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(54) **COOKER**

(57) The present invention relates to a cooker with a control unit (5) for controlling an operation of the cooker which comprises a hob (9) configured to be heated by a burner (13). Further, the cooker comprises a gas supply line (17) configured to supply the burner (13) with gas for heating the hob (9) and a gas supply valve (21) connected to the gas supply line (17) and configured to be set in an open state where gas is allowed to pass the gas supply valve (21) in the direction of the burner (13) and a closed state where gas is prohibited from passing the gas supply valve (21) in the direction of the burner (13). Opening and/or closing of the gas supply valve(21) is performed by the control unit (5) . An induction assembly (1) is arranged between the gas supply valve (21) and the burner (13) and inductively connected to the gas supply line (17) so as to, in the open state of the gas supply valve (21), induce an electric current and feed the electric current to the control unit (5).

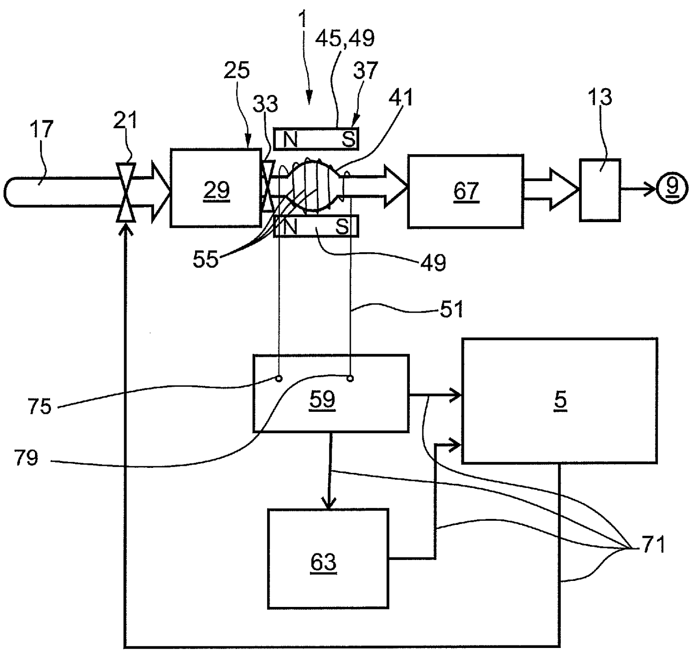

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to an energy efficient cooker with a control unit for controlling an operation of the cooker. The invention also relates to a method for inducing an electric current in such a cooker.

TECHNCIAL BACKGROUND

[0002] From US 2,733,760 an ignition system for a gas stove is known where an igniter is energized for igniting a burner. The energization of the igniter is controlled by means of a switch. Further, the opening and closing of the switch is controlled by diaphragm means which are operative in response to gas pressure changes. However, modern ovens or cookers require an electronic control unit for controlling operation of the oven or cooker. The electronic control unit and usually additional circuitry connected with the control unit need to be powered by additional external DC current. This power is fed by an external electric network such that energy consumption and power consumption costs are increased. Also, these additional power circuits may cause electromagnetic interference problems and heat dissipation.

[0003] Therefore, there is a need for a cooker where the power supply of the electronic control unit is independent from external power supply.

SUMMARY

[0004] It is an object of the present invention to overcome the above-mentioned disadvantages of the state of the art. One aspect relates to a cooker with an integrated energy recovery system for powering the electronic control unit such that energy consumption, electromagnetic interference problems, and heat dissipation of the cooker are reduced and, at best, prevented.

[0005] This objective is solved by the subject matter of the independent claims. Advantageous embodiments are subject to the dependent claims and will be set out herein below.

[0006] A general idea of the invention relates to using gas pressure which is used for heating a hob, or an oven cavity, of a cooker also for energizing a control unit and connected control circuitry being provided for controlling operation of the cooker. A general idea further relates to using the energy of the gas pressure in order to cause an induction assembly to induce an electric current which may then be supplied to/used to power electric components, such as a control unit and circuitry, such that the control unit and the circuitry do not require additional external power supply. Therefore, energy consumption of the cooker may be reduced and electromagnetic interference, which may be caused by additional circuitry that supplies the control unit with additional external power, may be reduced. The realization of the induction assembly is subject to example embodiments of the cooker according to the invention and will be explained herein below.

[0007] In an embodiment of the invention a cooker, oven, stove, for example gas stove, or cooking range, has a control unit for controlling an operation of the cooker. Also, there may be circuitry connected to the control unit. The control unit may process user inputs, such as heating of a specific hob of the oven or changing display information to be output on an oven display. The hob may be heated by an igniter being energized in response to gas pressure. Additionally to a hob or instead of a hob, the cooker may comprise an oven cavity which may be heated, wherein the oven cavity defines an inner volume where food to be heated may be placed. A gas supply line may supply the igniter with gas pressure for heating the hob. In order to control gas supply to the igniter, a gas supply valve is connected to the gas supply line and may be set in an open state where gas is allowed to pass the gas supply valve in the direction of the igniter and a closed state where gas is prohibited from passing the gas supply valve in the direction of the igniter. For example, opening and/or closing of the gas supply valve is performed by the control unit.

[0008] User input may cause operation of the control unit. The oven may for example include or be connected to a human machine interface. Further, the control unit, and also its circuitry, needs to be powered. Instead of requiring supply of additional external electric current from an external source, the control unit may be powered by an integrated energy recovery system using the gas pressure on a gas supply line. The gas pressure may be responsible for heating the hob. Therefore, an induction assembly may be arranged between the gas supply valve and the igniter. The induction assembly may be inductively connected to the gas supply line so as to, in the open state of the gas supply valve, induce an electric current and feed the electric current to the control unit. In this way, the control unit may be charged and/or supplied with electrical current without the need of an additional external power supply source. Thus, energy consumption and related costs may be reduced. Also, as no additional circuitry needs to connect the control unit with an external power supply source, electromagnetic interference problems can be avoided.

[0009] In an example embodiment of the invention, the induction assembly may comprise a spring assembly. The spring assembly may, in the open state of the gas supply valve, periodically vary a gas amount, i.e. a gas pressure amount, supplied in the direction of the igniter between a minimum and a maximum. In other words, the spring assembly may transform a constant gas flow, i.e. a gas flow having a constant gas pressure value, into an alternating, for example sinusoidally alternating, gas flow, i.e. a gas flow having an alternating gas pressure value. Further, a power generator may, in response to a change of the gas amount, respectively the gas pressure amount, induce an electric current. As explained above, the induced electric current is then supplied to the control unit.

[0010] In a further example embodiment, the spring assembly may comprise a spring. The spring may be a spiral torsion spring, hairspring, balance spring or the like. In general, the spring may have a first end connected to an output of the gas supply valve. The spring assembly may also have a control means connected to a second end of the spring. Exemplarily, the control means may be a valve, flap, or similar opening/closing armature. The control means may be set, in response to an essentially elastic deformation of the spring, in an active state where the gas amount reaches the maximum and a passive state where the gas amount reaches the minimum. The switching between its active and its passive state may be performed periodically. Essentially elastic is to be understood in that a plastic deformation of the spring to a certain degree may also occur. The degree of plastic deformation may be held at a low level in order to increase life time of the spring.

[0011] According to an example embodiment of the invention, in response to opening the gas supply valve, the spring is configured to periodically switch the control means between its passive state and its active state in order to periodically vary the gas amount between the minimum and the maximum. Conclusively, the induced current may be AC current which periodically reverses direction, respectively absolute value or modulus.

[0012] In another example embodiment, the power generator may comprise a flexible or elastic gas supply line section. For example, a flexible balloon or flexible bellows may be used. Flexible respectively elastic is to be understood in that the gas supply line section may elastically expand and/or compress, for example in a length and/or a radial direction of the gas supply line section. The flexible gas supply line section may be connected to an output of the control means such that, in response to the control means switching between its active and its passive state, the flexible gas supply line section periodically expands and/or compresses. Further, a magnet assembly may apply a magnetic flux onto the flexible gas supply line section. For example, the magnet assembly may comprise two permanent magnets arranged parallel with respect to each other. Other magnets and/or arrangements are also possible, however, a magnetic flux shall be applied onto the flexible gas line section. In an embodiment, a flexible or elastic coil may be wound around the flexible gas supply line section. At least one winding may be provided. It is clear that an increasing number of windings increases the amount of generated magnetic flux. The flexible coil may at least cover a part of the flexible gas line section. It is also possible that the flexible coil covers the entire outer surface of the flexible gas line section. Further, the flexible coil may, in response to the expansion and/or compression of the flexible gas supply line section, expand and/or compress in order to induce an electric current. The induced electric current may then be tapped between a first coil end and a second coil end. The first and the second coil end being distal from the flexible gas line section. In an example embodiment, the entire flexible gas line section is covered by the flexible coil so as to increase respectively maximize the induced current. The first and the second end of the coil may be brought and attached to a circuit so as to supply the control unit with energy. The windings may have additional electrical connections, such as taps, along their length. Also, a single tap winding in the center of its length, which is called center-tapped, may be used.

[0013] According to a further embodiment of the invention, the flexible gas supply line section is a balloon. The balloon may essentially uniformly expand and/or compress in its radial direction so as to increase and/or decrease an inner balloon volume. In other words, in the passive control means state, namely when the gas pressure amount reaches a minimum, the inner balloon volume has an initial value being indicative of a non-expanded state. Then, in the active control means state, i.e. when the gas pressure amount reaches a maximum, the inner balloon volume increases to an expanded state value.

[0014] In a further example embodiment of the invention, the coil essentially evenly expands and/or compresses in a longitudinal direction of the coil so as to increase and/or decrease a coil length. In other words, in the passive control means state, namely when the gas pressure amount reaches a minimum, the coil length has an initial value being indicative of a non-expanded state. Then, in the active control means state, namely when the gas pressure amount reaches a maximum, the coil length increases respectively lengthens to an expanded state value.

[0015] According to another example embodiment of the invention, the coil may be attached to an outer surface of the balloon. Therefore, an increase and/or decrease of the inner balloon volume causes an increase and/or decrease of the coil length. In an example embodiment, the induced electric current and the induced electric voltage are linear dependent on the ratio of increase and/or decrease of the inner balloon volume, respectively coil length. This is due to the equations [1], [2] according to Ohm's law

$$U = R * I = N * B * \frac{\Delta(A)}{\Delta(t)} = N * B * \frac{\Delta(l) * \Delta(b)}{\Delta(t)} \qquad [1]$$

$$I = \frac{U}{R} = \frac{N * B * \frac{\Delta(A)}{\Delta(t)}}{R} = \frac{N * B * \frac{\Delta(l) * \Delta(b)}{\Delta(t)}}{R} \qquad [2]$$

wherein U correlates to voltage, R to resistance, I to current, N to the number of windings of the coil, B to magnetic flux, Δ(A) to a change of the surface of the balloon respectively coil during a time period Δ(t). Δ(l) corresponds to a change of a coil length and A(b) corresponds to a change of a coil width, and/or balloon length respectively balloon width. The resistance R may correspond to an electrical resistance of the coil and may for example depend on the coil material and/or temperature. When an electric current I flows through an electrical resistance R an electric voltage U is induced, wherein thermal losses occur which reduce the amount of induced electric voltage U.

[0016] It can be seen, that the arrangement and functioning of the induction assembly may be alternated so as to, while maintaining the surface of the balloon respectively coil constant, cause a change of the magnetic flux generated by the magnet assembly in response to a varying gas pressure input which is produced by the spring assembly. The magnetic flux may for example be varied in accordance with different coil materials, coil lengths, and/or different distances of the magnet assembly with regards to the coil.

[0017] In another example embodiment of the invention, before supplying the control unit with induced electric current, the induced AC current is transformed into DC current by means of a power converter. The power converter may be a diode, such as a rectifier. In an example embodiment, the first and the second coil end are connected to the power converter such that the induced electric AC current may be tapped by the power converter and then, may be transformed into DC current which is necessary for powering the control unit.

[0018] In a further embodiment of the invention, the power converter may also be connected to a battery or a capacitor, such as a supercap, so as to charge the battery with at least a subset of the transformed DC current. The battery may for example be used for an initializing ignition of the igniter, i.e. when powering-on the cooker and performing a first ignition process. This means that, in order to initially ignite the igniter, the control unit accesses the electric current stored in the battery so as to open and/or close the gas supply valve. The battery may also allow an emergency operation of the control unit, such as an emergency shut off.

[0019] In an example embodiment, a gas regulator may be arranged between the induction assembly and the igniter. The gas regulator may rectify the periodically varying gas amount leaving the induction assembly into a constant gas amount. This may be advantageous in order to feed the igniter with a constant gas pressure amount so as to perform reliable and constant heating of the hob, respectively the oven cavity is.

[0020] According to a further example embodiment of the invention, the gas regulator mechanically rectifies the varying gas amount. In other words, the gas regulator rectifies the varying gas amount by means of mechanical control actions.

[0021] In variation of the example embodiment of the invention, the gas regulator works independent from the control unit so as to automatically rectify the varying gas amount, in response to varying gas amount inputs. The gas regulator may therefore not require a power supply and/or a control input triggered by the control unit. This further decreases the energy consumption respectively the power consumption of the cooker so as to reduce power costs for power provided from an external power supply.

[0022] It is noted that the method according to the invention can be defined such that it realizes the cooker according to the described aspects of the invention, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The following detailed description refers to the accompanying drawings. The same reference numbers may be used in different drawings to identify the same or similar elements. In the following description, for purposes of explanation and not limitation, specific details are set forth such as particular structures, functionality, etc. in order to provide a thorough understanding of the various aspects of the claimed invention.

[0024] However, it will be apparent to those skilled in the art having the benefit of the present disclosure that the various aspects of the invention claimed may be practiced in other examples that depart from these specific details. In certain instances, descriptions of well-known devices and methods are omitted so as not to obscure the description of the present invention with unnecessary detail.

Fig. 1 shows a schematic diagram indicating the functioning of a cooker according to the invention with an integrated energy recovery system according to the invention;

Fig. 2 shows a graph indicating a profile of the gas pressure after leaving a spring assembly of the cooker according to the invention, a corresponding profile of the increase/decrease of an elastic member of an induction assembly, and a corresponding graph of a profile of the electric current or voltage induced by the induction assembly of the cooker according to the invention; and

Fig. 3 shows an alternative graph indicating the profile of the gas pressure after leaving the spring assembly of the cooker according to the invention, a corresponding profile of the increase/decrease of the elastic member of the induction assembly, and a corresponding graph of the profile of the electric current or voltage induced by the induction assembly of the cooker according to the invention.

DETAILED DESCRIPTION

[0025] In the following detailed description preferred embodiments of a cooker according to the present invention are explained.

[0026] A general idea of the invention relates to using gas pressure which is used for heating a hob 9, and/or an oven cavity (not shown) defining an inner volume, of a cooker also for energizing a control unit 5 and connected control circuitry being provided for controlling operation of the cooker. A general idea further relates to using the energy of the gas pressure in order to cause an induction assembly 1 to induce an electric current which then may be supplied to electric components, such as a control unit 5 and circuitry, such that the control unit 5 and the circuitry does not require additional external power supply. Therefore, energy consumption of the cooker may be reduced and the cooker may also avoid electromagnetic interference, which may be caused by additional circuitry that is to supply power the control unit 5. The realization of the induction assembly 1 is subject to example embodiments of the cooker according to the invention and will be explained herein below.

[0027] In an embodiment of the invention a cooker, oven, stove, for example gas stove, or cooking range, has a control unit 5 for controlling an operation of the cooker. Also, there may be circuitry (not shown) connected to the control unit 5. The control unit 5 may process user inputs, such as heating of a specific hob 9 of the oven or changing display information to be output on an oven display. The hob 9 may be heated by an igniter 13 being energized in response to gas pressure. A gas supply line 17 may supply the igniter 13 with gas pressure for heating the hob 9. In order to control gas supply to the igniter 13, a gas supply valve 21 is connected to the gas supply line 17 and may be set in an open state where gas is allowed to pass the gas supply valve 21 in the direction of the igniter 13 and a closed state where gas is prohibited from passing the gas supply valve 21 in the direction of the igniter 13. For example, opening and/or closing of the gas supply valve 21 is performed by the control unit 5. It is clear, that an operation of the control unit 5 may be caused by user inputs, for example using a human machine interface integrated into the oven. Further, the control unit 5, and also the circuitry, needs to be powered. Instead of requiring additional external electric current, the control unit 5 may be powered by an integrated energy recovery system using the gas pressure which in general is responsible for heating the hob 9. Therefore, an induction assembly 1 may be arranged between the gas supply valve 21 and the igniter 13. The induction assembly 1 may be inductively connected to the gas supply line 17 such that, in the open state of the gas supply valve 21, an electric current is induced and fed to the control unit 5. In this way, the control unit 5 may be charged without the need of additional external power supply. Thus, energy consumption and conclusively power costs may be reduced. Also, as no additional circuitry needs to connect the control unit 5 with an external power supply source, electromagnet 49ic interference problems may be prevented.

[0028] In an example embodiment of the invention, the induction assembly 1 may comprise a spring assembly 25. The spring assembly 25 may, in the open state of the gas supply valve 21, periodically vary a gas amount, i.e. a gas pressure amount, supplied in the direction of the igniter 13 between a minimum and a maximum. In other words, the spring assembly 25 may transform a constant gas flow, i.e. a gas flow having a constant gas pressure value, into an alternating gas flow, i.e. a gas flow having an alternating gas pressure value. The gas pressure value may for example sinusoidally alternate. Further, a power generator 37 may, in response to a change of the gas amount, respectively the gas pressure amount, induce an electric current. According to a variant of this embodiment, during a certain time period defining an initial starting phase of the cooker, an elastic deformation of the spring assembly 25, for example an elastic expansion and/or elastic compression, is triggered by opening and/or closing of the gas supply valve 21. Then, in order to reduce energy consumption of the cooker during operation, the periodically varying of the gas amount is exclusively performed via deformation of the spring 29 without any further interaction with the gas supply valve 21 and/or without any further opening-closing-actions of the gas supply valve 21. This means that the gas supply valve 21 does not need any further power supply. In other words, the spring assembly 25 may function as a valve during operation of the cooker, namely after the initial starting phase of the cooker.

[0029] In a further example embodiment, the spring assembly 25 may comprise a spring 29. The spring 29 may be a spiral torsion spring 29, hairspring 29, balance spring 29 or the like. In general, the spring 29 may have a first end connected to an output of the gas supply valve 21. The spring assembly 25 may also have a control means 33 connected to a second end of the spring 29. Exemplarily, the control means 33 may be a valve, flap, or similar opening/closing armature. The control means 33 may be set, in response to an essentially elastic deformation of the spring 29, in an active state where the gas amount reaches the maximum and a passive state where the gas amount reaches the minimum. The switching between its active and its passive state may be performed periodically. Essentially elastic is to be understood in that a plastic deformation of the spring 29 to a certain degree may also occur, wherein the degree of plastic deformation shall be held low in order to increase life time of the spring 29. For example, the spring 29 may be essentially elastically biased so as to maintain the control means 33 in its passive state. In response to the gas supply valve 21 performing an opening action in order to allow passage of gas, the resulting gas pressure may release the bias of the spring 29 so as to cause the control means 33 to switch from passive state to active state. According to an alternative embodiment, the spring 29 may be in a not-deformed state correlating to the control means 33 being in the passive state. In response to the gas supply valve 21 performing an opening action in order to allow passage of gas, the resulting gas pressure may essentially elastically bias the spring 29 so as to cause the control means 33 to switch from passive state to active state. The deformation restoring force, resulting from biasing the spring 29, causes the control means 33 to again switch from active state to passive state in response to a closing action of the gas supply valve 21.

[0030] With regards to Fig. 1, the functioning of an integrated energy recovery system of the cooker according to the invention is exemplarily explained under reference to an induction assembly 1 where the induction of the electronic current is mainly realized by alternating expansion and/or compression of an elastic induction assembly member. However, alternative embodiments of the induction assembly 1 which may generate an electric current in response to pressure changes caused by a control means arranged upstream, i.e. before, the induction assembly 1 in a gas flow direction are also covered by the present invention.

[0031] As can be seen in Fig. 1, the control unit 5 is connected to the gas supply valve 21 so as to cause the gas supply valve 21 to open and/or close, namely to allow and/or prevent the passage of gas pressure through the valve. The opening and/or closing orders may be caused by user inputs. In the open valve state, gas pressure reaches the spring assembly 25. Then, the elastic spring 29 elastically deforms so as to cause a switching of the control means 33 between its active state and its passive state, and vice versa. For example, the control means 33 is initially set in the passive state and, in response to a deformation of the spring 29, which in turn is caused by opening the gas supply valve 21, the control means 33 switches into its active state to allow the passage of gas.

[0032] According to an example embodiment of the invention, in response to opening the gas supply valve 21, the spring 29 is configured to periodically switch the control means 33 between its passive state and its active state in order to periodically vary the gas amount between the minimum and the maximum. Conclusively, the induced current may be AC current which periodically reverses direction. In an example embodiment, during a certain time period defining an initial starting phase of the cooker, in order to switch the control means 33 between the passive state and the active state, and vice versa, the deformation of the spring, namely its expansion and/or compression, is triggered by the opening and/or closing of the gas supply valve 21. Then, in order to reduce energy consumption of the cooker, switching the control means 33 may be exclusively performed via expansion and/or compression of the spring 29. This means that the gas pressure valve 21 does not need any further power supply. In other words, the spring 29 may function as a valve. This may be achieved by a suitable mechanical structure of the spring 29 allowing a periodical switching of the control means 33. In a further example embodiment, the deformation of the spring may be defined as a mainly elastic deformation. The elastic deformation, in comparison to a plastic deformation, has the advantage of being material-saving and long-lasting, therefore being more cost-efficient. Due to the resilient behavior of the spring 29, the control means 33 may be springloaded so as to perform the switching between its active state and its passive state, and vice versa, automatically, i.e. exclusively in response to an expansion and/or compression of the string 29.

[0033] In Fig. 2 and Fig. 3, example profiles of the gas pressure leaving the spring assembly 25, respectively the control means 33, are illustrated by the corresponding graph in each figure. In both Fig. 2 and 3, the pressure P at a certain time t is referenced by the sign P(t) and correlates to the y-axis, wherein the time t correlates to the x-axis.

[0034] In Fig. 2, the gas pressure continuously increases from a minimum, in Fig. 2 "o", which means that the control means 33 initially was set in its passive state, until the gas pressure reaches the maximum $|P_{max}|$ after the control means 33 was set into active state. In case of a valve or a flap, this means that the valve for flap is completely opened. Then, the control means 33 starts switching from active state to passive state again, causing the gas pressure to decrease from the maximum $|P_{max}|$ back to value "o", where the control means 33 has reached the passive state. In case of a flap or valve, the flap or valve is completely closed.

[0035] With regards to Fig. 3, an alternative profile of the gas pressure is shown. However, the profile from Fig. 3 only differentiates from the profile according to Fig. 2 in that the pressure exponentially increases and/or decreases. When the control means 33 is realized by a flap or valve, when switching from passive state to active state, the valve or flap exponentially releases a free space to allow passage of gas.

[0036] In another example embodiment, the power generator 37 may comprise a flexible or elastic gas supply line section 41. For example, a flexible balloon or flexible bellows may be used. Flexible respectively elastic is to be understood in that the gas supply line section 41 may elastically expand and/or compress, for example in a length and/or a radial direction of the gas supply line section 41. The flexible gas supply line section 41 may be connected to an output of the control means 33 such that, in response to the control means 33 switching between its active and its passive state, the flexible gas supply line section 41 periodically expands and/or compresses. Conclusively, in response to expansion and/or compression, in any of volume of the gas supply line section 41 increases and/or decreases. Further, a magnet assembly 45 may apply a magnetic flux onto the flexible gas supply line section 41. For example, the magnet assembly 45 may comprise two permanent magnets 49 at least in part facing each other. In an example embodiment, the permanent magnets 49 are such arranged that each of the magnets 49 may apply a magnetic flux onto the flexible gas line section 41. In a further example embodiment, the magnets 49 are arranged parallel with respect to each other. The magnets 49 may have the same size, material, and/or orientation with respect to the flexible gas supply line section 41. Other magnets 49 and/or arrangements are also possible. However, a magnetic flux has to be applied onto the flexible gas line section 41. It shall be clear, that the amount of applied magnetic flux may depend on the design of the cooker, particularly may depend on the requirements of the cooker in order to reliably and energy-efficiently perform the heating process.

[0037] In an embodiment, a flexible or elastic coil 51 may be wound around the flexible gas supply line section 41 and/or attached to the flexible gas supply line section 41. At least one winding 55 may be provided. It is clear that an increasing number of windings 55 increases the amount of generated magnetic flux. The flexible coil 51 may at least cover a part of the flexible gas line section 41. Further, the flexible coil 51 may, in response to the expansion and/or compression of the flexible gas supply line section 41, expand and/or compress in order to induce an electric current. The induced electric current may then be tapped between a first coil end 75 and a second coil end 79. The first and the second coil ends 75, 79 may be distal from the flexible gas line section 41. In an example embodiment, the entire flexible gas line section 41 is covered by the flexible coil 51 so as to increase respectively maximize the induced current. The first and the second end 75, 79 of the coil 51 may be directed and attached to a circuitry so as to supply the control unit 5 with energy. The windings 55 may have additional electrical connections, such as taps, along their length. Also, a single tap winding in the center of its length, which is called center-tapped, may be used.

[0038] According to a further embodiment of the invention, the flexible gas supply line section 41 is a balloon. The balloon may essentially evenly expand and/or compress in its radial direction so as to increase and/or decrease an inner balloon volume. In other words, in the passive control means state, namely when the gas pressure amount reaches a minimum, the inner balloon volume has an initial value being indicative of a non-expanded state. Then, in the active control means state, namely when the gas pressure amount reaches a maximum, the inner balloon volume increases to an expanded state value. In an example embodiment of the balloon, the expansion and/or compression is essentially performed in an elastic manner, without any plastic deformations. Suitable materials for the balloon may be plastic, rubber, latex, or the like. It shall be clear that the dimension and degree of expansion and/or compression may depend on the design of the cooker, respectively the requirements of the cooker in order to achieve a reliable and energy-efficient heating process, while realizing the energy recovery system according to the invention. Also, particularly the degree of expansion and/or compression may be adjusted in order to generate optimum electrical values resulting in an optimum energy recovery.

[0039] In a further example embodiment of the invention, the coil 51 essentially evenly expands and/or compresses in a longitudinal direction of the coil 51 so as to increase and/or decrease a coil 51 length. In other words, in the passive control means state, namely when the gas pressure amount reaches a minimum, the coil 51 length has an initial value being indicative of a non-expanded state. Then, in the active control means state, namely when the gas pressure amount reaches a maximum, the coil 51 length increases respectively lengthens to an expanded state value. In an example embodiment of the coil 51, the expansion and/or compression is essentially performed in an elastic manner, without any plastic deformations. Suitable materials for the coil 51 may be plastic, rubber, latex, or the like. It shall be clear that the dimension and degree of expansion and/or compression may depend on the design of the cooker, respectively the requirements of the cooker in order to achieve a reliable and energy-efficient heating process, while realizing the energy recovery system according to the invention. Also, particularly the degree of expansion and/or compression may be adjusted in order to generate optimum electrical values resulting in an optimum energy recovery.

[0040] According to another example embodiment of the invention, the coil 51 may be attached to an outer surface of the balloon. The attachment of the coil 51 to the outer surface of the balloon may be continuous or discrete. Therefore, an increase and/or decrease of the inner balloon volume causes an increase and/or decrease of the coil 51 length. In an example embodiment, the induced electric current is linear dependent on the ratio of increase and/or decrease of the inner balloon volume, respectively coil 51 length. This is due to the equations [1], [2] according to Ohm's law

$$U = R * I = N * B * \frac{\Delta(A)}{\Delta(t)} = N * B * \frac{\Delta(l) * \Delta(b)}{\Delta(t)} \qquad [1]$$

$$I = \frac{U}{R} = \frac{N * B * \frac{\Delta(A)}{\Delta(t)}}{R} = \frac{N * B * \frac{\Delta(l) * \Delta(b)}{\Delta(t)}}{R} \qquad [2]$$

wherein U correlates to voltage, R to resistance, I to current, N to the number of windings 55 of the coil 51, B to magnetic flux, Δ(A) to a change of the surface of the balloon 41 respectively coil 51 during a time period Δ(t). Δ(l) corresponds to a change of a coil length and A(b) corresponds to a change of a coil width, and/or balloon length respectively balloon width. The resistance R may correspond to an electrical resistance of the coil 51 and may for example depend on the coil material and/or temperature. When an electric current I flows through an electrical resistance R, i.e. the coil 51, an electric voltage U is induced, however thermal losses occur which reduce the amount of induced electric voltage U. For a given coil 51 used in exemplary embodiments of the present invention, in general the electrical resistance R may remain constant for the entire coil 51. It is clear that, for a constant electrical resistance R of the coil 51, a change of the induced electric voltage U, respectively induced electric current I, mainly depends on a change of the other parameters according to the equations [1], [2]. The coil material may be chosen in accordance with the requirements of the corresponding cooker. In an embodiment of the invention, the coil 51 comprises a material having a low electrical resistance R in order to increase the induced electric current I, respectively electric voltage U. The magnetic flux may for example be varied in accordance with different coil materials, coil lengths, and/or different distances of the magnet assembly 45 with regards to the coil 51.

[0041] With regards to Fig. 2 and Fig. 3, a second graph indicating a change of the surface of the elastic gas supply line section 41, respectively the elastic coil 51, is illustrated, wherein the y-axis corresponds to a surface A at a time t and the x-axis corresponds to the time t. In a third graph, the change of the induced electric voltage U, respectively induced electric current I, is illustrated, wherein the y-axis corresponds to an electric voltage value U, respectively electric current value I, at a time t and the x-axis corresponds to a time t.

[0042] It may be seen that the graph of the surface A, which is used for inducing the electric current U, linearly depends on the profile of the pressure P. Further, it may be seen that the induced electric current I, respectively the induced electric voltage U, is linearly dependent on the ratio of increase and or decrease of the corresponding surface A. In the following description of a preferred embodiment, the coil 51 has a circular cross-section and the effective surface inducing a current and/or voltage correlates to a surface of the coil 51, in particular a circumferential surface of the coil 51 part being wound around the elastic gas supply line section 41. This means that, when the flexible gas supply line section 41 expands, the flexible coil 51 expands in a coil 51 length direction so as to increase the effective surface of the coil 51 inducing an electric current. In Fig. 2, the change of the effective surface comprises a linear profile resulting in an alternating, stepwise profile of induced electric current respectively induced electric voltage. With regard to Fig. 3, an exponential profile of the change of the effective surface of the coil 51 is shown, resulting in a linearly alternating induced electric current I(t), respectively induced electric voltage U(t). Each maximum pressure value $|P_{max}|$, as it is indicated via the pointed lines in Fig. 2, 3, corresponds to a maximum surface value $|A_{max}|$ of the corresponding effective surface relating to the flexible gas supply line section 41 or to the coil 51. The absolute maximum value for the induced electric voltage $|U_{max}|$ and the absolute maximum value for the corresponding electric current $|I_{max}|$ are also indicated in the respective graph.

[0043] From above mentioned equation, it may be concluded that the arrangement and functioning of the induction assembly 1 may be alternated so as to, while maintaining the surface of the balloon respectively coil 51 constant, causing a change of magnetic flux generated by the magnet assembly 45 in response to a varying gas pressure input which is produced by the spring assembly 25.

[0044] In another example embodiment of the invention, again referring to Fig. 1, before supplying the control unit 5 with induced electric current, the induced AC current is transformed into DC current by means of a power converter 59. The power converter 59 may be a diode, such as a rectifier. In an example embodiment, the first and the second coil 51 end are connected to the power converter 59 such that the induced electric AC current may be tapped by the power converter 59 and then, may be transformed into DC current which is necessary for powering the control unit 5.

[0045] In a further embodiment of the invention, the power converter 59 may also be connected to a battery 63 or a capacitor so as to charge the battery 63 with a subset of the transformed DC current. The battery 63 may for example be used for an initializing ignition of the igniter 13, i.e. when powering-on the cooker and performing a first ignition process. This means that, in order to initially ignite the igniter 13, the control unit 5 accesses the electric current stored in the battery 63 so as to open and/or close the gas supply valve 29. The battery 63 may also allow an emergency operation of the control unit 5, such as an emergency shut off. As indicated by arrows correlating to current supply lines 71 in Fig. 1, the electric current is, firstly, fed from the power converter 59 directly to the control unit 5 and, secondly, to the battery 63, which then may supply electric current to the control unit 5 during an initial igniting phase, which is also indicated by an arrow correlating to a current supply line 71.

[0046] In an example embodiment, a gas regulator 67 may be arranged between the induction assembly 1 and the igniter 13. The gas regulator 67 may rectify the periodically varying gas amount leaving the induction assembly 1 into a constant gas amount. This may be advantageous in order to feed the igniter 13 with a constant gas pressure amount so as to perform reliable and constant heating o the hob 9. For example, the gas regulator 67 may perform a smoothening and/or dampening function.it is clear that the outcome of the gas regulator 67 depends on the efficiency of the functioning of the gas regulator 67. This may be adjusted depending on the requirements of the corresponding cooker.

[0047] According to a further example embodiment of the invention, the gas regulator 67 mechanically rectifies the varying gas amount. In other words, the gas regulator 67 rectifies the varying gas amount by means of mechanical control actions where no additional for example electronic inputs are necessary.

[0048] In a variant of the example embodiment of the invention, still referring to Fig. 1, the gas regulator 67 works independent from the control unit 5 so as to automatically rectify the varying gas amount, in response to varying gas amount inputs. The gas regulator 67 may therefore not require a power supply and/or a control input for example triggered by the control unit 5. This further decreases the energy consumption respectively the power consumption of the cooker so as to reduce power costs.

[0049] It is noted that the method according to the invention can be defined such that it realizes the cooker according to the described aspects of the invention, and vice versa.

[0050] The features disclosed in the above description, the figures and the claims may be significant for the realization of the invention in its different embodiments individually as in any combination.

REFERENCE SIGN LIST

[0051]

1	induction assembly
5	control unit
9	hob
13	igniter
17	gas supply line
21	gas supply valve
25	spring assembly
29	spring
33	control means
37	power generator
41	flexible gas supply line section
45	magnet assembly
49	magnet
51	coil
55	winding
59	power converter
63	battery
67	gas regulator
71	line
75, 79	coil end

P_{max}	maximum pressure value
$P(t)$	pressure at a time (t)
A_{max}	maximum surface value
$A(t)$	surface at a time (t)
U_{max}	maximum electric voltage value
$U(t)$	electric voltage at a time (t)
I_{max}	maximum electric current value
$I(t)$	electric current at a time (t)

Claims

1. A cooker having a control unit for controlling an operation of the cooker, comprising:

- a hob configured to be heated by an igniter;

- a gas supply line configured to supply the igniter with gas for heating the hob;
- a gas supply valve connected to the gas supply line and configured to be set in an open state where gas is allowed to pass the gas supply valve in the direction of the igniter and a closed state where gas is prohibited from passing the gas supply valve in the direction of the igniter, wherein opening and/or closing of the gas supply valve is performed by the control unit; and
- an induction assembly arranged between the gas supply valve and the igniter and inductively connected to the gas supply line so as to, in the open state of the gas supply valve, induce an electric current and feed the electric current to the control unit.

2. The cooker according to claim 1, wherein the induction assembly comprises a spring assembly configured to, in the open state of the gas supply valve, periodically vary a gas amount supplied in the direction of the igniter between a minimum and a maximum, and a power generator configured to, in response to a change of the gas amount, induce an electric current.

3. The cooker according to claim 2, wherein the spring assembly comprises a spring having a first end connected to an output of the gas supply valve, and a control means connected to a second end of the spring and configured to be set, in response to an essentially elastic deformation of the spring, in an active state where the gas amount reaches the maximum and a passive state where the gas amount reaches the minimum.

4. The cooker according to claim 3, wherein, in response to opening the gas supply valve, the spring is configured to periodically switch the control means between its passive state and its active state in order to periodically vary the gas amount between the minimum and the maximum.

5. The cooker according to any of claims 2 to 4, wherein the power generator comprises a flexible gas supply line section connected to an output of the control means such that, in response to the control means switching between its active and its passive state, the flexible gas supply line section periodically expands and/or compresses, a magnet assembly configured to apply a magnetic flux onto the flexible gas supply line section, and a flexible coil wound around the flexible gas supply line section and configured to, in response to the expansion and/or compression of the flexible gas supply line section, expand and/or compress in order to induce an electric current between a first coil end and a second coil end.

6. The cooker according to claim 5, wherein the flexible gas supply line section is a balloon which essentially evenly expands and/or compresses in its radial direction so as to increase and/or decrease an inner balloon volume.

7. The cooker according to claim 5 or 6, wherein the coil essentially evenly expands and/or compresses in a longitudinal direction of the coil so as to increase and/or decrease a coil length.

8. The cooker according to any of claims 5 to 7, wherein the coil is attached to an outer surface of the balloon such that an increase and/or decrease of the inner balloon volume causes an increase and/or decrease of the coil length, wherein the induced electric current is linear dependent on the ratio of increase and/or decrease of the inner balloon volume, respectively coil length.

9. The cooker according to any of claims 1 to 8, wherein, before supplying the control unit with induced electric current, the induced AC current is transformed into DC current by means of a power converter.

10. The cooker according to claim 9, wherein the power converter is further connected to a battery so as to charge the battery with a subset of the transformed DC current.

11. The cooker according to any of claims 2 to 10, wherein a gas regulator is arranged between the induction assembly and the igniter and configured to rectify the periodically varying gas amount leaving the induction assembly into a constant gas amount.

12. The cooker according to claim 11, wherein the gas regulator mechanically rectifies the varying gas amount.

13. The cooker according to any of claims 11 or 12, wherein the gas regulator works independent from the control unit so as to automatically rectify the varying gas amount, in response to varying gas amount inputs.

14. Method for inducing an electric current in a cooker according to any of claims 1 to 11.

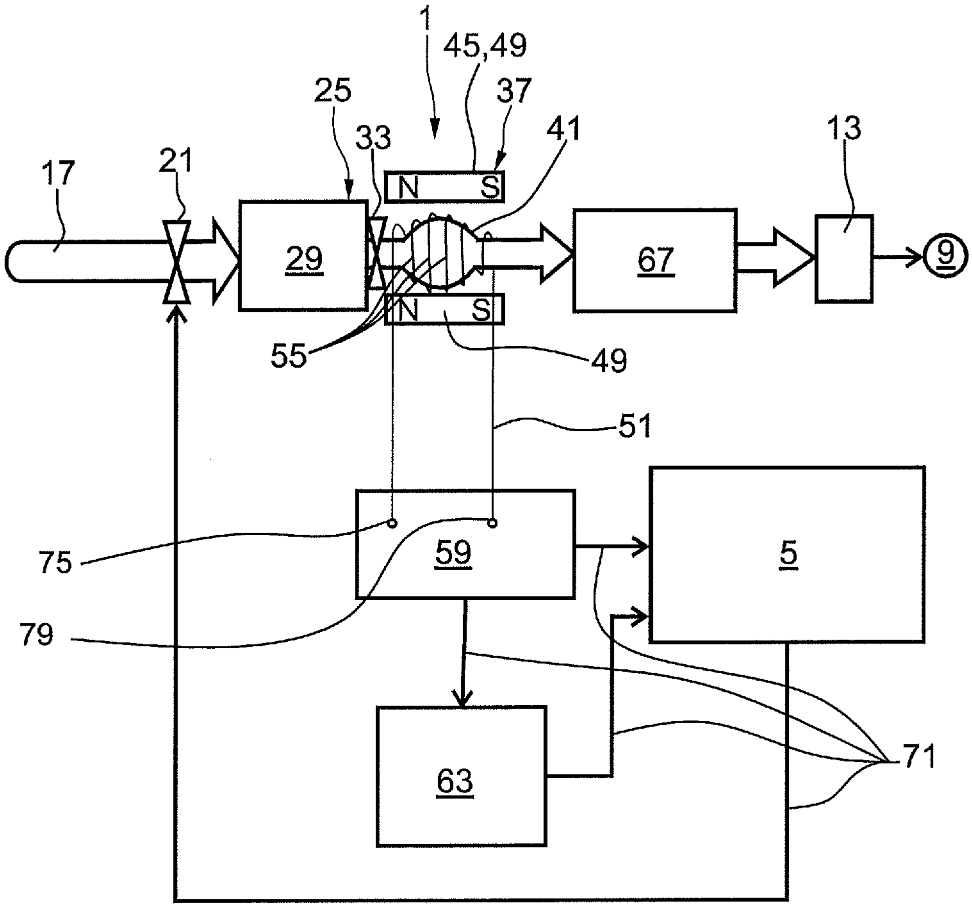

Fig. 1

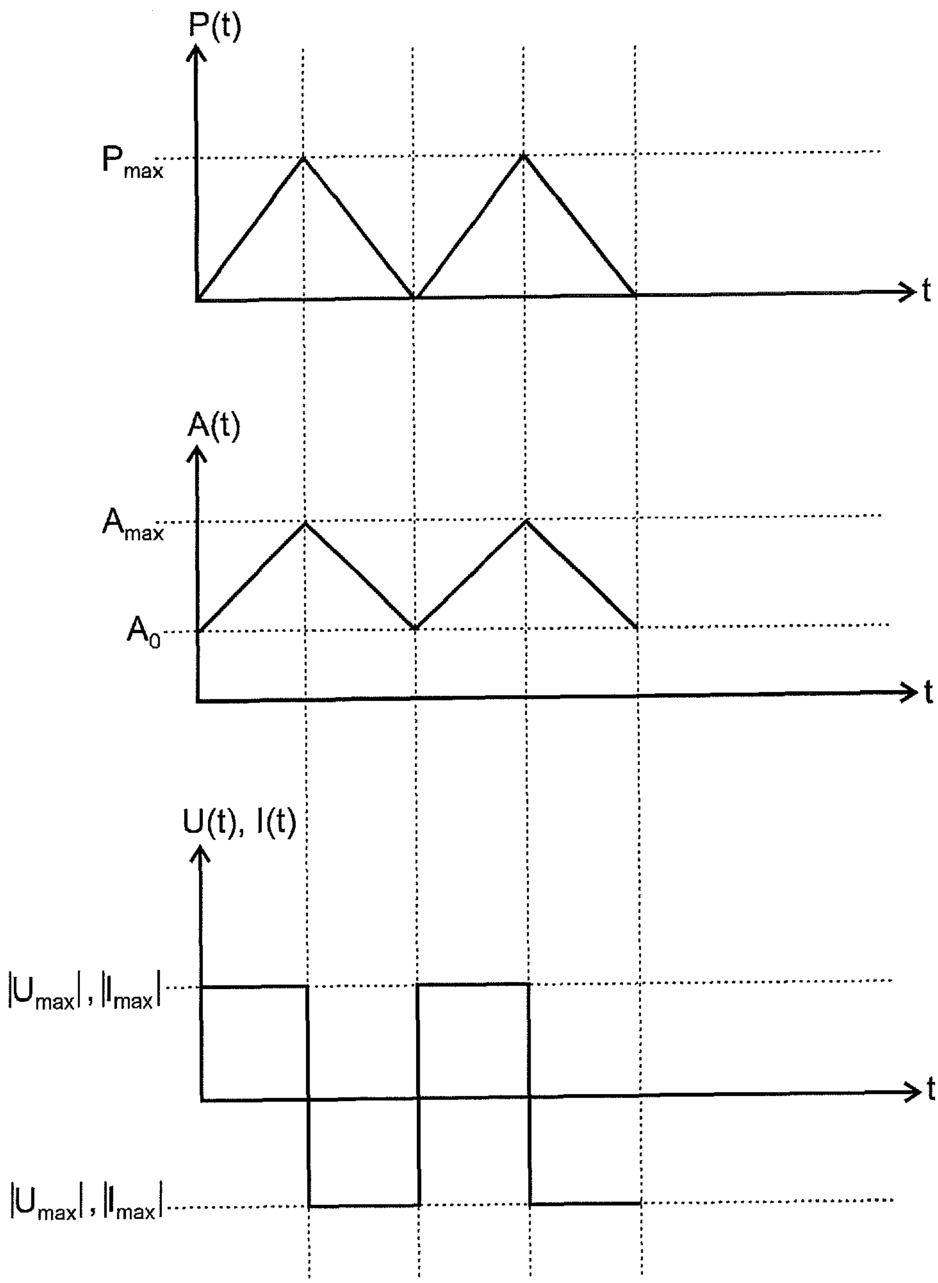

Fig. 2

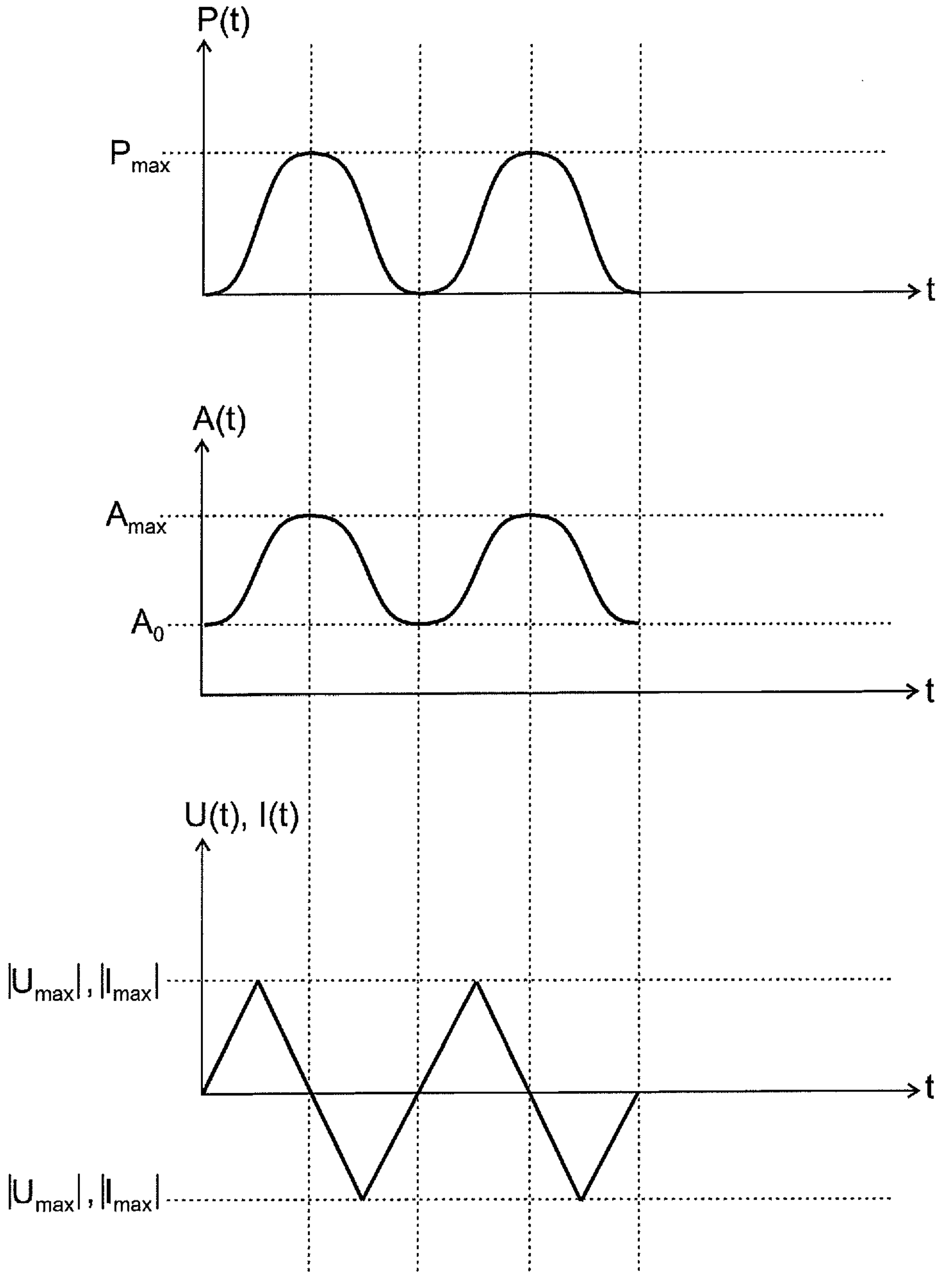

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 9528

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	25 May 2018	Adant, Vincent

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