text{CdTe}$ ).

For the praxis of influencing the weather by turning undercooled clouds into ice particles mainly copper sulphide and cupro oxide come into question, because the other active substances enumerated are more or less unsuitable either owing to their poisonous character or for economic reasons.

The aforesaid seed-forming substances have to be brought into a state of fine dispersion for the seeding of the atmosphere, in the same manner as known for silver iodide.

For this purpose the following methods have been found particularly suitable:

- (a) Atomizing by evaporation of colloidal solutions or emulsions of these substances,
- (b) Dispersing and atomizing by the aid of an explosive charge,
- (c) Dispersing and atomizing by the burning off of pyrotechnical mixtures,
- (d) Atomizing of pulverized substances by means of air-spray diffuser appliances.

While we have herein described what may be considered typical and particularly useful embodiments of our invention, we wish it to be understood that we do not limit ourselves to the particular details and compounds enumerated, for obvious modifications will occur to a person skilled in the art.

What we claim as our joint invention and desire to secure by Letters Patent is:

A method for artificially influencing the weather by turning undercooled clouds into ice particles for the formation of rain and for the prevention of the formation of hail by the seeding in of ice forming nuclei as the cores of freezing and sublimation in an atomized state into such clouds wherein the seeding material is copper sulphide ( $\text{CuS}$ ).

References Cited in the file of this patent

UNITED STATES PATENTS

2,527,230 Schaefer et al. ----- Oct. 24, 1950