Sept. 1, 1936. H. G. HOUGHTON, JR 2,052,626

METHOD OF DISPELLING FOG

Filed June 5, 1933 3 Sheets-Sheet 1

Fig. 1.

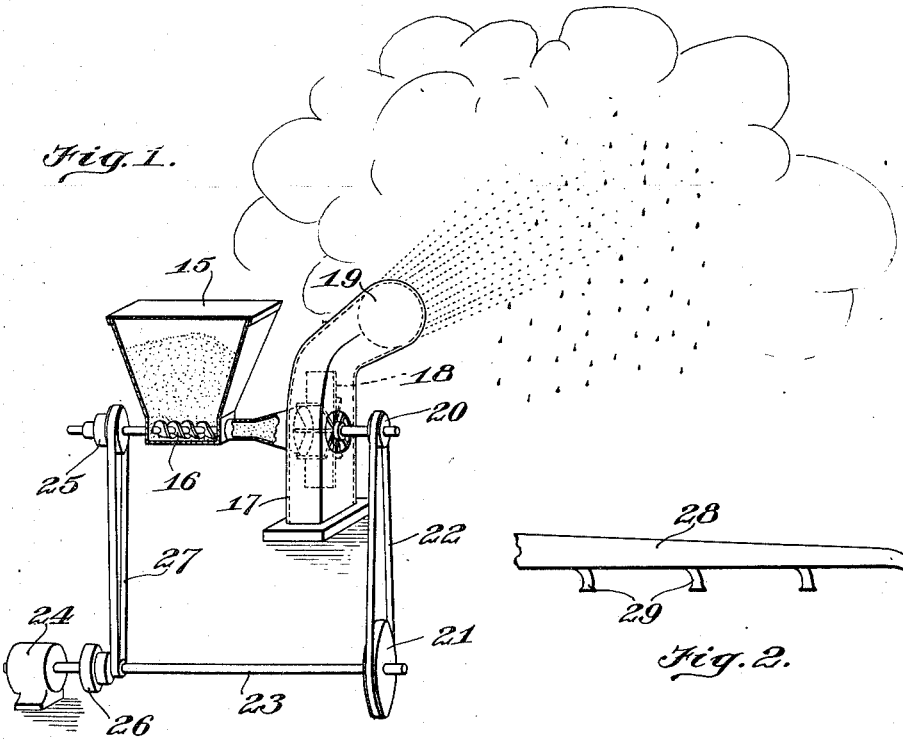

Fig. 2.

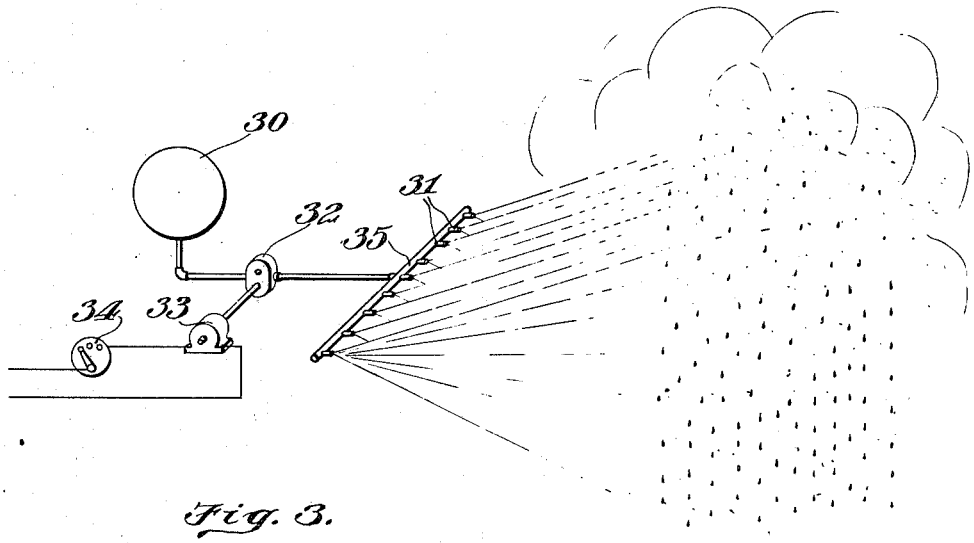

Fig. 3.

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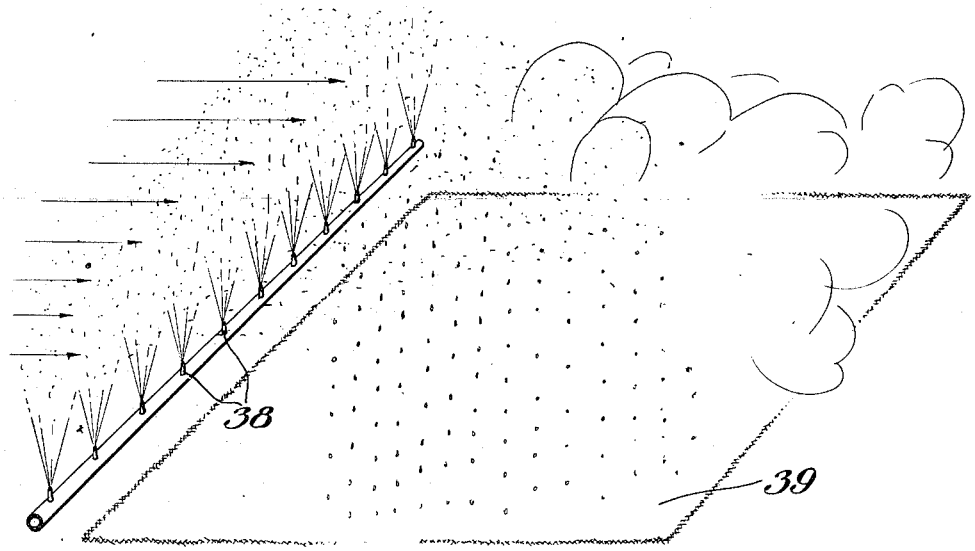

Fig. 5.

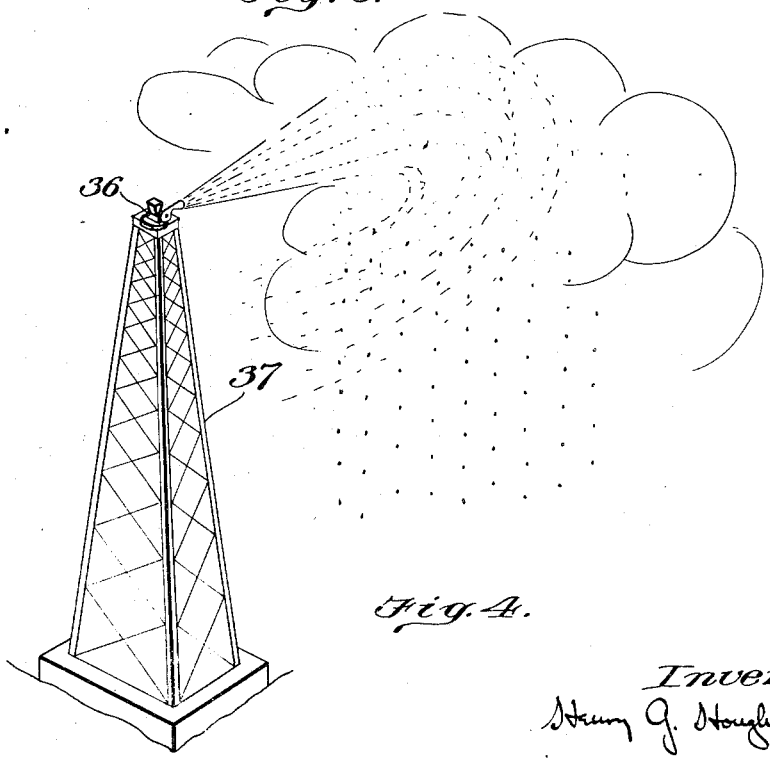

Fig. 4.

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Filed June 5, 1933 3 Sheets-Sheet 3

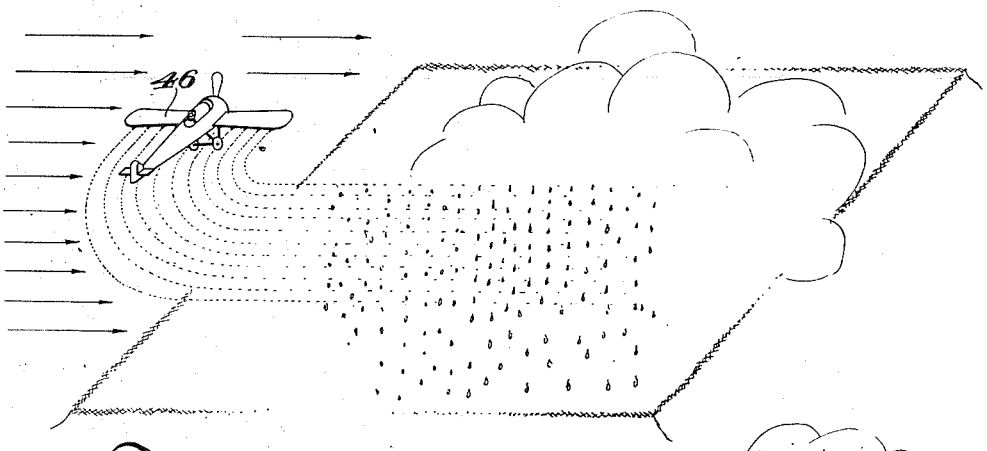

Fig. 7.

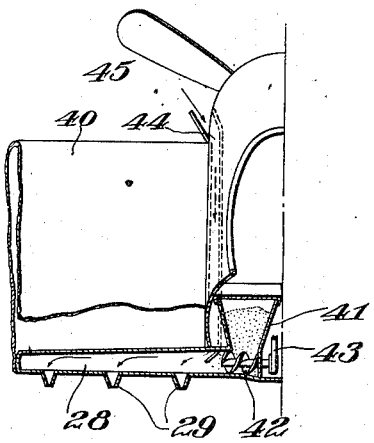

Fig. 6.

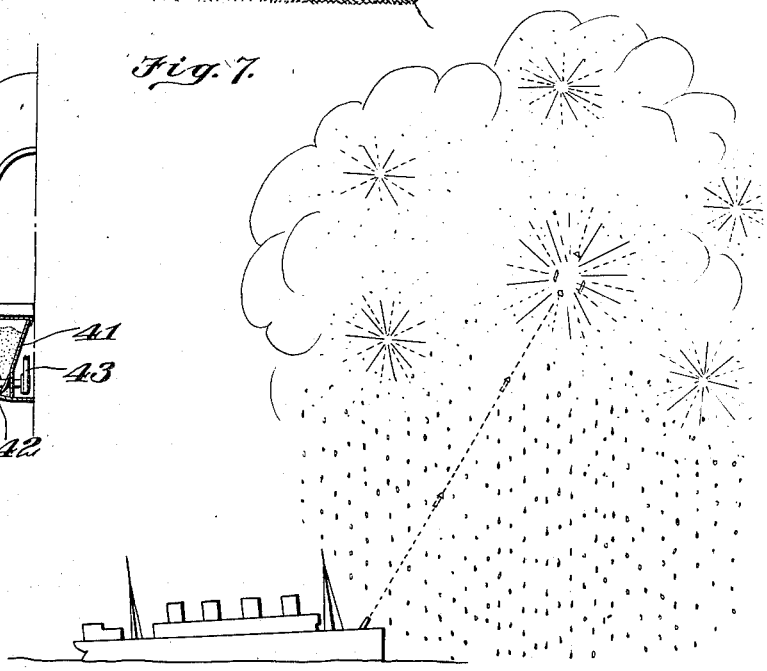

Fig. 9.

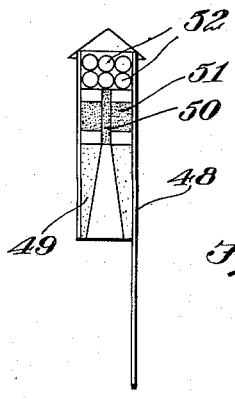

Fig. 8.

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UNITED STATES PATENT OFFICE

2,052,626

METHOD OF DISPELLING FOG

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Application June 5, 1933, Serial No. 674,359

4 Claims. (Cl. 299—28)

This invention relates to means for altering the liquid and vapour phase equilibrium conditions within a given region, and more particularly to the dissipation of fog.

The presence of fog has ever been a serious factor affecting the normal course of commerce. For example, shipping and travel by rail and water are subject to delay and danger from this natural phenomenon. Today, since the realization of air commerce, the limitations due to fog have made themselves felt even more acutely. A ship on the water may anchor but a ship in the air cannot. An aeroplane cannot remain in the air for an unlimited time and therefore cannot ride out a fog.

More specifically then, the present invention has as its object the mitigation of these delays and dangers incidental to navigation in fog and in fact directs itself to any fields where it is desirable to alter the vapour pressure of a substance in a medium such as air and to dispel liquid particles such as those of fog.

I have found that, if finely divided hygroscopic material is dropped through foggy air, droplets of water will tend to form about these hygroscopic particles or artificial nuclei at the ultimate expense of the water of the fog drops, since the removal of the moisture from the air reduces its humidity and thereby permits the evaporation of the remaining moisture in suspension therein. Furthermore, and in addition to this phenomenon, it has also been found that the drops thus formed about the hygroscopic nuclei have in themselves a sweeping action in falling, since by virtue of their physical dimension these drops will collide with the fog particles and at once combine with these particles thus struck, forming even larger drops.

The first phenomenon, that is the condensation of water drops around hygroscopic nuclei, when these nuclei are in the presence of a vapour such as that of water in a given region, and the consequent evaporation of the liquid phase of the substance in the region, that is fog for example, I have investigated and explained as follows:

The vapour pressure of an aqueous solution of a non-volatile solute is less than that of pure water. The amount of this lowering of the vapour pressure is dependent on the concentration of the solution and the nature of the solute. The lowering is greatest for the so-called deliquescent and hygroscopic material, such as concentrated sulphuric acid, calcium chloride, phosphoric anhydride, magnesium chloride, etc. The water of which fog particles are composed contains only a relatively small amount of dissolved salts; therefore, if finely divided hygroscopic material be introduced into foggy air, drops of water will tend to form about these artificial nuclei at the expense of the water of the fog drops.

In the process of dissipation of fog it has been found that as the drops about the neuclei become larger and larger the effect of the falling aggregations of these droplets is to exercise a mechanical clearing or sweeping action by actually colliding with fog particles. This sweeping effect increases with the distance of fall since the sweeping drops are becoming larger and larger compared with the fog particles. Thus, even though a droplet about a hygroscopic nucleus may become of such low saturation that it is in equilibrium with the ambient vapour, and is thus no longer active in reducing the vapour pressure in its surroundings, it may, nevertheless, exert this effective sweeping action on the liquid water particles, that is the fog it encounters in falling. For a given amount of hygroscopic material, the rate of water vapour absorption increases as the particles are made smaller. Further, small particles fall more slowly and are therefore able to act for a longer period than larger particles. On the other hand, the particles must be large enough so that they will reach the ground before the fog can fill in the cleared space. In other words, the size of the particles must be such as to cause them to fall through the atmosphere by gravity, or at least such as to cause condensation thereabout, as nuclei, of drops of sufficient mass to be precipitated out of the atmosphere by gravity and not to remain in permanent suspension therein. This minimum practical size is a function of the wind velocity and the nature and location of the apparatus for disseminating the hygroscopic material and hence it is important to have a means for varying the size of the particles.

This invention, dealing as it does with fog dissipation, has many commercial applications only a few of which need be enumerated here for illustration. In connection with marine navigation it is extremely valuable to know the whereabouts of adjacent ships or other objects in a fog. Vision may be accomplished by projecting or discharging into the air in the desired direction a stream, cloud or spray of hygroscopic particles in dry or liquid form, thus cutting a vision channel out into the surrounding fog. In connection with aerial navigation in a fog it is of paramount importance to be able to view the ground for the sake of orien-

tation or location, and particularly to view the landing field, even if only in part. This invention offers means of dissipating fog locally by dropping or otherwise discharging from an airplane or other airship the necessary quantity of hygroscopic material to clear an area by reduction of vapour pressure, thus causing evaporation of the fog, as well as by the sweeping action of the falling droplets thus produced. The clearing or dissipating discharge of hygroscopic material may be from appropriate apparatus located on the ground.

The invention will be more clearly understood from the following description of several illustrative modes of practicing the same by the use of apparatus shown in the accompanying drawings. It will be appreciated, however, that the particular adaptations of the invention shown and described have been chosen for purposes of exemplification merely, and that said invention, as defined by the claims hereunto appended, may be otherwise practiced without departure from the spirit and scope thereof.

In said drawings:

Fig. 1 is a fragmentary, diagrammatic view of an apparatus suitable for projecting a dry or solid hygroscopic material;

Fig. 2 is a fragmentary sectional view of a modified form of discharge nozzle for use in connection with the apparatus shown in Fig. 1;

Fig. 3 is a view similar to Fig. 1 illustrating an apparatus suitable for projecting a hygroscopic liquid;

Fig. 4 is a perspective view of an installation for clearing the atmosphere in an area around a fixed station;

Fig. 5 is a diagrammatic view of an installation for clearing the atmosphere above an aeroplane landing field;

Fig. 6 is a fragmentary sectional view of discharging apparatus installed in an aeroplane;

Fig. 7 is a diagrammatic view illustrating the use of an aeroplane equipped as shown in Fig. 6 for the purpose of clearing a landing field;

Fig. 8 is a sectional view of a rocket suitable for use in clearing an elevated area;

Fig. 9 is a diagrammatic view illustrating the use of rockets such as that illustrated in Fig. 8.

The apparatus shown in Fig. 1 comprises a hopper 15 for containing a solid hygroscopic material in finely divided form, said material being delivered by a feed screw 16 from said hopper to a blower 17 having an impeller 18 and a suitable discharge nozzle 19. The impeller 18 is driven through pulleys 20 and 21 and belt 22 from the shaft 23 of an electric or other motor 24. The feed screw 16 is likewise driven from the shaft 23 by step pulleys 25 and 26 and belt 27, whereby the rate of supply of the hygroscopic material from the hopper 15 may be varied independently of the speed of the impeller 18.

The discharge nozzle 19 shown in Fig. 1 is of a form suitable for projecting a cloud of the hygroscopic material into the atmosphere in a single stream of considerable volume. In some cases it may be desirable to discharge said material along a line, in which event the discharge nozzle shown in Fig. 2 may be substituted for the nozzle 19. The multiple jet nozzle shown in Fig. 2 comprises a header 28 of any suitable length and provided along its length with a series of individual nozzles 29. The individual nozzles can be so arranged as to size, in combination with a graded cross sectional area of the header 28, that the cloud discharged from the system will form, in effect, a uniform sheet.

When the hygroscopic material is in liquid form, it may be conveniently distributed by a simple pump and nozzle array such as is shown in Fig. 3. In this figure, the hygroscopic liquid is contained in a supply tank 30 and is fed to one or more nozzles 31 under a conveniently controlled pressure by means of a pump 32 driven by an electric motor 33 having a suitable speed controller 34. As shown in Fig. 3, a series of nozzles 31 are supplied from the pump 32 through a header 35, whereby the spray of hygroscopic liquid is supplied in the form of a substantially continuous sheet, as in the case of the dry material supplied by the nozzle shown in Fig. 2.

As illustrated in Fig. 4, projecting apparatus 36 such as that shown in either Fig. 1 or Fig. 3 may be installed upon a tower 37 located in an area which it is desired from time to time to clear of fog. Said tower is of a sufficient height so that the sweeping, as well as the condensing effect above described may be obtained. The projecting apparatus 36 is preferably rotatably mounted on the tower, whereby it may become the center of a circular region of fog clearance. In case of wind, the projecting apparatus may be oriented with respect to it in such a way as to make the clearance in a desired direction most effective.

For the purpose of clearing a landing field at an airport, a battery of discharge nozzles 38 may be set up to the windward of the landing space 39 and so arranged as to project jets of hygroscopic material vertically upward to a considerable height, which material, falling gradually and drifting down the wind, will clear a considerable area. The nozzles 38 may be supplied by individual blowers or pumps, or a less number of blowers or pumps may supply headers provided with individual nozzles, as above described in connection with Figs. 2 and 3.

As shown in Fig. 6, an aeroplane is provided with a discharge nozzle 28, 29, similar to that shown in Fig. 2, along the rear edge of a wing 40, said nozzle being supplied with finely divided solid hygroscopic material from a hopper 41 by means of a feed screw 42 driven through a belt 43 from the aeroplane motor, not shown. In such an installation, the blower 17 of Fig. 1 may be dispensed with, and a suitable draft for distribution purposes supplied, from the propeller 45, through a conduit 44. In lieu of this apparatus, an apparatus similar to that shown in Fig. 3 may be employed for discharging a sheet of hygroscopic liquid spray from the wing edge.

As shown in Fig. 7 an aeroplane 46 having one or both wings equipped as above described may be flown across the wind and clear a wide space to the leeward. With a plane equipped with such an installation, spaces for emergency landings can also be readily cleared.

In Fig. 8 is shown a rocket 48 containing the usual propelling charge 49 and exploding or disseminating charge 50 and also containing a charge 51 of hygroscopic material. Said material may be in the form of a loose quantity of finely divided dry material contained within the body of the rocket, or said material may wholly or in part be carried by separate explosive packets or bombs 52. With the latter arrangement, the propelling charge lifts the rocket to a considerable height, and the explosive charge then distributes the packets or bombs 52 over a wide region, after which said packets in turn explode and shower the finely divided hygroscopic mate-

rial over a large area, thereby quickly clearing a considerable space of fog, as diagrammatically illustrated in Fig. 9. This method, as illustrated in the latter figure, is of a particular use when ships in a dense fog are close together but unaware of their exact relative positions.

In some cases it may be desirable to control the travel, fall or drift of the dissipating material by charging it with sand or other inert material. The sand particles may be coated with a thin layer of the hygroscopic material. Again, it may be desirable so to select the type of material used that it will be of value as a fertilizer to the land upon which it settles, well moisture laden or leached. Numerous other beneficial results and applications of the invention will, however, readily suggest themselves as occasion may arise.

While the embodiment of the invention described is directed to the dissipation of fog, it will be understood that the invention is applicable for treating any gaseous medium containing liquid particles and their vapor. Fog, as the term is used in the appended claims, is intended to include any gaseous medium containing liquid particles and their vapor. Hygroscopic particles, as used in the appended claims, is intended to include either or both liquid or solid particles.

I claim:

1. The method of dispelling fog which comprises passing hygroscopic particles through the atmosphere to be cleared in such quantity and at such rate that they act to absorb and remove such a quantity of water vapor from said atmosphere and reduce the vapor pressure to such an extent as to cause evaporation of the major portion of the liquid particles in said atmosphere.

2. The method of dispelling fog which comprises passing through the atmosphere to be cleared hygroscopic particles of such size as to fall therethrough by gravity, and in such quantity and at such rate that they act to absorb and remove from the atmosphere a quantity of water vapor sufficient to reduce the vapor pressure to such an extent as to cause evaporation of the major portion of the liquid particles suspended in said atmosphere.

3. The method of dispelling fog which consists in removing from the atmosphere to be cleared such a quantity of water vapor as will reduce the vapor pressure of said atmosphere sufficiently to cause evaporation of the major portion of the liquid particles suspended therein, said removal being effected by discharging into and passing through said atmosphere particles of hygroscopic material upon which the water vapor condenses in drops of sufficient mass to be precipitated out of the atmosphere by gravity.

4. The method of dispelling fog which comprises bringing into contact with and removing from the atmosphere to be cleared hygroscopic material in such quantity and at such rate as to absorb and remove such a quantity of water vapor from said atmosphere and reduce the vapor pressure to such an extent as to cause evaporation of the major portion of the liquid particles suspended in said atmosphere.

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