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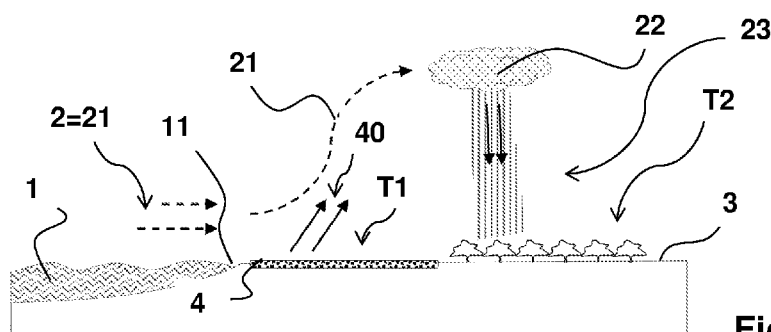


Fig. 1

(57) **Abstract:** The invention relates to a method of producing rainfall (23) near the coast (11) of oceans (1) or other large bodies of water over arid earth's surface (3) surface with a prevailing direction (21) of the flow of moisture containing air (2) inland over the arid earth's surface (3), wherein the arid earth's surface (3) extends up to a distance of hundreds of kilometres from the coast (11) and can be made fertile, comprising the following steps: - the formation of a first heat island (T1) by reducing the albedo of the earth's surface (3) at a short distance from the coast (11) by depositing a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar on the earth's surface in an amount of at least 20 tonnes of biochar (4) per 1 hectare on an area of 10 x 10 km, - the formation of warm upward air currents (40) over the biochar (4), which from the frontal/inflow parts of the first heat island (T1) begin to deflect the current of moisture containing air (2) upward, wherein upon reaching the condensation altitude of the water vapour, the moisture contained in the air (2) causes clouds (22) to form and drift inland, - the formation of a second heat island (T2) in places of rainfall (23) from the clouds (22) formed in the preceding step by planting the earth's surface (3) in this place with agricultural plants, or by depositing a continuous biochar (4) and planting this layer (4) with agricultural plants, - gradually planting of a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar of the first heat island (T1) with plants with a low albedo and the creation of a low albedo plant plantation (41).

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A method of formation of rainfall over the arid earth's surface near the coast

Technical field

5 The invention relates to a method of producing rainfall in a designated location near the coast of oceans or other large bodies of water over arid earth's surface with the prevailing wind direction from the water body inland over the arid earth's surface, wherein the arid earth's surface extends up to hundreds of kilometres from the coast and can be made fertile.

10

Background art

 Currently, the world is facing a major problem, which is considered to be the change of the Earth's global climate. Various solutions and geoengineering processes have been proposed to mitigate some of the effects of climate change.

15 The most frequently proposed solution is to slow the effects of global warming by reducing the production of anthropogenic greenhouse gases, especially carbon dioxide CO₂.

 Many proposals to reduce greenhouse gas production include proposals to reduce the rate of CO₂ formation. For example, CO₂ production can be slowed
20 by meeting energy and transport needs by using alternative energy generation, such as solar, wind, hydropower and nuclear power, and by using alternative transport fuels, such as electricity and various forms of bioenergy. These schemes, and other similar schemes, are likely to be an important part of a long-term solution reducing the increase in human-caused CO₂, but they may take
25 decades to implement on a large scale, and there are significant technological, sociological, political and economic barriers.

 Moreover, these measures do not address the scarcity of water in many parts of the world, which causes impossibility of agricultural production or leads to agriculture with inappropriate land use and low production, and, consequently,
30 to food shortages, one of the major causes of increased migration.

Poor soil management in arid, semi-arid and dry sub-humid areas results in desertification, which is caused primarily by human activities and climatic variations. Desertification occurs because dryland ecosystems, which cover more than a third of the world's land area, are extremely vulnerable to overexploitation and inappropriate land use. Poverty, political instability, deforestation, overgrazing and poor irrigation practices can all undermine the productivity of the land. More than 250 million people are directly affected by desertification, and approximately one billion people in more than a hundred countries are at risk.

The goal of many scientific teams is therefore to propose the options of transforming the above-mentioned desert or semi-desert ecosystems, savannas and other arid, semi-arid and dry sub-humid areas to fertile land, on which it will be possible to ensure agricultural production suitable for the respective area.

One option is to establish plantations of drought loving plants, such as *Jatropha Curcas* or *Jojoba*, in hot and dry areas, as it is confirmed that these plants are well adapted to harsh conditions and are able to grow alone or in combination with other types of trees or shrubs with minimal irrigation in hot areas, such as deserts, where it rains only sporadically. These plants grow quickly, develop a large root system below the soil and are able to obtain water from a great depth. Nevertheless, if the plants do not have enough water, they do grow, but slowly. It is therefore necessary to irrigate such plantations, usually with desalinated seawater.

Desalination plants are therefore located on coastal deserts and the output of the desalination plant is used to irrigate plantations. After some time, the operation of the plant can be supported by burning part of the biomass produced on the plantation. If the plantation is mature and large enough, the formation of dew and rainfall is expected due to the modification of processes associated with the atmospheric boundary layer. This rainfall would reduce the amount of water needed for irrigation and create a milder local climate.

However, based on the applicant's research and experience with simulation of quantitative precipitation, it is necessary to confirm this using a new generation of convection-permitting models. On separate *Jatropha curcas* plantations up to 100 km × 100 km, the applicant's model predictions are much more modest, so a *Jatropha curcas* plantation would always require desalinated

water. For this reason, such plantations can only be established in those desert areas that are close to the coast in order to minimize the cost of transporting water to the plants both vertically and horizontally. In any case, the increase in rainfall would save some of the water from the desalination plant needed to
5 irrigate the plantations in the summer season.

On the other hand, it should be noted that the increase in rainfall is not the amount that ends up in the root zone for irrigation. This value depends on runoff, interception, evapotranspiration, and infiltration into the soil. Rainfall increment has a diurnal cycle, and because it is controlled by an increase in sensible heat
10 flux, water accumulation in soil also depends on the diurnal cycle. Therefore, the increase in soil moisture and thus the decrease in water demand depends in a non-linear manner on the temporal and spatial evolution of the individual induced precipitation events.

From the above, it is clear that plantations of drought loving plants can only
15 be established and managed on arid earth's surface near water sources, so that their irrigation can be ensured.

Another option for weather modification over arid land located near a body of water is described in patent application US 3,409,220 A.

Basically, it is a method based on the creation of a thermal temperature
20 gradient over an area of land over which air coming from a body of water/ and containing moisture moves. This moisture-laden air normally moves over the arid land from the body of water in an inland direction, but the moisture contained in the air does not precipitate, condense or form clouds in the lower layer of the atmosphere from which rain could fall, so the land area remains dry.

25 The patent application describes that upward currents of air containing moisture represented by water vapour can be induced moving to the altitude where the air reaches the dew point and the moisture will gradually condense until clouds form.

By this process, rain and other forms of precipitation can be produced over
30 the inland and thereby restore or create arable land on large areas that are currently destroyed or become worthless barren or marginal pastures. Thus,

some of the world's large arid desert regions can be made productive by increasing rainfall.

According to the present invention, coating of selected large areas of soil with a coating material which is a highly effective absorber of solar radiation, namely asphalt and/or heavy petroleum oils, or emulsions containing asphalt and/or heavy petroleum oils, the material being substantially black or very dark in colour, is used to induce upward currents of moisture containing air.

The coating material must be able to withstand high temperatures in order to be heated to high temperatures for long periods of time, at which it is able to transfer sufficient heat to the humid air moving over it to form ascending air currents that transport the humid air to altitudes at which clouds form, which move in the direction of the air flow beyond the covered area above the land continuing inland, on which they fall in the form of rainfall, thereby gradually fertilizing the land and making it suitable for agricultural use.

The asphalt covered areas proposed by the invention are approximately 1 mile from the water surface and their dimension along the water surface is also about 1 mile, while their length leading inland is proposed to be approximately 10 miles. Of course, it is possible to create more such asphalt strips leading inland next to each other.

The disadvantage of this solution is that the formed asphalt or similar solid surface is otherwise completely unusable.

Based on the weather modification method according to US 3,409,220 A, "The Geshem Rain System" was created in Israel. On the arid earth's surface near the Mediterranean Sea, at a short distance from the coast, within approximately thirty km in the direction of the prevailing winds, a black area of 3 x 3 km is formed, absorbing solar radiation and forming a heat island, over which air currents coming from the sea rise upwards and enter the cold layers of the atmosphere, where the water vapour in the air condenses to form clouds which then form rainfall. Clouds and rainfall form downwind of the heat island at a distance of 25 to 30 km into the continent over the originally arid area. The precipitation generated by the system allows agriculture to take place on an area of about 70 to 90 km². After the rainfall has ceased, the air current drops again

and flows in any direction. In a preferred embodiment, part of the rainwater is collected in above-ground or even underground tanks.

The black sunlight absorbing surface which creates a heat island is made of a very black foil that is strong and impermeable to water.

5 The disadvantage of both systems containing a black surface to form a heat island is the impermeability of this surface to water, whether it is a solid black foil or a solid surface of asphalt or an asphalt-like emulsion, so that this surface is otherwise of no use and serves only its basic purpose, i.e., to lift the air current flowing away from the body of water and containing moisture to the altitudes at
10 which the moisture condenses to form clouds.

 The object of the invention is to propose a method of generating water precipitation over arid earth's surface near the coast, which would eliminate the above-mentioned disadvantages of the background art and, moreover, enable the spread of vegetation further inland. In addition, the proposed method should
15 not require additional irrigation after a certain period of operation.

Principle of the invention

 The object of the invention is achieved by a method of producing water precipitation in warm areas over the originally arid earth's surface near the coast
20 of oceans or other large bodies of water with a prevailing direction of the flow of moisture containing air inland over the originally arid earth's surface, which extends/extended up to a distance of several hundreds of kilometres from the coast, comprising the following steps:

 - the formation of a first heat island by reducing the albedo of the earth's
25 surface at a distance of at least 1 km from the coast by depositing a continuous layer of biochar and/or nano-biochar and/or liquid nano-biochar on the earth's surface in an amount of at least 20 tonnes per one hectare on an area of at least 10 x 10 km,

 - the formation of warm upward air currents over the biochar, which from
30 the frontal/inflow parts of the first heat island begin to deflect the moisture containing air current upward, and upon reaching the condensation altitude of the

water vapour, the moisture contained in the air condenses to form clouds which are drifted inland,

- the formation of a second heat island in places of rainfall from the clouds created in the preceding step by planting the earth's surface in this place with agricultural plants, or by depositing a continuous layer of biochar and planting this layer with agricultural plants,

- gradual planting of the continuous layer of biochar and/or nano-biochar and/or liquid nano-biochar of the first heat island with plants with a low albedo and the creation of a low albedo plant plantation.

As a result of the lowering of the albedo of the first heat island by the application of a continuous layer of biochar, rising currents of moisture containing air are formed over the first heat island, rising to altitudes where water vapour condenses and gradually gathers into clouds that drift beyond the first heat island above the second heat island, where water is released from the clouds in the form of rain.

Other advantages and features of the invention are described in the dependent claims.

Brief description of drawings

Drawings will be used to illustrate the invention, wherein Fig. 1 shows a diagram of generating rainfall with a flat first heat island with a layer of biochar applied, followed by a second heat island planted with plants, Fig. 2 shows a diagram of generating rainfall with a mountainous first heat island with a layer of biochar applied followed by a second heat island planted with plants, Fig. 3 shows a diagram of generating rainfall with a planar first heat island with a biochar layer planted with plants with a low albedo (*Jatropha Curcas*/*Jojoba*) followed by a second heat island planted with plants, Fig. 4 shows a diagram of generating rainfall with a mountainous first heat island with a biochar layer planted with plants with a low albedo (*Jatropha Curcas*/*Jojoba*) followed by a second heat island planted with plants. Fig. 5 shows a diagram of generating rainfall with a flat first heat island with an applied biochar layer planted with plants with a low albedo (*Jatropha Curcas*/*Jojoba*) combined with additional geoengineering means and a

second heat island situated behind it, with a layer of biochar planted with plants, and Fig. 6 shows a diagram of generating rainfall with a mountainous first heat island with an overlying biochar layer planted with plants with a low albedo (Jatropha Curcas/Jojoba) and followed by a second heat island, with an applied
5 biochar layer planted with plants.

Examples of embodiment

The invention relates to a method of generating rainfall near the coast of oceans or other large bodies of water over arid earth's surface with a prevailing
10 direction of moisture-containing winds inland over the arid earth's surface, wherein the arid land surface extends up to a distance of hundreds of kilometres from the coast. The invention will be explained with reference to the following examples of embodiments of the invention, which are merely for the purpose of illustrating the invention and potential applications and are not intended to be
15 limiting.

In the first stage, a location on the coast 11 of the ocean 1 or other large body of water with a prevailing direction 21 of the flow of moisture containing air 2 inland over the arid earth's surface 3 extending up to a distance of hundreds of kilometres from the coast should be selected. Initial conditions are such that water
20 evaporates from the water surface of the ocean 1 in the form of water vapour, creating moist air that rises upwards. As a result of the direction 21 of the moisture containing air 2 moving from the ocean 1 over the arid earth's surface 3, the current of the moisture containing air 2 drops above the earth's surface and uselessly departs from the coast over the land to a great distance inland without
25 forming rainfall. This is due to the high albedo of the earth's surface, which is usually desert sand in the given area, compared to the albedo of the water surface of the ocean.

Albedo (from Latin albus - white) is the fraction of the reflectivity of a body or its surface. It is the ratio of reflected electromagnetic radiation to the amount
30 of incident radiation. The fraction, usually expressed as a percentage from 0 to 100 %, is an important concept in climatology and astronomy, with percentages

usually written as a decimal number. For comparison, the albedos of various surfaces occurring on Earth are shown below.

	Ocean level	0.06
	Desert sand	0.40
5	Bare soil	0.17
	Deciduous forest	0.15-0.18
	Green grass	0.25
	Black asphalt	0.04
	Biochar	0.034

10 The albedo of the earth's arid surface, usually desert sand, near the coast must therefore be lowered to achieve high absorption of solar radiation, which over a surface with lowered albedo causes an upward air current that lifts large masses of moist air.

15 According to the invention, the reduction of the albedo of the arid earth's surface is achieved by applying a continuous layer of biochar **4** in an amount of at least 20 tonnes per 1 hectare on an area of at least 10 x 10 km, wherein the distance from the coast **11** is chosen according to the specific conditions of the chosen location, for example in the range of 1 to 10 km, optionally even more, for example in the range of 30 to 50 km. This forms the first heat island **T1** covered
20 with the biochar **4**, above which warm upward air currents **40** are formed, which from its frontal/inflow part will start to deflect the current of air **2** containing moisture upwards, wherein after reaching the condensation altitude of the water vapour, the moisture contained will begin to condense in the air **2** and clouds **22** are formed, as shown in Fig. 1, which are carried further inland by the wind,
25 wherein in the cloud **22** large droplets of water are formed gradually in a known manner, which fall on the earth's surface **3** in the form of rainfall **23**, which means that water is released from the cloud **22** in the form of rain.

30 Thus, in the direction **21** of the flow of moisture containing air **2**, i.e., in the direction inland, in the places of rainfall **23** from the clouds **22** formed in the preceding heat island, the conditions will begin to form for planting the area in which rain falls with agricultural plants suitable for the respective area, thereby forming a second heat island **T2**. The area of the second heat island **T2** before planting can be covered with a continuous layer of biochar **4**, optionally mixed

with appropriate fertilizers and/or compost, and only then planted. The plants used have a lower albedo than the original desert sand, but greater than the first heat island T1 covered with biochar. Consideration should be given to the fact that if the second heat island T2 is covered with a layer of biochar 4 and subsequently planted with plants, the increase in the albedo of the second heat island T2 covered with the biochar 4 will be lower until the plants grow and cover the majority of the area of the second heat island T2.

The area of the second heat island T2 is greater than the area of the first heat island T1, optimally up to ten times. However, the direction 21 of the air 2 flow inland is maintained. Since water is released from the cloud 22 in the form of rain and due a slight increase in the albedo of the second heat island T2, air currents slightly drop after water is released from the cloud 22, but at the same time there is evaporation of water through plants and the surface of the second heat island T2, and so the air above it is again enriched with moisture and if we create a third heat island behind the second heat island T2, whose albedo is lower than the albedo of the second island T2, the events described for the first heat island T1 will be repeated, i.e., the formation of warm upward air currents 40 above the biochar 4, which deflects a current of air 2 containing moisture, which condenses at altitude to form clouds 22 which continue to move in the direction inland and release water in the form of rain beyond the third heat island, creating the conditions for another area to be planted with agricultural plants, thereby forming a fourth heat island. In the areas of heat islands, over which it rains, it is advantageous to build tanks 5 for collecting water, either above-ground or underground tanks, which can be used for additional irrigation. When building underground tanks or using existing natural reservoirs, the risk of seepage or seawater synergy must be anticipated.

According to the invention, formation of additional heat islands in the direction inland can be further repeated.

Biochar 4, which forms a layer that reduces the albedo of the arid earth's surface, is a charred biomass for application to soils. It differs from charcoal in that it is fine-grained, charring is not applied to lump wood and the resulting solid product is not used as fuel. Biochar is produced by a process called pyrolysis. In it, biomass is heated without air access at high temperatures of 300-600 °C. In

terms of nutrients, the composition of biochar, except for the reduced nitrogen content, is almost the same as that of the input biomass. However, the largest part is pure carbon, which is in a very stable form and is almost not subject to further decomposition. Nutrients that bind to carbon are released slowly from it and do not wash away. Carbon itself remains in the soil in this form for centuries and millennia.

With the advancement in nanotechnology, researches have been conducted on the generation of nano-biochar (nano-BC) for soil and agricultural application in a sustainable way (Gao and Wu, 2014). At the time of the carbonization process, the micro-sized BC having dimensions lower than a micrometre (μm) as well as up to nanometre (nm), designated as “dissolved” and “nano-BC” is synthesized. In a recent study, nano-BC having a diameter lower than 5 nm was obtained (Xiao and Chen, 2017). Differences between bulk-BC and nano-BC (dissolved and nano-BC) appear in terms of structural variations along with the physicochemical attributes. Nano-BC can display varying elemental compositions, aromatic/polar nature, pH, cation exchange capacity (CEC), specific surface area (SSA), pore characteristics, and Zeta potential (Oleszczuk et al., 2016). In addition, there can be soluble and insoluble phases of nano-BC. Typically, the soluble carbon content is enhanced with increasing solvent pH and reduced with increasing pyrolysis temperature and ranges from 14 % (100 °C) to 0.2 % (700 °C) in dairy manure BC (Chen et al., 2015). Therefore, the nano-BC becomes more interesting due to an increasing incidence of environmental contamination and low crop yields under changing climatic conditions (Liu et al., 2018).

Rajput, V. D., Minkina, T., Ahmed, B., Singh, V. K., Mandzhieva, S., Sushkova, S... & Wang, B. (2022). Nano-biochar: A novel solution for sustainable agriculture and environmental remediation. *Environmental Research*, 210, 112891.

Agro-waste is designed to produce potentially valuable biochar-based organic fertilizers economically while managing waste. Biochar (BC) produced from agriculture waste helps to improve the soil because of its neutral pH, addition of organic carbon to the soil and lower salt index values. This study focused on the development of nano-biochar into a more enhanced biochar product where it was checked whether the biochar derived from wheat straw can absorb nutrients

and then act as support matter for releasing micro-nutrients and macro-nutrients for the plants on slow liberation basis. Wheat biochar (WBC) and wheat nano-biochar (WBNC) were synthesized by pyrolysis at two different temperatures and nutrients were fused into the WBC via impregnation technique. Physical parameters such as Proximate, Ultimate analysis and others were also studied and inspected by standard control procedures. Studies were also carried out on water retention (WR), water absorbance (WA), swelling ratio (SR) and equilibrium water content (EWC) for all samples; data was collected and compared for the better sample. Slow-release studies performed portrayed the release pattern of nutrients for prolonged periods, which is very important for the plant growth, yield and productivity. Overall, the experimental results showed that BNC produced at 350 °C which exhibited promising characteristics (SI:0.05, SR: 3.67, WA:64%, EWC:78.6%, FC:53.05% and pH:7.22) is a good substance. Nevertheless, the nano-biochar has better results; it is environmentally friendly and could be utilized as a potential fertilizer on slow release for sustainable and green agriculture application.

Khan, H. A., Naqvi, S. R., Mehran, M. T., Khoja, A. H., Niazi, M. B. K., Juchelková, D., & Atabani, A. (2021). A performance evaluation study of nano-biochar as a potential slow-release nano-fertilizer from wheat straw residue for sustainable agriculture. *Chemosphere*, 285, 131382.

Liquid nano-biochar

Agroforestry waste used as biochar for agricultural, environmental and climate applications has attracted considerable attention, but there are only a few reports on biochar as electrode modified materials and solid fuel briquettes. In this paper, a new strategy for the mass preparation of micro/nano-powders of biochar with water dispersibility and their potential applications in different fields is demonstrated. Ultra-fine powders of biochar were easily obtained through pyrolyzing fine powders of smashed biomass waste based on pitch pine at high temperature under oxygen-limited conditions.

Micro/nano-powders of biochar were conveniently prepared through milling and sieving ultra-fine powders of biochar. Water-dispersible biochars were easily developed through sonicating and centrifugally separating micro/nano-

powders of biochar. The structures and properties of two biochar types were characterized, and upper-layer biochar was more steadily dispersed in water and had a smaller size than lower-layer biochar, which was mainly employed as an electrode material in a Pb^{2+} voltammetric sensor and as solid fuel briquettes for pellet biofuels and other preliminary applications, such as use as rice bio-fertilizers and Pb^{2+} bio-adsorbents were also given. The satisfactory results indicated that micro/nano-structured and/or water-dispersible biochar will provide promising platforms for electrochemical applications as electrode materials, as a cleaner and renewable alternative to coal fuel, and for other uses, for example as bio-fertilizers for crops, seedlings and growth, and as bio-adsorbents for the removal of hazardous substances.

Li, L., Zhang, K., Chen, L., Huang, Z., Liu, G., Li, M., & Wen, Y. (2017). Mass preparation of micro/nano-powders of biochar with water-dispersibility and their potential application. *New Journal of Chemistry*, 41(18), 9649-9657.

Liquid nano-biochar can be applied using water produced from atmospheric water generators (e.g., in the production of biochar itself by condensation of the produced hot moist air - e.g., using mobile atmospheric water generators, which can be used at any time in another location compared to, e.g., conventional large desalination plants).

Biochar is produced and supplied in fine-grained loose form, in which for the purposes of the invention it can only be spread over the arid earth's surface in the selected area. Other forms of biochar are nano-biochar and liquid nano-biochar. Nano-biochar in loose form can be used in a mixture with regular biochar for the purposes of the invention. Liquid nano-biochar can be created by mixing bulk nano-biochar with water, and for the purposes of the invention it can be used as the first, i.e., base, layer applied to the dry earth's surface, and then regular biochar is applied to this layer in a layer of at least 20 t/ha, optimally 30 up to 60 t/ha. If liquid nano-biochar were to be used, a large amount of water must be provided, for example using atmospheric water generators, or using a desalination device, since up to 40 l of water is needed for producing liquid nano-biochar per 1 m² of surface area. In order to simplify the description, the general name biochar will be used for all types of biochar in most cases.

According to the applicant's assumptions, the optimal distance of the frontal/inflow part of the first heat island **T1** from the coast is 30 to 50 km, but it can be changed according to the specific conditions of the selected site, so it can be smaller or larger, as well as its size of the area of the biochar **4**, which should preferably, according to the applicant's assumptions, 100 x 100 km, but it can be divided into several narrow strips extending inland, or be smaller.

With the size of the biochar area of 100 x 100 km, it is assumed that part of the rainfall **23** will fall in the rear part of this area, which will allow the use of this part of the area for planting with suitable plants and the formation of the second heat island **T2** already above part of this area and its further continuation inland.

The fundamental advantage of biochar, nano-biochar and liquid nano-biochar is their compatibility with the cultivation of plants, since they retain water and nutrients, so even the area of the first heat island **T1**, or at least its rear part, can be gradually planted with suitable plants, for example Jatropha Curcas or Jojoba, and a low albedo plant plantation **41** can be established. This procedure has a significant advantage in that initially the area of the first heat island **T1** is made up of biochar **4**, the efficiency of which gradually decreases, so the layer of biochar **4** needs to be renewed or replenished continuously in order to maintain its desired albedo. After planting the area with suitable plants and plant growth, it is assumed that the albedo given by the plant cover will be further used, which is lower than the albedo of biochar **4**, but with a sufficient size of the plant plantation (100 x 100 km), this plant plantation will generate a sufficient amount of heat to generate warm upward currents **40** to deflect air current **2** containing moisture upwards, where moisture condensation will occur and generate sufficient rainfall **23** to create sufficient precipitation water to grow plants in the following areas. Furthermore, in places where plants on the first heat island **T1** do not grow or die, or are too far apart, the albedo of the original biochar layer **4** which will be continuously renewed, will enter the system and be continuously renewed, thus keeping the albedo of the entire area of the first heat island **T1** sufficiently low.

Nevertheless, in view of the previous paragraph, it seems more advantageous to leave the frontal/inflow part of the first heat island **T1** only covered with biochar **4**.

Biochar, nano-biochar and liquid nano-biochar can be brought to the selected site or can be produced at the site. The energy required for this can be obtained by any of the known methods that are most suitable for the given locality. The optimum method appears to be the production of electricity by pyrolysis of biomass to produce biochar + electricity + water by the condensation of the moist hot air produced.

Example 1

At an arid earth's surface location at a distance of 15 to 30 km from the coast of the ocean 1 inland in the direction of the prevailing flow of air 2 containing moisture evaporated from the ocean 1, the albedo of the earth's surface is reduced by applying a continuous layer of biochar 4 to the earth's surface 3 in an amount of 30 to 60 tonnes/ha. The area covered with the biochar 4 is 100 x 100 km. This creates a first heat island T1, whose surface absorbs a large amount of solar radiation and, as a result, has a high surface temperature, and warm upward air currents 40 form above its surface. The moisture containing air 2 flowing from the ocean inland will begin to be lifted by warm air currents 40 at the frontal/inflow part of the first heat island T1 and create a rising current of the moisture containing air 2 in which, after reaching the altitude of condensation of the water vapour, the moisture contained in the air 2 will begin to condense and form clouds 22 moving further inland and after the formation of larger water droplets, the rain 23 from the cloud/clouds falls on the earth's surface 3. In the area where water from the clouds 22 release water in the form of rain, a second heat island T2 is established, which is covered with a layer of biochar 4 and subsequently planted with plants for example Jatropha Curcas, or Jojoba, as shown in Figs. 5 and 6, either for agricultural production or for maintaining a low surface albedo.

Example 2

This example represents a test rather than commercial implementation. Since most of the currently known attempts to create water precipitation near the coast over the arid earth's surface above which the air moves inland, are based more on theoretical conclusions without thorough verification by long-term use.

The first heat island **T1** is established as in example 1 at a distance of 10 to 30 km from the coast **11** and the albedo of the arid earth's surface **3** is reduced by applying a layer of biochar **4** in an amount of 30 to 60 tonnes/ha on an area of 10 x 10 km. In the direction **21** of the inland flow of moisture containing air **2**, the first heat island **T1** will be complemented by a low albedo plantation consisting of *Jatropha Curcas*/*Jojoba* plants having a size of 90 x 90 km. The amount of water produced by the area of the biochar depends on the specific conditions of the given location and, among other things, on its relief, since if the earth's surface in this area rises or is mountainous, the effects of the biochar **4** on raising air currents **2** containing moisture are greater. Preferably, the area of the plantation planted by *Jatropha Curcas*/*Jojoba* may be before planting covered with a layer of biochar **4**, which means that in the first phase before planting and after planting, the effects of the biochar **4** will prevail, and only after the growth of the plants will the effects of the plant plantation appear. The present solution can be combined with cloud ionization, electric rain generation and laser-guided weather modification, i.e., geoengineering means **6** of weather modification that would not be effective without surface albedo reduction.

Industrial applicability

The method of generating rainfall in warm areas over the formerly arid earth's surface near the coast of oceans with a prevailing flow of moisture containing air from the ocean inland can be used to fertilize the earth's surface and create agricultural areas without polluting the environment. The use of this method changes the local weather over the formerly arid area to the weather favourable for settlement and agricultural activities, wherein the implementation of the method does not require additional energy and water and is, as a result, self-stable after reaching equilibrium between the heat islands.

List of references

- 1 ocean
- 11 coast
- 5 2 moisture containing air
- 21 direction of the flow of moisture containing air
- 22 cloud
- 23 rainfall
- 3 arid earth's surface
- 10 4 biochar
- 40 a warm upward air current above a biochar or plant plantation
- 41 low albedo plant plantation
- 5 water collection tank
- 6 geoengineering means of weather modification
- 15 T1 first heat island
- T2 second heat island

PATENT CLAIMS

1. A method of formation of rainfall (23) near the coast (11) of oceans (1) or other large bodies of water over arid earth's surface (3) surface with a prevailing direction (21) of the flow of moisture containing air (2) inland over the arid earth's surface (3), wherein the arid earth's surface (3) extends up to a distance of hundreds of kilometres from the coast (11) and can be made fertile, comprising the following steps:

- the formation of a first heat island (T1) by reducing the albedo of the earth's surface (3) at a short distance from the coast (11) by depositing a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar on the earth's surface in an amount of at least 20 tonnes of biochar (4) per 1 hectare on an area of 10 x 10 km,

- the formation of warm upward air currents (40) over the biochar (4), which from the frontal/inflow parts of the first heat island (T1) begin to deflect the moisture containing air (2) current upward, wherein upon reaching the condensation altitude of the water vapour, the moisture contained in the air (2) causes clouds (22) to form and drift inland,

- the formation of a second heat island (T2) in places of rainfall (23) from the clouds (22) formed in the preceding step by planting the earth's surface (3) in this place with agricultural plants, or by depositing a continuous biochar (4) and planting this layer (4) with agricultural plants,

- gradually planting a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar of the first heat island (T1) with low albedo plants to form a low albedo plant plantation (41).

2. The method according to claim 1, **characterized in that** the biochar layer (4) of the first heat island (T1) is monitored and, if necessary, replenished to its original thickness while maintaining its continuity.

3. The method according to claim 1 or 2, **characterized in that** a third thermal is formed behind the second heat island (T2) in the inland direction by reducing the albedo of the Earth's surface (3) by depositing a continuous layer

of biochar (4) and/or nano-biochar and/or liquid nano-biochar on the earth's surface (3) and/or by planting the earth's surface (3) with a low albedo plant plantation (41).

4. The method according to any of the preceding claims, **characterized in**
5 **that** the heat islands have an area of at least 100 x 100 km.

5. The method according to any of the preceding claims, **characterized in**
that the low albedo plant plantations (41) are formed by *Jatropha Curcas* and/or Jojoba plants.

6. The method according to any of the preceding claims, **characterized in**
10 **that** the distance of the first thermic island (T1) from the coast (11) is 10 to 30 km.

7. The method according to any of claims 1 to 5, **characterized in that** the distance of the first thermic island (T1) from the coast (11) is less than 10 km.

8. The method according to any of the preceding claims, **characterized in**
15 **that** the amount of biochar (4) in a continuous area of biochar (4) is 30 to 60 t/ha.

9. The method according to any of the preceding claims, **characterized in**
that the size of the continuous area of biochar is 100 x 100 km².

AMENDED CLAIMS

received by the International Bureau on 22 April 2024 (22.04.2024)

PATENT CLAIMS

1. A method of formation of rainfall (23) near the coast (11) of oceans (1) or other large bodies of water over arid earth's surface (3) surface with a prevailing direction (21) of the flow of moisture containing air (2) inland over the arid earth's surface (3), wherein the arid earth's surface (3) extends up to a distance of hundreds of kilometres from the coast (11) and can be made fertile, which involves the application of a coating of low albedo material to the earth's surface, over which, after heating, warm upward currents are formed that deflect the moisture-laden air upwards, where, after reaching the condensation height, the moisture condenses, forming clouds which are carried inland, where they cause rainfall, **characterized in that** that the coating of low albedo material deposited on the earth's surface is compatible with growing plants, absorbs a large amount of solar radiation and as a result has a high surface temperature and warm upward currents (40) form over its surface, wherein the coating is formed by depositing a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar on the earth's surface in an amount of at least 20 tons of biochar (4) per hectare over an area of at least 10 x 10 km at a distance of 1 to 50 km from the coastline, thereby forming a first thermal island (T1), wherein, from the frontal part of the first thermal island (T1), warm upward currents deflect the moisture-laden air (2) current upward, and when the condensation height of the water vapour is reached, the moisture contained in the air (2) condenses, clouds (22) form and drift inland, where the conditions for planting the area are created in places of rainfall (23), thereby forming a second thermal island (T2) by planting the earth surface (3) in this area with plants, or by depositing a continuous layer of biochar (4) and planting this layer of biochar (4) with plants, wherein the layer of biochar (4) of the first thermal island (T1) is monitored and, if necessary, replenished to its original thickness while maintaining its continuity.

2. The method according to claim 1, **characterized in that** the area of the second thermal island (T2) is covered with a continuous layer of biochar before planting.

3. The method according to claim 1 or 2, **characterized in that** the surface of the first thermal island (T1) is gradually planted with low albedo plants, wherein the

frontal part of the surface of the first thermal island (T1) is left only covered with biochar (4).

4. The method according to any of claims 1 to 3, **characterized in that** a third thermal is formed behind the second heat island (T2) in the inland direction by reducing the albedo of the Earth's surface (3) by depositing a continuous layer of biochar (4) and/or nano-biochar and/or liquid nano-biochar on the earth's surface (3) and/or by planting the earth's surface (3) with a low albedo plant plantation (41).

5. The method according to any of the preceding claims, **characterized in that** the heat islands have an area of at least 100 x 100 km.

6. The method according to any of the preceding claims, **characterized in that** the low albedo plant plantations (41) are formed by *Jatropha Curcas* and/or *Jojoba* plants.

7. The method according to any of the preceding claims, **characterized in that** the distance of the first thermic island (T1) from the coast (11) is 10 to 30 km.

8. The method according to any of claims 1 to 6, **characterized in that** the distance of the first thermic island (T1) from the coast (11) is less than 10 km.

9. The method according to any of the preceding claims, **characterized in that** the amount of biochar (4) in a continuous area of biochar (4) is 30 to 60 t/ha.

10. The method according to any of the preceding claims, **characterized in that** the size of the continuous area of biochar is 100 x 100 km².

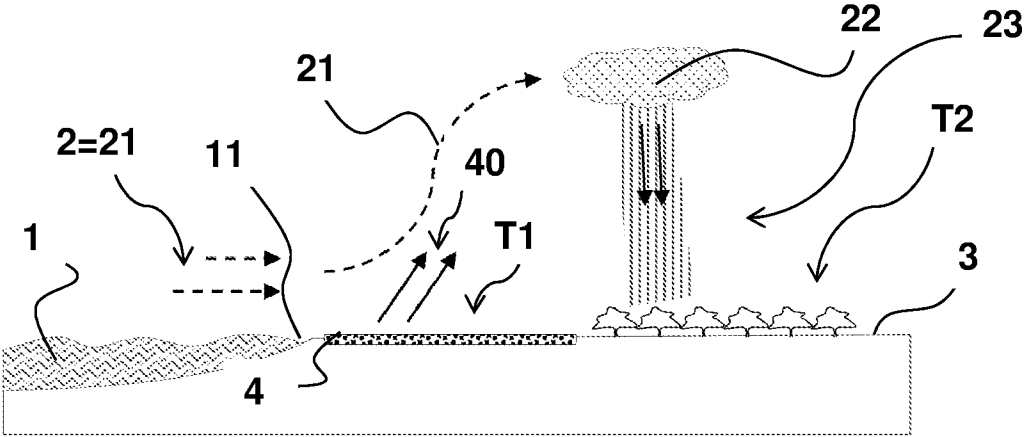


Fig. 1

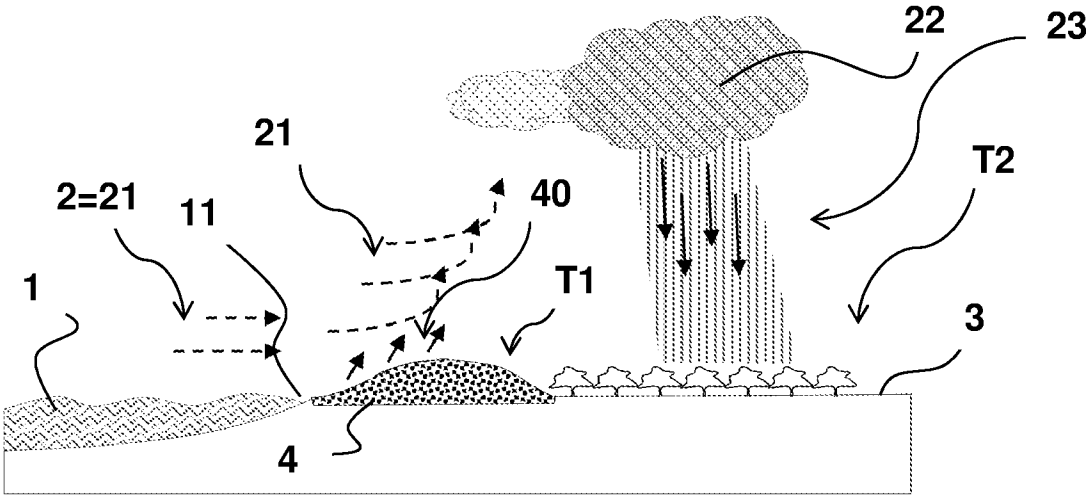


Fig. 2

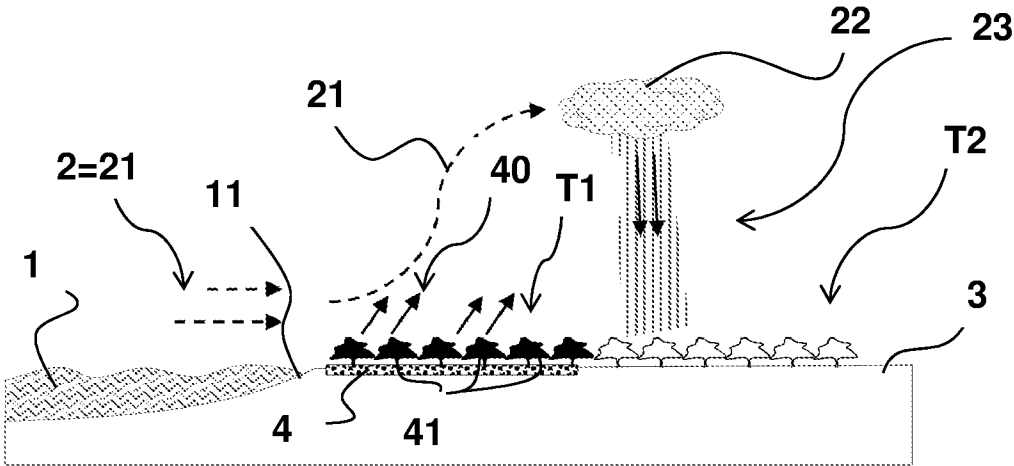


Fig. 3

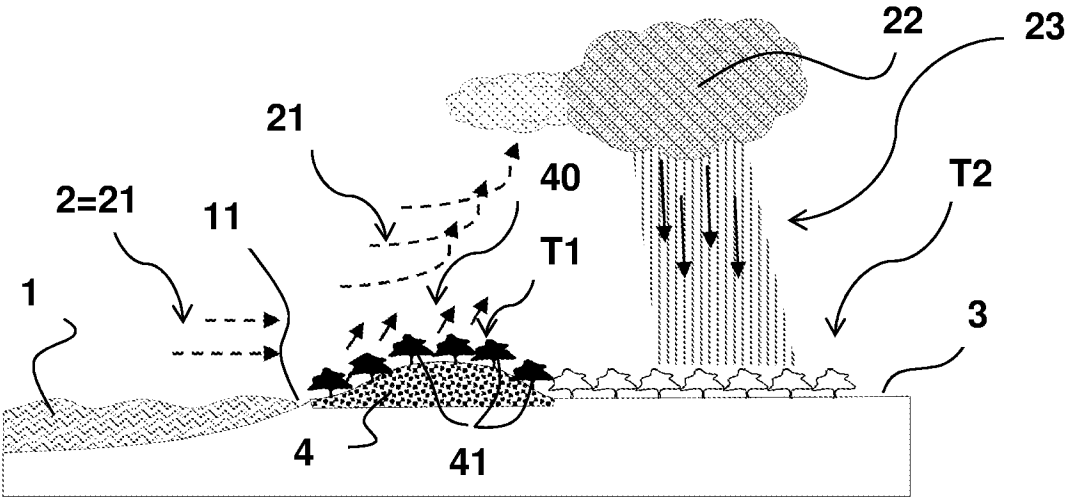


Fig. 4

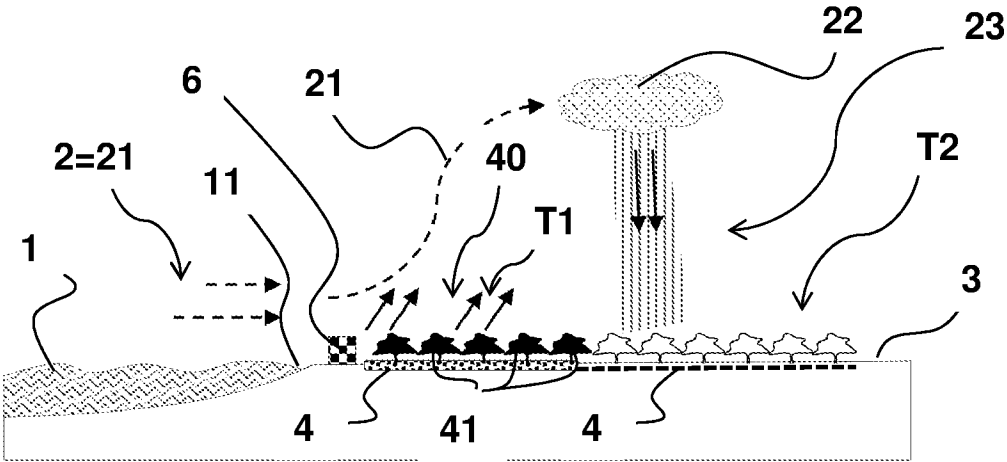


Fig. 5

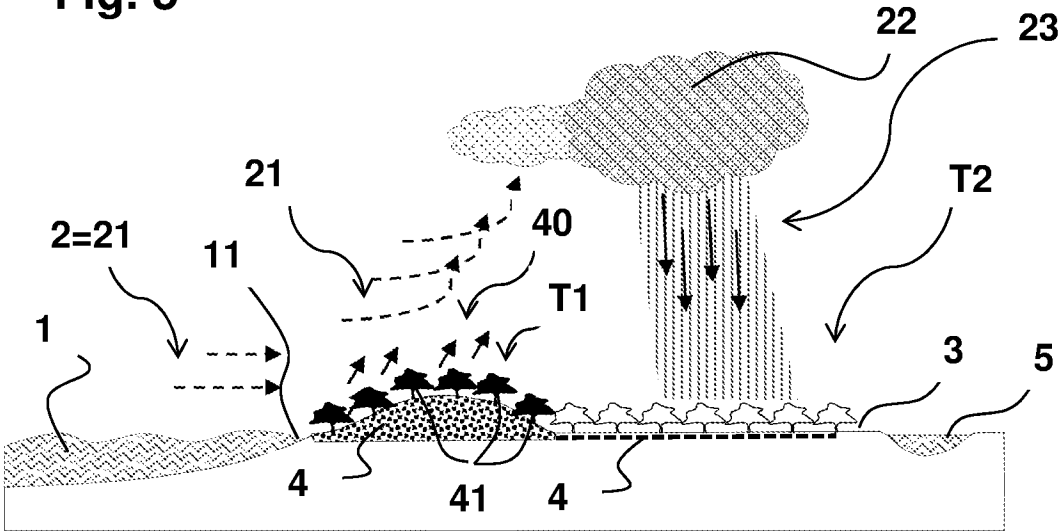


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2023/050070

A. CLASSIFICATION OF SUBJECT MATTER INV. A01G15/00 ADD.												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols) A01G												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
Y	GB 988 109 A (EXXON RESEARCH ENGINEERING CO) 7 April 1965 (1965-04-07) claims 1-2, 12; figures 3-5 page 1, line 45 - page 2, line 10 page 3, line 86 - page 4, line 44 page 5, lines 11-20, 25-29 ----- -/--	1-4, 6-9										
<table><tr><td>☒ Further documents are listed in the continuation of Box C.</td><td>☒ See patent family annex.</td></tr></table>			☒ Further documents are listed in the continuation of Box C.	☒ See patent family annex.								
☒ Further documents are listed in the continuation of Box C.	☒ See patent family annex.											
* Special categories of cited documents : <table><tr><td>"A" document defining the general state of the art which is not considered to be of particular relevance</td><td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td></tr><tr><td>"E" earlier application or patent but published on or after the international filing date</td><td>"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td></tr><tr><td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td><td>"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td></tr><tr><td>"O" document referring to an oral disclosure, use, exhibition or other means</td><td>"&" document member of the same patent family</td></tr><tr><td>"P" document published prior to the international filing date but later than the priority date claimed</td><td></td></tr></table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
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"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
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"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 12 February 2024		Date of mailing of the international search report 23/02/2024										
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Guillem Gisbert, I										

INTERNATIONAL SEARCH REPORT

International application No

PCT/CZ2023/050070

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GENESIO L ET AL: "Surface albedo following biochar application in durum wheat", ENVIRONMENTAL RESEARCH LETTERS, BR, vol. 7, no. 1, 22 February 2012 (2012-02-22), page 14025, XP020220501, ISSN: 1748-9326, DOI: 10.1088/1748-9326/7/1/014025	1-4, 6-9
A	abstract page 2, left-hand column, paragraph 6 page 2, right-hand column, paragraph 3 page 6, left-hand column, paragraph 2 -----	5
A	US 2012/056006 A1 (BENDAH DAVID [US]) 8 March 2012 (2012-03-08) paragraph [0174]; figure 1 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/CZ2023/050070

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 988109	A	07-04-1965	NONE	

US 2012056006	A1	08-03-2012	NONE	
