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DESCRIPTION

Field of the invention

[0001] This invention relates to an apparatus and method to control or prevent growth of forest pathogens.

Background of the invention

[0002] Diseases of the root system are some of the most serious problems of forest and nursery trees. The major root diseases of trees are caused by wood decaying fungal pathogens that are capable of persisting long periods as saprophytes. In general, trees exhibiting good growth and vigor are resistant to root diseases while those suffering from various stresses and/or less vigor are most susceptible to root diseases. Root diseases caused, for example, by the following forest pathogens *Armillaria* species, *Heterobasidion* species, *Leptographium* species or *Phytophthora* species are widely distributed. More particularly, *Heterobasidion* species (e.g. *H. annosum*) are highly destructive and cause a root rot in most pines and butt rot inside the trunk of spruce trees. The fungus mainly spreads via airborne spores and successful infection can occur when spores germinate on a freshly cut, moist surface that is not immediately subjected to drying or heat. The fungus may then grow into the stump and roots and nearby trees through root connections. Nearly one-fourth of spruce stands in southern Finland have already been damaged by the root and butt rot fungus. The disease will spread to healthy forests unless aerial infection is prevented by treating the stumps in connection with tree felling.

[0003] Logging during the warm season, creating freshly cut stump surfaces and wounding the trees at harvest are the main reasons for rot damages in forests, which means that harvesting activity in the summertime has a strong effect on the spread of the disease. As a result of summertime logging and global warming, it is even expected that decay of spruce will further increase if infection by the root and butt rot fungus cannot be sufficiently prevented. Airborne fungal spores infect the surface of freshly cut tree stumps, where they begin to grow, and ultimately colonize the entire stump. The fungus grows into the stump and spreads along its roots to spruces nearby. This is how the disease spreads below ground to surrounding healthy trees.

[0004] Root and butt rot infection caused by *Heterobasidion* species can be prevented by performing all logging operations in the winter or by treating the exposed surfaces of the cut stumps with a protective substance in summertime logging. Since the disease cannot be completely eliminated by any procedures, it is very important to protect healthy forest stands where root and butt rot fungus is not yet established.

[0005] Prevention of root and butt rot or forest pathogens is therefore extremely important, and one important step in it is to treat the stumps created in the felling process with a substance preventing the root and butt rot fungus. There are several substances available for the treatment of tree stumps and prevention of root and butt rot, but for biological control of the pathogen, a particularly suitable product is one containing *Phlebiopsis gigantea* fungal spores in a culture medium or not, which itself is

powdery but applied manually or mechanically as a solution with water. *Phlebiopsis gigantea* is a natural competitor of the root and butt rot fungus, and treating the freshly cut stumps with spores of this fungus prevents the root and but rot fungus from infecting them.

[0006] The main problem in the application of the *Phlebiopsis gigantea* fungus composition in liquid form to prevent root and butt rot by stump treatment is the large amount of water needed for application of the aqueous solution of the *Phlebiopsis gigantea* preparation on stumps in commercial logging operations. An additional problem is the limited survival of *Phlebiopsis gigantea* in an aqueous solution. Furthermore, mixing the *Phlebiopsis gigantea* preparation (i.e. spores) homogeneously with water can be problematic.

[0007] CA875912 discloses a spreading device adapted to administer a composition onto a tree stump and a corresponding method.

[0008] With the above prior art as a starting point, the present invention is intended to eliminate or at least alleviate the above-mentioned problems.

Summary of the invention

[0009] Thus, the object of the invention is intended to specifically provide a method and apparatus for applying microbial propagules onto a tree stump in a composition which allows considerably lower amounts of the composition containing the microbial propagules to be applied.

[0010] On a more general level, the object of the present invention is intended to provide an applicator device for administering microbial propagules onto a tree stump for controlling or preventing forest pathogens, for example bacterial or fungal pathogens. In an embodiment, the pathogens are forestry pathogenic fungi. Specifically, the object is to provide microbial propagules, which comprise spores of a *Phlebiopsis* or microbial propagules which comprise spores of *Phlebiopsis gigantea.*

[0011] Furthermore, the present disclosure provides composition in the form of a powder-like mixture comprising *Phlebiopsis gigantea* spores in which the fungus would be more stable compared to a conventional liquid formulation comprising *Phlebiopsis gigantea* spores. In conventional liquid formulation, it has been determined that the spores survive only one or two days. However, the spores mixed with a fine-grained carrier have an enhanced stability for prolonged periods. In addition, the objective of the disclosure is to provide a composition in which *Phlebiopsis gigantea* spores would be homogeneously distributed. Again, on a more general level the object of the present disclosure is to provide a composition in the form of a powder-like mixture comprising microbial propagules in a stable form.

[0012] Accordingly, above mentioned objectives can be achieved, for example, by means of a spreading device according to claim 1.

[0013] Further, the above mentioned objectives can be achieved by means of a spreading device according to claim 15.

[0014] The disclosure also relates to a composition in the form of powder-like mixture, the

composition comprising microbial propagules and a solid fine carrier and the microbial propagules being fungal spores which control or prevent the growth of forest pathogens on a tree stump and wherein said solid fine carrier has a volumetric weight of at least 0.50 g/cm^3, at least 0.60 g/cm^3, or at least 1 g/cm^3.

[0015] A further solution to above mentioned problems which fulfil the above objections of this disclosure is to provide a method to control or prevent growth of *Heterobasidion* fungal pathogen on a tree stump, the method comprising the steps of: a) providing a composition as described herein, and b) spreading the composition in a powder-like mixture on said tree stump by a machine or manually.

[0016] Yet another solution to above mention objections of the invention is to provide a method for spreading a powder-like mixture onto a tree stump according to claim 21. Specifically, the present disclosure relates to the use of the composition comprising the powder-like mixture for controlling or preventing growth of forest pathogens on a tree stump, which use includes the spreading of the powder-like mixture on said tree stump by machine or manually.

[0017] The powder-like mixture comprises (or consists of) fungal spores, in the presence or not of a culture medium (S), and, additionally, a solid fine-grained carrier (K) and can include a marker dye or a nutritional supplement, or a mixture thereof. The powdery mixture of the present invention is capable of absorbing water.

[0018] As used herein, the term "microbial propagules" is intended to refer to a material that can used for the purpose of propagating an organism to the next stage in their life cycle via dispersal and comprises spores or vegetative cells of microbiological origin including all bacteria, fungi, viruses, protozoans, yeasts, slime molds, chlamydospores, hyphae, and cysts. Generally, spores in this application mean either spores of fungi or bacteria, preferably spores of fungi. As it is known in the art, "spores" are reproductive structures, usually adapted for dispersal and surviving for extended periods of time in unfavorable conditions. Fungal propagules also include conidia (also termed conidiospores or mitospores) which are asexual non-mobile spores.

[0019] In the present application, the microorganism is cultivated on a culture medium as, for example, a solid growth medium. For example, amorphous silica (i.e. silica gel) or rice can be used as a culture medium (or solid growth medium) for the cultivation of fungal spores. It can be understood that any of the well-known solid growth medium can be used in the context of the present invention. After cultivation, the colonized culture or growth medium is dried to obtain a powdery product comprising fungal spores. A colonized growth medium usually does not contain enough nutrients to promote the growth of the fungus on a tree stump. Therefore, nutritional supplements can be dispensed into the powdery-like mixture comprising fungal spores to accelerate the growth of the fungus (as, for example, the growth of *Phlebiopsis* sp.) on a tree stump as well as to improve its efficacy against the forest pathogen. Such nutritional supplements can be e.g. lignin and its derivatives such as lignosulphonates or lignohumates.

[0020] To be more precise, the invention relates to a spreading device according to claim 1.

[0021] Preferably, the feeder apparatus comprises a powder storage with a container having powder-like mixture and means for bringing the powder-like mixture to the inside of the frame.

[0022] Advantageously the powder-like mixture of the present invention comprises microbial propagules which control or prevent the growth of *Heterobasidion* spp. More particularly, the powder-like mixture of the present invention controls or prevents the growth of *Heterobasidion occidentale, Heterobasidion irregulare, Heterobasidion parviporum* or *Heterobasidion annosum.*

[0023] In a preferable embodiment of the present invention the powder-like mixture (S, K) is made up of microbial propagules in the presence or not of the culture medium used for producing the microbial propagules and a solid fine carrier and can include a marker dye and a nutritional support. In an embodiment, the microbial propagules are free of culture medium. In an embodiment, the microbial propagules are in combination with a culture medium used for producing the microbial propagules.

[0024] Advantageously the microbial propagules are fungal spores. For example, the fungal spores are from the genera *Phlebiopsis.* In a further embodiment, the spores are from *Phlebiopsis gigantea.* An advantage of using *Phlebiopsis gigantea* is its ability to colonize a stump surface, *Phlebiopsis gigantea* grows into the stump and penetrates deep into the root system, naturally outcompeting *Heterobasidion spp.* and preventing it from becoming established or spreading.

[0025] In an embodiment, the strains of *Phlebiopsis gigantea* used in the present invention are *Phlebiopsis gigantea* strain ATCC 90304, *Phlebiopsis gigantea* strain DSMZ 26191, *Phlebiopsis gigantea* strain DSMZ 26192 or *Phlebiopsis gigantea* strain DSMZ 16201, or a combination thereof. These strains are highly effective against *Heterobasidion spp.*

[0026] In another embodiment, the powder cartridge is used in a feeding device containing the powder-like mixture, which comprises microbial propagules and a solid fine carrier. In an embodiment, the volume weight (or volumetric weight or density) ratio of the solid fine carrier is at least 0.3 g/cm^3 (or g/ml), 0.4 g/cm^3, 0.5 g/cm^3, 0.6 g/cm^3, 0.7 g/cm^3, 0.8 g/cm^3, 0.9 g/cm^3 or at least 1.0 g/cm^3 or more than 1.0 g/cm^3.

[0027] In a preferred embodiment of the invention, the powder cartridge available in the applicator includes powdery mixture comprising fungal spores of *Phlebiopsis gigantea* in the presence or not of a culture medium used for producing the spores and a solid fine-grained carrier having a volume weight ratio of at least 0.5 g/ml (or g/cm^3). In an embodiment, the fungal spores are in the presence of the culture medium used for producing the spores. The culture medium for fungal spores comprises preferably amorphous silica.

[0028] The invention is based on the one hand to the general idea that microbial propagules, which may or may not include their culture or growth medium, are applied in the form of powder onto a tree stump in combination with a solid fine carrier having a volume weight ratio of at least 0.5 g/ml (0.5 g/cm^3) in order to obtain a high density powder-like mixture. This high density powder-like mixture facilitates the application of fungal spores and their retention onto the stumps. Application of microbial propagules as a powdery mixture of the present invention makes it possible to use significantly smaller amounts of powder-like-mixture compared to an equivalent preparation applied as an aqueous solution while maintaining the same activity or efficacy.

[0029] On the other hand the present invention is based on the general idea of spreading above mentioned microbial propagules in combination with a solid fine carrier onto a tree stump by using a

spreading device which uses pressurized air for spreading microbial propagules in combination with a solid fine carrier onto tree stump. Advantageously this spreading device will receive wireless control commands relating to amount of microbial propagules in combination with a solid fine carrier and the amount and delivery time automatically from a harvester head hydraulic system. Advantageously these control commands are received from a hydraulic circuit which controls the hydraulic actuator connected to the use of chain saw when a standing tree is cutted to a tree stump.

[0030] More particularly, fungal spores of *Phlebiopsis* (as, for example, fungal spores of *P. gigantea*) in the presence or not of amorphous silica used as a solid growth media, are applied in the form of powder onto a tree stump in combination with a solid carrier having a volume weight ratio of at least 0.5 g/ml to obtain a high density powder-like mixture. This high density powder-like mixture facilitates the application of fungal spores and their retention onto the stumps. Application of fungal spores of *Phlebiopsis* as a powder mixture makes possible to use significantly smaller amounts of powder-like mixture compared to an equivalent preparation applied as an aqueous solution while maintaining the same activity or efficacy.

[0031] It has been established that the required amount of *Phlebiopsis gigantea* spores (in combination or not with a solid growth media) is of about 25 to 100 g per hectare of harvested forest area, regardless of the application method. If the composition is in an aqueous solution, the spores of *Phlebiopsis gigantea* are mixed in water and the solution is applied at a rate of 25 to 100 liters per hectare of harvested area. Thus, the application rate of the composition comprising *Phlebiopsis gigantea* microbial propagules, in the presence or not of the culture medium used for producing the microbial propagules, in a liquid form is about 25-100 kg per hectare of harvested area.

[0032] On the other hand, the application rate of the powder-like mixture according to the present invention is only 0.25-1 kg per hectare of harvested area. This represents about 1/100 of the consumption of a similar formulation applied as an aqueous solution as described above. Both the powder-like mixture and the aqueous solution contain the same number of active spores of *Phlebiopsis gigantea,* but the spore content per unit of weight of the powder-like mixture is considerably higher than the spore content of aqueous solution per unit of weight in the aqueous solution.

[0033] The spores of *Phlebiopsis gigantea* in combination or not with the solid growth medium used for the cultivation of the fungus form a cultivation powder (or a colonized growth medium). The volume weight density of this combination is very low (e.g. if the medium is silica gel, the volume weight of the colonized growth medium is only about 0.22 g/ml), which implies that its mechanical application can be problematic as the colonized growth media sprayed on the tree stumps may easily be blown away. However, when a suitable solid carrier such as, for example lime which has a sufficiently high volume weight (about 1.44 g/ml), is added to the colonized growth media, a powder-like mixture according to the present invention is obtained which powdery-like mixture allows a better distribution and surface colonization of the stump by the fungus.

[0034] This concept may be broadened to application of any microbial propagules as a powder mixture. Indeed, as mentioned, very light microbial propagules may easily be blown away from the tree stump by wind. Adding a suitable high volume weight (or density) solid carrier to a spore mixture will allow a better surface colonization by the microbial propagules. From the powder-like mixture an aerosol of solid matter is formed in the spreading device by means of pressurized air, after which the

powder-like mixture can be aimed at and mechanically applied to a desired location.

[0035] In addition, as mentioned, the invention achieves the significant benefit that in a powder-like mixture such as powdery mixture comprising spores of *Phlebiopsis gigantea,* fungal spores remain alive much longer than in an aqueous solution.

[0036] The use of a powder-like mixture such as a powdery mixture further achieves a significant additional benefit compared with a liquid formulation, as a powdery mixture does not need to be mixed with water at the place of use. Indeed, the powdery mixture can simply be mounted in the container of the applicator in the form of a powder cartridge and thereafter the powder contained in the powder cartridge can be delivered to the target by means of an applicator using pressurized air.

[0037] In a preferred embodiment of the invention, the powder cartridge includes a solid fine-grained carrier. As used herein, the solid carrier comprises one or more organic or inorganic carriers or a mixture thereof. Examples of inorganic carriers that could be used in the context of the present invention comprise, but are not limited to, lime, calcium carbonate, kaolin, bentonite, talc, gypsum, vermiculite, perlite, amorphous silica, granular clay or a mixture thereof. In a preferred embodiment, the solid carrier is lime or calcium carbonate. In an embodiment, the fine-grained carrier is calcium carbonate. Examples of organic carriers comprise, for example, fine-grained cellulose powder (e.g. microcrystalline cellulose), polysaccharides (chitin, chitosan, polyacrylamide), sugars, lignin derivatives, cereal flours, yeast extract, betaine or fine-grained composition made of cereal grains, bran, sawdust, peat or wood chips or a mixture thereof. Alternatively, any other suitable solid fine-grained carrier can be used in the context of the present invention.

[0038] The solid carriers used in the context of the present invention have a sufficient specific gravity (or density) to allow the powder-like mixture to be mechanically applied onto the tree stump.

[0039] For example, the volume weight density of lime or calcium carbonate is relatively high and in addition, their particle size is favorable from the standpoint of distribution of the powder mixture on the stumps. If the grain size of the carrier particles is too small, the powdery mixture easily flies away with the wind, and an excessive grain size of the carrier particles relative to the particle size of the culture powder colonized growth media in turn causes uneven spread of the powder and the fungal spores of *Phlebiopsis gigantea* therein onto the tree stump. The size distribution of the lime or calcium carbonate particles is the same order of magnitude as with the solid growth media (e.g. amorphous silica) (about 0.01 mm). Therefore, the fungal spores of *Phlebiopsis gigantea* spread evenly into the powdered mixture.

[0040] The powder-like mixture of the present invention is an inoculant comprising (or consisting of) 5 to 50 w-% of microbial propagules, 5 to 90 w-% of a solid carrier, 0 to 5 w-% of a marker dye (or a colouring substance) and 0 to 40 w-% of a nutritional supplement. In an embodiment, the powder-like mixture of the present invention comprises (or consists of) 10 to 30 w-% of microbial propagules and 20 to 80 w-% of a solid carrier and may further comprises 0.5 to 5 w-% of a marker dye (or a colouring substance) or 0.5 to 20 w-% of a nutritional supplement, or a mixture thereof. In a further embodiment, the powder-like mixture comprises (or consists of) 20 to 30% w-% of *Phlebiopsis gigantea* spores, 60 to 70 w-% of calcium carbonate, 0.5 to 3 w-% of marker dye and 0.5 to 10 w-% of a nutritional supplement.

[0041] In one preferred embodiment of the invention, the powder cartridge further comprises (or contains) microbial propagules in the presence or not of the culture medium used for producing the microbial propagules and can include a marker dye and/or supplemental nutrients. Any known supplemental nutrients can be used in the context of the present invention. For example, the supplemental nutrient is selected from a group including lignin and its derivatives such as lignosulfonate and lignohumate.

[0042] Supplemental nutrients are beneficial for starting the growth of *Phlebiopsis gigantea* spores while the dye is for marking a treated tree stump.

[0043] In the following, the invention and the benefits that can be achieved with it will be further illustrated with reference to the accompanying drawings and example 1 which describes the properties of the powder-like mixture.

Short description of the figures

[0044]

Figure 1A shows an applicator according to the invention in a perspective view.

Figure 1B shows an applicator according to Figure 1, viewed from the direction IB of Figure 1A.

Figure 1C shows an applicator according to Figure 1, viewed from the direction IC of Figure 1A.

Figure 2 shows the applicator presented in Figures 1A-1C as an exploded view.

Figure 3 shows schematically the principle of forming aerosol from dry matter.

Figure 4 shows a sieve analysis of lime.

Figure 5 illustrates schematically the control system and measurements of the harvester head.

Figure 6 shows the general method of the present invention.

Figure 7 illustrates schematically spreading device and a chain saw , as viewed from a side and at a beginning of the present method .

Detailed description of the invention

[0045] In the following, the main structures a spreading device according to the invention are first described with reference to Figures 1-3.

[0046] Figures 1A-1C show a fungal spore applicator (spreading device) 1 according to the invention from slightly different angles of view but without any regulating means 41 or pressure accumulator needed for controlling and storing of the pressurized air (I). The feeding of pressurized air I is illustrated in figure 3. Figure 2 shows the spreading device as an exploded view.

[0047] Spreading device 1, such as aerosol applicator, has a tubular frame 2. Aerosol spreading head 3, is associated with the first end of tubular frame 2 seen in the forefront. Frame 2 also includes administering means 4 for forming a spore-containing aerosol A which is applied using spreading head 3, equipped with a back-pressure valve, onto a tree stump T. Tubular frame 2 may also include measurement means 21 such as measuring devices for measuring flow, pressure and temperature of pressurized air. Through the measurement data obtained from these measuring devices, the formation of aerosol A from the pressurized air I and the powder-like mixture S, K to be combined with it can be adjusted first. Subsequently, information received from the measuring means 21 can still be used while applying the formed aerosol A onto a tree stump in a manner described later.

[0048] Administering means 4 for dispensing of pressurized air I and powder-like mixture S, K comprises regulating means 4; 41 associated with the frame 2 of the aerosol applicator 1; for adjusting the volume flow of pressurized air I entering frame 2 via a pressurized air supply pipe 413

[0049] The volume flow of pressurized air I may be adjusted using valve 4; 415 such as solenoid valve shown in figure 1A and 1B. However, in a preferred embodiment of the present invention, the volume flow of the pressurized air I is controlled automatically using a pressure accumulator 42 and electromagnetic on/off valves 411; 411 a and 411; 411 b shown in Figure 3. Administering means 4 also includes pressure accumulator 42 of pressurized air I for generating and supplying pressurized air I to electromagnetic valve 411; 411a, 411b as well as further inside of the frame 2, through a short supply pipe 413 of pressurized air (compare to Figure 3).

[0050] Administering means 4 further comprises communication means 47 (Figure 3) for providing to the regulating means 41, preferable electromagnetic regulating valves, for example, data about starting time of pressurized air I delivery and data about pressure level of said pressurized air I.. Said communication means 47 also provide the control apparatus 43 with the data relating to starting time and duration of the dosage of powder-like mixture S, K inside the frame 2. The pressure of delivered pressurized air and dosage of powder-like mixture S, K depends primarily on the diameter of the tree stump T to be sawed from a trunk (see Figure 7). Communication means are preferably wireless communication means which comprise a transmitter and a receiver of an electromagnetic signal. Suitable wireless communication means comprises of a receiver in connection of electromagnetic valve or control apparatus and an electromagnetic signal transmitter in connection with chain saw hydraulic circuit 91 or in connection with a hydraulic circuit controlling the actuator affecting to a stump treatment device for liquid 97 (see Figure 5).

[0051] Administering means 4 further comprises control apparatus 43, incorporating a stepper motor 431; 431a to dispense / dosage powder-like mixture S, K onto the inside of frame 2. The aerosol A can thereafter be formed on the inside of frame 2 and dispensed to the target, i.e. to the tree stump, by supplying a burst of pressurized air I flow inside of frame via supply pipe 413.

[0052] Tubular frame 2 also includes a powder storage 4; 45 communicating with the inside of body 2 by means of supply tube 453 shown in exploded view of Figure 2. Powder storage 45 comprises container 451 having powder cartridge 452, which contains powdery mixture beeing powder-like mixture S, K. The powder-like mixture S, K is composed of a mixture of *Phlebiopsis gigantea* spores, in the presence or not of the culture medium S used for producing the spores, mixed with a heavier solid powdery carrier K (compare Figure 3). Powder storage 45 is operatively coupled with the previously described control apparatus 43 having a stepper motor 431 for dispensing and bringing the

powder-like mixture S, K to the inside of frame 2 with supply tube 453. The powder-like mixture S, K arrives from container 451 to the inside of tubular frame 2 along supply tube 453.

[0053] Pressurized air I is then supplied from pressure accumulator 42 via pressurized air supply pipe 413 first to the inside of frame 2 and from there to spreading head 3.

[0054] Regulating means 41 of pressurized air I may also be used for adjusting the rate of powder-like mixture S, K coming from the powder storage 45 in a case regulating means comprises solenoid valve or like. However, normally regulating means 41 began their action only after powder-like mixture S, K have been dispended inside of the frame by means of the stepper motor 431.

[0055] The regulating means 41 are controlled by communication means 47, which are used delivering proper control commands to regulating valve(s) 411 for dispensing of pressurized air (compressed air) I and to control apparatus 43 for adjusting the dosage of powder-like mixture by the use powder cartridge 452. This is now illustrated more accurately in referring to Figures 3, 5, 6A-6B and 7. Powder-like mixture S, K contains fine carrier K and microbial propagules S, which, in turn, contains about 5% of water and is formed by the possible culture medium and the fungal spores.

[0056] The more general method of the invention is first presented by referring to Figures 5, 6A-6B. Said method comprises first receiving data about dosage of the powder-like mixture (S, K) by the regulating means 41.

[0057] In a general method according to present invention onto a tree stump T is spread a powder-like mixture, which comprises microbial propagules which control or prevent the growth of a forest pathogen and a solid fine carrier having a volumetric weight of at least at least 0.50 g/cm^3, preferable at least 0.60 g/cm^3 or most preferable at least 1 g/cm^3.Said method comprises the following steps:

- receiving data about dosage of a powder-like mixture S, K by the regulating means 41,
- dosing the powder-like mixture S, K inside the frame 2 of an amount which depends on the diameter of the tree stump,
- forming an aerosol A from pressurized air I and a powder-like mixture S, K by delivering pressurized air having an adjusted level into the powder like-mixture S, K,
- spreading the formed aerosol (A) onto a tree stump by means of pressurized air (I) flow.

[0058] As can be seen from the above general method, the amount of powder-like mixture S, K dispensed automatically inside the frame 2 depends on the diameter of the tree stump T. Also, the pressure level and starting time of pressurized air I delivered automatically inside the frame 2 depends on the diameter of the tree stump T. Proper control commands to regulating means 41, which control the delivery of pressurized air I inside the frame 2 is done by the action of communication means 47. These communication means 47 operate automatically and receives data which comprise control commands for starting time of delivery, the duration of the delivery and pressure level of the pressurized air I and/or starting time and the duration of the dosage of powder-like mixture S, K from the overall harvester control system 100 presented in figure 5.

[0059] In figure 5 is schematically illustrated a part of a forest harvester. This part of forest harvester comprises crane with a boom 7 and harvester head 6.Harvester head 6 comprises harvester head

tilting device (not shown), feed rollers 61, delimbing knives 62, chain saw 5, stump treatments device for liquid (urea) and stump treatment device (spreading device) 1 for microbial propagules. The latter uses pneumatics circuit whereas the other devices, which are connected to harvester head, are controlled by hydraulic circuits. Each hydraulic circuit comprises hydraulic pump driven by an electric or a combustion motor (for example diesel motor) and proper valve, piping, filter and the actuator, Actuator can be hydraulic motor, hydraulic cylinder, electric motor or like which uses harvester head 1 device. Same hydraulic pump may provide hydraulic fluid to several harvester head 6 devices.

[0060] The hydraulic circuits of different device may be controlled in different way depending on the overall harvester control system 100. For example, overall hydraulic system 100 may employ only one hydraulic pump, which then gives power to crane 92, base machine, electricity 103 and also to working hydraulics 105 of the harvester head 6 devices. There may be overall hydraulic system 100 in which many device hydraulic circuits have their own hydraulic pumps; for example, each delimbing knife 62 may have their own hydraulic motor and one hydraulic pump employ each knife hydraulic motor. However, we will consider here the most common harvester control system 100 which uses the same hydraulic pump to employ all working hydraulics 105 in a harvester head 6. Working hydraulics 105 comprises then following device controls controlled by corresponding hydraulic circuits, shown in figure 5: Chain saw 91, knives 92, harvester head tilt 94, feed rollers 95, stump treatment device for microbial propagules 96 and stump treatment device for liquid 97. Each hydraulic circuit for controlling corresponding harvester head 6 device includes hydraulic pump, electromagnetic valve and proper hydraulic fluid tubes or pipe leading hydraulic fluid to actuator (hydraulic motor hydraulic cylinder) connected to this specific device.

[0061] Fluid pipes leading to harvester head device may be provided by pressure gauges for measuring fluid pressure. Control system100 may also comprise data measurements 80, for example trunk shape measurement 81, trunk diameter measurement 82 and trunk length measurement 83. The information (data) derived from data measurement(s) can be used in combination of data derived from hydraulic circuit of a harvester head 6 device to compose control command(s) for controlling other harvester head devices. For example, data derived from chain saw 5, knives 92, harvester head tilt device 94, feed rollers 95, and stump treatment device for liquid 97 can be combined to data measurements 80 and this combined information can then be used for structuring a control command.

[0062] In the present invention it is used mainly those control commands which are derived from harvester control system 100 and which comprise control commands which relate to working hydraulics of the harvester head 6 and which specifically are derived from the hydraulics circuit 91 of the chain saw 5 or/and derived from the hydraulic circuit of the tree stump treatment device for liquid 97.

[0063] Control commands from chain saw hydraulic circuit 91 are generated by the electromagnetic valve(s) which open /close the fluid pressure connection between hydraulic pump and chain saw 5. Control commands derived from the hydraulic circuit 91 connected to the usage of chain saw 5 or/and usage of the tree stump treatment device for liquid 97 relate, for example to start/shut down chain saw motor (hydraulic motor) or to turn/swing the bar with saw chain into a saw box or out from the saw box. The saw box is connected to the harvester head 6 (see also Figure 7).

[0064] Control commands from chain saw 5 hydraulic circuit 91 can be also generated by the pressure gauge in the pipe or tube of the hydraulic circuit 91 of the chain saw 5.

[0065] The measurement derived from the pressure gauge may indicate, for instance when the bar of the chain saw is turned back and forth when the standing tree is sawed and cutted at its lowermost part. This will result a tree stump T which can be treated with liquid urea, liquid colour markings or as in the present invention, with powder-like mixture.

[0066] Those control commands derived from chain saw 5 hydraulic circuit 91 and which relate to hydraulic actuators of employing chain saw (hydraulic motor or hydraulic cylinder) are then delivered by means of communication means 47 to control apparatus 43 for the dosage of the powder-like mixture (S, K) with the stepper motor 431. Same kind of control commands are also delivered by the action of communication means 47 to regulating means for controlling first and second electromagnetic valve 411a, 411b and pressure accumulator 42.

[0067] As mentioned before communication means 47 comprise preferable from wireless transmitter-receiver systems. This kind of wireless communication means 47 based on wireless technology is widely known and we refer here to existing literature on this field. Exemplary wireless communication means 47 are transmitter using electromagnetic signals transmitted from an antenna and a proper receiver of these signals (receptor),

[0068] As shown in figure 3 pressurized air is arranged to flow automatically inside the frame 2 and onward to the spreading end 3 from pressure accumulator 42 by means of two on/off electromagnetic valves 411.

[0069] Referring now also to Figure 7, there has been schematically presented in a side view a chain saw 5, which is connected to a harvester head 6 of the forest machine from its saw box (not shown in figure). The harvester head 1 has been placed against the standing tree and chain saw 5 has been activated the. During the tree cutting operation the bar 51 with the saw chain 53 swings out from the saw box and cuts the tree forming a tree stump T. The tree is cutted so that the bar 5 moves in path P having starting point P2 and end point P1. At the end point of this path P tree has been cutted and began to fell down and the bar with the saw chain swings back to the saw box. The control commands from chain saw 5 hydraulic circuit 91 is generated from hydraulic actuators which controls the actions of chain saw 5 after the chain saw 5 have reached the starting P2 at its path P in cutting a standing tree. These actuators are for example hydraulic motor for using the saw chain 53 and and a hydraulic cylinder for swinging the bar. In the beginning of cutting tree, chain saw bar51 is turned outside of the saw box connected to the harvester head 6.

[0070] Control command defining the beginning of the loading of accumulator 42 by opening the first electromagnetic valve 411a and also the starting point of the dosage of the powder-like mixture S, K containing microbial propagules and their possible culture medium S with the proper carrier K inside the frame 2 is generated by means of the control commands derived from chain saw 5 hydraulic circuit 91. This hydraulic circuit 91 controls the actuators which will be connected to actions of chain saw 5 when cutting the standing tree and forming a tree stump T.

[0071] In figure 7 it has been presented how bar 51 of the chain saw 5 reaches the end point P1 at its path P in sawing/cutting a tree. This event generates a new control command identifying the end of the loading of pressure accumulator 42 by closing the first electromagnetic valve 411a and end of dosage of powder-like mixture S, K inside frame by means of the control apparatus 43. The timing of the opening and closing each valve 411a, 411b depends on the diameter of the tree stump, which can

be also measured in the beginning of the method, at the stage 110. However, as stated above the diameter of the tree stump T to be achieved, can also be derived from the actions of chain saw 5 when it goes in its path P from point P2 to point P1.

[0072] The control command defining the delivery time of the pressurized air I inside the frame 2 by opening the second electromagnetic valve 411b is generated by the control command which is identified or derived from the chain saw hydraulic circuit 91 when the tree began to fell and tree stump T will be formed. Because delivering /spreading of mixture of microbial propagules and their possible culture medium S in connection with the carrier K onto the tree stump T should be made immediately after the tree stump T has been formed or when the cutted tree T is still felling down this event should be connected with turning of bar 51 of the chain saw 5 back in to saw box. This event can also be connected to a certain time delay from the release of control command(s) identifying the end of the loading of accumulator 42 by closing the first electromagnetic valve 411a. This means that the second electromagnetic valve 411b is opened only after some time delay has been elapsed from the dosage of powder-like mixture S, K inside the frame 2.

[0073] The above described advantageous embodiment of the present invention is also presented in figure 6B: Diameter of the tree stump T is measured or will be get from the actions of chain saw when sawing a tree, in the beginning of the method at the stage 110. Powder cartridge 452 containing a powder-like mixture S, K is brought into the storage 451 of a powder feeding device 45, which powder-like mixture comprises microbial propagules and a solid fine carrier, having a volumetric weight of at least 0.50 g/cm^3, at least 0.6 g/cm^3 or at least 1.0 g/cm^3.

[0074] Aerosol A can then be formed from pressurized air I and powder-like mixture S, K. First is released /dosed the powder-like mixture S, K into the pressurized air I inside the frame 2 (stage 200). This is done by receiving and defining automatically data about administering time and duration of the powder-like mixture S, K from the hydraulic circuit control commands derived from chain saw 5 hydraulic circuit 91 and by transmitting these control commands to control means 43 (stage 200) which will dosage said powder-like mixture into frame by means of stepper motor 431. Due to small amount of powder-like mixture the stepper-motor should be provided with a suitable reduction gear.

[0075] Powder-like mixture S, K is first brought with powder cartridge 452 having a removable cap into the container 451 of the powder storage 45. Cap is removed from the cartridge 452 which may be tube made of plastic, cardboard or thin metal. Hollow frame 2 of the spreading device 1 can be connected into flow connection of the powder-like mixture S, K via a supply tube 453. From the container 451 the powder-like mixture S, K can be dispensed by means of stepper motor 431 along the supply tube 453 to the inside of frame 2.

[0076] The amount of powder-like mixture S, K depends preferably on the diameter of the tree stump, which is measured in the beginning of the method, at the stage 110.

[0077] After the powder-like mixture S, K have been dispensed inside the frame, the pressurized air I is brought inside the frame 2 along pressurized air I supply pipe 413. Aerosol A is formed (stage 600), as shown in Fig. 3, inside of frame 2 from the powder-like mixture S, K and the pressurized air I. This pressurized air I is first loaded into pressure accumulator 42 (stage 350) by opening the first electromagnetic valve 411a and then delivered inside the frame by closing the first electromagnetic valve 411 and opening the second electromagnetic valve 411b (stage 401). The control commands

defining these valve actions and loading of pressure accumulator into a certain pressure level has been described above. Shortly said, these control commands are generated from chain saw 5 hydraulic circuit 91 and transmitted to valves 411a, 411b by means of communication means 47 (stage 301).

[0078] The flow or pressurized air to the inside of the frame 2 and further into spreading head 3 is controlled by first electromagnetic valve 411a which is located just after pressure accumulator 42 in the flow direction of pressurized air I. Aerosol A of dry matter formed on the inside of frame 2 is dispensed through application head 3 to the target, i.e. onto a tree stump T.

[0079] Spreading the aerosol (A) (stage 700) to a tree stump is done by means of a pressurized air I released from the pressure accumulator 42.

[0080] Once aerosol A has been dispensed onto a tree stump through nozzles 31 of spreading head 3, the spores of *Phlebiopsis gigantea* contained in the powder-like mixture S, K begin to germinate, the fungal mycelium starts to occupy the tree stump T and prevent the growth of the root and butt rot on the tree stump.

[0081] Powder-like mixture S, K in powder cartridge 452 contains fungus spores as well culture medium S of these fungal spores as well as solid fine-grained carrier K. When the fungal spores are *Phlebiopsis gigantea* spores, their culture medium may be, for example, powdery silica gel. The fungal spores associated with the culture medium have a particle size of about 10 µm and therefore the particle size K of the fine-grained carrier K should be of the same order of magnitude as the relatively dry powder S.

[0082] Figure 4 further presents a screen chart showing the particle size distribution of a preferred fine-grained carrier K, i.e. lime filler. Figure 4 presents on the vertical axis (Y axis) the pass-through percentage of powder passing the screen, and the size of openings of the screen respectively on the horizontal axis (x-axis). As seen from Figure 4, the particle size of lime according to a screen analysis is approximately equal to the particle size of the culture medium and the fungal spores of *Phlebiopsis gigantea,* whereby a homogeneous, dry powdery mixture S, K can be formed of lime, culture medium (silica gel) and fungal spores *Phlebiopsis gigantea.*

[0083] Table 1 further shows volume weights of some powdery substances. Of these powdery substances, Rotstop contains silica gel and fungal spores, and ammonium lignosulphonate can be used as an additive in a powdery mixture. Other powder-like substances (such as, for example but not limited to, lime, gypsum, kaolin) shown in Table 1, could be used as a solid carrier K in a powder-like mixture according to the invention to transfer the dry powder formed by fungal spores and the culture medium onto the target, i.e. a tree stump. As shown in Table 1, the volume weight of lime is about 1.44 g/ml, so it is sufficiently heavy to carry the mixture of fungal spores and their culture medium to the target, i.e. the tree trunk. Gypsum and kaolin may also be used as a solid carrier K, although their volume weight is somewhat lower than that of lime (volume weight of phosphogypsum is 1.04 g/ml and of kaolin, 0.58 g/ml, compare Table 1). The volume weight of the solid carrier K should at least be approximately 0.50 g/ml, however preferably at least 1 g/ml. As can be seen, the Rotstop powder, which mainly contains fungal spores and the medium (silica gel) used to grow them, has a relatively low volume weight of only about 0.22 g/ml, whereby the spreading of a dry matter aerosol A onto a tree stump matter containing it alone could be troublesome, at least in windy conditions. It has further

been demonstrated that *Phlebiopsis gigantea* colonizes well the stump surface, even without a liquid carrier, as there is enough moisture on the freshly cut stump surface to allow for this. However, to ensure a proper density of fungal spores across the stump surface, the total volume of powder applied has to be increased by adding a carrier.

Table 1: Densities of some ingredients contained in the powder-like mixture S, K.

Material/density	g/ml	g/l
Ammonium lignosulphonate	0.60	604
Filler lime (Nordkalk)	1.44	1442
Phosphogypsum (Siilinjärvi)	1.04	1043
Kaolin (standard porcelain)	0.58	583
Rotsop WP	0.22	220

[0084] Only some embodiments of the invention have been described above and it will be apparent to those skilled in the art that the invention can be implemented in many other ways within the scope of the inventive idea set forth in the claims.

[0085] Dispensing of aerosol A can be done for example by using a servo motor or like with a feedback instead of a stepping motor. Control valve 411 may in some cases also be a damper plate.

[0086] Besides fungal spores and their culture medium as well as fine-grained carrier substance K, the powdery mixture S, K contained in powder cartridge 452 may also preferably contain dye and supplemental nutrients. The supplemental nutrients are preferably selected from a group including lignin and its derivatives such as lignosulphonate and lignohumate and those will help increase the growth rate of fungal spores on a tree stump. In powdery mixture S, K the activity of the fungal spores remains at a high level significantly longer than in a solution-based product.

[0087] The powder-like mixture S, K blown onto the tree stump with aerosol A should be water-absorbent so that the fungal spores will adhere properly. Water absorption can be increased either by selecting a suitable water absorbing culture medium for fungal spores (for example silica gel) or a suitable fine-grained carrier.

EXAMPLE:

Study comparing the efficacy of liquid and solid formulation of *Phlebiopsis gigantea* spores

[0088] The upper surfaces of freshly cut billets of Norway spruce were treated with powder containing *Phlebiopsis gigantea* (strain ATCC 90304) spores. Spores were obtained by cultivating *Phlebiopsis gigantea* on solid silica carrier and drying the colonized growth medium. Inert carriers, calcium carbonate and ammonium lignosulphonate, were mixed with the dry growth medium to obtain the following powder formulation:

25% *P. gigantea* spores on silica

65% $CaCO_3$

10% ammonium lignosulphonate

[0089] The surface of each billet (length about 30 cm, diameter 14-18 cm) was divided in two sectors, one section was treated with the powder mixture comprising the fungal spores and a root rot fungus *Heterobasidion parviporum,* and the second section was treated only with *Heterobasidion parviporum.*

[0090] Two powder application rates were studied, 1.0 and 2.0 mg/cm^2. Control billets were treated with a commercial stump treatment agent, Rotstop SC, as a 1 g/l water suspension. The billets were kept in open air for 2.5 months. Then the billets were cut 5 cm below the surface and a 2 cm thick disc was taken, incubated in a plastic bag for one week and analyzed under a dissecting microscope for *Heterobasidion* covered area based on conidiophore development during the incubation. Only discs where an established *Heterobasidion* infection in the control side was observed were taken into account in calculation of the results.

Table 2: Area infested with *Heterobasidion* in spruce discs treated with different preparations containing *Phlebiopsis gigantea* in comparison with control discs with *Heterobasidion* only.

	Number of discs pes	Discs with no Heterobasidion		Area treated with the product and Hererobasidion			Control area treated with Hererobasidion only			**Efficacy of treatment**
				Total disc area	Infested area		Total disc area	Infested area		
		pcs	**%**	cm^2	cm^2	%	cm^2	cm^2	%	
Powder, 1 mg/cm2	21	16	**76%**	1428	1,62	0,113%	1488	20,53	1,38%	**92%**
Powder, 2 mg/cm2	24	22	**92%**	1596	1,75	0,110%	1799	27,53	1,53%	**94%**
Rotstop suspension	23	14	**61%**	1394	1,34	0,096%	1520	48,59	3,20%	**97%**

[0091] The results show that all the preparations containing *Phlebiopsis gigantea* controlled *Heterobasidion* root rot fungus very effectively. The efficacy was over 90% with all the treatments. Efficacy of the treatment with the powder formulation was comparable to the treatment with the commercial stump treatment method which is in an aqueous formulation.

Reference Number List

[0092]

1

Spreading device

2 Frame

21 measurement means

3 Spreading head

31 nozzles

4 Administering means

41 regulating means

411 regulating valve(s)

411a first electromagnetic valve

411b second electromagnetic valve

413 (pressurized) air supply pipe

42 pressure accumulator

43 control apparatus

431 stepper motor

45 powder storage

451 container

452 powder cartridge

453 supply tube

47 communication means

5 Chain saw

51 bar

52 bar holder

53 chain

6 Harvester head

7

Boom

80

Data measurement

81

trunk shape

82

trunk diameter

83

trunk diameter

90

Hydraulic circuit

91

chain saw

92

crane, boom

93

knives

94

harvester head tilt

95

feed rollers

96

stump treatment device for microbial propagules

97

stump treatment device for liquid

100

Harvester control system

101

crane hydraulics

102

pneumatics

103

electricity

105

working hydraulics for harvester head

I

Compressed air

K

Carrier

P

Path of the bar

P1

End point of the path

P2

Starting point of the path

S

Mixture of microbial propagules and their culture medium

S1
: Mixture of fungal spores and their culture medium

S, K
: Powder-like mixture

T
: Tree stump

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- CA875912 [0007]

Patentkrav

1. Spredningsindretning (1) indrettet til at tilføre en sammensætning på en træstub (T), hvilken sammensætning omfatter mikrobielle formeringer til at bekæmpe eller forebygge væksten af et skovpatogen, hvilken spredningsindretning (1) omfatter: et spredningshoved (3) forbundet til en ledningslignende ramme (2), og tilførselsorgan (4) til tilførsel af nævnte sammensætning, **kendetegnet ved, at**
nævnte tilførselsorgan (4) omfatter en trykakkumulator (42) til påfyldning af trykluft (I), idet nævnte trykakkumulator (42) er forbundet til en første ende af den ledningslignende ramme (2) via en forsyningsledning (413) og reguleringsorgan (41), som omfatter mindst en reguleringsventil (411) til regulering af strømningen af trykluften (I), som kommer ind i rammen (2), hvilket reguleringsorgan (41) yderligere omfatter kommunikationsorgan (47) til tilvejebringelse til mindst en reguleringsventil (411) af data vedrørende starttidspunktet for trykluft- (I) levering og data vedrørende varigheden af nævnte trykluft- (I) levering, hvor nævnte tryk af leveret trykluft (I) afhænger af diameteren af træstubben (T) og hvilket tilførselsorgan (4) yderligere omfatter

- et pulverlager (45) som indeholder en pulverlignende blanding (S, K) omfattende mikrobiel formering (S) og en fast fin bærer (K), hvilket pulverlager (45) er konfigureret til at være i stand til at blive bragt ind i en strømningsforbindelse af den pulverlignende blanding (S,K) med rammen (2), og
- et styreapparat (43) forbundet til en anden ende af rammen (2) til tilførsel af den pulverlignende blanding (S, K) inden i rammen (2) og organ til at blæse den pulverlignende blanding (S, K) på en træstub (T), via spredningshovedet (3) forbundet til rammen (2).

2. Spredningsindretningen (1) ifølge krav 1, hvor kommunikationsorganet (47) yderligere muliggør tilvejebringelse af data til styreapparatet (43) vedrørende starttidspunktet og varigheden af doseringen af den pulverlignende blanding (S, K) inden i rammen (2).

3. Spredningsindretningen (1) ifølge krav 1 eller 2, hvor reguleringsorganet (41) omfatter to reguleringsventiler; en første reguleringsventil (411a) før

trykakkumulatoren (42) og en anden reguleringsventil (411b) efter trykakkumulatoren (42) i strømningsretningen af trykluft (I).

4. Spredningsindretningen (1) ifølge krav 3, hvor mindst en reguleringsventil (411) er en elektromagnetisk ventil, fortrinsvis er den første og den anden reguleringsventil (411) elektromagnetiske ventiler, hvor den første elektromagnetiske ventil (411a), som er placeret før trykakkumulatoren (42) i strømningsretningen af trykluft (I), definerer trykniveau af trykluft (I) i trykakkumulatoren (42), og den anden elektromagnetiske ventil (411b), som er placeret efter trykakkumulatoren (42), definerer starttidspunktet for levering af trykluft til rammen (2) af spredningsindretningen (1).

5. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 1-4, hvor nævnte kommunikationsorgan (47) fungerer automatisk og modtager data fra et skovningsmaskine-styresystem (100), hvilket data omfatter styreordrer vedrørende starttidspunktet for levering og tryk af trykluft (I) og/eller starttidspunktet og varigheden af en dosering af den pulverlignende blanding (S, K).

6. Spredningsindretningen (1) ifølge krav 5, hvor styreordrene modtaget fra skovningsmaskine-styresystemet (100) omfatter styreordrer vedrørende arbejdshydraulik (105) af et skovningskine-hoved, som styrer det hydrauliske kredsløb (91, 97) forbundet med anvendelse af en kædesav (5) eller/og anvendelse af træstub-behandlingsindretning til væske.

7. Spredningsindretningen (1) ifølge krav 6, hvor styreordrer er indrettet til at blive genereret af eller stamme fra ventil(er), som åbner eller lukker fluidtryk-forbindelse mellem en hydraulisk pumpe og hydrauliske aktuatorer af kædesaven (5), eller styreordrer er indrettet til at blive genereret af eller stamme fra en trykmåler i ledningen/røret i det hydrauliske kredsløb (91) af kædesaven (5).

8. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 5-7, hvor styreordrer fra skovningsmaskine-styresystemet (100), som vedrører trykniveauet af leveret trykluft og/eller dosering af den pulverlignende blanding (S, K), afhænger af træstammeformen/-diameteren (81,82), afhænger især af

diameteren af den savede træstub (T).

9. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 5-8, hvor trykket af trykluften (I), som skal fyldes på trykakkumulatoren (42), afhænger af dimensionen af træstubben T og muligvis også af varigheden af leveringen af trykluft (I) og kan påbegyndes automatisk via funktionen af kommunikationsorganet (47).

10. Spredningsindretningen (1) ifølge krav 1, hvor nævnte pulverlager (45) yderligere omfatter en beholder (451) konfigureret til at modtage en pulverpatron (452) omfattende en pulverlignende blanding (S,K) af mikrobielle formeringer (S) og en fin fast bærer (K), fortrinsvis er nævnte mikrobielle formeringer svampesporer, og fortrinsvis har nævnte faste fine bærer (K) en volumenvægt på mindst 0,50 g/cm^3, mindst 0,60 g/cm^3 eller mindst 1 g/cm^3.

11. Spredningsindretningen (1) ifølge krav 10, hvor nævnte svampesporer er i kombination med et dyrkningsmedium anvendt til fremstilling af svampesporerne.

12. Spredningsindretningen (1) ifølge krav 10, hvor nævnte pulverpatron (452) yderligere indeholder en aftagelig hætte, og nævnte pulverlager indeholder organ (453) til at bringe nævnte pulverlignende blanding (S, K) i strømningsforbindelse med indersiden af rammen (2) efter fjernelse af nævnte hætte, fortrinsvis er nævnte pulverpatron (452) et rør fremstillet af plast, pap eller tyndt metal, og fortrinsvis er nævnte beholder (451) forbundet til strømningsforbindelse af den pulverlignende blanding (S,K) med indersiden af rammen (2) via et forsyningsrør (453).

13. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 10-12, hvor nævnte svampesporer er sporer af *Phlebiopsis gigantea;* fortrinsvis er sporer af *Phlebiopsis gigantea Phlebiopsis gigantea*-stamme ATCC 90304, *Phlebiopsis gigantea*-stamme DSMZ 26191, *Phlebiopsis gigantea*-stamme DSMZ 26192 eller *Phlebiopsis gigantea*-stamme DSMZ 16201 eller en kombination deraf.

14. Spredningsindretningen (1) ifølge krav 1, hvor nævnte reguleringsventil (41) af tilførselsorganet (4) omfatter en magnetisk ventil (411a) og/eller et spjæld til

ændring af volumenstrømmen eller/og trykket af trykluft (I), som kommer ind i rammen (2), og fortrinsvis hvor den magnetiske ventil (411a) er en start-/stopventil, og fortrinsvis hvor nævnte styreapparat (43) omfatter en stepmotor (431) eller en servomotor.

15. Spredningsindretningen (1) ifølge krav 1, omfattende en pulverpatron (452) indeholdende den pulverlignende blanding (S,K), hvor nævnte pulverlignende blanding (S,K) af pulverpatronen bringes ind i strømningsforbindelse med rammen (2) af spredningsindretningen (1) under anvendelse af styreapparatet (43), hvor den pulverlignende blanding (S,K) omfatter mikrobielle formeringer (S), fortrinsvis svampesporer, og en fast fin bærer (K), nævnte faste fine bærer (K) har en volumenvægt på mindst 0,50 g/cm^3, mindst 0,60 g/cm^3 eller mindst 1 g/cm^3, og hvor mængden af nævnte pulverlignende blanding (S,K) tilført på træstubben (T) afhænger af diameteren af den behandlede træstub (T).

16. Spredningsindretningen (1) ifølge krav 15, hvor nævnte pulverpatron (452) omfatter 5 til 50 vægt-% svampesporer og 5 til 90 vægt-% af en fast fin bærer, fortrinsvis 10 til 30 vægt-% svampesporer og 20 til 80 vægt-% af en fast fin bærer; fortrinsvis, hvor nævnte pulverpatron (452) yderligere omfatter 0,5 til 5% af et markørfarvestof eller 0,5 til 20% af et næringssupplement eller en blanding deraf.

17. Spredningsindretningen (1) ifølge krav 16, hvor nævnte svampesporer er i kombination med et dyrkningsmedium anvendt til fremstilling af svampesporerne, og nævnte dyrkningsmedium omfatter eventuelt amorf siliciumdioxid.

18. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 15-17, hvor nævnte svampesporer er sporer af *Phlebiopsis gigantea;* fortrinsvis sporer af *Phlebiopsis gigantea*-stamme ATCC 90304, *Phlebiopsis gigantea*-stamme DSMZ 26191, *Phlebiopsis gigantea*-stamme DSMZ 26192 eller *Phlebiopsis gigantea*-stamme DSMZ 16201 eller en kombination deraf.

19. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 15-18, hvor nævnte faste fine bærer (K) er kalk, calciumcarbonat, kaolin, bentonit, talkum, gips, chitosan, vermiculit, perlit, amorf siliciumdioxid, granuleret ler, finkornet

cellulosepulver, polysaccharider, chitin, chitosan, polyacrylamid, ligninderivater, kornmel, gærekstrakt, betain eller finkornet sammensætning fremstillet af kornkerner, klid, savsmuld, tørv eller træspåner eller en blanding deraf; fortrinsvis calciumcarbonat.

20. Spredningsindretningen (1) ifølge et hvilket som helst af kravene 16-19, hvor nævnte næringssupplement omfatter lignin og ligninderivater, såsom lignosulfonat eller lignohumat.

21. Fremgangsmåde til spredning af en pulverlignende blanding (S, K) på en træstub (T), **kendetegnet ved, at** spredningen udføres manuelt eller med spredningsindretningen ifølge krav 1, hvor den pulverlignende blanding (S, K) omfatter mikrobielle formeringer (S), som bekæmper eller forebygger væksten af et skovpatogen, og en fast fin bærer (K), idet den faste fine bærer (K) har en volumenvægt på mindst 0,50 g/cm^3, mindst 0,60 g/cm^3 eller mindst 1 g/cm^3, hvor nævnte fremgangsmåde omfatter følgende trin:

- modtagelse af data vedrørende dosering af den pulverlignende blanding (S, K) via reguleringsorgan,
- dosering af den pulverlignende blanding (S, K) til en mængde, som afhænger af diameteren af træstubben (T),
- dannelse af aerosol (A) fra trykgas og den pulverlignende blanding (S, K) ved levering af trykgas med tilpasset tryk til den pulverlignende blanding (S, K),
- spredning af aerosolen (A) på en træstub (T) ved hjælp af trykgasstrøm, og hvor nævnte trykgas fortrinsvis er trykluft (I).

22. Fremgangsmåden ifølge krav 21, med spredningsindretningen (1) ifølge krav 1, omfattende i pulverlageret (45) en pulverpatron (452), som indeholder den pulverlignende blanding (S, K), hvor nævnte fremgangsmådetrin inkluderer:

- modtagelse af data vedrørende mængde eller/og tilførselstidspunkt og varighed af den pulverlignende blanding (S, K) via reguleringsorganet (41) hvilken mængde eller/og tilførselstid afhænger af diameteren af træstubben (T),
- dosering af den pulverlignende blanding (S, K) inden i rammen (2) ved hjælp af styreapparatet (43),

- automatisk definering af trykniveauet af luft, som skal fyldes på trykakkumulatoren (42),
- påfyldning af trykluft (I) i trykakkumulatoren (42) ved dosering af den pulverlignende blanding (S, K) inden i rammen (2),
- dannelse af en aerosol (A) fra trykluft (I) og den pulverlignende blanding (S,K), ved levering af trykluft (I) med et foretrukket automatisk tilpasset trykniveau af en varighed til den pulverlignende blanding (S,K), som er til stede inden i rammen (2) og
- spredning eller dispergering af aerosolen (A) på træstubben (T) ved hjælp af trykluft- (I) strømmen.

23. Fremgangsmåden ifølge krav 22, hvor nævnte fremgangsmåde yderligere omfatter at arrangere trykluft (I) til at strømme automatisk inden i rammen (2) og videre til spredningshovedet (3) fra trykakkumulatoren (42) ved hjælp af mindst en, fortrinsvis ved hjælp af to reguleringsventiler (411).

24. Fremgangsmåden ifølge krav 23, hvor nævnte fremgangsmåde omfatter modtagelse af styreordrer vedrørende starttidspunkt og trykniveau af leveret trykluft og/eller dosering af den pulverlignende blanding (S, K) fra et skovningsmaskine-styresystem (100) fortrinsvis fra styreordrene fra skovningsmaskine-styresystemet (100) omfattende styreordrer vedrørende arbejdshydraulik af skovningsmaskine-hovedet (105), som styrer anvendelsen af kædesaven (5) eller/og anvendelsen af træstubbehandlingsindretning til væske.

25. Fremgangsmåden ifølge et hvilket som helst af kravene 23 eller 24, hvor styreordrer til anvendelsen af kædesaven (32) eller/og anvendelsen af træstubbehandlingsindretningen til væske er baseret på det hydrauliske kredsløb (91, 97), som er forbundet til aktuatorer, som styrer funktionerne af kædesaven (5) af skovningsmaskine-hovedet (6).

26. Fremgangsmåden ifølge krav 25, hvor styreordre, som definerer begyndelsen af påfyldningen af akkumulatoren (42) og doseringen af den pulverlignende blanding (S, K) inden i rammen (2), stammer fra eller er genereret af det hydrauliske kredsløb (91), som styrer aktuatorerne, som anvender funktionerne af kædesaven (5), når stangen (51) af kædesaven (5) når startpunktet (P2) af

dens bane (P) til skæring af en træstub (T) fra et stående træ.

27. Fremgangsmåden ifølge krav 25 eller 26, hvor styreordrer, som definerer afslutningen af påfyldningen af akkumulatoren (42) og doseringen af den pulverlignende blanding (S, K) inden i rammen, også stammer fra eller genereres af det hydrauliske kredsløb (91), som styrer aktuatorerne, som anvender kædesaven (5), efter stangen (5) af kædesaven (5) når slutpunktet (P1) af dens bane (P) til skæring af en træstub (T) fra et stående træ.

28. Fremgangsmåden ifølge et hvilket som helst af kravene 25-27, hvor styreordre, som definerer leveringstrykket af trykluften (I) til rammen (2) og af den pulverlignende blanding (S, K), hvilke er blevet doseret deri tidligere, genereres eller stammer fra det hydrauliske kredsløb (91), som styrer aktuatorerne, som anvender kædesaven (5), efter kædesav- (5) stangen (51) når starten (P2) af dens bane (P) til savning af en træstub (T) fra et stående træ.

29. Fremgangsmåden ifølge et hvilket som helst af kravene 24-28, hvor nævnte styreordrer fra skovningsmaskine-styresystemet (100) vedrører trykniveauet af leveret trykluft (I) og/eller dosering af den pulverlignende blanding (S, K), hvilke styreordrer yderligere afhænger af træstammeformen/-diameteren (81,82).

30. Fremgangsmåden ifølge et hvilket som helst af kravene 21-29, hvor nævnte mikrobielle formeringer er svampesporer, som bekæmper eller forebygger væksten af *Heterobasidion.*

31. Fremgangsmåden ifølge et hvilket som helst af kravene 21-30, hvor nævnte sammensætning omfatter 5 til 50 vægt-% svampesporer og 5 til 90 vægt-% af en fast fin bærer, fortrinsvis 10 til 30 vægt-% svampesporer og 20 til 80 vægt-% af en fast fin bærer (K), og fortrinsvis hvor nævnte sammensætning yderligere omfatter 0,5 til 5% af et markørfarvestof eller 0,5 til 20% af et nærings-supplement eller a blanding deraf.

32. Fremgangsmåden ifølge krav 31, hvor nævnte svampesporer i nævnte pulverpatron (452) er i kombination med et dyrkningsmedium anvendt til fremstilling af sporerne, og nævnte dyrkningsmedium eventuelt omfatter amorf

siliciumdioxid.

33. Fremgangsmåden ifølge et hvilket som helst af kravene 21-32, hvor nævnte svampesporer er sporer af *Phlebiopsis gigantean*, fortrinsvis sporer af *Phlebiopsis gigantea*-stamme ATCC 90304, *Phlebiopsis gigantea*-stamme DSMZ 26191, *Phlebiopsis gigantea*-stamme DSMZ 26192 eller *Phlebiopsis gigantea*-stamme DSMZ 16201 eller en kombination deraf.

34. Fremgangsmåden ifølge et hvilket som helst af kravene 21-33, hvor nævnte faste fine bærer (K) er kalk, calciumcarbonat, kaolin, bentonit, talkum, gips, chitosan, vermiculit, perlit, amorf siliumdioxid, granuleret ler, finkornet cellulose-pulver, polysaccharider, chitin, chitosan, polyacrylamid, ligninderivater, kornmel, gærekstrakt, betain eller finkornet sammensætning fremstillet af kornkerner, klid, savsmuld, tørv eller træspåner eller en blanding deraf, fortrinsvis calciumcarbonat.

35. Fremgangsmåden ifølge et hvilket som helst af kravene 31 til 34, hvor nævnte næringssupplement omfatter lignin og ligninderivater, såsom lignosulfonat eller lignohumat.

DRAWINGS

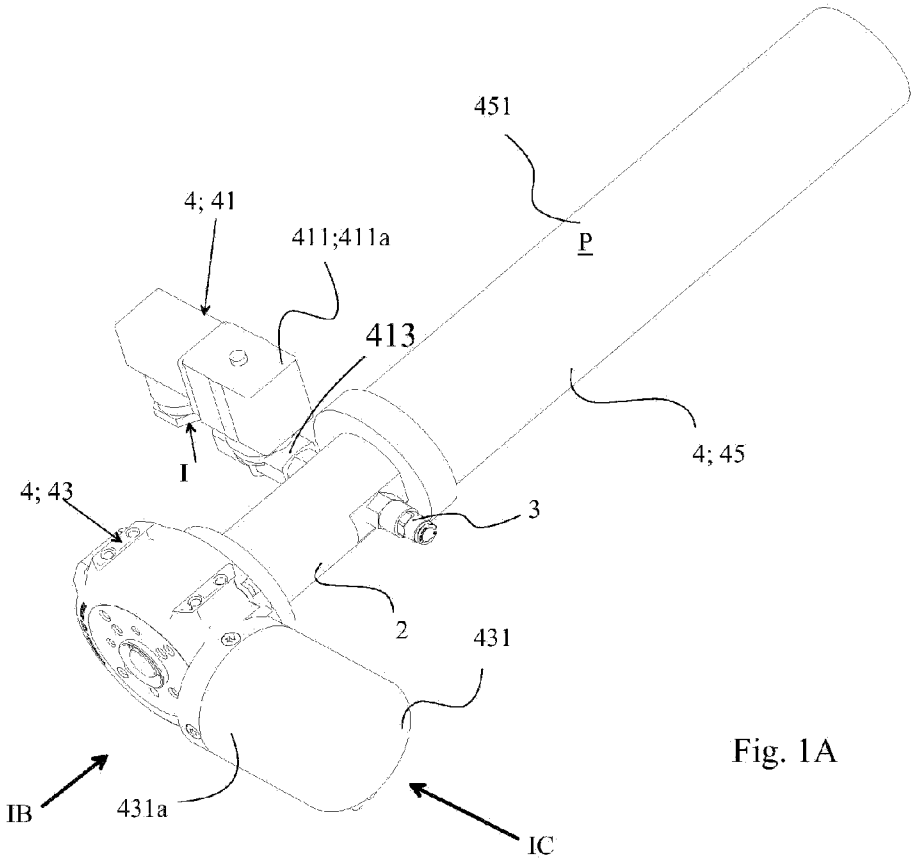

Fig. 1A

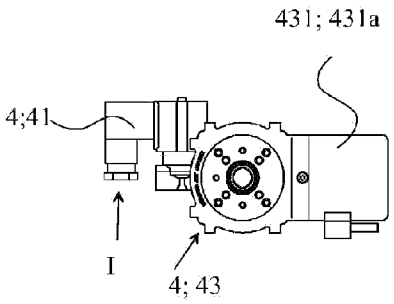

Fig. 1B

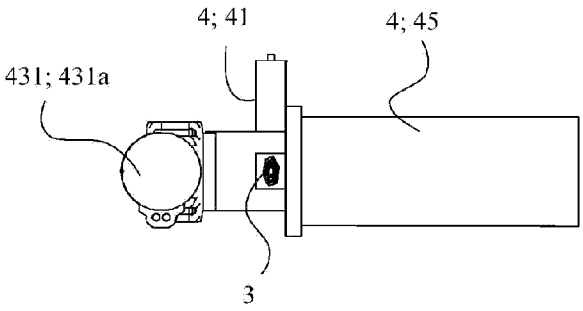

Fig. 1C

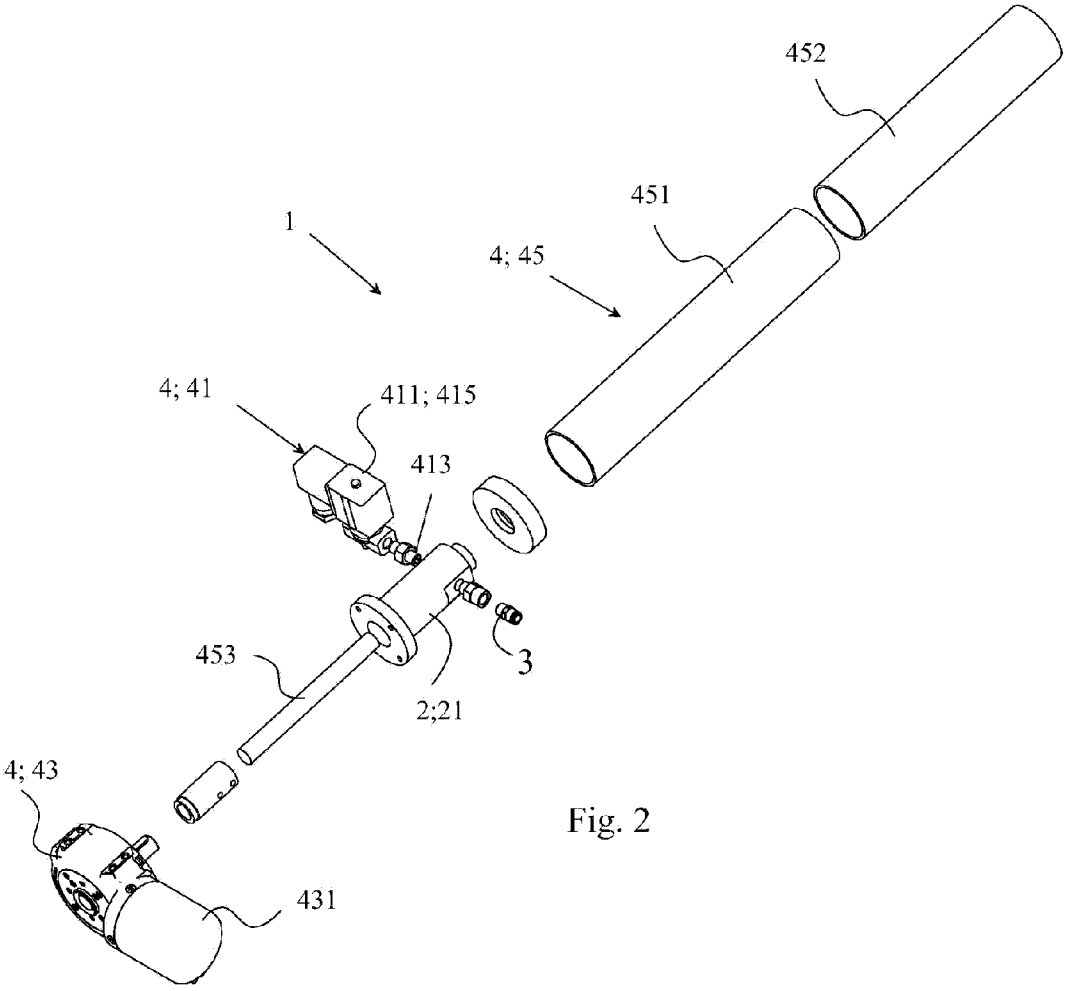

Fig. 2

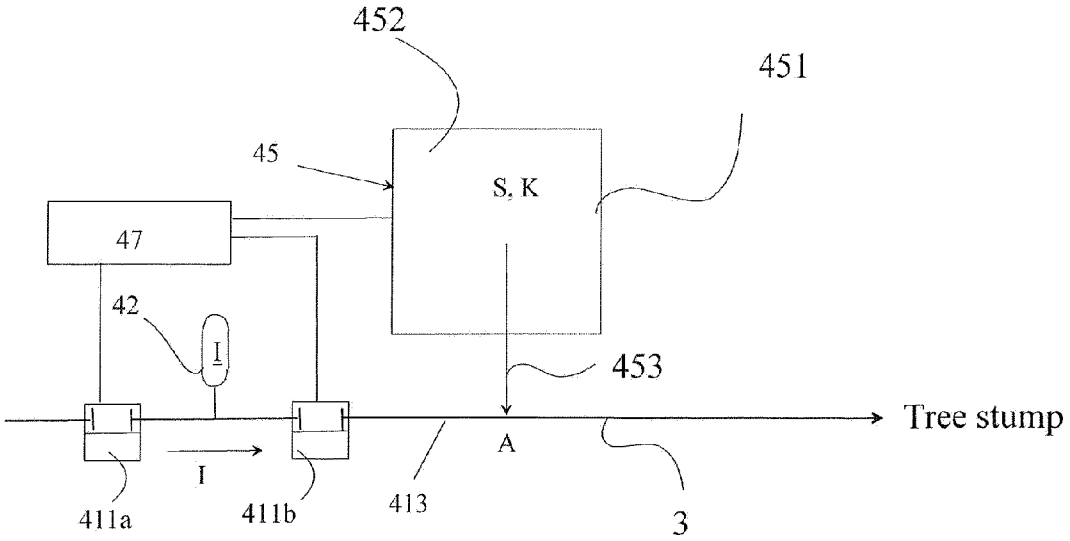
452
451
45
S, K
47
42
I
453
Tree stump
A
I
411a
411b
413
3

Fig. 3

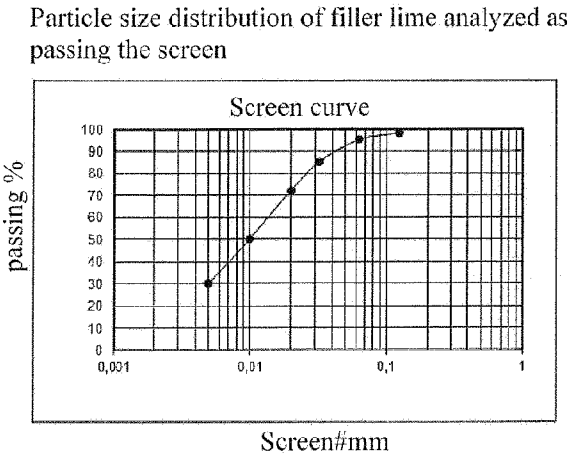
Particle size distribution of filler lime analyzed as material passing the screen
Screen curve
passing %
100
90
80
70
60
50
40
30
20
10
0
0,001
0,01
0,1
1
Screen#mm

Fig. 4

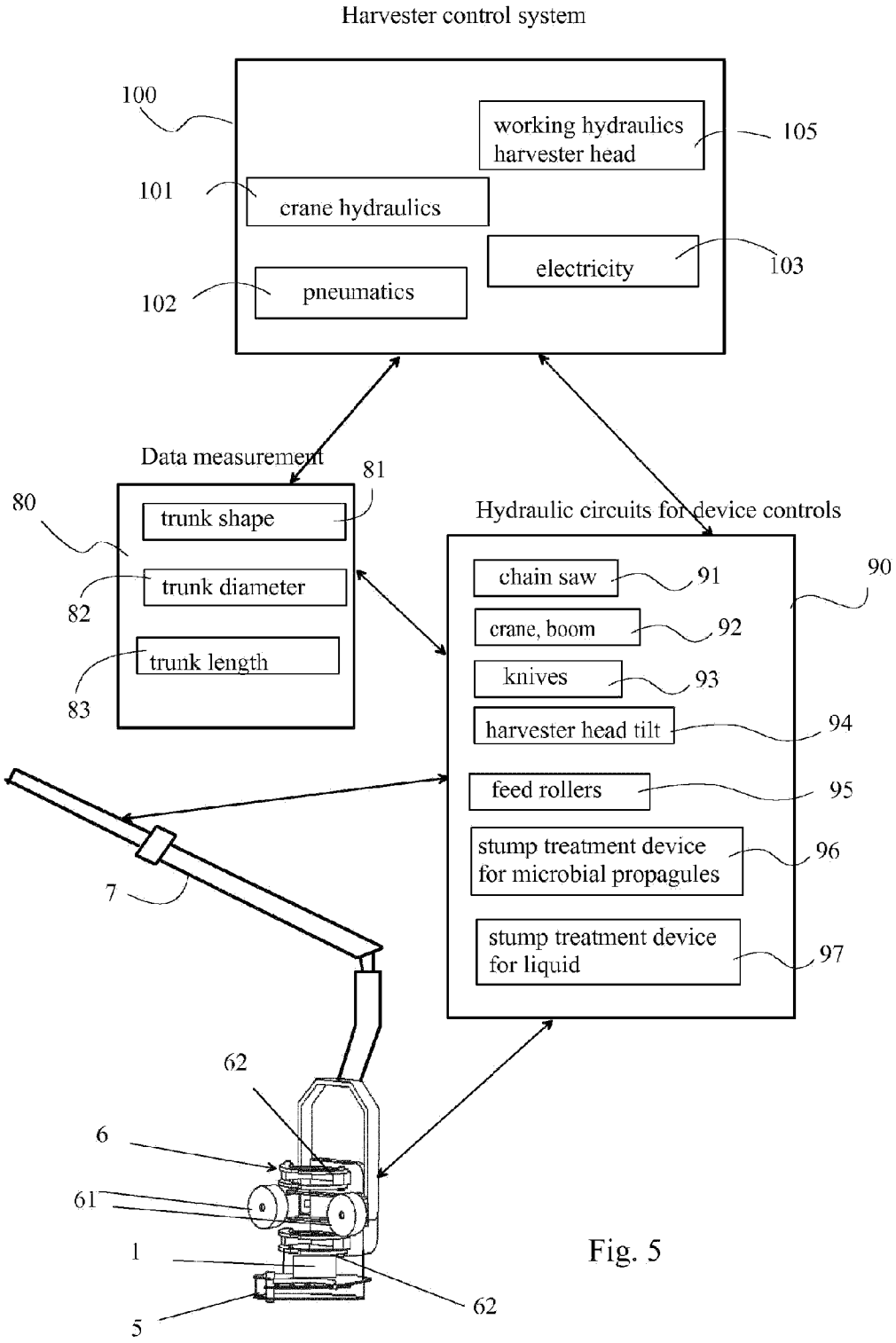
Harvester control system
100
working hydraulics harvester head
105
101
crane hydraulics
electricity
103
102
pneumatics
Data measurement
81
80
trunk shape
Hydraulic circuits for device controls
trunk diameter
82
chain saw
91
90
crane, boom
92
trunk length
83
knives
93
harvester head tilt
94
feed rollers
95
stump treatment device for microbial propagules
96
7
stump treatment device for liquid
97
62
6
61
1
62
5

Fig. 5

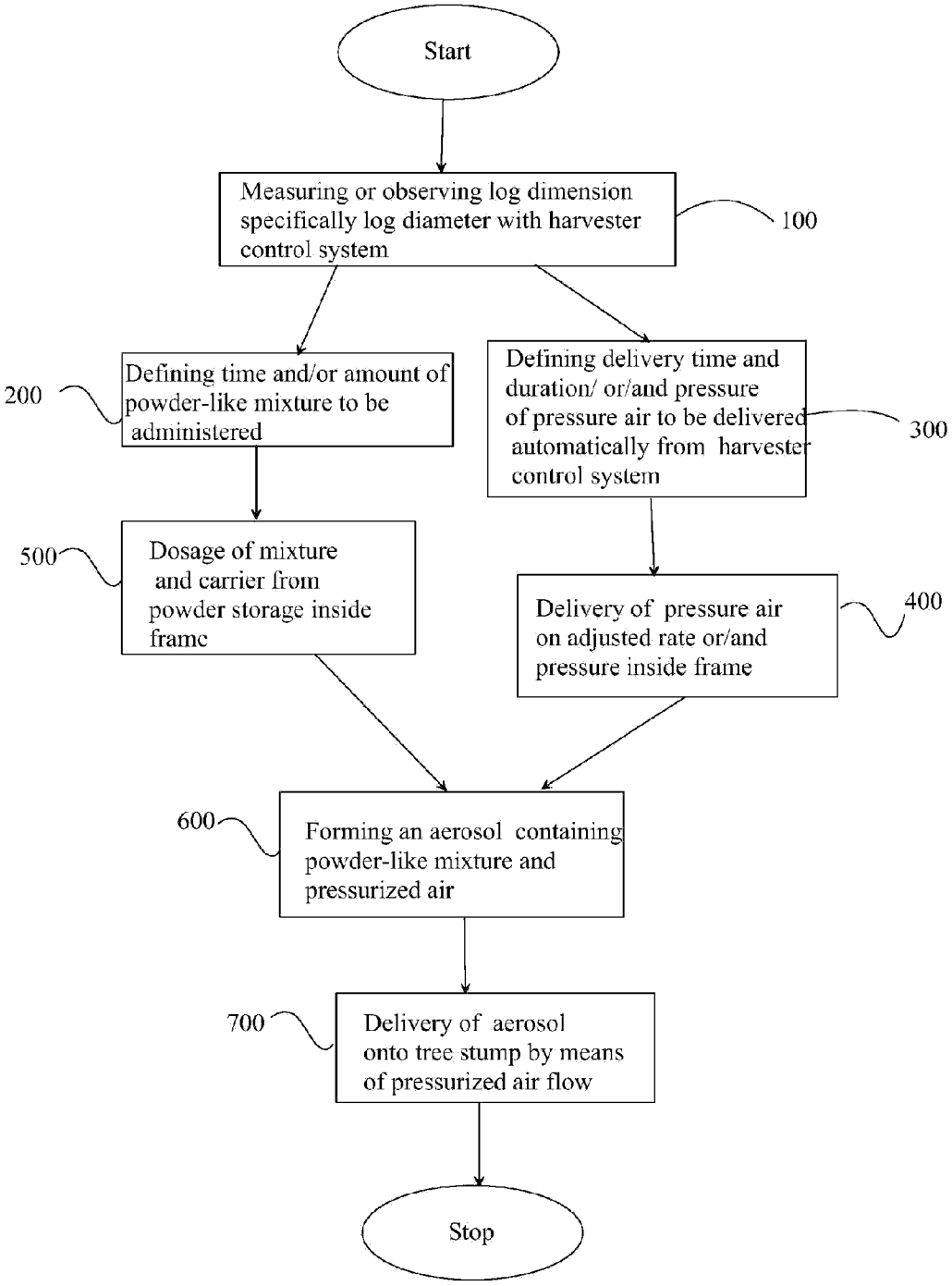
Start
Measuring or observing log dimension specifically log diameter with harvester control system
100
Defining time and/or amount of powder-like mixture to be administered
200
Defining delivery time and duration/ or/and pressure of pressure air to be delivered automatically from harvester control system
300
Dosage of mixture and carrier from powder storage inside frame
500
Delivery of pressure air on adjusted rate or/and pressure inside frame
400
Forming an aerosol containing powder-like mixture and pressurized air
600
Delivery of aerosol onto tree stump by means of pressurized air flow
700
Stop

Fig. 6A

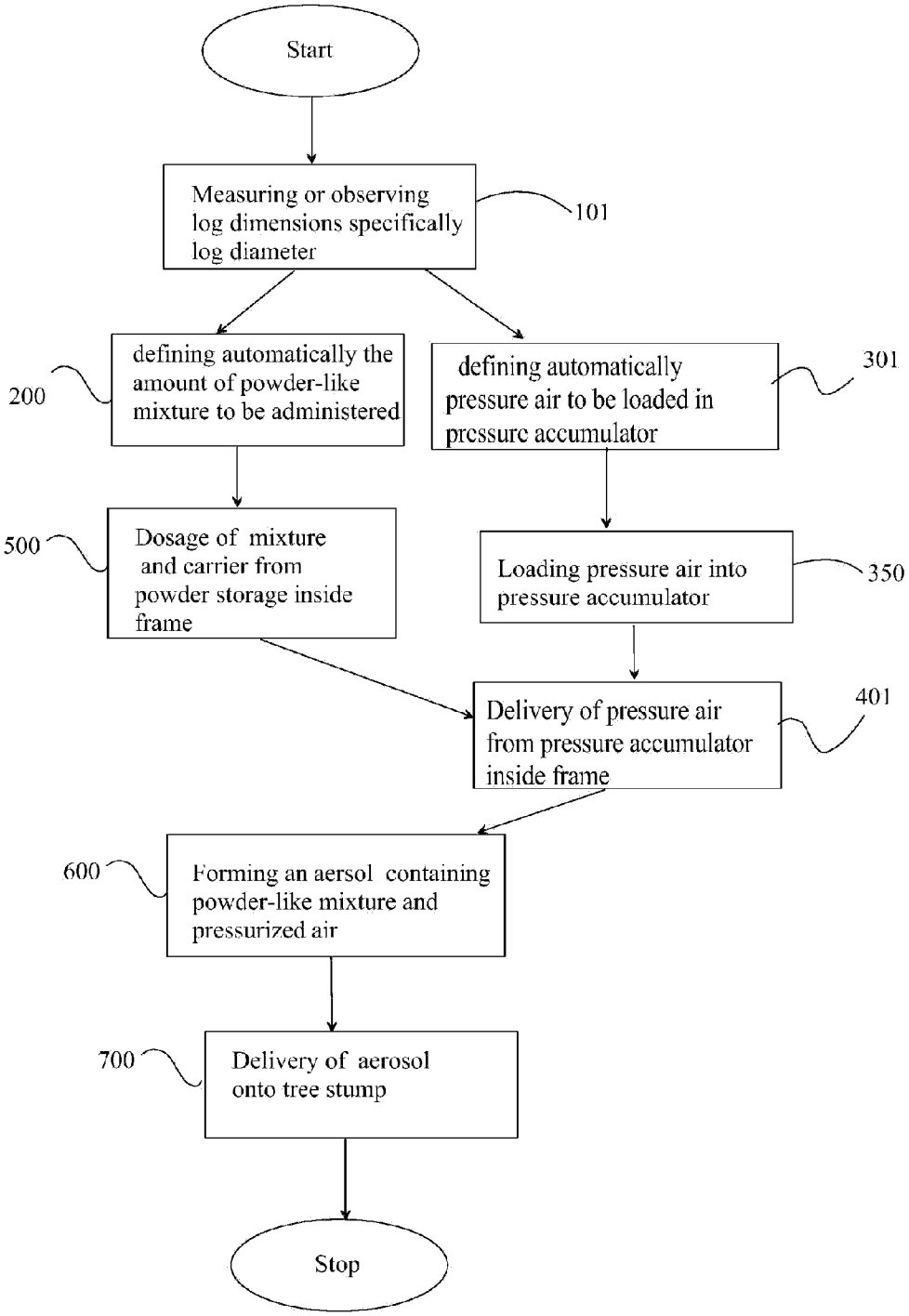
Start
Measuring or observing log dimensions specifically log diameter
101
defining automatically the amount of powder-like mixture to be administered
200
defining automatically pressure air to be loaded in pressure accumulator
301
Dosage of mixture and carrier from powder storage inside frame
500
Loading pressure air into pressure accumulator
350
Delivery of pressure air from pressure accumulator inside frame
401
Forming an aersol containing powder-like mixture and pressurized air
600
Delivery of aerosol onto tree stump
700
Stop

Fig. 6B

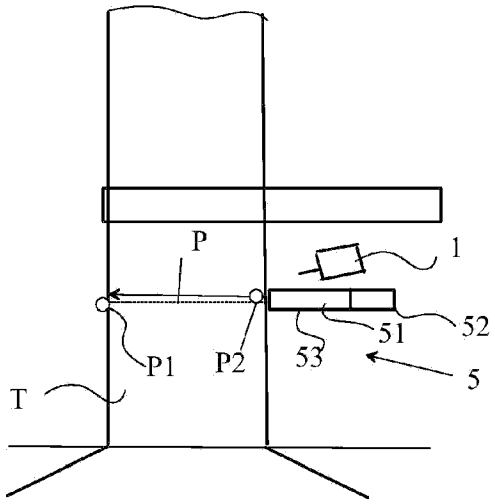

Fig. 7