



(86) Date de dépôt PCT/PCT Filing Date: 2004/03/15  
(87) Date publication PCT/PCT Publication Date: 2004/09/23  
(45) Date de délivrance/Issue Date: 2014/06/03  
(85) Entrée phase nationale/National Entry: 2005/09/07  
(86) N° demande PCT/PCT Application No.: EP 2004/002661  
(87) N° publication PCT/PCT Publication No.: 2004/080251  
(30) Priorité/Priority: 2003/03/13 (DE103 11 400.9)

(51) Cl.Int./Int.Cl. *C09K 5/18* (2006.01),  
*A47J 36/28* (2006.01)  
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(54) Titre : MELANGE THERMOGENE ET DISPOSITIF ET PROCEDE POUR PRODUIRE DE LA CHALEUR  
(54) Title: HEAT-GENERATING MIXTURE AND DEVICE AND METHOD FOR HEAT GENERATION

(57) Abrégé/Abstract:

The invention relates to a heat-generating mixture, to a method and a device for generating heat, especially for heating food such as water, coffee, etc.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES  
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG(19) Weltorganisation für geistiges Eigentum  
Internationales Büro(43) Internationales Veröffentlichungsdatum  
23. September 2004 (23.09.2004)

PCT

(10) Internationale Veröffentlichungsnummer  
WO 2004/080251 A3(51) Internationale Patentklassifikation<sup>7</sup>: C09K 5/18,  
A47J 36/28

(21) Internationales Aktenzeichen: PCT/EP2004/002661

(22) Internationales Anmeldedatum:  
15. März 2004 (15.03.2004)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:  
103 11 400.9 13. März 2003 (13.03.2003) DE(71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von  
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(DE).(81) Bestimmungsstaaten (soweit nicht anders angegeben, für  
jede verfügbare nationale Schutzrechtsart): AE, AG, AL,  
AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH,  
CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES,  
FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,  
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,  
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,  
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,  
ZW.(84) Bestimmungsstaaten (soweit nicht anders angegeben, für  
jede verfügbare regionale Schutzrechtsart): ARIPO (BW,  
GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM,  
ZW), eurasisches (AM, AZ, BY, KG, KZ, MD, RU, TJ,  
TM), europäisches (AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT,  
RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA,  
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— mit internationalem Recherchenbericht

(88) Veröffentlichungsdatum des internationalen  
Recherchenberichts: 4. November 2004Zur Erklärung der Zweibuchstaben-Codes und der anderen Ab-  
kürzungen wird auf die Erklärungen ("Guidance Notes on Co-  
des and Abbreviations") am Anfang jeder regulären Ausgabe der  
PCT-Gazette verwiesen.

(54) Title: HEAT-GENERATING MIXTURE AND DEVICE AND METHOD FOR HEAT GENERATION

(54) Bezeichnung: WÄRME ERZEUGENDE MISCHUNG SOWIE VORRICHTUNG UND VERFAHREN ZUR WÄRMEER-  
ZEUGUNG(57) Abstract: The invention relates to a heat-generating mixture, to a method and a device for generating heat, especially for heating  
food such as water, coffee, etc.(57) Zusammenfassung: Die Erfindung betrifft eine Wärme erzeugende Mischung, ein Verfahren und eine Vorrichtung zur Erzeu-  
gung von Wärme, insbesondere für die Erhitzung von Lebensmittel wie Wasser, Kaffee etc.

WO 2004/080251 A3

**Heat-generating mixture and device and method for  
heat generation**

The invention relates to a heat-generating mixture and to a method and a device for heat generation, especially for heating foodstuffs such as water, coffee, instant meals, etc.

Heat generation by the thermite process is known per se in traditional welding technology. However, thermite cannot be used in heat generation for foodstuffs because it forms a molten ball that can lead to mechanical instability to the point of melting through the casing  
10 of the device for heat generation.

US patent 6,267,110 B1 discloses a disposable heating unit for a food container. As the heat-generating mixture, the device disclosed in this document also contains components that react together spontaneously at room temperature when they are brought into contact with one another, at least one of these components being in liquid form.

The document GB 572,573 discloses heat-generating compositions comprising a mixture of solid oxidizable agents and reducing agents, whereby iron oxide and/or  
20 lead oxide is/are present as the oxidizing agent, and a metal, an alloy or a metal silicide such as calcium silicide is present as the reducing agent. In the example, a mixture of 32.5 wt% calcium silicide, 60 wt% red lead oxide ( $Pb_3O_4$ ) and 7.5 wt% talc (magnesium silicate hydrate) is used. These compositions are used for heating foods or beverages. The compositions are heated with the help of a priming composition and an igniter.

The document DE 856 953 C describes heating bodies having a heating cartridge

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which reacts chemically and can be used for heating foods. A heating charge, an ignition charge and an ignition device are used. The heating charges contain a silicide consisting of silicon and calcium with a high silicon content and iron oxide. A preferred heating charge contains 35 wt% calcium silicide, 55 wt% iron oxide, 5 wt% strontium chromate and 5 wt% red lead ( $\text{Pb}_3\text{O}_4$ ). For igniting the mixture, an ignition charge is used and is ignited with the help of an ignition device. The ignition device may be activated electrically or mechanically, for example.

10 The document US 3,311,459 A discloses heating devices in which a powdery mixture containing iron oxide ( $\text{Fe}_2\text{O}_3$ ) and calcium silicide is used; after ignition, it undergoes an exothermic chemical reaction. The exothermic mixture is applied to asbestos fibers and is shaped to form thin, flexible sheets of a papery physical structure.

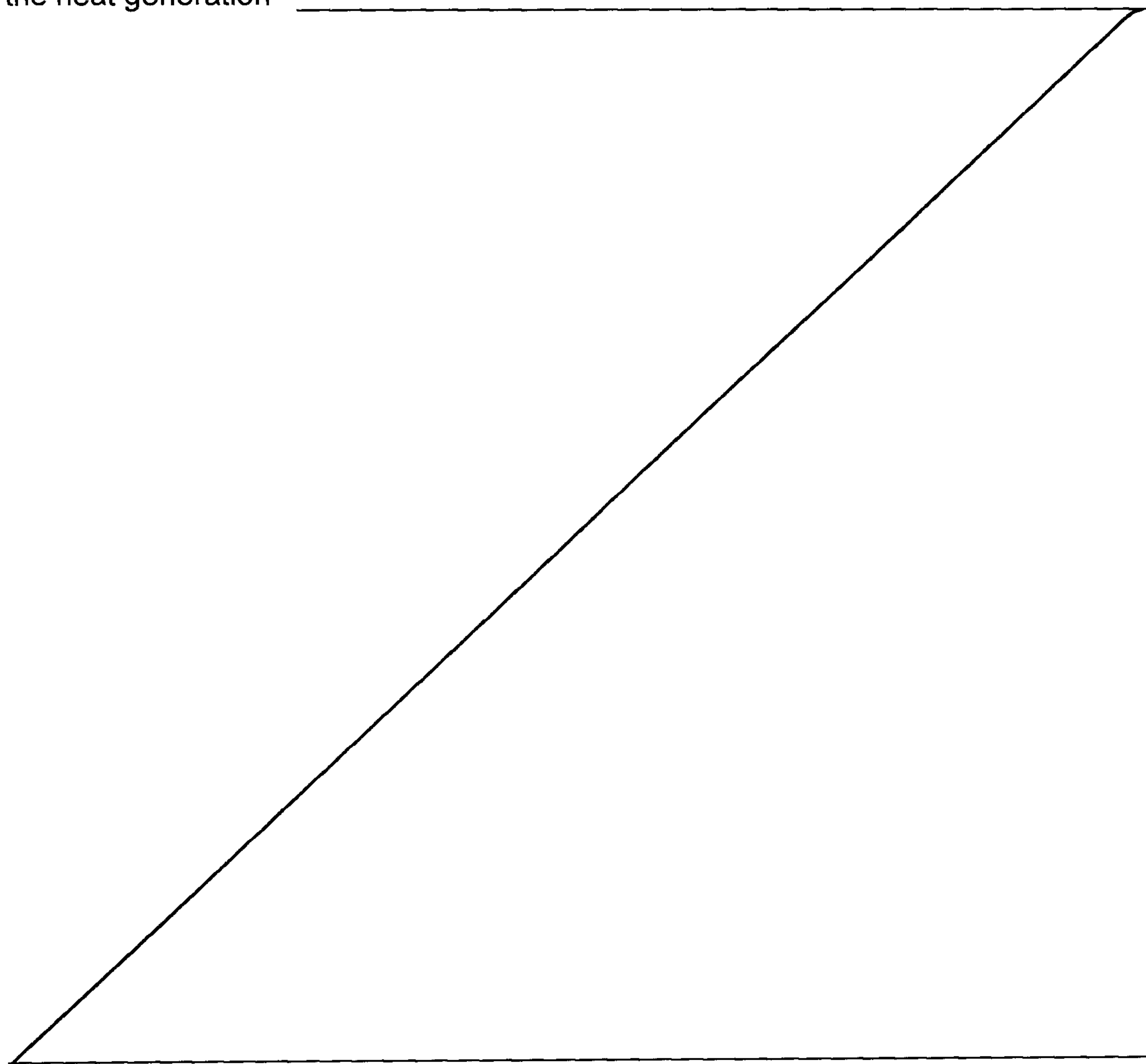
The document JP 11-310504 A describes a granular heat-generating material containing, among other things, silicon or iron silicide, a metal oxide, a mineral combustion regulator and nitrocellulose in a porous state. This mixture serves as a vaporizer for pesticides and insecticides.

The object of the present invention was to provide heat-generating mixtures.

20 The solution according to the invention provides a heat-generating mixture, containing one or more of the following constituents, metal silicide, iron oxide and silicon, optionally together with additives and processing aids selected from the group consisting of silicon dioxide and water glass, wherein the heat-generating mixture contains 48 wt.% of iron silicide, 50 wt.% of iron(III) oxide, 2 wt.% of silicon, 0 wt.% to 5 wt.% of silicon dioxide and 0 wt.% to 20 wt.% of water glass, and wherein, on burning, the heat-generating mixture forms a non-melting, porous slag

1b

The heat-generating mixture according to the invention is generating mixture according to the invention is accommodated in a device which contains, in and/or on a casing, inter alia in addition to the substance to be heated, a booster charge and an igniter capable of being actuated mechanically or electrically, preferably piezoelectrically. The casing can be made of metal and/or plastic. If necessary, in the heat generation



according to the invention, the booster charge is ignited by the igniter and in turn reliably and uniformly ignites the heat-generating mixture according to the invention. In a suitable mechanical casing, the slow and smoke-free combustion of the heat-generating mixture heats e.g. water. The thermomechanical stresses on the casing are markedly reduced because, on burning, a desirable non-melting, porous slag is formed in which the beads of iron cannot combine to form a molten ball.

10 The temperature and the time taken to reach the maximum temperature can be controlled by way of the formulation, the amount of mixture used, the amount of water and/or the type of mechanical casing. Thus, for example, 25 g of the mixture according to the invention heat 125 ml of water from 20°C to 98°C within 60 seconds in a suitable apparatus.

Only solids that do not react with one another at room temperature are used in the heat-generating mixture according to the invention, in the associated booster

20 charge and in the igniting mixture. The booster charge for the heat-generating mixture can consist e.g. of mixtures containing light metals such as titanium, magnesium and/or aluminium, and metal silicides such as calcium silicide and/or iron silicide, iron oxide, silicon and additives, or other mixtures known from the state of the art. The igniters used for the booster charge are preferably anvil-shaped igniter caps that are capable of being actuated mechanically and are based on igniting mixtures free of lead and heavy metals. These are known

30 from the state of the art and contain e.g. potassium

dinitrobenzo-furoxanate or diazodinitrophenol, tetrazene, zinc peroxide, nitrocellulose, and additives such as powdered glass and titanium. The heat-generating mixtures according to the invention are prepared by methods known per se: the components are mixed in the indicated amounts and optionally compressed. The same applies to the igniting mixture and the booster charge.

The batch formulations are illustrated by the Examples below without thereby limiting the invention:

Heat-generating mixture (Table 1):

Example 1.1	Example 1.2	Content [wt.%]
Calcium silicide	Iron silicide	40 - 55
Iron(III) oxide	Iron(III) oxide	40 - 60
Silicon	Silicon	0 - 10
Silicon dioxide	Silicon dioxide	0 - 5
Water glass	Water glass	0 - 20

Booster charge (Table 2):

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Example 2.1	Example 2.2	Content [wt.%]
Magnesium	Titanium	10 - 30
Calcium silicide	Calcium silicide	25 - 35
Silicon	Silicon	0 - 10
Iron(III) oxide	Iron(III) oxide	40 - 55
Additives:	Additives:	
Binder	Binder	0 - 10
Silicon dioxide	Silicon dioxide	0 - 10
Graphite	Graphite	0 - 10
Boron nitride	Boron nitride	0 - 10

Igniting mixture (Table 3):

Example 3.1	Example 3.2	Content [wt.%]
Potassium dinitro-benzofuroxanate	Diazodinitrophenol	20 - 40
Zinc peroxide	Zinc peroxide	20 - 40
Tetrazene	Tetrazene	0 - 10
Titanium	Titanium	0 - 20
Nitrocellulose	Nitrocellulose	0 - 40
Powdered glass	Powdered glass	0 - 20

The following compositions may be mentioned as preferred  
 5 embodiments without thereby excluding other possible  
 formulations:

10	Heat-generating mixture:	iron silicide:	48 wt.%
		iron(III) oxide:	50 wt.%
		silicon:	2 wt.%
15	Booster charge:	magnesium:	20 wt.%
		calcium silicide:	30 wt.%
		silicon:	3 wt.%
		iron(III) oxide:	47 wt.%
20	Igniting mixture:	potassium dinitro- benzofuroxanate:	30 wt.%
		zinc peroxide:	25 wt.%
		tetrazene:	5 wt.%
		titanium:	5 wt.%
		nitrocellulose:	35 wt.%

The heat-generating mixture according to the invention  
 can be used e.g. to prepare for consumption foodstuffs  
 such as water, coffee, instant meals, etc., in a  
 suitable device.

**WHAT IS CLAIMED IS:**

1. A heat-generating mixture, containing one or more of the following constituents, metal silicide, iron oxide and silicon, optionally together with additives and processing aids selected from the group consisting of silicon dioxide and water glass, wherein the heat-generating mixture contains 48 wt.% of iron silicide, 50 wt.% of iron(III) oxide, 2 wt.% of silicon, 0 wt.% to 5 wt.% of silicon dioxide and 0 wt.% to 20 wt.% of water glass, and wherein, on burning, the heat-generating mixture forms a non-melting, porous slag.
- 10 2. A method of heat generation, wherein, to generate heat, a mechanically or electrically triggerable igniter ignites a booster charge, which in turn ignites the heat-generating mixture as defined in claim 1.
3. The method of heat generation according to claim 2, wherein the igniter is piezoelectrically triggerable.
4. The method of heat generation according to claim 2, wherein the igniter is actuated mechanically.
5. A device for heat generation, comprising a mechanically or electrically triggerable igniter, a booster charge and the heat-generating mixture as defined in claim 1 fixed and/or contained in and/or on a casing.
- 20 6. The device according to claim 5, wherein the igniter is a piezoelectrically triggerable igniter.
7. The device for heat generation according to claim 5, wherein the igniter is a mechanically actuated anvil-shaped ignition cap.
8. Use of the device as defined in any one of claims 5 to 7 for heating foodstuffs.
9. Use of the heat-generating mixture as defined in claim 1 for heating foodstuffs.