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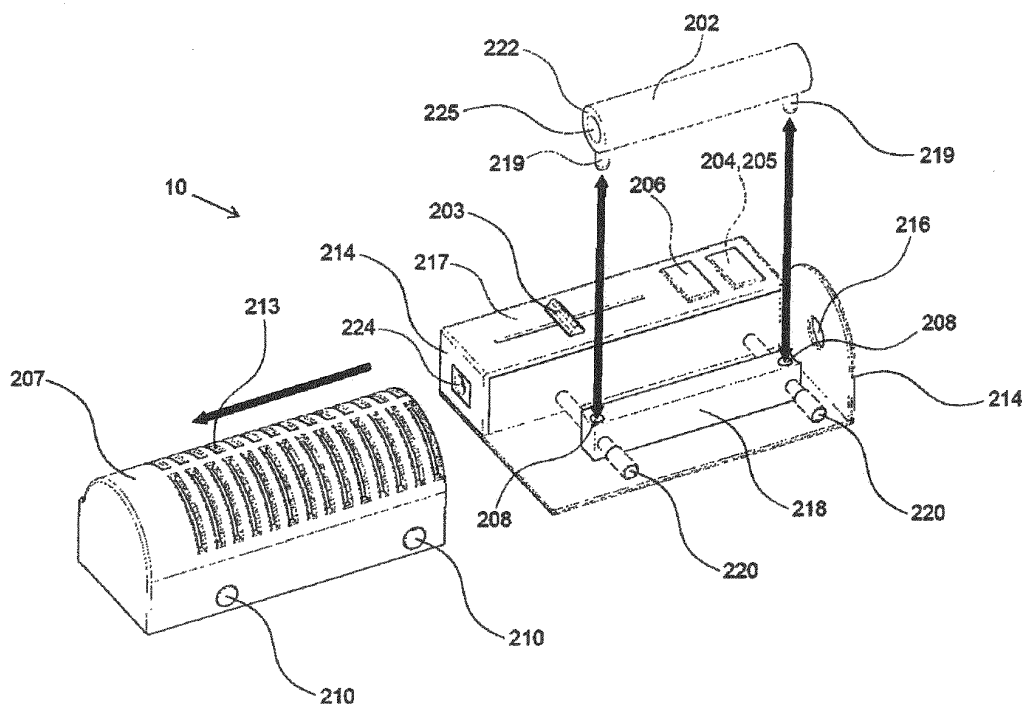
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(54) **Heat treatment of tobacco, heater, method and apparatus**

(57) A heater for treatment of tobacco material, the heater (202) comprising: (a) a cavity (225) adapted for receiving the tobacco material; (b) an electrical heater adapted for converting an electrical current into heat and

for heating the cavity; and (c) an absorber (222) adapted for absorbing volatile components from the cavity; a method and apparatus using such heater for heat-treating tobacco material.



**Fig. 2**

## Description

### Technical Field

[0001] The present invention relates to a method of heat-treating tobacco plant material, a heater, and an apparatus for heat-treating tobacco plant, in particular the invention relates to a method and apparatus for removing harmful substances from pre-manufactured tobacco material in smoke tobacco products such as in cigarettes, cigars and pipe tobacco.

### Background Art

[0002] Tobacco plants comprise taste and aroma substances that produce flavours that can stimulate the human sensory taste and smell nerve cells in the nose, mouth, or throat. Taste sensations usually include sweet, sour, bitter, and salty. However, in order to recognise a flavour, taste combines with texture, temperature, and odour. Perception of flavour varies for the individual user and the way the tobacco components are delivered.

[0003] Tobacco delivery systems comprise delivery of taste and aroma substances that primarily stimulate taste, smell, or both. Delivery systems comprise smoke delivery and smoke-free delivery. Smoke tobacco delivers taste and aroma substances through the mouth, nose, and throat. Smoke-free tobaccos include snuff tobacco and chewing tobacco that deliver substances through the buccal cavity primarily stimulating taste.

[0004] Tobacco plants comprise substances that may be harmful to a human once delivered to the user. Thus, tobacco plant material comprises 0.2-5% of nicotine. Nicotine causes addiction of users to consume tobacco.

[0005] In combustion of tobacco material, the heat provides temperatures that depend on the tobacco and the combustion zone. In pipe tobacco combustion temperatures ranges from about 350 °C to about 650 °C whereas as in cigarettes the combustion temperatures ranges from about 450 °C to about 850 °C. In addition to production of combustion residues, at such temperatures, the heat causes evaporation of volatile ingredients from the tobacco material. Combustion particles disperse in the vapour of volatiles, which the delivery system delivers to the user.

[0006] Consumers of tobacco products, in particular smokers, seek to achieve the taste and aroma experience of their preferred tobacco, or tobacco blend. Thus, smokers prefer to include smoke particles and other components produced during combustion of their tobacco material in perception of their preferred tobacco flavours. However, the unavoidable presence of various tobacco components that might be considered harmful to the health, such as nicotine, provides a risk that smoked tobacco negatively affects the health and provides addiction to tobacco. To reduce or avoid this risk, there is a need to reduce the content of harmful substances such as nicotine in smoke tobacco materials.

[0007] Smoke tobacco products comprise products such as cigarettes, cigars, and pipe tobacco. However, the pre-manufactured smoke tobacco products may not meet the expected smoke experience by the individual smoker.

[0008] Therefore, there is a need for a method and apparatus to treat pre-manufactured tobacco products to meet the smokers' needs.

[0009] Known apparatus for heat treatment of pre-manufactured tobacco materials for removal of volatile tobacco components comprise vaporizers that comprise heaters. A vaporizer is a device wherein a heater heats an airflow that heats a tobacco material and provides a vapour of ingredients of the heated tobacco plant material which vapour is then delivered to a user. The vaporizer operates at temperatures at typically 125-200 °C and drives off volatile ingredients without providing high-temperature combustion residues. The perception is that the high-temperature tobacco components and combustion residues above the vaporizer's temperature comprise harmful substances, which the user wish to avoid.

[0010] WO 2012/178028 discloses a vaporizer device that comprises a tobacco receptor adapted for receiving a tobacco plant material; an air inlet adapted for drawing in air; a heater adapted for heating drawn-in air; a passage adapted for passing the heated air through the tobacco receptor and, when in use, evaporate volatile ingredients from the plant material into the air flow; and a delivery means adapted for delivering the air flow and evaporated volatile tobacco components to the user. When operated at temperatures below the combustion temperature of the tobacco material this vaporizer device does not produce any smoke. Thus, vaporizers provide an alternative delivery to delivery by smoking smoke tobacco that burns the tobacco material at temperature above the combustion temperature. Smoked tobacco products provide flavours that vaporizers cannot provide. However, although vaporizers might reduce irritating toxic and carcinogenic high-temperature by-products produced in smoking tobacco, vaporizers do not reduce or avoid volatile tobacco components evaporated in the vaporizer's temperature range of operation. On the contrary, vaporizers operated at low-temperatures of 125-200 °C evaporate volatile tobacco components such as nicotine.

[0011] Other, known apparatus for heat treatment of pre-manufactured tobacco materials for removal of volatile tobacco components comprise heaters made of either glazed ceramics or glass. For this kind of apparatus, the problem is that it collects condensation that can only be led away by the tobacco material itself. Therefore, some apparatus is equipped with a pump or blower that pushes air through the heater and/or cigarette to remedy this. However, if overheated, glows may occur in the tobacco, where the air flows through the cigarette and/or heater. This may result in ignition of the cigarette. Due to the additional injection of oxygen flowing from the pump and/or blower, the glows may ignite the heated

gases. Thus, there is a further risk of providing pinpoint flames due to the extra oxygen and/or air supplied by the fan and/or pump.

**[0012]** Known apparatus comprise heating elements of glass wherein the hot wire is wrapped around a glass tube, which then are left exposed. Touching such a thread with an electrically conductive work piece will cause an electric shock.

**[0013]** Also, known apparatus are either digitally pre-programmed to control temperature, blower, pump and time, or they must be programmed correctly by pressing various buttons in one or more sequences that can be difficult for people to use.

### Summary of invention

**[0014]** It is the object of the present invention to provide a method and apparatus adapted for treatment of tobacco products to remove volatile tobacco components from the tobacco material to be smoked.

#### *Heater for treatment of tobacco material*

**[0015]** In an aspect, the present invention provides a heater for treatment of tobacco material as defined in claim 1.

**[0016]** The heater comprises: (a) a cavity adapted for receiving tobacco material; (b) an electrical heater adapted for converting an electrical current into heat and further adapted for heating the cavity; and (c) an absorber adapted for absorbing volatile plant components from the cavity whereby, in use, volatile tobacco components can be evaporated from the tobacco material received in the cavity and absorbed in the absorber so that the evaporated volatile tobacco components are prevented from being re-absorbed into the heat-treated tobacco. Also, collection of liquid tobacco residue and water condensate in the cavity is reduced or avoided.

#### *Cavity*

**[0017]** The cavity comprises any suitable cavity wherein a tobacco material to be heat-treated can be received. For tobacco material in form of cigarette products it is preferred that the cavity is a longitudinally extending cavity having a diameter that encloses a pre-manufactured cigarette. It is preferred that as little free space is available as possible between the cavity wall and cigarette surface thereby reducing entrance of air and the risk of ignition of the tobacco material.

**[0018]** In a preferred embodiment, the cavity is incorporated into the absorber whereby the tobacco material to be heat-treated can be surrounded by the absorber in a location where the generated heat can effectively enter the tobacco material and evaporate off the volatile components which are then able to diffuse into the absorber.

#### *Electrical heater*

**[0019]** The electrical heater is any suitable heater that is able to convert an electrical current into heat and concentrate the heat in the cavity where the tobacco to be heat-treated is received.

**[0020]** In a preferred embodiment, the electrical heater is incorporated into the absorber whereby there is obtained an intimate contact between the heater and absorber. Further, following a heat-treatment of a first tobacco material and before heat treatment of a second tobacco material, the electrical heater can be re-generated by heating the absorber to drive off absorbed volatile tobacco components.

**[0021]** The electrical heater comprises any suitable heating wire that produces heat in response to a current, e.g. a resistive conductor. Particularly preferred heating wires comprise a material selected among the group consisting of: nickel-chromium alloys, e.g. Nichrome™ and Inconel™; FeCrAl alloys e.g. Kanthal™.

#### *Absorber*

**[0022]** The absorber is any suitable absorber for absorbing volatile tobacco components at the temperature of heat treatment that is able to prevent the evaporated volatile tobacco components from being re-absorbed in to the heat-treated tobacco material.

**[0023]** Generally, the absorber comprises a porous material that allows the volatile tobacco components to diffuse into the material. In use the evaporated volatile tobacco components diffuse in and out of the absorber during the heat treatment. A temperature gradient away from the electrical heater provides diffusion from a higher temperature in the absorber to a lower temperature, allowing transport of the absorbed components from a higher to a lower concentration.

**[0024]** Depending on the absorber material, its pore size and its pore number, the absorbed components can be retained in the absorber during the heat treatment. In order to re-generate the absorber, the absorbed components can be driven off by a heat-treatment with an empty cavity. Optionally, the re-generation heat treatment comprises a heat treatment at a higher temperature and/or in a longer treatment time.

**[0025]** In a preferred embodiment, the absorber comprises gypsum or ceramics whereby it surprisingly turns out that the absorber can be prepared in a mouldable material that can be cast into a desirable shape, e.g. in a silicon mould. The absorber is porous and allows absorption of water and other volatile tobacco components. It is also heat resistant. In particular, a gypsum-based absorber can be produced cost effectively.

**[0026]** Gypsum is a mineral composed of calcium sulphate dihydrate,  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . When heated to 150 °C water is driven off producing  $\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$ . The dried gypsum powder is mixed with water to form a mixture which is cast into a desired form. The hydrated gypsum

sets in the form forming calcium sulphate dehydrate again while giving off heat. Setting takes about 45 minutes. Full setting takes three days. Dried gypsum heated to above 200 °C forms gypsum anhydrite,  $\text{CaSO}_4$  which will also take up water and re-form gypsum,  $\text{CaSO}_4 \cdot 0.5\text{H}_2\text{O}$  if mixed with water.

**[0027]** When heating the absorber, in use, water bound to gypsum will be driven off forming gypsum anhydrite that will react with the absorbed water and generate heat. Consequently, the absorber is constantly re-generating gypsum that unexpectedly increases the absorber's lifetime.

**[0028]** Ceramics are inorganic, non-metallic materials formed by burning ceramic powders such as aluminium oxide mixed with water at temperatures up to 900-1000 °C. Another ceramic material is natural clay.

**[0029]** In a further preferred embodiment, the absorber comprises a cylindrical body and a cavity having a thickness in the range 1-20 mm whereby the absorber encloses the heating wire of the electrical heater so that a user, e.g. during exchange of the heater, cannot touch any exposed part of the heating wire. The thickness of the absorber has an upper limit determined by the effective absorption of the absorber and practical dimensions of the heater. Typically, the thickness is in the range 2-20 mm, preferably 3-15 mm, in particular 5-10 mm whereby a cavity, an electrical heater, and an absorber of sizes suitable for a portable heat-treatment apparatus for heat-treatment of cigarette-shaped tobacco products can be obtained

**[0030]** Generally, according to the invention, the absorption of a volatile tobacco component in the absorber depends on the diffusion properties of the component, i.e. the ability to transport volatile components from a high concentration to a region of low concentration, e.g. measured as the diffusion length. Thus, if the diffusion length is so that the concentration of volatile component has not propagated the extent of the absorber in the heat treatment time at the prevailing temperature, the component is absorbed. Otherwise, the component is transported partially or fully out the absorber. If the extent of the absorber is large compared to the diffusion length most of the evaporated volatile components will diffuse into the absorber and only few, if any, will diffuse out of the absorber. If the extent of the absorber is small, the volatile components will diffuse in and out leaving few volatile components in the absorber. It is within the skills of a skilled person to optimize the thickness of the absorber between these extremes.

**[0031]** Generally, for various geometric shapes and absorber configurations, e.g. triangular, rectangular, hexagonal, cylindrical, the amount of absorber can be chosen by calibration of the weight gain/loss of the tobacco material and of the weight gain/loss of the absorber for different heating treatment times of the desired tobacco material in the cavity. For a given tobacco material, the weight loss depends on the heating time. At some heating time, the treated tobacco material exhibits a dry-

ness and texture for which the user is satisfied. The weight loss of the tobacco material corresponds to that which the absorber should be able to absorb, if all evaporated components are absorbed. Depending on the shape and size of the absorber and the cavity, the amount of absorber and its absorption capacity, evaporated tobacco components will be transported away from the absorber while heating is on. However, if the tobacco material is left for cooling, the tobacco may re-absorb some vapour from the absorber.

**[0032]** Generally, in an embodiment, to avoid this "memory absorption" effect the heat-treated tobacco material is removed from the cavity while at an elevated temperature. If done manually, this is conveniently done for a tobacco material in a cigarette having a filter that can be used as a thermally insulated grip. In another embodiment the absorber is provided with less absorption capacity so that non-absorbed evaporated volatile components diffuse from the heater and absorber into the surroundings. This might produce smells considered pleasant by the user. Still another embodiment allow little, if any, vapour to become re-absorbed in the heat-treated tobacco material. Again, the user can calibrate the time of the heat treatment according to his preferences of the heat-treated tobacco material and the flavours that it generates.

**[0033]** Generally, volatile tobacco components include various chemical forms of the components. For example, nicotine is an oily liquid. However, nicotine is a base that forms salts with acids, which are solids and usually water-soluble. Therefore, volatile component may be dissolved in water and evaporated together with the water. Thus, the vapour of the evaporated tobacco components is a mixture of various physical phases, including gasses, vapours e.g. water vapour, aerosols, emulsions, particles, and more.

#### *Method for heat-treating tobacco material*

**[0034]** In another aspect, it is the object to provide a method for heat-treating tobacco material as defined in claim 6.

**[0035]** The method comprises: (a) providing a tobacco material in a cavity adapted for receiving tobacco material; (b) applying current to electrical heater adapted to provide heat to the cavity; (c) vaporizing volatile components of the tobacco material in the cavity; (d) absorbing evaporated volatile components in an absorber adapted for absorption of volatile tobacco components; (e) optionally cooling the heat-treated tobacco material in the cavity; and (f) removing the heat-treated tobacco material from the cavity, whereby volatile tobacco components can be evaporated from the tobacco and absorbed in an absorber so that the absorbed tobacco components are prevented from being re-absorbed into the treated tobacco.

**[0036]** In a preferred embodiment, the method comprises desorbing the absorbed volatile tobacco components from the absorber by applying a current to the elec-

trical heating without tobacco material present in the cavity whereby the absorber can be re-used and its lifetime increased.

**[0037]** In a preferred embodiment, the heat in the cavity provides temperatures range 100-400 °C, preferably 100-300 °C, more preferably 100-200 °C, in particular 125-200 °C whereby volatile tobacco components, e.g. nicotine is evaporated. In addition, these temperatures are below the combustion temperature of most tobacco materials at standard pressure and temperature.

**[0038]** In a preferred embodiment, the tobacco material to be treated is a pre-manufactured smoke tobacco material selected from the group comprising one or more tobacco materials for cigarettes, cigars, and pipe tobacco.

#### *Apparatus for heat-treating tobacco material*

**[0039]** In still another aspect, the invention relates to an apparatus for heat-treating tobacco material as defined in claim 10.

**[0040]** The apparatus comprises (a) at least one cavity adapted for receiving the tobacco material; (b) an electrical heater adapted for converting an electrical current into heat and for heating the cavity; (c) an absorber adapted for absorbing volatile components in the cavity; and (d) an electrical power supply and control module whereby it is obtained that a portable apparatus for heat-treating tobacco material is obtained.

#### *Electrical heater and absorber*

**[0041]** The heater and absorber are described in previous sections above. They are the components that are exposed to heat and consequently subject to wear. For maintenance of the apparatus, the electrical heater and absorber can be serviced by disassembling the respective parts.

**[0042]** In a preferred embodiment, the electrical heater and the absorber are replaceable. Thus, it is easy for a user to exchange the electrical heater and the absorber for replacement or service.

#### *Removable cover*

**[0043]** During heat treatment, evaporated volatile tobacco components are removed from the tobacco material and absorbed in the absorber. During regeneration of the absorber, volatile components are desorbed and driven off the absorber. The thus heat-generated component can be discarded in any convenient way. In an embodiment, the components are let to a waste storage where they are stored for later disposal.

**[0044]** In a preferred embodiment, the apparatus further comprising a removable cover which comprises ventilation slots whereby the desorbed volatile tobacco components can be ventilated out of the apparatus through the ventilation slots. Further, heat is led away. Also, the

cover provides protection that the user does accidentally touch the electrical heater when in operation.

#### *Power supply and control module*

**[0045]** Operation of the heater requires electrical power and control of when and how much current is applied to the electrical heater.

**[0046]** In a preferred embodiment, the electrical power supply and control module is adapted to apply a current for a pre-set heating time whereby it is obtained that the total heat provided can be pre-calibrated with respect to the applied current and heating time. This pre-calibrated total heat can be adjusted so that combustion of the tobacco material can be avoided.

**[0047]** In another embodiment, the electrical power supply and control module further comprises computation means adapted to control the current to the electrical heater to provide at least one series of heating treatments and cooling whereby the tobacco material can be subjected to a pre-selected heating and cooling sequences. Thus, selected volatile tobacco components can be removed.

**[0048]** In still another embodiment, the electrical power supply and control module comprises temperature-controlling means adapted to control the current to the electrical heater to provide a temperature below the combustion temperature of the tobacco material to be heat-treated whereby it is ensured that the risk of burning the tobacco material is low.

**[0049]** Further, embodiments are disclosed elsewhere in the description and drawings.

#### **Brief description of drawings**

##### **[0050]**

Fig. 1 shows a schematic 3D view of an embodiment of the apparatus according to the invention,

Fig. 2 shows a schematic 3D exploded view of an embodiment of the replacement process of the heater,

Fig. 3 shows a schematic 3D view of an embodiment of the assembling process of an additional heater,

Fig. 4 shows a schematic 3D view of an embodiment of a twin heater,

Fig. 5 shows a schematic longitudinal, cross-sectional side views of an embodiment of the heater, without gypsum,

Fig. 6 shows a schematic longitudinal, cross-sectional side views of an embodiment of the heater, with gypsum,

Fig. 7 shows a schematic longitudinal, cross-sectional side view along line B-B of the embodiment of the heater in operation shown in Fig. 8,

Fig. 8 shows a schematic longitudinal, cross-sectional end view along line A-A of the embodiment of the heater in operation shown in Fig. 7, and

Fig. 9 shows a temperature characteristic.

### Description of embodiments

[0051] Fig. 1 shows a schematic 3D view of an embodiment of the apparatus according to the invention. The apparatus 10 comprises housing walls 114, a base 115, a control module 117, and a removable cover 107 comprising ventilation slots 113 adapted to ventilate tobacco vapours from the heater inside the housing out through the cover. A wall 114 comprises an opening 116 adapted for receiving a cigarette 11 into the heater 102 shown partially hidden behind the wall in the opening 116. The control module 117 comprises a potentiometer 103 electronically connected to a control circuitry (not shown) for controlling the timing of the heater. Further, the control module comprises a start button 104 with a LED indicator connected to the control circuitry and adapted to indicate when a current is supplied to the heater. The control circuitry is adapted to apply a current for a pre-set heating time. The apparatus also comprises a stop button 106 connected to the control circuitry and adapted to stop application of current to the heater when activated.

[0052] Fig. 2 shows a schematic 3D exploded view of an embodiment of the replacement process of the heater 202. The cover 207 is removed from the apparatus exposing the interior thereof. The apparatus comprises a control module 217 arranged to comprise a power supply (not shown) for the heater and a control circuitry (not shown) adapted to control the current to the heater 202, and adapted to providing control signals to the start button 204 and LED indicator 205 and to receive manual signals from the stop button 206. Optionally, the control circuit comprises means for automatic control signals for one or more consecutive, fixed or variable start and stop sequences. The control module is provided with a contact 224 adapted for connection to a suitable external power supply for the internal power supply for the heater and for control circuit, such as a 220 V to 12 V dc converter. Alternatively, the control module can be supplied from a battery, e.g. a rechargeable battery bank.

[0053] The apparatus further comprises an electrical heater 202 having a cavity 225 adapted to receive a smoke tobacco product to be heat treated and comprising an absorber 222 adapted for absorbing volatile components evaporated from the tobacco product produced by heating the tobacco product. Further, the electrical heater comprises connection means adapted to electrically connect its two male contacts 219 to a contact fixture 218.

[0054] The apparatus also comprises a contact fixture 218 adapted to electrically communicate with the control module 217 and mounted on the base 215 so that manual exchange of the heater can be performed in a mechanically stable and operational safe way. The contact fixture 218 comprises female contacts 208 adapted to connect with male contacts 219 of the heater 202 for replacement of the heater or for removal of the heater for service. The contact fixture 218 further comprises connections

for contact with female contacts 220 for connecting an additional heater module 30 to the apparatus, as seen in Fig. 3, thereby increasing the capacity of the heat treatment.

[0055] Fig. 3 shows a schematic 3D view of an embodiment of the assembling process of an additional heater. The apparatus 10 comprises cover plugs 310 of which one is removed from the opening 312 thereby allowing access to the female contact 220, see Fig. 2, connected to the contact fixture 218 inside the apparatus. When adding the additional heater 30 to the heater 10 the female contacts 220 receive the male contacts 311 for electrical connection and supply of power to the additional heater. The control circuit senses the additional heater and adjust the supply of power accordingly.

[0056] Fig. 4 shows a schematic 3D view of an embodiment of a twin heater 402. Two heat threads (not shown) are embedded in gypsum 422 providing two cylindrical cavities 425a and 425b for receiving two cigarettes 11a and 11 b, respectively, each prepared as further discussed for Fig. 5. The gypsum supports 423 comprising contacts (not shown) for fixation in the contact fixture 218 comprises more gypsum material, optionally reinforced, for mechanically stabilising the twin heater 402. The twin heater is enclosed in an outer surface 407.

[0057] Fig. 5 shows a schematic longitudinal, cross-sectional side view of an embodiment of the heater, without gypsum. Fig. 6 shows a schematic longitudinal, cross-sectional side view of an embodiment of the heater, with gypsum. A heat thread is coiled into a longitudinal coil 521 with two male contacts 519 at its terminals. The coil is embedded into gypsum 522 and adapted to provide an open cavity 525 in its centre. A part of the gypsum 523 comprising the thread terminals and contacts 519 comprises more gypsum material for mechanically stabilizing the heater 502.

[0058] Fig. 7 shows a schematic longitudinal, cross-sectional side view along line B-B of the embodiment of the heater in operation shown in Fig. 8. The cavity 525, see Fig. 8, comprises a cigarette 11.

[0059] Fig. 8 shows a schematic longitudinal, cross-sectional end view along line A-A of the embodiment of the heater in operation shown in Fig. 7. The cigarette 11 is heated and volatile components evaporate from the cigarette tobacco material and diffuse outwards through the gypsum. The thickness d of the gypsum determines the amount of gypsum through which the vapour produced in the cavity can diffuse. The thickness of the gypsum d can be determined by calibration of the amount of gypsum used in the manufacture of a heater and the amount of vapour absorbed for a given cigarette. The thickness is not critical in the sense that non-absorbed vapour diffuses out in the surrounding air. This might even be desirable for the user because pleasant smells might spread in the room. After removal of the cigarette, the heater can be heated without a cigarette inserted in the cavity, thereby evaporating the volatile components absorbed in the gypsum and regenerating the heater for

the heat treatment of a new cigarette. Once left for cooling the heat-treated cigarette is removed and stored for later use or for further processing including addition of desirable taste and smell substances.

**[0060]** Most vaporizers are not portable devices. All known devices are stationary devices, and they are not built to be portable due to their size. Furthermore, for these devices are difficult or completely impossible for the user to exchange the heater.

**[0061]** According to an aspect of the invention, the prior art problems can be overcome by using a heater wherein a hot-wire is embedded in gypsum and not in a glass or glazed ceramics. Due to the permeable gypsum, the heating element absorbs the condensate and moisture, which may be present as such. The heating element is manufactured with a fitting that prevents that flames can occur from the cigarette. To simplify the operation, the device not equipped with a temperature / air control, but instead it is solely controlled by setting the time on a rotating or sliding potentiometer, insert a cigarette in the heater, and finally press the start button. To make the device more transportable and portable, it is designed so that it may fit in a pocket, and it can either run on 220 V from the mains transformed to 12 V via adapter, or it can run on a 12 V battery bank manufactured for the purpose, so it can be used anywhere, without having to rely on a power supply.

**[0062]** The device is made of aluminium or plastic that is self-extinguishing, and therefore cannot burn or ignite.

**[0063]** The invention is explained in more detail below, where reference is made to the drawings, in which Fig. 1 shows the apparatus, Fig. 2 shows the replacement of the heating element, and Fig. 3 shows how an extra heater becomes engaged in its corresponding case.

**[0064]** When operating the apparatus of Fig. 1, the cigarette 11 is inserted into the absorbing heater 102, then the time is set by a potentiometer 103, in order to activate the heater 102 the start button 104 is pressed. Thereafter the cigarette inside the absorbing heater 102 is warmed up in the appropriate time set via the potentiometer 103 to remove as many harmful substances as possible. A L.E.D. (Light Emitting Diode) 105 flashes while the unit is on. To cancel the process before the set time, press the stop button 106.

**[0065]** When replacing the heating element in Fig. 2, the cover 107 is pushed off, and the heater 102 is pulled vertically upwards. The new heating element 102 is pressed vertically down into its associated contacts 208.

**[0066]** When an additional absorbing heater is connected in its corresponding housing (9) Fig. 3, the two small lids (10) are removed, and the contacts (11) of the additional heater are inserted into the two holes (12). The coupled heater is controlled in synchronism with the main heating element (2) which is in the apparatus itself as shown in Fig. 1

## Examples

**[0067]** Experiments were performed for preparation and test of the heater and apparatus.

### Preparation of absorber

**[0068]** Terminals of a 113 cm Kanthal™ wire of the type: 0.80 mm/20 °C: 2.9 ohm from Sandvik AB were soldered with two Bullet™ connectors (model: OH091205) supplied by Orient Hoppy Shenzhen Co. Ltd. The solder material consisted of 2 portions of 0.5 g Rolot™ 609 solder supplied by Rothenberger Industrial GmbH. The wire was wrapped around a 9 mm diameter iron rod to provide a coiled wire. The coil was inserted into a mould cavity with walls for defining the outer shape of the absorber and with a 8 mm diameter cylindrical rod in its centre for defining the cavity of the absorber. Gypsum powder, Cera-Mix Special™, supplied by Grafical ApS, was mixed with water and stirred until no clumps could be seen. The mixture was poured into the mould and left curing for 1 hour. The cured absorber was then removed from the mould and the rod was removed from the cured absorber. The absorber was heat cured in an oven at 250 °C for 2 hours. The heat cured absorber was left to cool for 4 hours.

**[0069]** In a typical curing profile the start temperature was raised from 23 °C to 33-34 °C within about 25 minutes after which the temperature levelled off to 23-22 °C within 1 hour and 30 minutes from the start.

### Absorber water-absorption characteristics

**[0070]** Cured gypsum cylindrical test samples of height 90 mm and diameter 30 mm and weight 107.6 g were prepared by mixing gypsum powder, Cera-Mix Special™, produced by Cera, supplied by Grafical ApS, and demineralised water. The mixture was added to a cylindrical mould in form of an iron tube adapted to remove the generated heat; the mould was left for curing in 48 hours. The cured test sample was removed and further cured for 2 hours in an oven at 250 °C)

**[0071]** The test samples were submerged in demineralised water at 20 °C for 3 hours, dried in oven at 250 °C for 1 hour. The gypsum test cylinder had a weight gain of 17.5%.

**[0072]** Cured Red Clay based ceramic cylindrical test samples of height 90 mm and diameter 30 mm and weight: 110.7 g were prepared by mixing Red Clay CL700 powder, supplied by Cerama A/S, and demineralised water, adding the mixture in a cylindrical mould.

**[0073]** Following drying the clay was subjected to a firing process comprising two steps. Step 1: stepwise increase of temperature by 75 °C per hour until 600 °C, then without retention at this intermediate temperature a further step 2: stepwise increase by 125 °C per hour until 1000 °C. No retention at the final temperature. The fired samples were cooled to room temperature while in the

oven before removal.

**[0074]** The test samples were submerged in demineralised water at 20 °C for 3 hours, dried in oven at 250 °C for 1 hour. The ceramic test cylinder had a weight gain of 7.5%.

#### Temperature characteristics

**[0075]** The temperature of the cavity was measure in a heat treatment to provide the temperature characteristic of a gypsum absorber is shown in Fig. 9.

#### Tobacco weight losses

**[0076]** Four different tobacco product materials were analysed for their weight loss as a result of a heat treatment using a gypsum absorber. Tobacco from the tobacco products were transferred to a standard cigarette paper, Filter cigarette tubes, Escort original, Scandinavian Tobacco group. The heat treatment was 12.0 V of power applied in 2.2 minutes until 276 °C, power off and cooling down to 30 °C in 15 minutes. The weight of the cigarettes were measured before and after the heat treatment. Test temperature was 20.3 °C and relative humidity was 12.45 rh.

A. Escort™ original, Fine cut tobacco from the Scandinavia Tobacco Group lost - 18.1 % from 1.10 g to 0.90 g.

B. Escort White, Pipe tobacco from the Scandinavia Tobacco Group lost - 18.6 % from 1.07 g to 0.87 g.

C. Escort™ Escort, Menthol lost from the Scandinavia Tobacco Group - 19.8 % from 1.11 g to 0.89 g.

D. La Reina de Manila™, Cigar tobacco from C.B. Møller & Co. A/S lost-11.5 % from 0.95 to 0.84 g.

**[0077]** In a separate experiment with the same heat treatment conditions a commercial cigarette Prince Light™, British American Tobacco Conditions loss of -12.4 % from 0.883 g to 0,773.

**[0078]** It was observed that before the treatment the absorber had weight of 38.0 g at a room temperature of 30 °C. After the treatment at 276 °C the weight was 37.9 g. That is, the absorber had a weight loss of -0.2%. Thus, the treatment time of 2.2 minutes was sufficient to dry out the absorber so that absorption of water from the atmosphere was obtained during cooling of 15 minutes.

#### Regeneration of absorber

**[0079]** A gypsum absorber of 38.09 g submerged into demineralised water for 30 minutes gained 21.8 % in weight to 46.43 g. Heat treatment of the wet absorber provided regeneration of weight within 11 minutes, see Table 1.

**Table 1**

| Time, minutes | Temperature, °C | Weight, g |
|---------------|-----------------|-----------|
| 0             | 20              | 46.43     |
| 2.2           | 276             | 44.16     |
| 5             | 446             | 42.39     |
| 7             | 519             | 40.06     |
| 10            | 559             | 38.79     |
| 11            | 565             | 38.09     |

#### Industrial applicability

**[0080]** The present invention relates to an apparatus that can be made in industry.

#### Claims

1. A heater for treatment of tobacco material, the heater (102, 202, 302, 402, 502) comprising: (a) a cavity (225, 525) adapted for receiving tobacco material; (b) an electrical heater (521) adapted for converting an electrical current into heat and adapted for heating the cavity; and (c) an absorber (222, 522) adapted for absorbing volatile components from the cavity.
2. The heater according to claim 1 wherein the electrical heater (521) is incorporated into the absorber (222, 522).
3. The heater according to claims 1-2 wherein the cavity (225, 525) is incorporated into the absorber (222, 522).
4. The heater according to claims 1-3 wherein the absorber (222, 522) comprises a material selected from the group consisting of: gypsum and ceramics.
5. The heater according to claims 1-4 wherein the absorber (222, 522) comprises a cylindrical body and a cavity (225, 525) having a thickness in the range 1-20 mm.
6. A method for heat-treating tobacco material, the method comprising:
  - (a) providing a tobacco material in a cavity adapted for receiving tobacco material;
  - (b) applying current to electrical heater adapted to provide heat to the cavity;
  - (c) vaporizing volatile components of the tobacco material in the cavity;
  - (d) absorbing evaporated volatile components in an absorber means adapted for absorption of volatile tobacco components;
  - (e) optionally cool-

ing the heat-treated tobacco material in the cavity; and (f) removing the heat-treated tobacco material from the cavity.

7. The method according to claim 6 further comprising (g) desorbing the absorbed volatile tobacco components from the absorber by applying a current to the electrical heater without tobacco material present in the cavity. 5  
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8. The method according to claims 6-7 wherein the heat in the cavity provides temperatures in the range 100-400 °C.
9. The method according to claims 6-7 wherein the tobacco material to be treated is a pre-manufactured smoke tobacco material selected from the group comprising one or more tobacco materials for cigarettes, cigars, and pipe tobacco. 15  
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10. An apparatus for heat-treating tobacco material, the apparatus 10 comprising (a) at least one cavity (225, 525) adapted for receiving the tobacco material; (b) an electrical heater (521) adapted for converting an electrical current into heat and for heating the cavity; (c) an absorber (222, 522) adapted for absorbing volatile components from the cavity; and (d) an electrical power supply and control module (117, 217, 317). 25  
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11. The apparatus according to claim 10 wherein the electrical heater (521) and the absorber (222, 522) are replaceable.
12. The apparatus according to claims 10-11 further comprising a removable cover (107, 207, 307a, 307b) which comprises ventilation slots (113, 213, 313a, 313b). 35
13. The apparatus according to claims 10-12 wherein the electrical power supply and control module (117, 217, 317) is adapted to apply a current for a pre-set heating time. 40
14. The apparatus according to claims 10-13 wherein the electrical power supply and control module further comprises computation means adapted to control the current to the electrical heater to provide at least one series of heating and cooling. 45  
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15. The apparatus according to claims 10-13 wherein electrical power supply and control module (117, 217, 317) comprises temperature controlling means adapted to control the current to the electrical heater to provide a temperature below the combustion temperature of the tobacco material to be heat-treated. 55

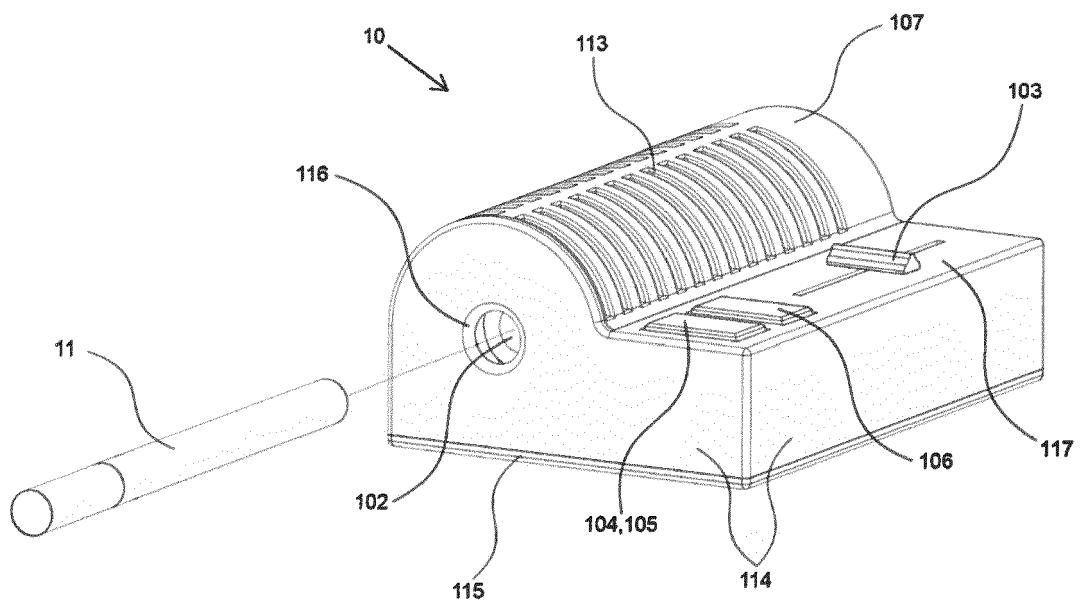


Fig. 1

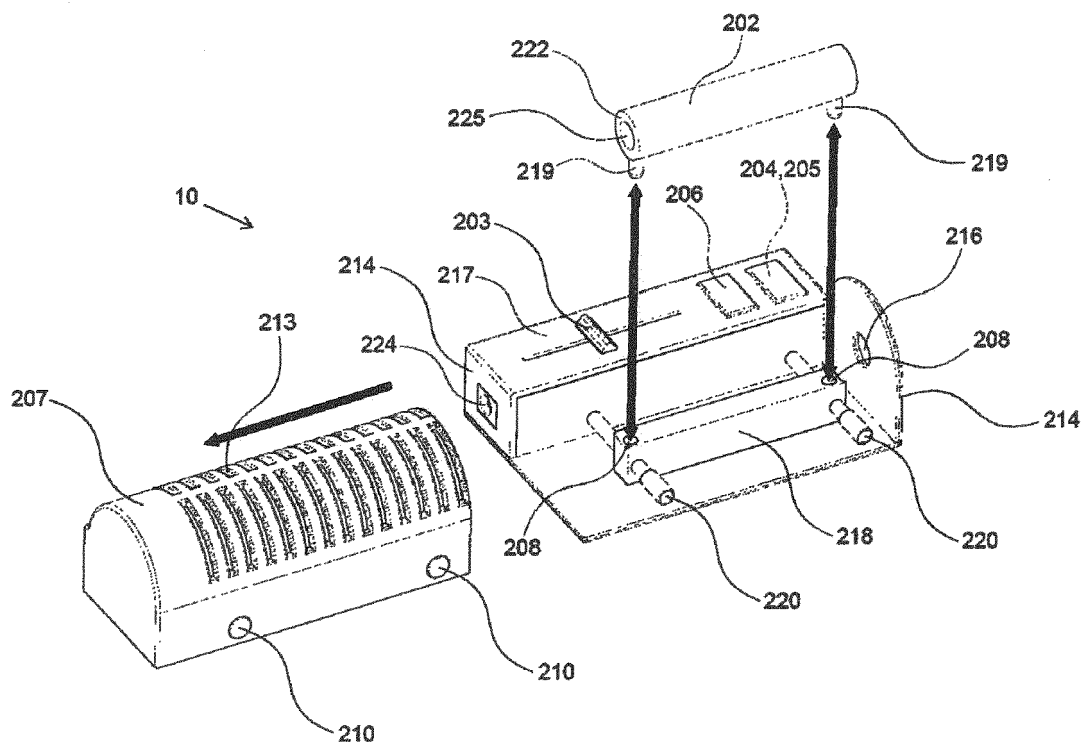


Fig. 2

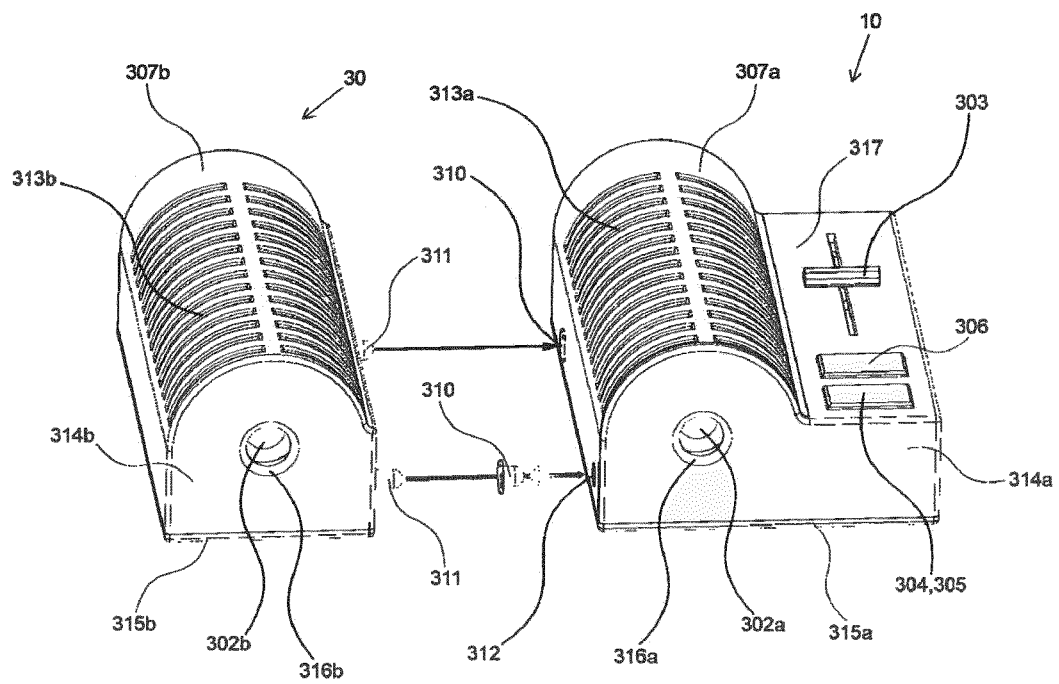


Fig. 3

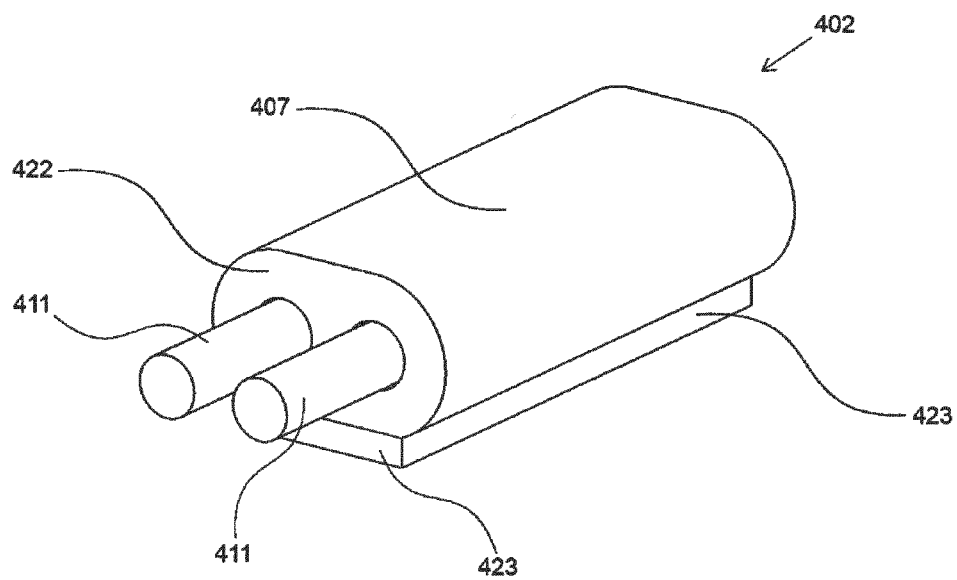


Fig. 4

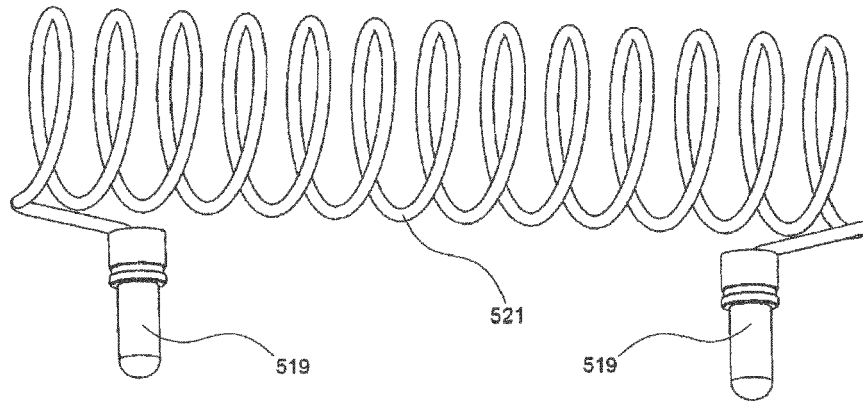


Fig. 5

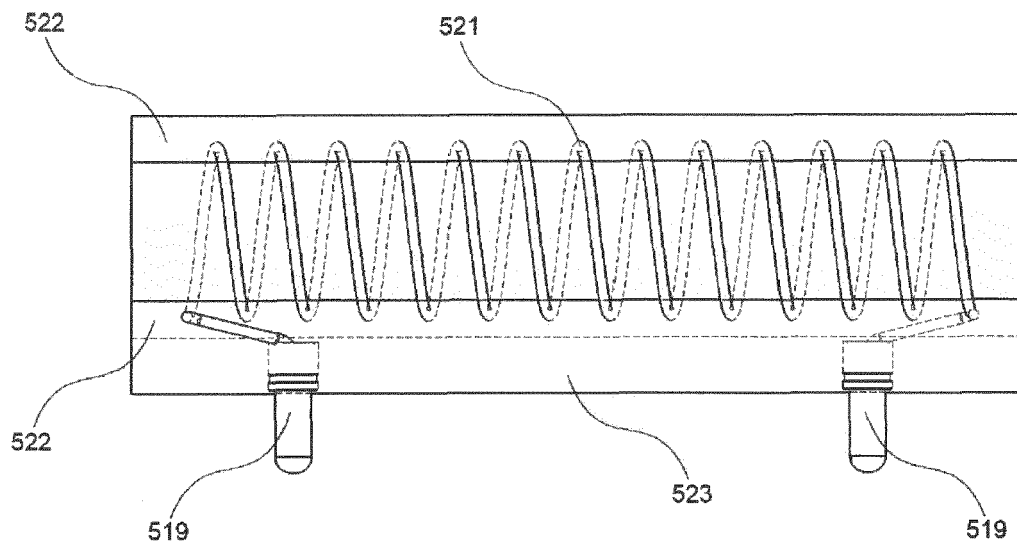


Fig. 6

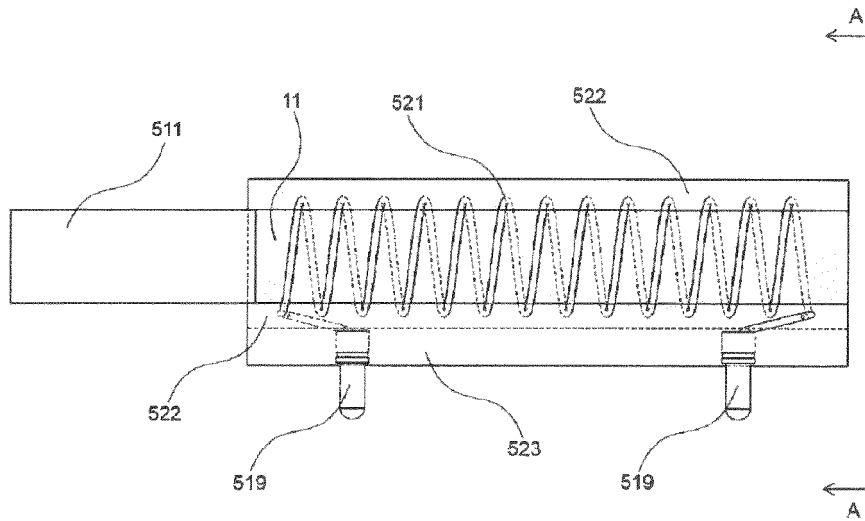


Fig. 7

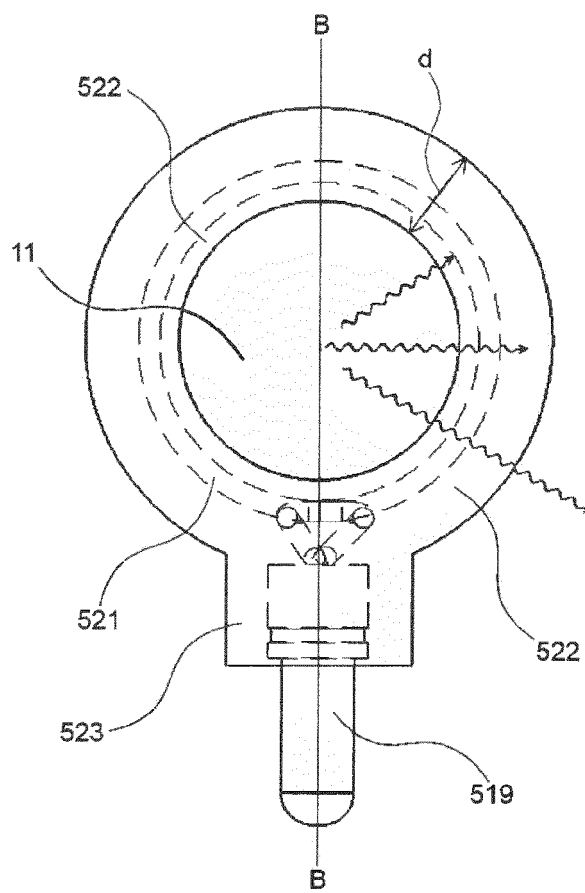
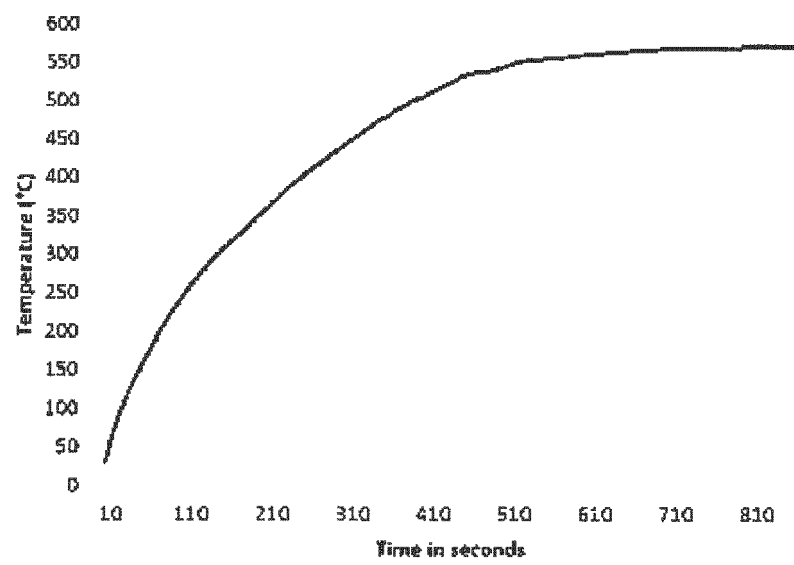


Fig. 8



**Fig. 9**



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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                    |                                                     |                                         |
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