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(54) **Drying apparatus and method for drying**

(57) The present invention provides a method for drying products such as vegetables, herbs and/or fruit, in combination with an apparatus for drying products, wherein the apparatus (1) comprises:

- a housing (2);
- drying means arranged in the housing, comprising one or more IR-modules (10) for emitting infrared

(IR) radiation of a desired spectrum for the purpose of drying the products;

- transporting means (6,14) arranged in the housing for carrying the products along the drying means at a desired speed; and
- fan means (18) arranged in or on the housing for discharging moisture from the products.

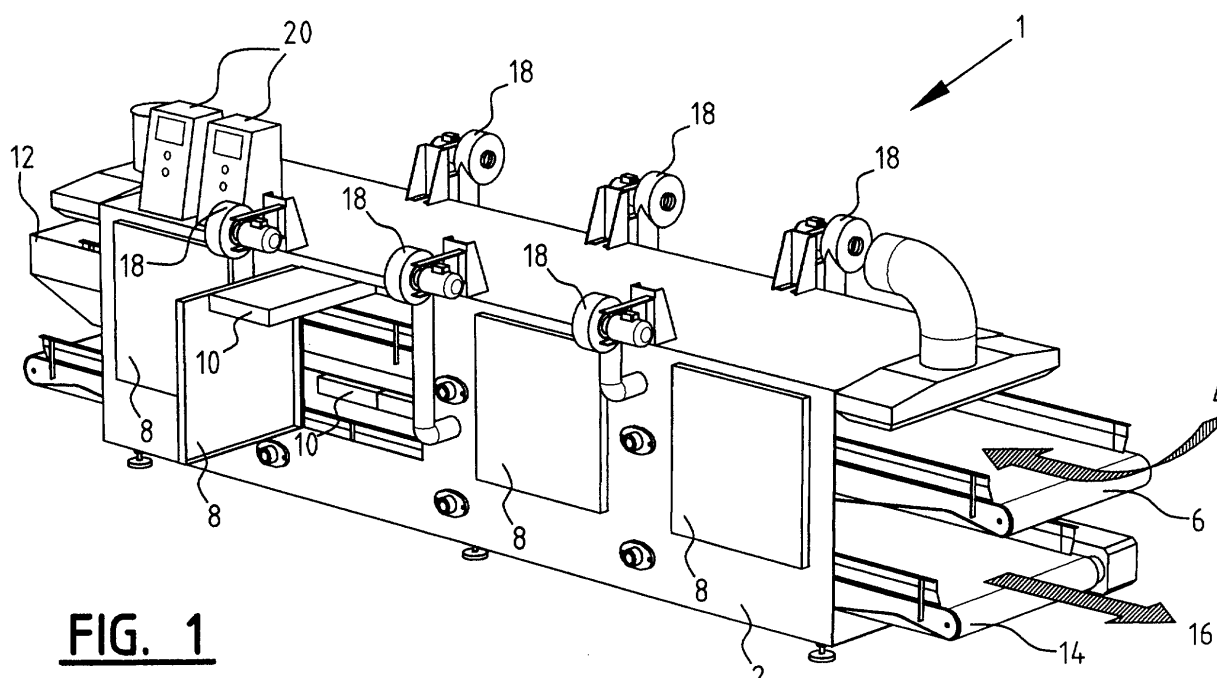


FIG. 1

Description

[0001] The present invention relates to a drying apparatus for drying for instance vegetables, herbs and/or fruit in combination with a method for drying vegetables, herbs and/or fruit, and to vegetables, herbs and/or fruit which have been dried according to the above stated method.

[0002] In the food industry the processing of products is subject to a constant improvement. The requirements made of the products in respect of freshness, bacterial growth and smell and appearance thereof are becoming more and more exacting. There is also an increasing demand for ready-to-eat meals and pre-cut fresh products. The vegetables and fruit included in these meals and pre-cut products must satisfy strict standards and the shelf life is also important here.

[0003] With systems known in the prior art, vegetables, herbs and/or fruit are dried, after processing thereof, by means of hot air which is carried over the products. This hot air serves both to dry the products and to discharge the evaporated water. Using such a drying method however, too short a shelf life is obtained to include fresh vegetables in for instance salads or other ready-to-eat, pre-cut fresh products.

[0004] The present invention has for its object to obviate the above stated problems and provides for this purpose a method for drying products such as vegetables, herbs and/or fruit, in combination with an apparatus for drying products such as vegetables, herbs and/or fruit, comprising:

- a housing;
- drying means arranged in the housing (infrared system) which comprise one or more IR-emitters which emit infrared radiation in a desired spectrum for the purpose of drying the products;
- transporting means arranged in the housing for carrying the products along the drying means at a desired speed; and
- fan means arranged in or on the housing for discharging the moisture released by the drying means from the surface of the products.

[0005] Such an apparatus can dry products to a desired moistness, wherein a longer shelf life of the products is achieved, wherein the products look better than products dried according to the prior art, wherein an energy saving is achieved relative to prior art drying and wherein the products are not damaged, whereby the quality of the end products improves.

[0006] In a further preferred embodiment the apparatus comprises jolting means for shaking the products. By applying such jolting means the products are dried uniformly on all sides thereof in order to improve the quality of the end products.

[0007] In a further preferred embodiment the transporting means comprise two or more, and preferably

three conveyor belts for transporting the products. The length of the apparatus is limited to a predetermined length by applying two or more conveyor belts.

[0008] In a further preferred embodiment the apparatus comprises cooling means for cooling the products with cool air, whereby the temperature of the products is reduced so that the shelf life of the products is improved and the nutrients remain stored therein.

[0009] In a further preferred embodiment the apparatus comprises first, second, third and fourth control means for controlling the fan means, the drying means, the transporting means and the cooling means respectively and which are coupled thereto in order to achieve, if possible, a rapid and energy-saving drying with a high quality of the products. By applying these control means the temperature of the fresh products can be limited during drying to below 20°C and preferably to 12°C - 17°C, at which temperature the nutritious substances remain stored in the products and the shelf life thereof is increased, and in dehydrating of the finally dried products preferably to 30°C - 70°C.

[0010] In a further preferred embodiment the components of the apparatus are embodied where possible in stainless steel for application thereof in the food industry. The apparatus complies with strict standards for the food industry through the use of qualitatively high-grade materials such as stainless steel.

[0011] In a further preferred embodiment the drying means comprise so-called STIR (Selective Transformed Infra-Red) modules for emitting infrared radiation of a predetermined wavelength. By applying such STIR modules it is possible to cause only the water molecules to evaporate without the food products being affected thereby, wherein the wavelength can be chosen such that the products are simultaneously sterilized.

[0012] In a further preferred embodiment the temperature of the infrared modules is limited to 180 - 270°C so as to minimize the thermal load on the products on the one hand and to improve the shelf life of the products on the other. By adjusting the infrared modules in this temperature range a sterilizing and cleaning drying of the products is obtained up to a residual moisture content of 0 - 4% during dehydration respectively a surface moistness of 0 - 2% during drying.

[0013] According to a further aspect the present invention provides a method for drying food products such as vegetables, herbs and/or fruit, comprising the steps of:

- arranging a housing;
- arranging in the housing drying means comprising one or more IR modules for emitting infrared (IR) radiation of a desired spectrum for the purpose of drying the products;
- arranging in the housing transporting means for carrying the products along the drying means at a desired speed; and
- arranging in or on the housing fan means for dis-

charging moisture from the products.

[0014] Using such a method products are dried to a desired moistness, wherein a longer shelf life of the products is achieved, wherein the products look better than products dried according to the prior art, wherein an energy saving is achieved relative to the prior art drying and wherein the products are not damaged, whereby the quality of the dried products improves.

[0015] Further advantages and features of the present invention are elucidated with reference to the annexed figures, in which:

- fig. 1 shows a perspective view of an apparatus according to the present invention in a first preferred embodiment;
- fig. 2 shows a perspective rear view of the apparatus of figure 1;
- fig. 3 shows drying means according to the present invention separated into components in a first preferred embodiment;
- fig. 4 is a side view of transporting means and jolting means according to the present invention in a first preferred embodiment; and
- fig. 5 shows jolting means according to the present invention in a first preferred embodiment.

[0016] A drying apparatus 1 (fig. 1) according to the present invention comprises a housing 2 inside which the drying process takes place. The foodstuffs are introduced into the machine at 4 and carried further into machine 1 via conveyor belt 6, which is embodied in a blue colour so that the distinction between the foodstuffs and the components of the conveyor belt is clear. In the housing is arranged a number of doors 8 which can be opened in order to slide infrared modules 10 in and out of the machine. Infrared modules 10 take an elongate and flat form so that they can be readily arranged above conveyor belt 6. At the other outer end of conveyor belt 6 is situated a collecting screen 12, via which screen the food products drop off belt 6 and come to lie on a second conveyor belt 14 located thereunder. This second conveyor belt 14 moves in an opposite direction so that the total length of machine 1 is reduced. In other preferred embodiments a plurality of conveyor belts, each one moving in opposite direction to the conveyor belt located thereabove, can be arranged as desired to further reduce the length of drying apparatus 1. Above conveyor belt 14 infrared modules 10 are once again arranged as desired for emitting infrared radiation so as to evaporate water and dry the products. The food products leave the drying apparatus 1 at 16 and are further transported therefrom for further processing. Also shown are fans 18, which blow air from outside the machine into the drying apparatus transversely of the direction of movement of the belt in order to cool the foodstuffs and also to discharge moist air. Control boxes 20 are arranged on top of respectively adjacently of housing 2 of the machine

to control the speed of jolting units 64,66, the speed of fans 18, the speed of conveyor belts 6, 14 and the energy of infrared modules 10.

[0017] A perspective rear view of drying apparatus 1 (fig. 2) shows, in addition to the components already described above, the two motors 22 and 24 for driving conveyor belts 6 and 14 respectively. Further shown are two electric motors 26 for driving jolting units which are arranged under conveyor belts 6 and 14 for slight shaking of the products on the conveyor belts, which jolting units are elucidated below. On the top side of drying apparatus 1 are arranged extractors with discharge pipes 28 and 30 for extracting in the longitudinal direction of the apparatus moist air which is situated above the conveyor belts, this using fans which are not further shown. The product temperature can be maintained at a predetermined value by controlling the extraction speed in the longitudinal direction.

[0018] An infrared module 10 (fig. 3) comprises ceramic elements 40 for a normal infrared (IR) respectively for STIR (Selective Transformed Infra-Red), through which run two or more electrically conducting filaments 42. By controlling the electric power dissipated in filaments 42 the infrared radiation emitted by the cylindrical ceramic elements 40 can be controlled up to a predetermined radiant power (W/cm^2). The radiation range respectively wavelengths λ predetermined by the ceramic herein remain substantially constant and correspond as far as possible with the absorption capacity (oscillation characteristic) of the water molecules. In this manner the water can be removed more efficiently from biological products during drying at lower temperatures than during drying with convection heat as according to the prior art. For this purpose a carrier is arranged round filaments 42, preferably a cylindrical tube of ceramic material. In the case of the STIR elements another ceramic layer is arranged round the carrier in order to achieve a higher efficiency. Characteristics of the described Selective Transformed Infra-Red element are a high emission number ϵ and an emission spectrum λ which is readily absorbed by water. The IR power P which can be generated with elements 40 lies in the range of about $1.25 - 25 \text{ kW}/\text{m}^2$.

[0019] Elements 40 are arranged in a holder 44 with wiring 46 at outer ends thereof for supplying electric power. Above elements 40 is arranged the reflector 48 of an effectively specular metal such as high-grade steel, which is polished on the surface or the surface of which is gilded. Reflector 48 ensures that IR radiation reaches the products for drying not only directly but also via reflector 48. On the visible side of elements 40 is also arranged a protective grid 50 of stainless steel. The whole unit of reflector 48, IR elements 40 and protective grid 50 is arranged in a stainless steel protective hood 52. This latter has an elongate, flat form so that this can slide easily in and out of drying apparatus 1 (fig. 1). For use in the food industry, in order to comply with the strict safety requirements and standards, the components

shown in fig. 3 are arranged in protective hood 52 by glueing, welding or clicking and not used are rivets, pins or screws or other fixing techniques which contaminate easily. The drying unit 10 is constructed such that it can be washed with cleaning methods usual in the food industry using acids, bases and mechanical cleaning means which comply with the hygienic requirements of the food processing industry.

[0020] For a better general drying, the products 60 situated on conveyor belt 6 (fig. 4) are shaken by jolting units arranged under the conveyor belt, so that products 60 dry on all sides thereof. A jolting unit consists of a central shaft 62 on opposite sides of which two eccentric shafts 64 and 66 are arranged. When shaft 62 rotates, the eccentric shafts 64, 66 alternately make contact with belt 6, whereby this latter is lifted in the order of 10 - 100 mm in order to shake the products 60. The rotation frequency of shaft 62 can be controlled subject to the desired drying and product 60.

[0021] Depending on the length of drying apparatus 1, one or more jolting units with the two shafts 64 and 66 rotating round shaft 62 can be successively arranged. Shafts 62 are driven by an electric motor 26. The power thereof is distributed over the central shafts 62 via transmission mechanism 68. On the opposite outer end thereof the shafts 62 are mounted in bearing 70.

[0022] Using the above described drying apparatus food products such as iceberg lettuce, leaf lettuce, spinach, broccoli, onions and carrots with a surface moistness of 25 - 7% can be dried to a surface moistness of 4 - 0%, wherein the freshness of the product is retained and the shelf life thereof is in the order of 4-20 days by holding the products in the temperature range of 20°C to 1°C during drying thereof. It is also possible to dry (leafy) food products such as tea, hops, herbs, onions and broccoli from a product moistness of about 90 - 60% to a product moistness of 12 - 0%, wherein the products are held in the nutrient-retaining temperature range of 90 - 20°C during the drying process.

[0023] A practical embodiment of drying apparatus 1 comprises 1 - 4 jolting units per metre, wherein the amplitude of the jolting unit is 10 - 100 mm, whereby the foodstuffs are moved in vertical direction in a range of 10 - 200 mm. The jolting unit frequency lies in the range of 0.1 - 10 Hz. The layer thickness of the foodstuff placed on conveyor belt 6 lies in the range of 0 - 200 mm. The intensity of the infrared heat generated by the IR modules lies in the range of 0 - 20 kW/m². The intensity of the aeration via fans 18 and the deaeration via pipes 28 can be controlled, wherein the aeration temperature lies in the range of 0 - 40°C and the moistness of the blown-in air lies in the range of dry to moist air. Depending on the belt speed, the drying duration can also be varied from for instance 2 - 120 min. With favourable adjustment of the above stated parameters the quality and freshness can be adjusted per product. For iceberg lettuce and other types of salad a longer shelf life of the products can be achieved of up to 4 - 20 days. The veg-

etables look better after the drying process. An energy saving is also achieved compared to centrifuge techniques or drying with air. The salad is not damaged herein, which again results in an improved freshness and shelf life thereof, and the temperature of the lettuce can rise to a maximum of 15°C during the drying process.

[0024] The protection sought is not limited to the above described preferred embodiment of the present invention in which many modifications can be envisaged, this protection being however defined by the appended claims.

Claims

1. Method for drying products such as vegetables, herbs and/or fruit with an apparatus for drying products, wherein the apparatus comprises:
 - a housing;
 - drying means arranged in the housing, comprising one or more IR-modules for emitting infrared (IR) radiation of a desired spectrum for the purpose of drying the products;
 - transporting means arranged in the housing for carrying the products along the drying means at a desired speed; and
 - fan means arranged in or on the housing for discharging moisture from the products.
2. Method as claimed in claim 1, wherein the apparatus also comprises jolting means arranged close to the transporting means for shaking the products.
3. Method as claimed in claim 1 or 2, wherein the transporting means comprise two or more, and preferably three conveyor belts for transporting the products.
4. Method as claimed in claim 3, wherein the conveyor belts are of plastic.
5. Method as claimed in claims 1-4, wherein the apparatus also comprises cooling means for cooling the products by means of airflows and for discharging surface moisture and space moisture.
6. Method as claimed in claim 5, wherein the cooling means comprise one or more fans for blowing in air at a desired speed and temperature.
7. Method as claimed in any of the claims 1-6, wherein the components of the apparatus are embodied where possible in stainless steel for application thereof in the food industry.
8. Method as claimed in any of the foregoing claims, wherein the IR-modules comprise a ceramic mate-

rial of metal oxide.

9. Method as claimed in claim 8, wherein the drying means comprise STIR (Selective Transformed Infra-Red) modules or normal ceramic IR-modules for emitting infrared radiation of a predetermined wavelength.

10. Method as claimed in any of the foregoing claims, wherein the apparatus also comprises first control means for controlling the fan means in order to hold the products at a desired temperature and to make the drying process more efficient.

11. Method as claimed in any of the foregoing claims, also comprising second control means for controlling the drying means in order to generate infrared radiation with a predetermined radiant power.

12. Method as claimed in any of the foregoing claims, also comprising third control means for controlling the transporting means in order to carry the products at a desired speed along the drying means.

13. Method as claimed in any of the foregoing claims, also comprising fourth control means for controlling the cooling means in order to hold the products at a desired temperature.

14. Method as claimed in any of the claims 1-13, wherein the fan means limit the temperature of the products to 20°C and preferably to a range of 12 - 17°C in order to improve the shelf life of the products.

15. Apparatus for drying products such as vegetables, herbs and/or fruit, comprising:

- a housing;
- drying means arranged in the housing, comprising one or more IR elements for emitting infrared (IR) radiation of a desired spectrum for the purpose of drying the products;
- transporting means arranged in the housing for carrying the products along the drying means at a desired speed; and
- fan means arranged in or on the housing for discharging the moisture from the products.

16. Apparatus as claimed in claim 15, also comprising jolting means arranged close to the transporting means for shaking the products.

17. Apparatus as claimed in claim 14 or 15, wherein the transporting means comprise two or more, and preferably three conveyor belts for transporting the products.

18. Apparatus as claimed in claim 17, wherein the con-

veyor belts are of plastic.

19. Apparatus as claimed in claims 15-18, also comprising cooling means for cooling the drying means by means of airflows.

20. Apparatus as claimed in claim 19, wherein the cooling means comprise one or more fans for blowing in air at a desired speed and temperature.

21. Apparatus as claimed in any of the claims 15-20, wherein the components of the apparatus are embodied where possible in stainless steel for application thereof in the food industry.

22. Apparatus as claimed in any of the foregoing claims, wherein the IR elements comprise a ceramic material of a metal oxide.

23. Apparatus as claimed in claim 22, wherein the drying means comprise STIR (Selective Transformed Infra-Red) elements for emitting infrared radiation of a predetermined wavelength.

24. Apparatus as claimed in any of the foregoing claims, also comprising first control means for controlling the fan means in order to hold the products at a desired temperature.

25. Apparatus as claimed in any of the foregoing claims, also comprising second control means for controlling the drying means in order to generate infrared radiation of a predetermined wavelength.

26. Apparatus as claimed in any of the foregoing claims, also comprising third control means for controlling the transporting means in order to carry the products at a desired speed along the drying means.

27. Apparatus as claimed in any of the foregoing claims, also comprising fourth control means for controlling the cooling means in order to hold the drying means at a desired temperature.

28. Apparatus as claimed in any of the claims 15-27, wherein the fan means limit the temperature of the products to 20°C and preferably to a range of 12 - 17°C in order to improve the shelf life of the products.

29. Vegetables, herbs and/or fruit dried with a method as claimed in any of the claims 1-15 or with an apparatus as claimed in any of the claims 15-28.

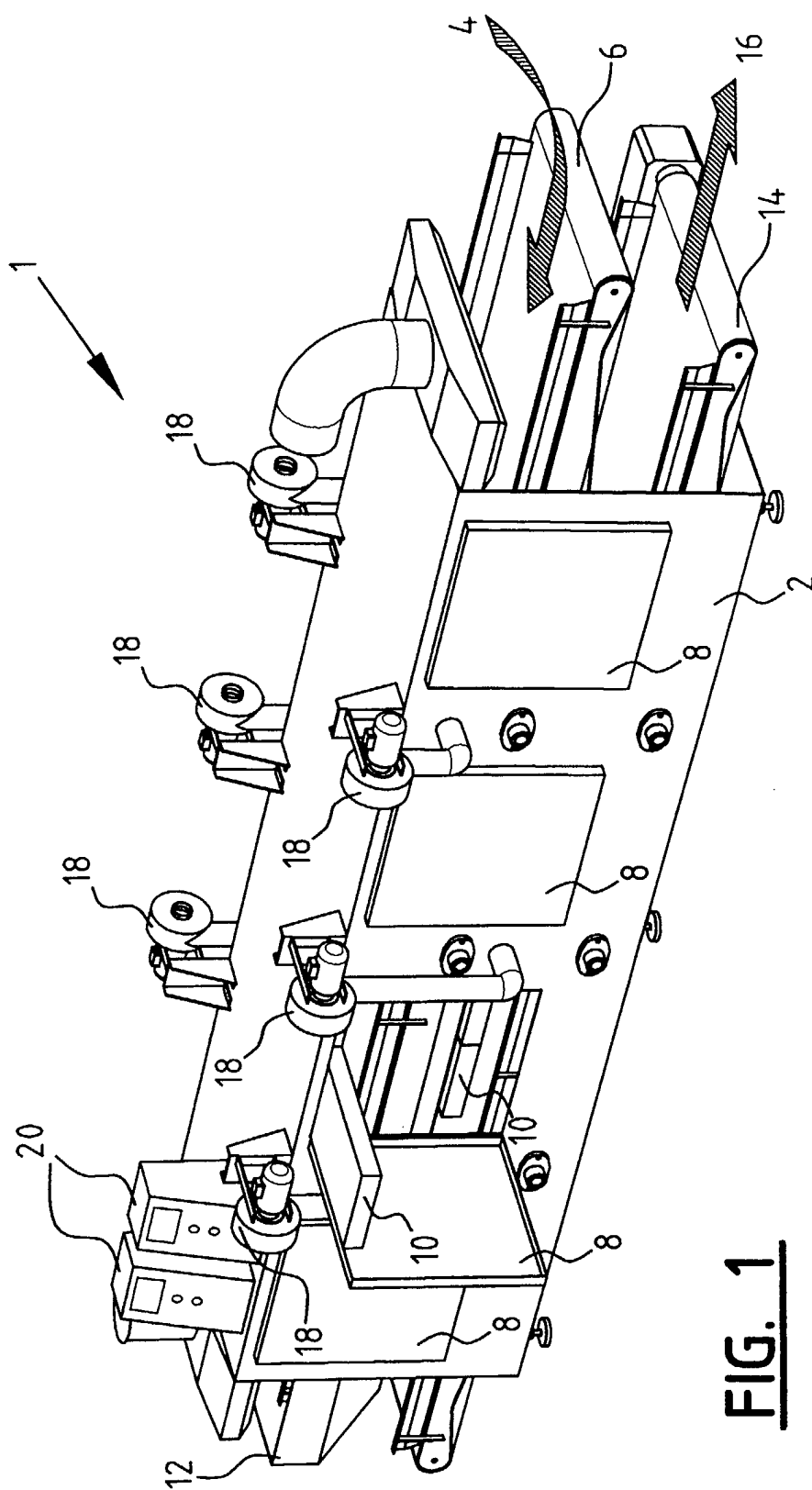


FIG. 1

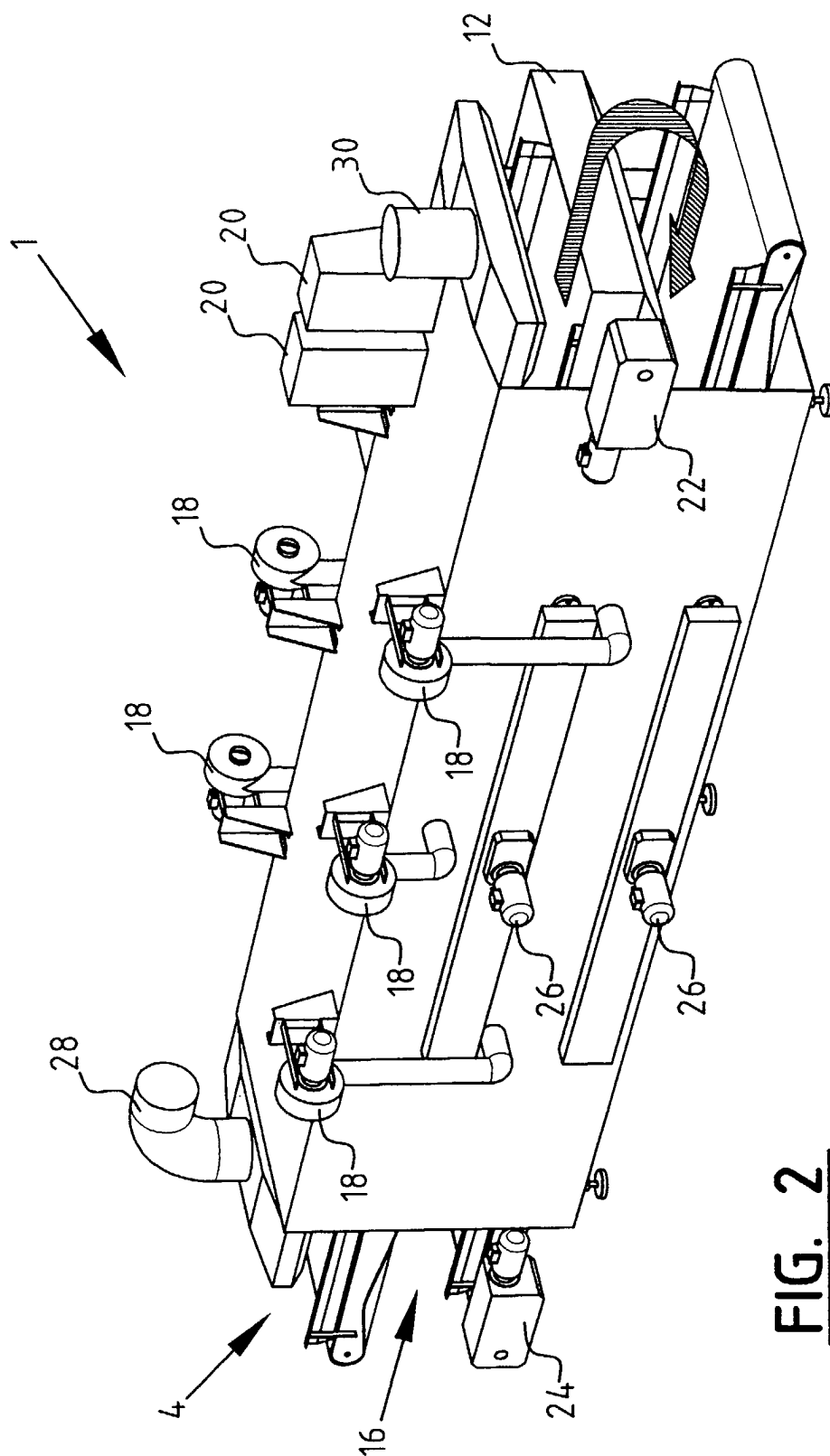


FIG. 2

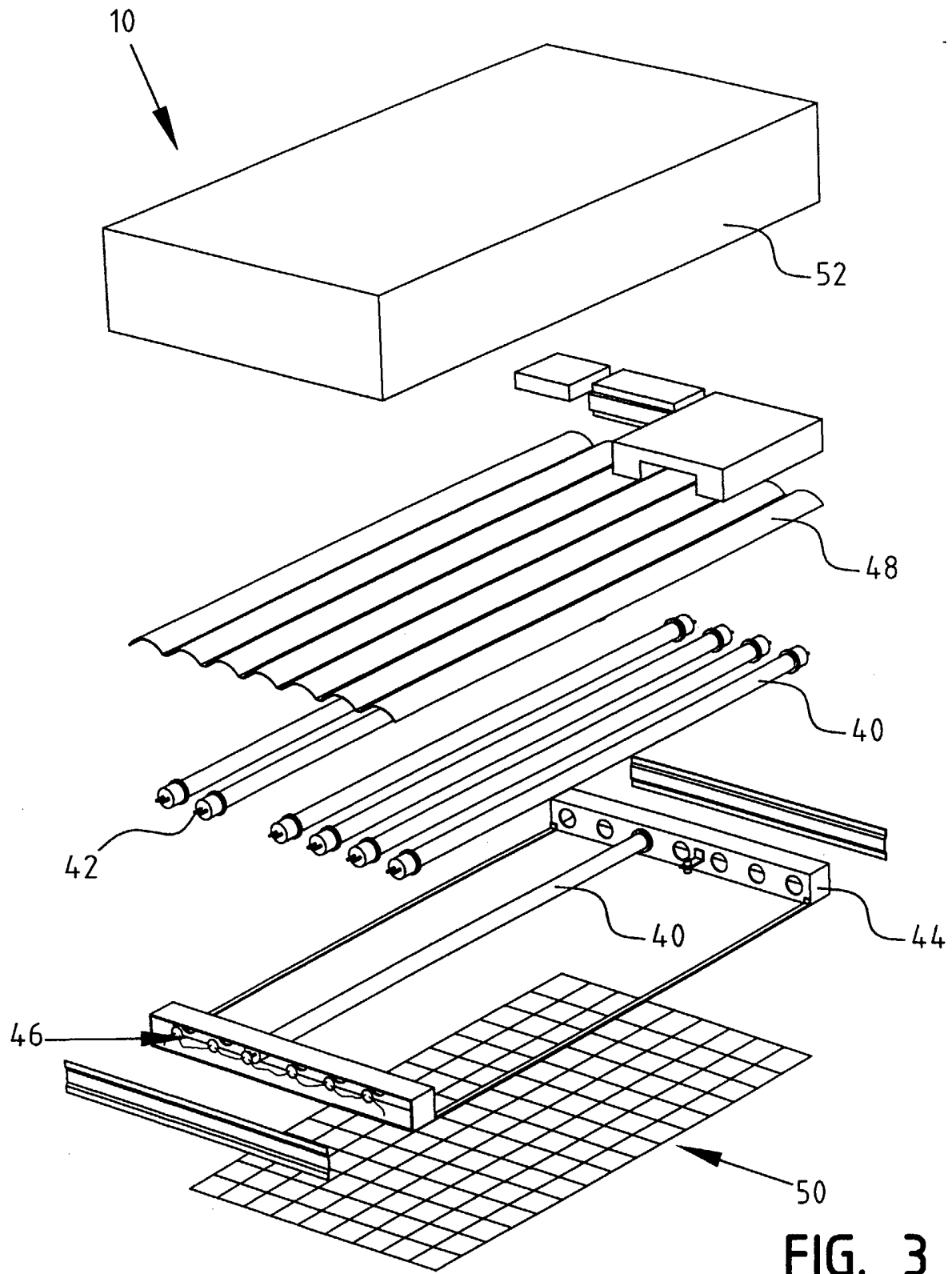


FIG. 3

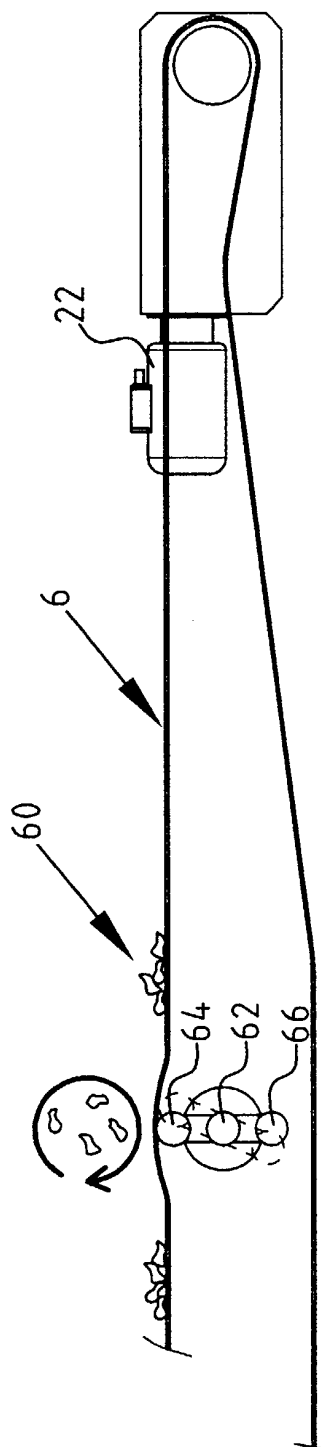


FIG. 4

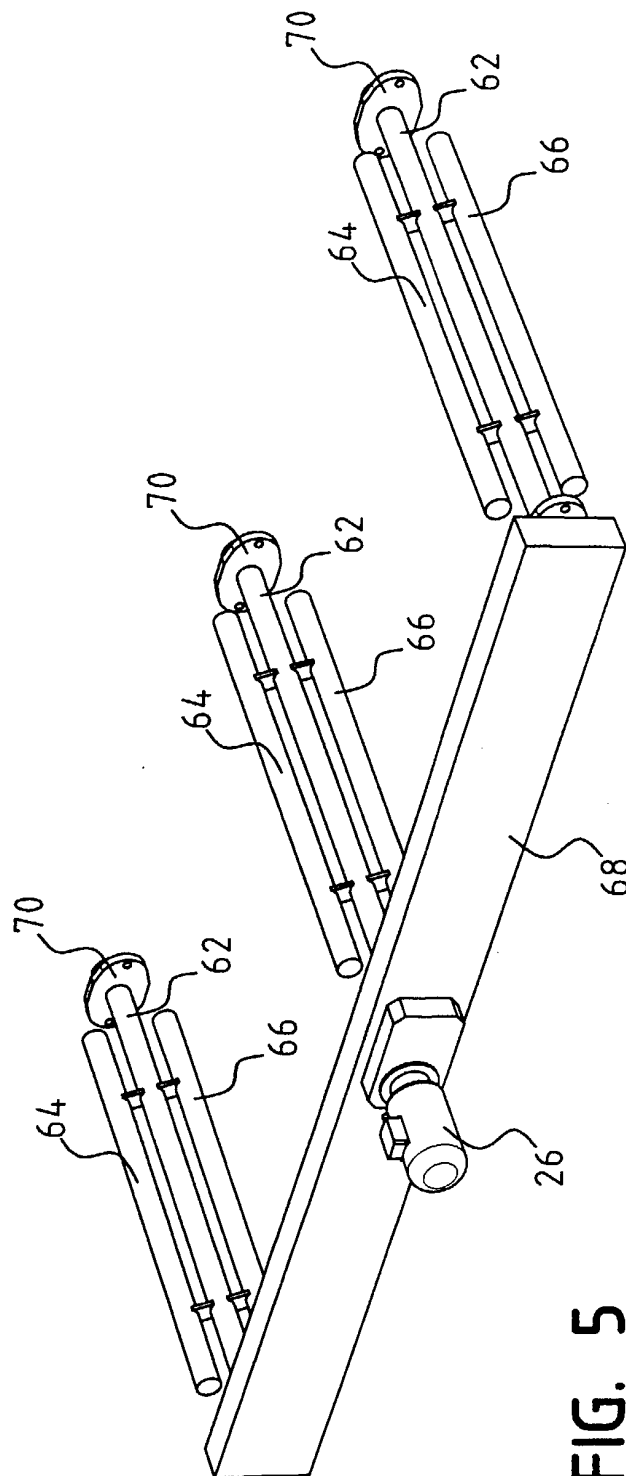


FIG. 5



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Place of search THE HAGUE		Date of completion of the search 12 August 2003	Examiner Silvis, H
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EPO FORM 1503 03/82 (P04C01)



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