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(54) Method for automatic and precise application of an anti-freeze agent

(57) A method for applying anti-freeze agent over a monitored surface by a spraying apparatus, wherein the apparatus comprises at least one nozzle (13, 20, 21, 22, 23, 24, 25), a fluid container (11), a pipeline (12) between the fluid container and the nozzles, and control logic (16) for the apparatus, the method comprising the steps of:
- measuring at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
- activating spraying of the agent from at least one nozzle (13, 20, 21, 22, 23, 24, 25) when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
- re-measuring said parameters; and
- stopping the spraying of the agent when, based on the remeasured parameters, the control logic (16) determines that friction of the monitored surface stays sufficiently high.

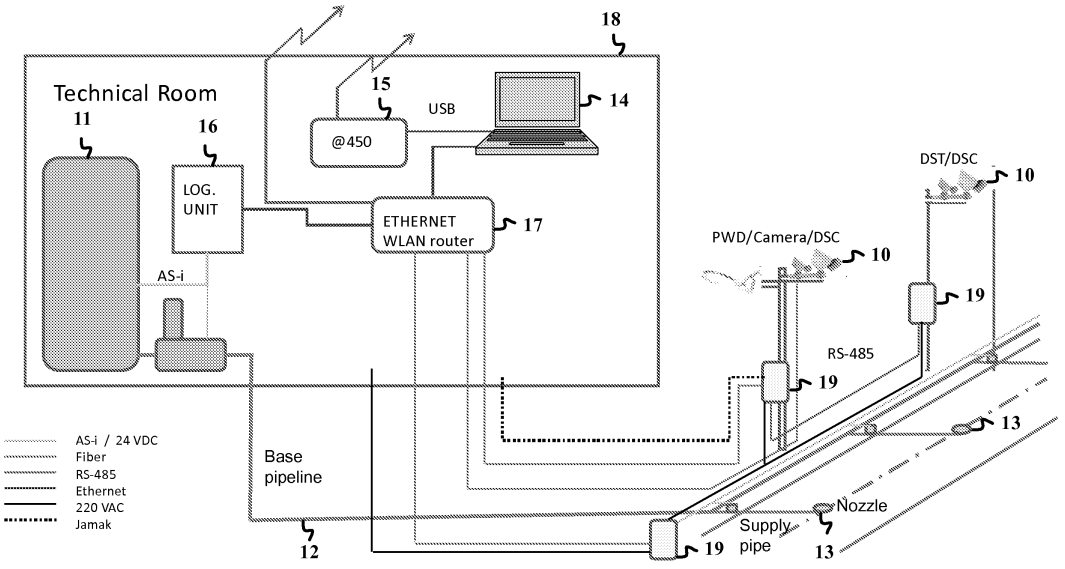

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to an antiskid treatment for road surfaces using a specific apparatus for applying an anti-freeze agent.

BACKGROUND OF THE INVENTION

[0002] Trafficked road surfaces are exposed to different weather conditions and temperature changes. In winter conditions, freezing of the road surfaces reduces the friction between the road surface and the tires which, combined with high speed, makes vehicles more difficult to control. Traditionally, skidding has been combated by the use of studded or friction tires, from the road maintenance perspective by brining the roads, and from the official perspective by imposing winter speed limits. Warming elements may be installed under the road in essential pedestrian and bicycle ways of city centers to keep the roads unfrozen throughout the year. A problem with the use of winter tires is that they wear the roads considerably, from which arises the need to pave the roads even on a yearly basis. Brining the roads, on the other hand, is not very environmentally friendly when for example sodium chloride is used. Nevertheless, ice-control salt has recently been replaced with more environmentally friendly substances such as for example potassium formiate which is non-toxic when used as aqueous solution and which is an environmentally safe agent in other aspects as well.

[0003] From the safety perspective, some places are more critical than others in terms of skidding. Typically, these places are found in locations where microclimatic changes take place, i.e. where air masses of different temperatures are likely to meet. Such places include for example bridges, mouths of tunnels, airport runways, entryways and highway ramps and, for bicycle and pedestrian traffic, for example footways.

[0004] One way of ensuring that the critical road areas stay unfrozen is to install a nozzle apparatus that sprays suitable anti-freeze agent over the area or in the proximity of the area which is to be kept unfrozen. For example, publication EP 981050776 describes a spraying apparatus that applies brine on the roads. In the publication, a large number of fixedly mountable spraying elements, i.e. nozzles, is employed to spray brine in fine distribution, the volume flow per nozzle being defined as relatively low, about 1.5 to 8 ml per second. The publication concentrates mainly on the dimensions of the spray pipe inside diameters, of the distances between the nozzles, as well as of the number of nozzles per road surface area to be covered. The main motivation of the disclosed apparatus is not to alarm the road users when the spraying system is activated as they travel the road.

[0005] Publication US 2005/0072859 describes a kind of an anti-freeze agent spraying apparatus. The nozzles have been provided waterproof so that water is not able to access the interior of the spraying housing in any situation. A set of valves has been installed inside the spraying housing. These valves allow separate control of each nozzle. The nozzles are mounted in socket parts on the road so as to be embedded below the road surface level. In the publication, the use of certain weather sensors, such as the use of temperature sensors, a moisture meter, an anemometer and video image, is also mentioned. These are used real-time to control the valves of the nozzles.

[0006] A main problem of the known technology is that the use of the nozzles in a spraying system has not yet been controlled intelligently, utilizing anticipation and direct slipping measurements as well as the sparing use of the anti-freeze agent.

OBJECTIVE OF THE INVENTION

[0007] The objective of the invention is to disclose a novel intelligent method and apparatus for spraying anti-freeze agent on road surfaces. One specific objective of the invention is to alleviate the problems referred to above.

SUMMARY OF THE INVENTION

[0008] The present invention discloses a method for applying anti-freeze agent over a monitored surface by a spraying apparatus, wherein the apparatus comprises at least one nozzle, a fluid container, a pipeline between the fluid container and the nozzles and control logic for the apparatus. The method is **characterized in that** it comprises the steps of:

- measuring at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
- activating spraying of the agent from at least one nozzle when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
- re-measuring said parameters; and
- stopping the spraying of the agent when, based on the re-measured parameters, the control logic determines that friction of the monitored surface stays sufficiently high.

[0009] In one embodiment of the present invention, the monitored surface is a traffic way.

[0010] In one embodiment of the present invention, the method further comprises the steps of:

- establishing an image of the monitored surface in advance when the surface is dry and unfrozen;

establishing an image of the monitored surface at the time of observation; and
based on a change in said images, determining the possible presence of water and/or ice on the surface, which information is transferred to the control logic.

[0011] In one embodiment of the present invention, the method further comprises the steps of:

gathering the measured parameters and status information about the apparatus to a control logic server; and
sending an alarm to an external control room if any part of the apparatus is damaged or if the conditions on the monitored surface turn dangerous.

[0012] In one embodiment of the present invention, the method further comprises the steps of:

determining the current weather from the measured parameters; and
selecting an operation mode for the spraying based on the weather and/or the time of observation.

[0013] In one embodiment of the present invention, said operation mode is an operation mode preset according to black ice, snowfall, subcool rain, rush hour, quiet traffic or night-time, providing periodically or non-recurrently, for each nozzle and as a function of time, a control signal that determines the activity of the nozzle.

[0014] In one embodiment of the present invention, the method further comprises the steps of:

monitoring the variation trend of the parameters as a function of time;
supplying a current weather report to the control logic; and
determining the need of starting the spraying based on the parameters, the variation trend thereof and the weather report.

[0015] In one embodiment of the present invention, the method further comprises adjusting the spraying angle, the opening diameter and the supply pressure of the agent in the desired nozzles.

[0016] In one embodiment of the present invention, the method further comprises the steps of:

gathering the measurement parameters and the use parameters of the apparatus in a log file; and
using the log file data to optimize the use of the nozzles.

[0017] According to a second aspect of the present invention, a system for applying an anti-freeze agent over a monitored surface by a spraying apparatus is disclosed, wherein the system comprises at least one nozzle, a fluid container and a pipeline between the fluid container and the nozzles.

[0018] The system is further **characterized in that** it comprises:

sensors for measuring at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
a technical room with a processor, control logic for the apparatus, and a memory unit; wherein
at least one nozzle has been arranged to start spraying the agent when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
the sensors have been arranged to re-measure said parameters; and
at least one nozzle has been arranged to stop the spraying of the agent when, based on the re-measured parameters, the control logic determines that friction of the monitored surface stays sufficiently high.

[0019] In one embodiment of the present invention, the system further comprises at least one warming element for warming at least one nozzle, respectively, to ensure that the nozzles stay unfrozen in all conditions.

[0020] In one embodiment of the present invention, the system further comprises a control room which can be contacted from the technical room to transfer the measurement parameters and control commands between them.

[0021] In one embodiment of the present invention, the system further comprises a separate weather station arranged to measure the above-mentioned parameters continuously or at the desired times.

[0022] In one embodiment of the present invention, the system further comprises at least one camera for taking a photographic image of the monitored surface at the desired times, wherein the received image signal is within a desired frequency band.

[0023] According to a third aspect of the present invention, the inventive idea further comprises a computer program for applying anti-freeze agent on a monitored surface by a spraying apparatus comprising at least one nozzle, a fluid container, a pipeline between the fluid container and the nozzles and control logic for the apparatus. The computer program comprises program code which, when run on a data-processing device, has been arranged to execute the steps of:

controlling a measurement of at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;

controlling an activation of spraying of the agent from at least one nozzle when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
controlling a re-measurement of said parameters; and
commanding the spraying of the agent to be stopped when, based on the re-measured parameters, the control logic determines that friction of the monitored surface stays sufficiently high.

[0024] The advantage of the present invention is that it allows intelligent, anticipatory and automatic control of an anti-freeze agent spraying system so that the monitored road surface stays free from ice. The intelligence of the control takes into account the weather parameters, history data, time of observation, traffic situation, and further ensures anticipatorily that the nozzles stay unfrozen. These characteristics have not been accomplished in any corresponding manner in the prior art.

[0025] The usefulness of the invention consists in the fact that by measuring the ratio of ice and water on the road surface, the application of the anti-freeze agent may be limited only to situations where the risk of slippery roads becomes too high, and on the fact that this procedure allows one to optimize the consumption of the anti-freeze chemicals to a minimum.

LIST OF FIGURES

[0026]

Fig. 1 presents an example of a system and apparatus according to the invention,
Fig. 2 presents a nozzle used in the invention as seen from different directions.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The present invention discloses a method for intelligent application of anti-freeze agent on a road surface by a specific spraying apparatus. The objective of the invention is to keep the road unfrozen in all situations so that friction of the road surface is sufficiently high in terms of grip in different weather and temperature conditions.

[0028] The apparatus of the invention is illustrated in Fig. 1. A weather station 10 may be disposed at a suitable site on the roadside, containing devices which monitor the road surface and the weather. The weather station 10 may include a camera, a thermometer for the temperature of the road surface and the air, a hygrometer to determine the dew point, an anemometer and a precipitation gauge, or only some of these measuring devices. In the examples of the invention, a camera refers broadly to a device which is able to receive information over different wavelength ranges and, where necessary, over other than the visible light range. This device allows one to monitor the color of the road surface over the selected frequency bands so as to be able to detect water or ice on the road surface. So-called dry calibration may be performed in advance to determine the color of the road surface for example in a dry cold weather during daylight. By measuring, at each time of observation, the difference between the color of the road surface and the reference color from the calibration over the suitably selected frequency bands it can be determined when there is water or ice on the road surface. Since the reflective properties of water and ice differ clearly from each other, a good estimate of the change of the color (or, more broadly, the received signal) relative to the reference is obtained for the quantities of ice and water on the monitored surface, taking into account the changes of lightness as well as the changes of the basic road surface asphalt color at different sites. In one example of the invention, the above-mentioned reference data may be used to determine the relative ratio of the quantities of ice and water, which may be used directly to determine the potential skidding at the time of observation. On the other hand, this kind of camera may also be used to determine the type of precipitation, i.e. whether the precipitation is water, snow or sleet. Also, the camera provides visual information about the general weather and for example about the degree of visibility. In one example of the invention, the camera may operate over the visible light or the infrared radiation range. On the other hand, a traditional camera that operates over the visible light range is by no means necessary for the functioning of the invention.

[0029] One or more containers 11 containing the employed anti-freeze agent may be disposed at an appropriate site on the roadside or in a separate technical room 18 (which is described in more detail below). In a preferred embodiment, about 50% potassium formiate solution is used as the agent, but the use of other concentrations and for example an aqueous solution containing sodium chloride or calcium chloride is also possible. From the containers 11, the fluid is led forth through supply pipes 12 to the spraying members, i.e. the nozzles 13. The pipes 12 are dimensioned longitudinally so that sufficient fluid pressure can be provided for the nozzles 13 to produce a jet that reaches sufficiently far. The jet range in a preferred embodiment is about 3.5 to 4 meters from each nozzle. The pipes 12 are installed slightly below the road surface level so that there is no risk of the pipes below the roadway becoming exposed due to formation of wheel tracks.

[0030] In one embodiment of the present invention, the flow rate from one nozzle is about 60ml per second. Of course, it is possible to apply other flow rates as well, if so desired. It depends much on the applied use whether distribution of the jet from the nozzle is of importance. On a regular highway, it is preferred to use fine-distributed jets, i.e. a relatively low flow rate per nozzle. On the other hand, for example on airport runways, it is possible to arrange the application of the anti-freeze agent so as to be carried out only when the runway is free. In this

case, it is possible to use even relatively high flow rates and a spraying angle of close to 45 degrees, if necessary, to provide a larger spraying range.

[0031] In one example of the system according to the invention, a technical room 18 constitutes an essential feature, accommodating part or all of the data processing logic required by the invention. In practice, the technical room may accommodate a server 14 which may be connected through an Ethernet connection to a radio transmitter 15. The server 14 is thus preferably connected to the outside world through the internet. In one embodiment, the radio transmitter 15 uses a 450MHz operating frequency. It is by all means possible to use some other operating frequencies or technologies as well. The required computation and control may thus be distributed, if desired, between the computer 14 in the technical room and an external computer (for example a computer in a "control room" which is described in more detail below).

[0032] The technical room 18 also accommodates a separate logic unit 16 that functions as the actual controller between the server 14 and the anti-freeze agent supply apparatus 11. Required between the server 14 and the logic unit 16 is a router 17 which additionally provides a fiber connection to the monitoring devices that further monitor the road surface. The router 17 may also have a proper radio connection. Provided from the technical room 18 is also voltage feed to separate power supply modules 19 to be disposed on the roadside and transferring electrical energy to the cameras as well as to other elements that need to be powered, such as the weather station 10 and the optional pumps or valves. In one embodiment of the invention, one or more fluid containers 11 containing the anti-freeze agent are specifically disposed inside the technical room 18, wherein the outward fluid supply is controlled by the logic unit 16. Also other alternative techniques, devices and routings between them can be used to provide the functionalities of the above-described technical room.

[0033] From the technical room 18, it is possible to establish a telecommunication connection for example to the premises of a system administering party (such as the above-mentioned control room), wherein the monitoring data from the site of the apparatus, for example in the form of camera images, temperature data and status data of the apparatus (whether the apparatus is switched on or off at the time of observation; whether any parts have been damaged; and other functional parameters) can be transferred to the administering party. In addition, this allows remote control of the system. It can be, for example, arranged so that the apparatus normally operates automatically using the technical room internal control process, but when a problem or a fault situation emerges, a notification is sent to the control room. From the control room, it is also possible to manually issue a control command for switching the spraying on or off if automatic control does not for some reason function as desired.

[0034] The key feature in the control of the spraying apparatus is anticipation; the anti-freeze agent can start to be sprayed before any ice has even formed on the road surface. On the other hand, for example in the case of snowfall, it is important to measure the ratio of ice and water on the road surface by the monitoring devices so as to determine the slipperiness, wherein the spraying can be started right when the slippery conditions develop, or even before that. Another key feature is the sparing and optimized spraying, i.e. the anti-freeze agent is sprayed only when it is necessary.

[0035] In the present invention, the essential idea is the control of the spraying nozzles, which is performed intelligently. The weather station provides information about the weather, the temperature on the road surface as well as in the air at the time of observation, and also about the variation trend of the above-mentioned variables, meaning in this context the rate of temperature change. In addition, information is provided about the quantities of water and ice and their relative ratio on the road surface. These can be combined with an estimate about the development of the weather and the temperature in the near future, issued from weather reports. Start conditions for activating the spraying may be set for the control logic of the apparatus. A start condition may for example state that temperature at the time of observation sinks below +3 degrees, the temperature trend is descending, the weather report forecasts frosty weather and the road surface is wet at the time of observation, either from earlier precipitation or as determined by the dew point measurement. Another example of a start condition for activating the spraying may be that the quantity of ice exceeds a preset threshold value in the ice-water mixture on the road surface. The conditions for the control logic may be set before the apparatus in brought to use, or they may be changed later in situ at the technical room or remotely from the control room.

[0036] In one embodiment of the invention, it is possible to set a number of different programs for the spraying operation according to the conditions. Examples of the conditions include "black ice", "snowfall" and "subcool rain". The control logic selects the program which best corresponds to the conditions according to the measurement data from the weather station. An example may be a situation of a heavy snowstorm where it is not appropriate to keep the spraying apparatus active at all because, in this case, it is simply not possible to melt the snow with the anti-freeze agent.

[0037] As to the above use of programs, it is possible to apply for example "a rush-hour program", "a quiet traffic program" or "a night-time program" in the invention. In the rush-hour algorithm, the anti-freeze agent distributing effect of the traffic can be taken into account, so that the required amount of the anti-freeze agent may be reduced. In the night-time program, on the other hand, quiet traffic combined with increased probability of slippery roads may be taken into account. In this case, the weather station may be set to carry out monitoring in a faster cycle than usually, or the spraying operation may

be switched on more readily than in the "normal program".

[0038] In one embodiment of the invention, the nozzle 20 to 25 comprises six spraying directions as can be seen from Fig. 2. The figure represents an example of one nozzle as seen from different directions in cross-sectional view. Thanks to the many spraying directions, the anti-freeze agent can be directed circularly sufficiently evenly in different directions. The anti-freeze agent spraying angle as viewed upwardly from the ground plane can also be adjusted, where necessary, by varying the direction angle of the slope 26 next to the opening 27. Similarly, it is possible to change the diameter of the nozzle opening 27. In this connection, the fluid pressure as well as the flow rate of the nozzle can also be measured.

[0039] In the above-mentioned spraying programs, the essential variable is the duration of the spraying. On one hand, the spraying may be carried out as a non-recurrent operation which is switched on and off only once; another alternative is to carry out the spraying in pulses for the desired period of time. In this case, the spraying switch-on time may be adjusted and, similarly, the length of breaks between spraying periods may be specifically set.

[0040] In one embodiment of the invention, particular nozzles may be specifically selected from the set of nozzles to spray the anti-freeze agent. In other words, each of the nozzles may be controlled separately so as to provide even more precise controllability to the application of the agent. Further, the amount of fluid applied by the nozzle (absolutely or in view of the application rate) and the active state of the nozzle may be freely adjusted.

[0041] It should be noted that application of a potassium formiate solution on a road surface covered with an ice-water mixture, and the consequent melting of the ice, thins further down the concentration of the potassium formiate solution, whereby its frost resistance becomes reduced. On the other hand, the traffic itself distributes the anti-freeze agent on the road surface over a larger area. Combining this with the constantly varying weather conditions, it is essential that after an appropriate time from the application of the agent it should be checked whether it is necessary to add more of the anti-freeze agent. On the other hand, it is not appropriate to add the agent to no effect to keep the costs from rising too much due to the anti-freeze agent consumption. For this reason, the road surface is monitored at suitable intervals after application of the agent. Based on this monitoring data combined with the measurement data from the weather station and the forecast provided by the weather report, the control logic determines whether the spraying apparatus must be switched on again with a given program. The objective is to utilize the constant monitoring of the road surface and the automatic control of the spraying apparatus to ensure safety of the road surface from the skidding perspective as well as possible.

[0042] In one embodiment of the invention, the measurement parameters from the weather station and the spraying apparatus use data parameters from the control logic may be collected in a log file specific for each site over a desired period. The log file may be saved for example on the computer in the technical room so as to be accessible to the control logic. Thus, the log data may be further used for improving the operation of the control logic, i.e. the intelligence of the apparatus. The longer the period of time for which the apparatus has been used at a certain site, the more useful is the log data for optimization of the spraying. For example, if on a clear late autumn night the temperature has sunk down to -5 degrees at the coldest, and it is known for example that pulsed hourly spraying between 01 and 07 o'clock has been sufficient to keep the road surface unfrozen, it can be determined that in an equivalent weather (and based on the information provided by the weather report) the spraying need not be intensified from the above-mentioned cycle.

[0043] The nozzles of the spraying apparatus may be installed for example between the traffic lanes in the case of a two-lane road or on the shoulder barrier in the case of an undivided road. The nozzles are embedded in the road so that their upper surface does not deviate significantly from the road surface level. The nozzle and the supply pipeline may be installed in a hole and a track on the road surface, and, after installation of the nozzle apparatus, the void left in the hole may be filled with suitable filling material.

[0044] In one embodiment of the present invention, the apparatus comprises a warming element in the immediate proximity of each nozzle, respectively. The warming element may be a self-adjusting warming cable or a thermal resistance, the operation of each of them being controlled separately. The warming cable may be installed below the nozzle in the form of a coil. The objective of the warming is to ensure that the nozzles stay unfrozen in all weather conditions.

[0045] In one embodiment of the invention, a temperature sensor is installed in the immediate connection to each nozzle, wherein the sensor is able to measure the temperature at the opening of the nozzle without the optional external warming element being able to warm the sensor directly.

[0046] The method of controlling the spraying nozzles according to the present invention may be carried out as a computer program stored on a computer-readable medium. The computer program may be run, in a preferred embodiment, by the processor of the computer disposed in the technical room. Another alternative is to run the computer program on an external computer used for the control.

[0047] The invention is not limited merely to the exemplifying embodiments referred to above; instead, many variations are possible within the scope of the inventive idea defined by the claims.

Claims

1. A method for applying anti-freeze agent over a monitored surface by a spraying apparatus, wherein the apparatus comprises at least one nozzle, a fluid container, a pipeline between the fluid container and the nozzles, and control logic for the apparatus, **characterized in that** the method comprises the steps of:

   measuring at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
   activating spraying of the agent from at least one nozzle when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
   re-measuring said parameters; and
   stopping the spraying of the agent when, based on the re-measured parameters, the control logic determines that friction of the monitored surface stays sufficiently high.

2. The method according to claim 1, **characterized in that** the monitored surface is a traffic way.

3. The method according to claim 1, **characterized in that** the method further comprises the steps of:

   establishing an image of the monitored surface in advance when the surface is dry and unfrozen:

      establishing an image of the monitored surface at the time of observation; and
      based on the change in said images, determining the possible presence of water and/or ice on the surface, which information is transferred to the control logic.

4. The method according to claim 1, **characterized in that** the method further comprises the steps of:

   collecting the measured parameters and status data of the apparatus to a control logic server; and
   sending an alarm to an external control room if any part of the apparatus is damaged or if the conditions on the monitored surface become dangerous.

5. The method according to claim 1, **characterized in that** the method further comprises the steps of:

   determining the current weather by the measured parameters; and
   selecting an operation mode for the spraying based on the weather and/or the time of observation.

6. The method according to claim 5, **characterized in that** said operation mode is a preset operation mode for black ice, snowfall, subcool rain, rush hour, quiet traffic or night-time, which provides periodically or non-recurrently, for each nozzle and as a function of time, a control signal that determines the active state of the nozzle.

7. The method according to claim 1, **characterized in that** the method further comprises the steps of:

   monitoring the variation trend of the parameters as a function of time;
   supplying a current weather report to the control logic; and
   determining the need to activate the spraying based on the parameters, the variation trend thereof and the weather report.

8. The method according to claim 1, **characterized in that** the method further comprises the step of:

   adjusting the spraying angle, the opening diameter and the supply pressure of the desired nozzles.

9. The method according to claim 1, **characterized in that** the method further comprises the steps of:

   collecting the measurement parameters and the apparatus use parameters in a log file; and
   using the log file data to optimize the use of the nozzles.

10. A system for applying anti-freeze agent over a monitored surface by a spraying apparatus, wherein the system comprises:

    at least one nozzle (13, 20-25, 31);
    a fluid container (11); and
    a pipeline (12) between the fluid container and the nozzles;
    characterized in that the system further comprises:
    sensors (10) for measuring at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
    a technical room (18) including a processor (14), control logic (16) for the apparatus and a mem-

ory unit (14); wherein
at least one nozzle (13, 20-25, 31) has been arranged to start spraying the agent when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
the sensors (10) have been arranged to re-measure said parameters; and
at least one nozzle (13, 20-25, 31) has been arranged to stop spraying the agent when, based on the re-measured parameters, the control logic (16) determines that friction of the monitored surface stays sufficiently high.

11. The system according to claim 10, **characterized in that** the system further comprises:

at least one warming element for warming at least one nozzle (13, 20-25, 31), respectively, so as to ensure that the nozzles stay unfrozen in all conditions.

12. The system according to claim 10, **characterized in that** the system further comprises:

a control room which can be contacted from the technical room (18) to transfer the measurement parameters and control commands between them.

13. The system according to claim 10, **characterized in that** the system further comprises:

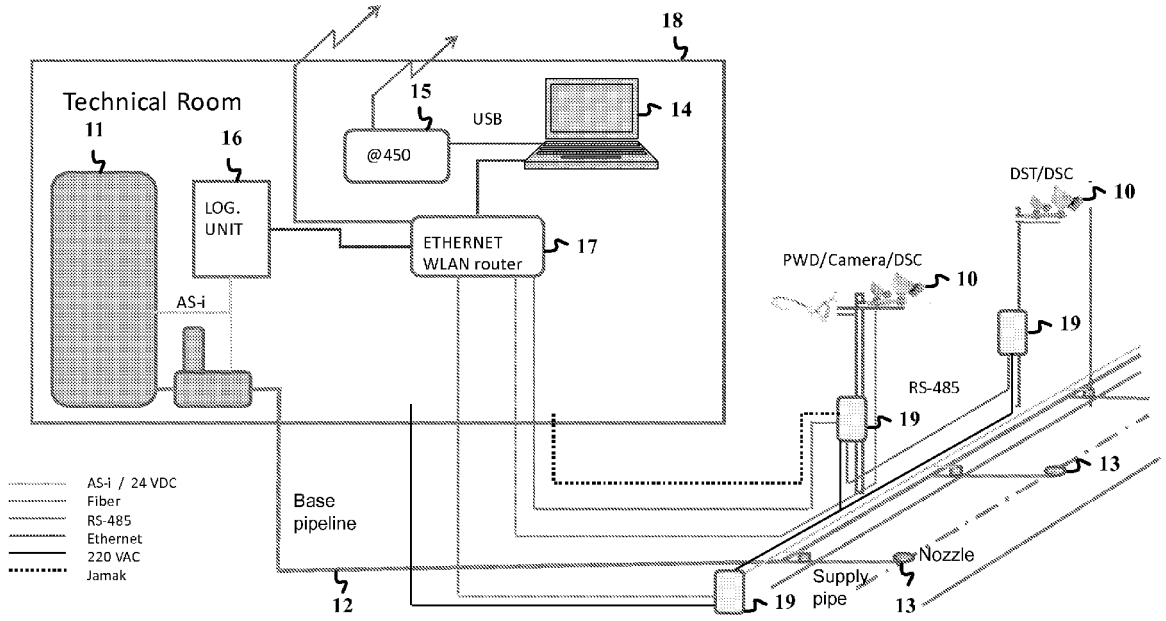
a separate weather station (10) arranged to measure the above-mentioned parameters continuously or at the desired times.

14. The system according to claim 10, **characterized in that** the system further comprises:

at least one camera for taking an image of the monitored surface at the desired times, wherein the received image signal is in the range of a desired frequency band.

15. A computer program for applying anti-freeze agent over a monitored surface by a spraying apparatus comprising at least one nozzle, a fluid container, a pipeline between the fluid container and the nozzles, and control logic for the apparatus, **characterized in that** the computer program comprises program code which, when run on a data-processing device, has been arranged to execute the steps of:

controlling a measurement of at least one of the following parameters: quantity of ice in aqueous solution, outside-air temperature, temperature of the monitored surface, temperature of the nozzles, atmospheric humidity, strength of wind, intensity and type of precipitation, image of the monitored surface;
controlling an activation of spraying of the agent from at least one nozzle when a desired start condition is fulfilled, wherein the start condition is a function of at least one measured parameter;
controlling a re-measurement of said parameters; and
commanding the spraying of the agent to be stopped when, based on the re-measured parameters, the control logic determines that friction of the monitored surface stays sufficiently high.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Jamak

Fig. 1

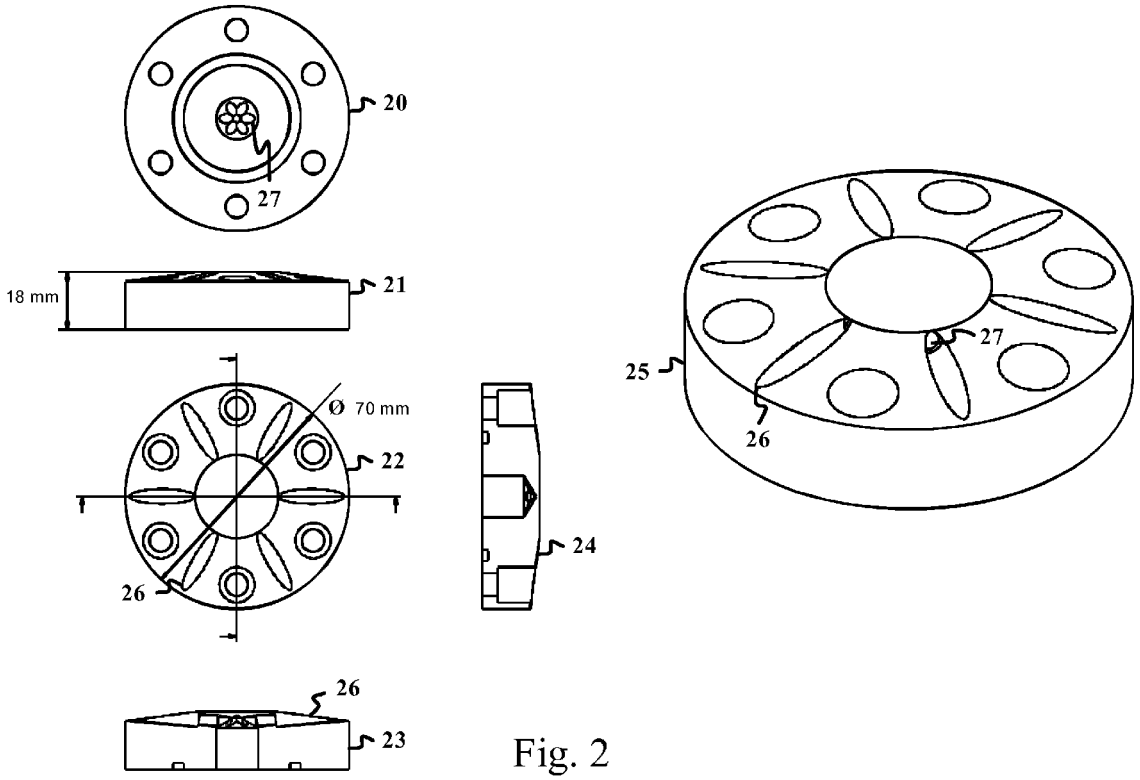

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 0843

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 May 2010	Fernandez, Eva

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 17 0843

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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