

09 JUN 2005

Device and use in connection with measure for combating

5 The present invention relates to an arrangement for producing a cooling function essentially for the purpose of controlling pests or insects in or of a target or a target surface and comprising an activable unit on the one hand with a nozzle arrangement having one or more nozzles which exhibit one or more discharge orifices so arranged as to be capable of being directed towards the target or the target surface at a distance, and on the other hand a
10 source of carbon dioxide or some other environmentally friendly substance, connected or capable of being connected to the nozzle arrangement via one or more connections, for the generation of snow particles.

Inter alia the arrangement in question is an arrangement for executing control measures
15 against vermin either directly or indirectly via objects giving shelter to the vermin (substrates or similar) or substances (e.g. flour or similar). The expression vermin denotes different forms of pests and different life cycles (eggs, larvae, etc.) of these. Insects, maggots, bacteria, wood lice, mites, etc., can be mentioned by way of example.

20 The invention also pertains to an application for snow particles generated in the unit, for example dry snow particles, which exit from the unit in larger and smaller sizes selected within a predetermined range of sizes and emerge at different velocities which lie within a predetermined range of speeds.

25 Previously disclosed in various contexts is the control of vermin in the form of the aforementioned insects, invertebrates, bacteria, etc., by the application of a snow-generating arrangement and methods, with the help of which the objects in question to be controlled are attacked. Reference can be made inter alia to PCT Application WO 00/02446 A1, which is based on Swedish Patent Application 9803530-6. This Application
30 proposes inter alia a nozzle arrangement and a method for the production of snow for the purpose of environmentally friendly insect control. The inventors of the aforementioned Applications are also the inventors of the present Patent Application.

Also previously disclosed, for example through US 5394643 A, is the utilization of snow-generating functions in which snow application is intended to cause slow degassing in order to asphyxiate the vermin, insects, etc., in question with the generated gas.

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Also previously disclosed is a number of different alternative gas-generating decontaminating devices which utilize carbon dioxide in conjunction with pest control, and reference can be made here to US 4413756 A and US 5165199 A.

- 10 Also previously disclosed, see for example US 5027546 A, is a proposal for control measures based on control by means of freezing or cooling of the objects to be controlled.

The design of snow-generating equipment is also previously disclosed in itself, and reference may be made in this context to US 5125979 A, which relates to snow particle-
15 generating equipment having nozzle and discharge functions which give different sizes of snow particles and snow particle velocities associated with these, which are adapted in the first instance for cleaning purposes.

The present invention is aimed at ensuring that the control measure in question is capable
20 of execution by cooling the pest, insects, invertebrates, etc., in question and/or objects, substrates or surfaces thereon, in association with which the pest or equivalent are present.

In conjunction with this it is appropriate for cooling to be capable of being executed effectively with optimally short processing times and preferably with the least possible
25 consumption of materials which give rise to snow formation. The equipment in question must also be capable of being used in a natural fashion which is not physically demanding. Control must be capable of being performed primarily free from toxicity and without impairing (at least temporarily) the surrounding atmosphere. Control must be effective and must not be based in any respect on the generation of gas which may be expected to
30 permeate down into cracks and constricted spaces. It has been found that the insects or equivalent cannot be reached with a sufficient quantity of gas for a sufficiently long period. There is thus a pressing need to be able to perform effective control in cases which have

proved difficult to control, and in cases where control has not been successful with previously described equipment. There is also a wish, in more normal cases, to be able to reduce the control periods, for example by 50%, in spite of the need to achieve complete killing. The purpose of the invention is also to solve this problem.

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In conjunction with the invention it is desirable to obtain optimized rapid cooling based on the need to produce one or more layers formed from small particles on an actual surface on vermin/accumulations of vermin, substrates, substances, etc. it is important in this respect for the layer(s) to be capable of sublimating as close as possible to the surface in question
10 at or on the surface itself, which must accordingly be covered with rapidly sublimating particles. The invention also solves this problem.

The different types of vermin and the location(s) of the vermin in conjunction with control impose requirements for considerable adaptability of the control equipment.

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It is important to be able to access the primary targets in the form of the aforementioned vermin, insects, etc., even if these are not exposed to direct hits. In accordance with the invention, the primary targets must be accessible for rapid cooling via and/or through heat-conducting materials (e.g. metal, alloys, etc.) and/or air. It is important in conjunction with
20 this that undesired snow accumulation does not occur so that the effect of the cooling sequence is reduced before the intended final cooling has been accomplished. The invention also solves this problem.

Previously disclosed is the process of making snow by allowing gas to expand in a suitable
25 nozzle. In conjunction with this it has been found that the cooling capacity of carbon dioxide snow varies considerably with both velocity and granule size. The method of producing snow with snow nozzles in accordance with previously disclosed technology is associated with shortcomings which mean that the previously disclosed arrangements and methods are not suitable for insect decontamination, for example. Although a certain
30 degree of distribution is achieved in respect of different particle sizes from one and the same nozzle, the previously disclosed arrangements and methods are not suitable for use in

the context indicated here because the velocities of the snow particles were selected with incorrect values. The invention also proposes to solve this problem.

It is also important to counteract the generation of heat after the heat response that is generated by the vermin/accumulation of vermin after a certain cooling/rate of cooling. The generation of heat counteracts cooling and continues for a predetermined period. The invention also solves problems which can arise in conjunction herewith.

What may primarily be regarded as characteristic of the invention is, among other things, that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are arranged and selected to generate snow particles with different discharge sizes and discharge velocities. The invention is also characterized in that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are so arranged and selected, at the aforementioned distance, as to generate smaller snow particles occurring close to the target with velocities within a selected velocity range, which smaller snow particles, in an initial phase of the rapid cooling function, perform the principal cooling by a process of sublimation near or on the target or the target surface. Finally, the invention is characterized in that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are also so arranged and selected, at the aforementioned distance, as to generate larger snow particles occurring close to the target, which, in a subsequent phase following the initial phase, execute the principal cooling by forcing a gas barrier formed at the end of the initial phase and by penetrating in towards the target and the target surface with the help of its masses and existing velocities at the target and the target surface.

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An arrangement for vermin control, for example pest or insect control, with a unit for generating snow particles, can be regarded as being characterized primarily in that the unit generates dry snow particles of smaller and larger sizes situated within a predetermined size range and emerging via a respective discharge orifice or nozzle in the unit at discharge velocities selected in accordance with the construction or setting of the respective nozzle and/or discharge orifice. The unit with its associated nozzle or nozzles and/or discharge orifice or discharge orifices is so arranged, at a selected range of distances between the

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respective nozzle and/or discharge orifice and the target or the target surface, as to cause a cooling function in two phases, whereby, in the first phase, the small particles strike the target or the target surface at velocities within a selected range of velocities and, in the second phase, the larger particles force a gas barrier generated in the first phase by the small particles and penetrate in towards the target and the target surface, in conjunction with which a principal cooling velocity is brought about by the small particles executing the principal cooling in the first phase, and by the large particles executing the principal cooling in the second phase.

- 10 An arrangement for executing control measures against vermin either directly or indirectly via objects giving shelter to the pests may be regarded as being characterized primarily in that the control measure is based essentially on a principal or predominant velocity in the cooling of the vermin, the object and the substances with the help of dry snow particles to which smaller and larger sizes are attributed within a selected range of sizes and velocities within a selected range of velocities.

Embodiments of the arrangement referred to in the foregoing can consist of the different velocities being related to selected velocities of the pest, the object and the substance, which latter velocities are capable of being determined in this case with the help of the discharge velocities from one or more nozzles or discharge orifices for the dry snow particles. The selected velocities are also selected with reference to the distance between the respective nozzle and/or discharge orifice. The snow particles (dry snow particles) generated in the unit are formed from or consist of carbon dioxide snow. The different sizes and velocities of the dry snow particles are selected, principally in conjunction with direct hits on the actual vermin, as to bring about a cooling velocity within a range of 3-30°C/s, essentially with a value or values within the range 10-25°C/s, and with particular advantage in the range 15-20°C/s. As far as the sizes of the dry snow particles are concerned, these relate to sizes which occur within the range 0-5 cm from the surface in question or its equivalent that is being controlled.

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Utilized in a preferred illustrative embodiment is a third phase, which is essentially selected to exceed the duration of a heat response on the part of the vermin. The period in

this case is selected so that the cooling temperature remains effective until such time as the heat response begins to subside.

In one embodiment, the different sizes and/or discharge velocities of the dry snow particles
5 for the nozzles and/or discharge orifice in question are selectable by means of one or more
actuators of components which determine the shape of the flow channel or flow channels
in the unit, its nozzle(s) and/or discharge orifice(s) and/or parameter(s), e.g. quantity,
velocity, choke functions, etc., in the carbon dioxide supply. In the aforementioned
embodiments, there is also a requirement, in the course of the cooling sequence, for the
10 greatest possible mass of dry snow to sublime extremely rapidly on or in the vicinity of
the vermin, the object, the surface of the object and/or the substance, etc., which gives
shelter to the vermin. The target or the target surface must be exposed rapidly to fully or
partially rapidly sublimating particles. The energy required for the sublimation process is
capable of being transferred from the vermin, the object, the surface of the object and/or
15 the substance, which in this way is/are subjected to the desired rapid cooling. An
accelerated cooling process is achieved in the event of collisions between the dry snow
particles and the vermin, the object, the surface of the object, etc.

Further embodiments of the new arrangement can be appreciated from the dependent
20 Patent Claims.

One application for dry snow particles generated in the unit, which are discharged from the
unit in smaller and larger sizes selected within a predetermined range of sizes and with
different velocities which lie within a predetermined velocity range, is characterized in that
25 the dry snow particles are used to cause a rapid cooling effect, which essentially executes
the control measure unassisted, in a control measure against vermin, insects, etc., or objects
or substances giving shelter thereto.

In a further development of the application, the smaller dry snow particles are used to bring
30 about a first phase in the cooling process, and the larger dry snow particles are used to
bring about a second phase in the cooling process following the first phase. A third phase

can be utilized as a temperature maintenance phase, by means of which an extremely good control result, for example 100%, can be achieved.

A series of benefits is obtained from what is proposed in the foregoing. A completely
5 toxicity-free control function can be established. The equipment concerned can consist, at
least to a large part, of previously disclosed equipment which represents tried and tested
technology in this context. The equipment for generating snow particles can in principle
comprise one or more nozzle arrangements and assemblies or tubes capable of attachment
thereto for the supply of carbon dioxide or some other environmentally friendly substance
10 which is utilized as a gas for snow generation. The nozzles, discharge orifices, etc., in
question can have different variations in length, diameter, geometry, material, etc.,
attributed to them. A working distance between the nozzle and the controlled target or its
surface can lie within the range of distances that is well proven in practice, e.g., at a
distance of 5-50 cm. Pulsed flows for the dry snow particles can be used, and the right
15 particle sizes and velocities and mass flows can be used to optimize the equipment in the
context of different applications. The balance between sublimation and the sizes and
velocities of the particles can thus be maintained in the different contexts. The arrangement
and the application in question are particularly advantageous in conjunction with
controlling the aforementioned vermin, insects, etc., but it is also entirely possible to
20 envisage their suitability for use in other applications. The invention also makes it possible
to start the cooling sequence with small particles which have a favourable relationship
between mass and surface. When the small particles reach the surface, they sublime
rapidly, and energy for the sublimation process is supplied by the object or the target
surface, the temperature of which falls as a result. A layer of cold carbon dioxide can thus
25 be formed above or in conjunction with the surface with a direction of flow outwards from
the surface. The larger the quantity of solid carbon dioxide (CO₂) that sublimates, the more
pronounced the layer of cold carbon dioxide gas becomes. If only small particles are
supplied by the unit, these particles will soon be slowed down by a forming gas layer and
will sublime further away from the surface. They will then not contribute to the continued
30 cooling of the surface in a significant fashion, and they will sublime in the gas which is
moving away from the surface. In this way the small particles will move rapidly relative to
this gas, which increases the rate of sublimation compared with transport as far as the

target surface, when gas and particles are moving in the same direction. In the resulting situation, the larger particles, with a greater mass in relation to the surface, will find it easier to reach the target surface and sublimate on it. Once the surface has cooled, the gas layer above the surface will reduce in thickness and an increasing number of particles will
5 then reach the surface. Particles can be bound to it in this way and can maintain the resulting lowest or low temperature until the desired result has been achieved. Situations which could not previously be controlled at all can now be controlled by means of the invention with excellent or 100% results. The control periods can be reduced to 50% in certain cases, which means reduced gas consumption and lower costs. Among other things,
10 there is no longer a need to subject the environment surrounding the vermin and the object to such strong cooling.

A proposed illustrative embodiment of an arrangement and an application which exhibit the significant characteristics of the invention will be described below with simultaneous
15 reference to the accompanying drawings, in which:

Figure 1 illustrates in an outline drawing viewed from the side a unit for the generation of dry snow particles, from which unit dry snow particles are discharged in different sizes and at different velocities in a direction towards
20 a target surface, in conjunction with which the principal structure of different layers on the surface is indicated;

Figure 2 illustrates in diagrammatic form and in outline various ranges of velocities and sizes in conjunction with different areas of application for snow, which
25 velocities and sizes are applicable at the moment before the target surface or equivalent is struck;

Figure 3 illustrates in diagrammatic form and in outline curves for the rate of cooling which are appropriate in conjunction with the control of vermin, insects,
30 etc., by direct hits;

Figures 4 and 5 illustrate in diagrammatic form examples of embodiments of curves, where the curves are related to the new and previous cases; and

Figure 6 illustrates a difficult control case in side view and in outline.

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In Figure 1 a unit or assembly for generating dry snow particles 1, 2 is designated as 3. The unit comprises a nozzle part 4 and a source 5 of carbon dioxide. The source is attached in a previously disclosed fashion to the nozzle via one or more connections 6. The snow-making function is previously disclosed and as such does not require more detailed description here. It need only be stated that the nozzle operates with an agglomeration function, which means that dry snow particles leave the mouth 7 of the nozzle 4 in different sizes (granule sizes) and at velocities selected with the help of the design of the nozzle and the supply of gas from the gas source. The particles, which are small at the end 9 of the injection tube 6, i.e. they exhibit small granule size, agglomerate in the channel 8 of the nozzle. In the channel it is possible to arrange brushes 10 or obstacles and/or recesses 10', which cause changes in the geometry and amplify the air turbulence in the channel, which means that the particles can increase in size as they move out towards the mouth 7 of the nozzle. Particle sizes and, if necessary, particle velocities can also be selected or may be dependent on the electrical charge, e.g. static or applied electricity. In Figure 1 arrows 11 and 12 are used to symbolize different discharge velocities for two particles, which different discharge velocities can thus be selected with the help of the gas supply. Characteristic of the nozzle design is thus that the particles have different sizes as they emerge from the nozzle, and three particles 13, 14 and 15 are accordingly illustrated with different sizes. It must be noted at this point that the Figure is not to scale, but that the differences in the particle sizes are illustrated with distinctly different relative sizes in the interests of clarity. Actuating devices, e.g. push-buttons 16, 17, are also indicated in principle on the nozzle 4 in Figure 1. Upon actuation of these actuating devices, the agglomeration and velocity functions and, if appropriate, the electrical charge, can be varied so that the sizes and the velocities 11, 12 of the dry snow particles 13, 14, 15 can be selected depending on the object to be controlled and the effect to be achieved thereby.

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In conjunction with the application of the unit or the assembly 3, the mouth 7 of the nozzle is aimed at a target 18. In the illustrative embodiment the nozzle is aimed in a more concrete fashion at the surface 18a of the target. The target can be in the form of a substrate, object, etc., where vermin 19 or accumulations of vermin are present. The distance between the mouth 7 of the nozzle and the target surface 18a is designated as A. In an illustrative embodiment of the invention, this distance A is selected within the range 5-50 cm. It is known that the dry snow particles are capable of changing in size through the agglomeration function as they travel towards the target surface 18a. Also previously disclosed is the reduction in the velocities 11, 12 as the particles travel towards the target surface 18a. Figure 1 shows how a particle 20 with a velocity 12 has reduced its velocity to 12' when the particle assumes the position 20'. In accordance with the invention, control of the target must take place with particle sizes and particle velocities that are defined at or within a distance B, which distance can vary from 0-5 cm. The sizes of the particles at or within the aforementioned distance are thus dependent on the attained agglomeration function and/or on the sublimation function described below. The velocity at or within the area B is dependent on the distance A and the discharge velocities 11, 12. The control function can thus be varied depending on the aforementioned discharge velocities and the aforementioned distance A.

Figure 1 also illustrates layer structures of sublimated dry snow particles. A part of the surface 18b is thus shown at the start of a cooling sequence where small particles 21 and 22 are able to strike the surface directly and to sublime immediately on it. The designation 23 shows a layer structure or gas barrier structure where the sublimation that has started directly against the surface has continued for a certain period so that a layer 23 or the barrier has begun to be constructed. Small particles 24, 25, 26, 27 are able to strike the upper surface 23a of the layer causing further construction of the layer. After a time, the layer or the barrier assumes a thickness t where the small particles are no longer able to execute an effective cooling function of the target surface 18a; see above. In this position the larger particles 28, 29, 30, 31 take over the cooling function. The larger particles are able, thanks to their larger mass, to penetrate the thickened layer 23' or the barrier and to take over the cooling function so that this can continue at its rapid speed. The cooling function can thus be considered to operate in two phases, where the smaller particles

provide the primary cooling function in a first phase or an initial phase, and where the larger particles take over the cooling sequence in a second phase, which follows the first phase. These two phases are followed by a third phase, during which the attained temperature is maintained.

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Figure 2 contains a diagram showing the sizes and velocities of the dry snow particles used in different applications. This shows a first area 30, which is suitable for use in the food industry to make dry ice, where 31 is an area used in the food industry for cooling and freezing food, and 32 is an area used in the cleaning industry. The designation 33 indicates
10 an area that is outstandingly suitable for use for pest and insect decontamination or vermin decontamination in accordance with the invention. The vertical axis of the diagram indicates the sizes (diameters) of the dry snow particles in micrometers on a logarithmic scale, and the horizontal axis of the diagram similarly shows, also on a logarithmic scale, the velocities in m/s that must be used for the dry snow particles in the various cases. The
15 area 33 lies within the size range 100 micrometers – 2 mm, preferably 50 micrometers – 3 mm, and the velocities lie within the range 1.5 – 150 m/s, for example 5 – 100 m/s. It must be noted in this respect that the aforementioned sizes and velocities are related to the sizes and velocities of the dry snow particles that are present in or adjacent to the area designated by B in Figure 1.

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In Figure 3 the vertical axis indicates the temperature T in question and the horizontal axis indicates the time h . The Figure shows an example of a preferred illustrative embodiment where the cooling rate must be 15°C/s . The curve 34 shows an advantageous cooling rate curve, the course of which may be regarded as starting from room temperature, and the
25 desired final cooling temperature may be ca. -30°C , for example, depending on the type of vermin. This rate of reduction is capable, in the case of a direct hit, of being executed for a period $h'-h''$, which, in the case of a direct hit, can be of the order of ca. 3 sec. – 1 min. The cooling effect or the cooling rate levels out after the time h'' and must be maintained for a certain predetermined time $h'-h''$, for example ca. 3 sec. or more after h'' . The curve
30 35 illustrates the case where a cooling rate of 2°C/s exists. This is associated with a lowering of the temperature from room temperature to -10°C . The differences indicated in accordance with Figure 3 may be regarded as being attributable to the case in accordance

with the invention, see curve 34, and the case in which the invention with cooling in two phases in accordance with the foregoing is not utilized because the particles do not exhibit the right size or velocity for the initial sublimation and the associated execution of rapid cooling to be achieved, but the small particles are allowed to continue to bombard the constructed layer 23' or the constructed barrier; see curve 35. The indicated examples are attributable in the first instance to direct hits or near misses. Shifts in the times are obtained in the case of indirect hits, although these are significantly better than in comparable cases with previously disclosed equipment.

10 The cooling effect in accordance with the invention is thus influenced by the velocities and sizes of the snow particles. Parameters which can influence the aforementioned velocities and sizes are executed in accordance with the foregoing with different embodiments and variations in length, diameter, geometry, materials, etc. By controlling the velocities and the particle sizes of the snow within the range indicated in accordance with the invention, optimal cooling is achieved which meets the principal objective. In order to optimize cooling, it is possible by means of the invention to ensure that the largest possible mass is sublimated as rapidly as possible as close to the surface as possible or on the actual surface, which in this way is covered with a layer of rapidly sublimating particles in accordance with the foregoing. Because the energy for the sublimation process is taken for the most part from the surface in question, the cooling produces the intended effective control. The snow construction effects referred to in the foregoing can be counteracted so that the cooling sequence can be executed in an optimal fashion throughout the entire sublimation process. In conjunction with testing of the invention, the inventors took high-speed photographs at short intervals and followed the different particles and determined their sizes and velocities as they approached the target surface or equivalent. Temperature measurements were performed in the tests in conjunction with the surface of the target; see Figure 3. The sizes, velocities and appearance of the particles could be linked directly in this way to the temperature and thus to the cooling capacity. Different types of appearance of the particles were identified. A very poor cooling capacity was present in slow particles, e.g. particles with velocities below 1.5 m/s. At very high velocities, on the other hand, it is conceivable that the large particles are broken up on impact and that more rapid cooling is achieved. Particle velocities exceeding 150 m/s are not considered to be suitable for a

variety of practical reasons, since flour and insects are displaced and undesired scatter and contamination are likely to result. The substrate is also adversely affected by wear, and the personal safety of the decontaminator is reduced. Very small particles, e.g. particles smaller than 0.05 mm in size, have been found not to be capable of practical application in the context indicated in conjunction with the invention, as their useful life is short and the practical decontamination distance is limited. The surface of very large particles, e.g. larger than 3 mm in size, is too small in relation to the mass to be capable of conducting the energy of the target surface away sufficiently rapidly. Furthermore, these particles are too large to penetrate into cracks and are not acceptable.

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The arrangement in accordance with Figure 1 can be installed in a fixed position in conjunction with a moving conveyor. Alternatively, the arrangement can be executed in a mobile fashion and used in areas and contexts where the nozzle needs to move in relation to the target or the target surface. The equipment 5 and 6 can be fixed or can accompany the nozzle. The connecting line 6 can be flexible or movable and can be executed, for example, as a hose or similar.

Figure 4 shows an example of a temperature curve 36 measured for an insect I, I', etc. The horizontal axis 37 indicates the time, and the vertical axis 38 indicates the temperature. The control measure shown in the foregoing causes cooling to a certain temperature 36b (e.g. -30°C as described above) to take place along the part 36a of the curve. The insect or similar emits a heat response at the aforementioned temperature 36b which is opposite to the cooling function and gives an upward-facing part 36c of the curve.

At point 36d on the curve, the heat response has reached its maximum value and begins to subside; see point 36e on the curve. According to the invention, the third phase, which is indicated with $F(t)$, must be maintained until the aforementioned maximum has been passed; i.e. until the time when point 36e on the curve begins. The first adopted temperature occurs at h'''' , and the time for completion of the third phase is indicated by h'''''' ; see also times h'' and h''' in Figure 3.

The cooling rate $/Ft$ after the critical temperature 36b in Figure 4 is shown in Figure 5. The horizontal axis 37 in Figure 5 indicates degrees/min, and the vertical axis 38' shows $Ft =$ time. The curve 38' shows the cooling rate as a function of Ft . In Figures 4 and 5, Ft thus indicates the time for which the critical temperature 36b must be maintained in order to be
5 certain that killing has occurred reliably. In spite of the low temperature reduction rates in accordance with the Figures, the effects are excellent in the case of direct hits on the insect (vermin) in question.

The designation 39 in Figure 6 is used to denote an inaccessible control point which is
10 capable of being controlled effectively with the equipment 40 in accordance with the invention indicated symbolically in Figure 6. The object in question, which comprises the area 39, is indicated by the designation 41, and the area 39 is situated after a curve 41a, via which a part 41b comprising the area turns off, for example perpendicular to a part 41c, via which the equipment 40 is capable of activation or application.

15 The part 41b can harbour dust, mould, impurities, 42, etc., which can make control with previously disclosed methods and arrangements more difficult. Absolute killing of inaccessibly situated vermin 43 can be achieved with the invention, which should be capable of counteracting or eliminating the development of resistance in the vermin. In one
20 and the same nozzle, the emerging snow particles exhibit the same discharge velocity as a rule. Very small particles disappear or are agglomerated during movement over the distance A. the particles normally reduce in size and velocity during the aforementioned movement. Where the distance A is small, the discharge velocity is selected to be comparatively small, and vice versa. As far as the size of the particles is concerned, these
25 can be distributed between minimum and maximum, in conjunction with which different size ranges can be attributed respectively as small/quite small and large/quite large. In principle, it is possible to imagine that snow particles of a medium kind do not participate in the cooling process.

30 The invention is not restricted to the illustrative embodiment shown above by way of example, but may be subjected to modifications within the scope of the following Patent Claims and the idea of invention.

PATENT CLAIMS

- 5 1. Arrangement for producing a cooling function essentially for the purpose of controlling pests or insects in or of a target or a target surface and comprising an activable unit on the one hand with a nozzle arrangement having one or more nozzles (4) which exhibit one or more discharge orifices (7) so arranged as to be capable of being directed towards the target or the target surface at a distance (A), and on the other hand a source (5)
- 10 of carbon dioxide or some other environmentally friendly substance, connected or capable of being connected to the nozzle arrangement via one or more connections (6), that can be supplied to the nozzle arrangement for the generation of snow particles, characterized by the following combination:
- 15 a) that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are arranged and selected to generate snow particles with different discharge sizes and discharge velocities;
- 20 b) that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are so arranged and selected, at the aforementioned distance (A), as to generate smaller snow particles occurring close to the target with velocities within a selected velocity range, which smaller snow particles, in an initial phase of the rapid cooling function, perform the principal cooling by a process of sublimation near or on the target or the target surface; and
- 25 c) that the nozzle arrangement and the supply respectively of the carbon dioxide and the environmentally friendly substance are so arranged and selected, at the aforementioned distance (A), as to generate larger snow particles occurring close to the target, which, in a subsequent phase following the initial phase, perform the principal
- 30 cooling by forcing a gas barrier formed at the end of the initial phase and by penetrating in towards the target and the target surface with the help of its masses and existing velocities at the target and the target surface.

2. Arrangement intended for controlling pests and comprising a unit on the one hand with a nozzle arrangement having one or more nozzles (4) which exhibit one or more discharge orifices (7) so arranged as to be capable of being directed towards a target or a target surface (related to the vermin or accumulations thereof), and on the other hand a source (5) of carbon dioxide or some other environmentally friendly substance, connected or capable of being connected to the nozzle arrangement via one or more connections (6), that can be supplied to the nozzle arrangement for the generation of snow particles, characterized in that the nozzle arrangement and the supply of the carbon dioxide and the environmentally friendly substance are so arranged and selected as to generate snow particles, preferably dry snow particles, of different sizes selected within a predetermined size range and discharged via a respective discharge orifice or nozzle at discharge velocities capable of being determined by the construction or setting of the respective nozzle and/or discharge orifice, and in that the nozzle(s) and/or discharge orifice(s) is/are so arranged, at a selected area (A) between the respective nozzle and/or discharge orifice and the target or the target surface, as to cause a cooling function in two phases, whereby, in the first phase, the small snow particles strike the target or the target surface at velocities within a selected range of velocities and, in the second phase, the larger snow particles force a gas barrier generated in the first phase by the small particles and penetrate in towards the target and the target surface, in conjunction with which a principal cooling velocity is brought about by the smaller snow particles executing the principal cooling in the first phase, and by the larger snow particles executing the principal cooling in the second phase.

3. Arrangement for executing control measures against vermin either directly or indirectly via objects giving shelter to the vermin (substrates or similar) or substances (e.g. flour), and comprising on the one hand a nozzle arrangement having one or more nozzles (4) which exhibit one or more discharge orifices (7) so arranged as to be capable of being directed towards the vermin and the object at a distance (A), and on the other hand a source (5) of carbon dioxide or some other environmentally friendly substance, connected or capable of being connected to the nozzle arrangement via one or more connections (6), that can be supplied to the nozzle arrangement for the generation of snow particles,

characterized in that the nozzle arrangement and the supply of the carbon dioxide and the environmentally friendly substance are so arranged and selected as to form snow particles which execute rapid cooling, preferably dry snow particles, with such different sizes and velocities in the vicinity of the vermin and the object that the smaller snow particles first
5 bombard and sublimate on the vermin and the object, and then the larger snow particles penetrate through a layer caused as a result of the sublimation and reach the vermin and the object.

4. Arrangement in accordance with Patent Claim 3, characterized in that the
10 velocities relate to actual velocities respectively at the vermin, the object/object surface/
/the substrate and the substance, and in that one or more nozzles or one or more discharge openings for the snow particles is/are arranged in order to determine the last-mentioned velocities by means of their one or more discharge velocities.

15 5. Arrangement in accordance with Patent Claims 3 or 4, characterized in that the selected velocities are capable of being determined with the distance between the respective nozzle and/or discharge opening and the target or target surface in question.

6. Arrangement in accordance with Patent Claims 3, 4 or 5, characterized in
20 that the unit is so arranged as to achieve rapid/fast cooling by operating with two sequences, whereby, in a first sequence, the smaller snow particles (dry snow particles) execute the primary cooling and, in a second sequence following the first sequence, the larger snow particles have taken over and execute the primary rapid/fast cooling.

25 7. Arrangement in accordance with one or other of Patent Claims 3-6, characterized in that the snow particles generated in the unit consist of carbon dioxide snow.

8. Arrangement in accordance with one or other of Patent Claims 3-7,
30 characterized in that the control measures are primarily gas-free and/or toxicity-free.

9. Arrangement in accordance with one or other of Patent Claims 3-8, characterized in that the unit is so arranged as to allocate different sizes and velocities to the (dry) snow particles which, principally in conjunction with direct hits on the actual vermin, bring about a cooling velocity within a range of 3-30°C/s, essentially with a value
5 or values within the range 10-25°C/s or ca. 15-20°C/s.
10. Arrangement in accordance with one or other of Patent Claims 3-9, characterized in that the unit is arranged with activable component(s) which determine the different sizes and/or discharge velocities of the (dry) snow particles by adjustment of the
10 form(s) of the flow channel(s) in the unit and/or adjustment(s) of the electrical charge (e.g. static electricity) and/or the form inside the unit of its nozzle(s) and/or discharge orifice(s) and/or discharge opening(s) and/or parameter(s), such as quantity, velocity, spray function, etc., of the supply of carbon dioxide or substance.
- 15 11. Arrangement in accordance with one or other of Patent Claims 3-10, characterized in that the aforementioned sizes and velocities of the snow particles are selected to give an optimal cooling effect for the control measure with regard to the effectiveness of the control, consumption of snow-generating materials or substances, time consumption, energy consumption, etc.
- 20 12. Arrangement in accordance with one or other of Patent Claims 3-11, characterized in that the sublimation in the cooling sequence is so arranged as to take place extremely rapidly on or in the vicinity of the vermin or the object/surface of the object, and/or the substance which gives shelter to the vermin, and in that this/these rapidly receive
25 a fully or partially covering layer of rapidly sublimating snow particles.
13. Arrangement in accordance with Patent Claim 12, characterized in that the energy necessary for the rapid sublimation sequence is capable of being transferred from the vermin/object/surface of the object and/or the substance, which in this way is/are
30 subjected to the desired rapid cooling function.

14. Arrangement in accordance with one or other of Patent Claims 3-13, characterized in that it takes advantage of a collision between dry snow particles and the vermin, the object, the surface of the object and/or the substance to ensure that the cooling effect on the latter obtains a more rapid cooling sequence.

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15. Arrangement in accordance with one or other of Patent Claims 3-14, characterized in that the unit or its nozzle(s) and/or discharge opening(s) is/are so arranged as to bring about a pulsed flow of the snow particles (dry snow particles).

10 16. Arrangement in accordance with one or other of Patent Claims 3-16, characterized in that the unit or its nozzle(s) and/or discharge opening(s) is/are so arranged as to execute different sizes and/or velocities of the dry snow particles during different time periods.

15 17. Arrangement in accordance with one or other of Patent Claims 3-16, characterized in that the particle sizes are selected to assume sizes within a range between 100 micrometers - 2 mm, preferably 50 micrometers - 3 mm, at a distance from the vermin/object/ /surface of the object and/or the substance of ca. 0.5 cm, and the particle velocities are selected within the range 1.5 - 150 m/s, preferably 5 - 100 m/s.

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18. Arrangement in accordance with one or other of Patent Claims 3-17, characterized in that the distance between the vermin/object/surface of the object and/or the substance and respectively the nozzle or the discharge opening is selected within the range 5 - 50 cm.

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19. Arrangement in accordance with one or other of Patent Claims 3-18, characterized in that the cooling function or the rapid cooling also operate with a third phase or a third sequence which follows the second phase or the second sequence, in which third phase and in which third sequence the resulting low or attained temperature is
30 retained for a period which is selected essentially as a function of the controlled vermin.

20. Arrangement in accordance with Patent Claim 19, characterized in that the selected time exceeds a period in which a heat response executed by the vermin and counteracting the cooling temperature occurs.

5 21. Arrangement in accordance with Patent Claim 20, characterized in that the time is selected to exceed the period after the heat response reaches its maximum value.

22. Arrangement in accordance with one or other of Patent Claims 3-21, characterized in that the unit is so arranged as to allocate different discharge velocities to the snow particles, for example with the help of two or more nozzles which generate different discharge velocities for the snow particles.

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23. Arrangement in accordance with one or other of Patent Claims 3-22, characterized in that it is capable of adaptation to different types and positions of vermin which are capable of being controlled with different phases, sequences, temperatures, cooling rates, control periods, etc.

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24. Application for a unit for control measures against vermin or an object giving shelter to it and comprising a nozzle arrangement having one or more nozzles (4) which exhibit one or more discharge openings (7) so arranged as to be capable of being targeted at the vermin or the object, characterized in that snow particles of different sizes and velocities generated by the nozzle(s) are used essentially unassisted to execute the control measures in a rapid cooling sequence.

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25. Arrangement in accordance with Patent Claim 24, characterized in that the smaller dry snow particles are used to bring about a first phase of the cooling sequence, and the larger snow particles are used to bring about a second phase of the cooling sequence following the first phase.