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DEVICE FOR COUNTERING THE VARROA MITE IN A BEE BROOD**Description**

[0001] The invention relates to a device for combating the
5 varroa mite in a bee brood, comprising at least one middle
wall that can be inserted in particular into a beehive and
that is provided with brood cells for female bees.

[0002] Bee keepers usually keep bee colonies in beehives,
also referred to as brooders, and use the bee colonies for
10 honey production. The beehives usually have a cuboid shape.
Rectangular middle walls are mounted side by side, which are
surrounded by frames, by means of which they are removably
inserted into the beehives. In the process, the term "middle
wall" within the scope of the invention and claims should be
15 understood as a wall of any shape, which - unlike the middle
walls of the device according to WO 2015/087197 A1, which has
not been published, - is furnished with pre-shaped brood cells
on one or both sides, to wit, regardless of whether the middle
wall is surrounded by a frame or not.

20 [0003] The middle walls are usually formed as rolled or cast
plates of beeswax into which the brood cells are impressed in
the form of equilateral hexagons, which form honeycombs. After
mounting the middle walls in the bee colony, the bees continue
the honeycomb pattern and build the pre-formed brood cells
25 with the assistance of the beeswax they have produced into a
brood comb.

[0004] In the case of the middle walls, a distinction is made
between middle walls with brood cells for female bees, the so-
called worker cells, and brood cells for the male bees, the
30 so-called drone cells. The latter are significantly larger in
diameter and in depth than the worker cells.

[0005] For a number of years now, beekeepers have been confronted with a drastic decrease in the mortality of bee colonies, in particular of the winter bee colonies. Mainly mites that are hazardous to bees are being held accountable for the high mortality rates, in particular the varroa mite. In principle, two routes have been taken to combat the varroa mite, specifically, on the one hand chemical treatment for example by means of organic acids, and on the other hand, thermal treatment. The chemical treatment has the disadvantage that there is a risk of residues of the treatment agent finding their way into the honey. There is no such risk in the case of purely thermal treatment.

[0006] Special heating cabinets have been developed for the thermal treatment, in which the brood combs are exposed to a hot air flow over several hours. To this end, the brood combs infested with varroa mites are removed from the beehive and the bees sitting on said brood combs are shaken off or wiped off. Then the temperature of the hot air flow is slowly increased, until a temperature ranging from 39 and 42°C is reached. This temperature is then maintained over several hours (WO 92/14355 A1 and EP 2 250 880 B1).

[0007] Due to the required placement of the brood comb into the heating cabinet and back to the beehive, the treatment by means of separate heating cabinet is very time-consuming. Moreover, the purchase of the heating cabinet represents a considerable investment, hardly worthwhile for hobby beekeepers. Due to the easier handling and the low costs, therefore, many beekeepers continue to use the chemical treatment.

[0008] As an alternative to hot air treatment in separate heating cabinets, the proposal has been made to combat the varroa mites by having a middle wall or several middle walls

with brood cells for the drones provided with a heating device, which has an embedded resistance heating element and a controller connected to it in the middle wall (cf. US 8,272,921 B1). The thus equipped middle wall or the thus
5 equipped middle walls are inserted into the brooder and built by the bees into a drone brood comb or drone brood combs. During the development of the drone larvae into adult drones the heating device can be switched on for the purpose of heating the drone brood comb or drone brood combs. This causes
10 the drone brood comb(s) to heat up to approximately 65°C in a few minutes. After a few minutes the heating device is switched off again. This intense heating causes both the varroa mites and the drone brood to die off.

[0009] WO 02/043475 A1 likewise discloses a device in which a
15 middle wall or a plurality of middle walls with brood cells for the drones is furnished with a heating device. In contrast to the device according to US 8,272,921 B1, the drone brood comb is heated to at least 44°C, in order to combat the varroa mite.

[0010] It is true that these systems have the advantage that
20 no special heating cabinet with the operations necessary for its use is required. However, the disadvantage is that the efficacy is unsatisfactory, since the varroa mite control is restricted to the drone brood comb designed for drones and
25 accordingly the brood cells for the worker bees, significantly more important for the bee colony, remain untreated and hence unprotected. In addition, the brood combs for drone broods are only subject to a varroa mite attack during the relatively short incubation period for drones and therefore combatting
30 the varroa mite is only possible during this time.

[0011] The invention addresses the problem of providing a device for combating the varroa mite in a bee brood which is

easy to handle and facilitates a significantly better protection of the bee population from mites harmful to bees over the entire harvest period.

[0012] This problem is solved in accordance with the invention with a device of the initially mentioned type in that an electric heating device is provided which has a resistance heating element embedded in the middle wall and a control device connected to the latter which is designed such that an automatically running heating process can be initiated with a temporally pre-determined heat-up phase that lasts until a temperature of 39°C to 45°C, preferably 39°C to 42°C, is reached in the bottom of the brood cells in the region of the resistance heating element and then with a subsequent phase of maintaining this temperature for a predetermined period of time, in accordance with independent Claim 1.

[0013] The basic principle of the invention is thus to provide a device with at least one middle wall with brood cells for female bees, which can be electrically heated in the beehives, to wit, in such a manner that in the process only the varroa mites are killed, while the bees and bee larvae remain unmolested in this area. Therefore, the heating - unlike the device according to US 8,272,921 B2 - occurs solely at a temperature harmful for the varroa mites. It turns out that by doing this an extraordinarily effective control of the varroa mite is possible, since the heating action takes place where the varroa mite is especially harmful. It is not necessary to remove the brood comb from the beehive to initiate the heating process, i.e. preferably the initiation of the heating process takes place in the beehive itself, so that a handling of the brood comb or the brood combs is not necessary.

[0014] Applying the basic principle of the invention does not rule out providing at least one, preferably all of the middle walls with brood cells for drones with the heating device in accordance with the invention and after insertion into the beehive and during the brooding period to likewise subject these middle walls to the heating process in accordance with the invention in order to perform the varroa mite control also in this area. However, this additional measure is not required for the protection of the worker bees, since the varroa mite infestation hardly causes any harm in the area of the brood cells for the drones.

[0015] The resistance heating element can have any design or length. For practical purposes, it should not extend over the entire area of the middle wall, but rather should be restricted to a central area. It should comprise at least 80% of the brood area. The upper food zone and the lateral cells for pollen reserves and possibly empty, underside residual cells can be kept free from the resistance heating element.

[0016] Under no circumstances should the heat-up phase happen as rapidly as in the case of the device according to US 8,272,921 B1. So that the brood cells are uniformly heated and the bee brood is protected from rapid temperature increases, the heat-up phase should last for at least 30 minutes, in particular at least 1 hour. The heating up should take place evenly at a specified rate, preferably a maximum of 0.1°C/min. The maintenance phase should also be significantly longer than is the case with the device according to US 8,272,921 B2, namely at least 30 minutes, in particular at least 1 hour, preferably at least 1.5 hours, in particular 2 hours. It can also be significantly longer. Ultimately, the length of the maintenance phase is determined by the objective, on the one hand to kill the varroa mites in the brood cells of the brood comb, on the other hand however, not to use too much power.

[0017] The control device can be formed such that the time periods of the maintenance and heat-up phases are fixed in the control device. However, the control device can also be formed such that the user of the device according to the invention
5 can adjust the time periods and hence can adapt to the respective situation in the beehive.

[0018] According to a further feature of the invention, the control device can be designed such that after the initiation of a first heating process at least one additional heating
10 process is automatically brought about, in particular at predetermined or settable intervals of time. The intervals between two consecutive heating processes can be adapted to the intensity of the infestation of varroa mites. During the breeding period from March to September heating process can be
15 initiated at weekly intervals, for example every three weeks, wherein the control device automatically performs this. Other, for example longer intervals may also be provided. In so doing, it is possible to set fixed intervals in the control device. However, for practical purposes the control device has
20 a setting option for the beekeeper, so that the beekeeper can determine the time periods of the intervals himself/herself, preferably within reasonable bounds gained through experience. It is important that the beekeeper is relieved such through the observation and actuation of the device that the
25 individual heating processes are initiated by the control device itself without the access or intervention of the beekeeper.

[0019] An especially advantageous feature of the invention consists in that the resistance heating element is in the form
30 of a PTC resistor (or thermistor). Typically, in the case of such PTC resistors the electric resistance increases in somewhat linear fashion with the temperature. This opens up the possibility of controlling the temperature in the heat-up

phase and in the maintenance phase by adapting the respectively measured values for current and voltage in the PTC resistor to values stored in the control device. This type of control device is elegant in design and makes the
5 installation of a temperature sensor in the connected middle wall unnecessary.

[0020] In one especially preferred embodiment the device has a number of middle walls with resistance heating elements embedded in the latter, all of which are connected to the
10 control device, by means of which a heating process can respectively be initiated in each of the middle walls. Preferably - as mentioned above, these are all middle walls with brood cells for female bees. In the process, the middle walls can form groups each comprising a number of middle
15 walls, each group being intended for use in a respective beehive. The device in accordance with the invention is therefore also suitable for combating the varroa mite in several beehives of an apiary, wherein the control of the heating processes in the middle walls built into brood combs
20 occurs centrally from a single control device. In the process, - as likewise already mentioned above - the brood combs for the drone brood can also be included, by means of also subjecting these in each case to a heating process in accordance with the invention.

25 [0021] In the case of the previously described embodiment of the device in accordance with the invention, the control device should be designed such that the heating processes for the individual brood combs are carried out one after the other. This prevents a too high heat application within a
30 beehive and too great power consumption, which would result if the heat processes were to run in parallel. The individual heating processes should be carried out immediately after one other. However, this is not necessary, i.e., for the purpose

of further reducing the heat load of the beehive intervals of time between the two heating processes of adjacent middle walls or brood combs may be provided. After completion of the heating processes for all of the brood combs a repetition of these heating processes can also be provided, to wit either predeterminable intervals of time or predeterminable intervals of time that can be set. Such intervals can - as already mentioned above - amount to several weeks within a breeding period.

10 [0022] The design of the control device can be enhanced in various ways in order to facilitate the control of the beekeeper over the heating processes initiated by the control device. Thus, the date and time of each heating process for each middle wall can be stored and then retrievable for the
15 beekeeper. The same applies for any disturbances, which can be displayed to the beekeeper through optical or acoustical warning elements. Such disturbances can occur in the power supply or in the case of insufficient power supply of the resistance heating elements. This can all be logged and
20 displayed in a display. Ultimately, the overall objective consists in designing the control device such that on the one hand, the beekeeper is relieved of his/her own actions to the greatest extent possible, on the other hand he/she is able to control and query the function of the device in accordance
25 with the invention at any time and in addition can be instructed about malfunctions.

[0023] The invention is illustrated in greater detail in the drawing on the basis of an exemplary embodiment. The figures show the following:

30 Figure 1 shows two beehives with the device for countering the varroa mite in accordance with the invention in perspective display;

Figure 2 shows a vertical section through a middle wall for the beehives according to Figure 1, and

Figure 3 shows a lateral view of the middle wall according to Figure 2.

5 **[0024]** In Figure 1 two essentially cube-shaped beehives 1, 2 are shown. In each case they have a base wall 3 or 4 and four side walls 5, 6, 7, 8 or 9, 10, 11, 12 arranged at right angles to one another. In each case a removable top wall 13 or 14 is part of the beehives 1, 2, said top wall shown here in
10 vertically raised state.

[0025] In each case, a plurality of middle walls - by way of example labeled 15 or 16 - are mounted in the beehives 1, 2, which extend vertically and parallel to the side walls 5, 7 or 9, 11. Part of the middle walls 15, 16 are designed as shown
15 in Figures 2 and 3.

[0026] The middle wall 15 shown in Figures 2 and 3 is made of wax and furnished on both sides with hexagonal brood cells likewise made out of wax - for example labeled 17 -, which are designed in terms of size as brood cells 17 for female bees
20 and of which only a portion is drawn in Figure 2. The middle wall 15 - as well as all other middle walls 15, 16, - is surrounded by a frame 18, via which the middle wall 15 can be mounted in one of the brooders 1, 2, so that it hangs perpendicularly downward.

25 **[0027]** A resistance heating element in the form of a rectangular heating element 19 made of resistor material is embedded in the middle wall 15. Its design and length arise in particular from Figure 3. The heating element 19 is conducted out from the middle wall 15 and ends in a plug 20. The heating
30 element 19 extends only in the middle region of the middle wall 15. The upper hatched region, also called feed zone, as well as the checkered drawn lateral regions, which are

intended for the storage of pollen, and a lower region, are left blank.

[0028] In the example according to Figure 1 in each case three of the middle walls 15, 16 are designed as shown in
5 Figures 2 and 3, i.e. these middle walls 15, 16 are in identical manner furnished with heating elements 19. The relevant middle walls 15, 16 are respectively connected to a colony controller 27 or 28 connected to one of the beehives 1 or 2 via lines 21, 22, 23, or 24, 25, 26. The colony
10 controllers 27, 28 are coupled via lines 29, 30 to an apiary controller 31. Said apiary controller is connected to a power source 33 via a further line 32, said power source for example providing line current or being designed as a battery or solar cell.

15 [0029] The apiary controller 31 has an integrated circuit via which a software program can be controlled. Primarily the apiary controller 31 makes it possible to control or regulate a heating process for a connected middle wall 15, 16. The colony controllers 27, 28 receive a power supply intended for
20 the heating process via the lines 29, 30. The colony controllers 27, 28 are used primarily in each case to switch to one of the connected middle walls 15, 16, i.e. the colony controllers 27, 28 ensure that, in each case, only one of the connected middle walls 15, 16 is supplied with electrical
25 current coming from the base controller 31. Specifically, this happens in the following manner.

[0030] The heating processes are carried out after mounting the middle walls 15, 16 in the beehives 1, 2, when the middle walls 15, 16 are built into brood combs and occupied with bee
30 brood. In the subsequent description the brood combs will nevertheless be referred to as middle walls 15, 16.

[0031] The heating processes for the connected middle walls 15 16 built into brood combs are initiated by the beekeeper by inputting the date and time via the corresponding function buttons on the apiary controller 31. A test run follows with respect to all connections and display of the number of beehives 1, 2 and the connected middle walls 15, 16. If the system reports an error, the test is performed again after the displayed error has been eliminated. If the error message is ignored, the system automatically starts after a specified period, but avoids treatment in the beehive 1, 2 where an error has occurred.

[0032] If the system reports a proper function in the apiary controller 31, a heating process automatically starts. In the process, first a first middle wall 15, i.e. its heating element 19 in the first beehive 1 is supplied with electrical current. Since the heating element 19 is designed as a PTC resistor, its resistance rises when the temperature increases. By measuring the respective current and the respective voltage in intervals of 1 minute and respectively by comparison with a stored value depending on the respective expired time the power supply is controlled by repetitive switching on and off. If, in the process, a maximum value for the current and the voltage is exceeded, the power supply is interrupted. If the maximum value is not exceeded, the current is switched off after a respective pre-programmed time. The switching on of the power supply then occurs after a specified time, and the measurement of current and voltage is performed anew. By means of the repetitive comparison with preceding values the heat-up phase is controlled corresponding to a desired course, a linear, i.e. uniform course. In the subsequent maintenance phase after reaching the maximum temperature the pre-described control is used to keep the temperature as constant as

possible to a value of 42°C on the bottom of the brood cells 17 in the region of the heating element 19.

[0033] In the exemplary embodiment the heat-up phase takes over 1 hour and the maintenance phase over 2 hours, so that
5 the heating process for a middle wall 15, 16 takes a total of 3 hours. After completion of the maintenance phase, the currently treated middle wall 15 is separated from the power supply in cooperation with the colony controller 27, and the preferably adjacent middle wall 16 is connected. Then the same
10 heating process immediately occurs for this middle wall 15. If all of the connected middle walls have been thermally treated in the beehive in the previously described manner, the apiary controller 31 switches the colony controller 28 of the second beehive 2, and the connected middle walls 16 are thermally
15 treated there in the previously described manner, to wit, one after the other and following on immediately from one another. If further beehives are present, a corresponding successive treatment of the connected middle walls takes place.

[0034] Once the treatment of the middle walls 15, 16 in the
20 beehives 1, 2 is concluded, the previously described process starts all over, unless an interval period is entered in the apiary controller 31 which the thermal treatment of the connected middle walls 15, 16 is interrupted. In the incubation period this interval time can be several weeks. The
25 beekeeper can adjust the repetitiveness on the basis of his/her observations about the varroa infestation.

[0035] The apiary controller 31 is not only equipped to control the individual heating processes for the middle walls 15, 16, but rather also has further functions. Thus, a
30 documentation of the individual heating processes according to date, time, associated beehives 1, 2 and connected middle walls 15, 16 is performed. The apiary controller 31 has a

display via which it is possible to read which individual middle wall 15, 16 is currently being thermally treated. Emergency functions are integrated which sound an alarm in the event of insufficient power supply, short circuits or the like
5 and also log such events. Backup batteries ensure that the processor of the base controller 31 backs up the data also in the event of a power outage. The logs can be read out via an SD card, and there is also the possibility of entering deviating sequences for the heating processes. Further, a
10 stand-by mode is provided, which makes it possible to work on the bee colonies during a heat-phase. In the process, the system switches back to normal operation after a specified, settable time.

Patentkrav

1. Anordning til bekæmpelse af varroa-miden i biyngel, som omfatter mindst én mellemvæg (154, 16), der kan indsættes i specielt et bistade (1, 2), og som er
5 forsynet med yngelceller (17) til kvindelige bier, hvori anordningen har en elektrisk opvarmningsenhed, der har et modstandsvarmeelement (19), der er integreret i midtervæggen (15, 16) og en kontrolanordning (27, 28, 31), der er forbundet med den sidstnævnte, der er designet på en sådan måde, at en automatisk kørende varmeprocess kan startes med en temporalt forudbestemt
10 opvarmningsfase, der varer, indtil der nås en temperatur på 39 °C til 45 °C, fortrinsvis 39 °C til 42 °C, i bunden af yngelcellerne (17) i området ved modstandsvarmeelementet (19) og derefter med en efterfølgende fase med opretholdelse af denne temperatur i et forudbestemt tidsrum.
- 15 2. Anordningen i henhold til krav 1, **kendetegnet ved, at** kontrolanordningen er udformet, så opvarmningsfasen varer mindst 30 minutter, specielt mindst 1 time, og/eller at temperaturen øges jævnt i opvarmningsfasen.
3. Anordningen i henhold til krav 1 eller 2, **kendetegnet ved, at**
20 kontrolanordningen er udformet, så vedligeholdelsesfasen varer mindst 30 minutter, specielt mindst 1 time, fortrinsvis mindst 1,5 time, specielt 2 timer.
4. Anordningen i henhold til ethvert af kravene 1 til 3, **kendetegnet ved, at**
25 kontrolanordningen (27, 28, 31) er designet, så, der efter initiering af en første opvarmningsproces, automatisk tilvejebringes mindst én yderligere opvarmningsproces, specielt ved forudbestemte eller indstillelige tidsintervaller.
5. Anordningen i henhold til ethvert af kravene 1 til 4, **kendetegnet ved, at**
30 modstandsvarmeelementet (19) er i form af en PTC-resistor, og kontrolanordningen (27, 28, 31) er konfigureret, så temperaturen i opvarmningsfasen og i vedligeholdelsesfasen kontrolleres ved at tilpasse de

respektivt målte værdier for strøm og spænding i PTC-resistoren til værdier, der er gemt i kontrolanordningen (27, 28, 31).

- 5 **6.** Anordningen i henhold til ethvert af kravene 1 til 5, **kendetegnet ved, at**
anordningen har et antal midtervægge (15, 16) med modstandsvarmeelementer (19) integreret i den sidstnævnte, og som er forbundet med kontrolanordningen (27, 28, 31), og ved hjælp af hvilken en varmeprocess kan initieres i henholdsvis hver af midtervæggene (15, 16).
- 10 **7.** Anordningen i henhold til krav 6, **kendetegnet ved, at** midtervæggene (15, 16) danner grupper, der hver omfatter et antal midtervægge (15, 16), hver gruppe er beregnet til brug i et respektivt bistade (1, 2).
- 15 **8.** Anordningen i henhold til krav 6 eller 7, **kendetegnet ved, at**
kontrolanordningen (27, 28, 31) er designet på en sådan måde, at varmeprocesserne for midtervæggene (15, 16) kan udføres én efter én, fortrinsvis umiddelbart efter hinanden.
- 20 **9.** Anordningen i henhold til ethvert af kravene 6 til 8, **kendetegnet ved, at**
kontrolanordningen (27, 28, 31) er designet på en sådan måde, at varmeprocesserne for alle midtervæggene (15, 16) kan foranlediges ved forudbestemte intervaller eller forudbestemmelige tidsintervaller, der kan indstilles.
- 25 **10.** Anordningen i henhold til ethvert af kravene 1 til 9, **kendetegnet ved, at**
kontrolanordningen (27, 28, 31) er designet på en sådan måde, at datoen og klokkeslættet for hver varmeprocess for hver midtervæg gemmes.

Fig. 1

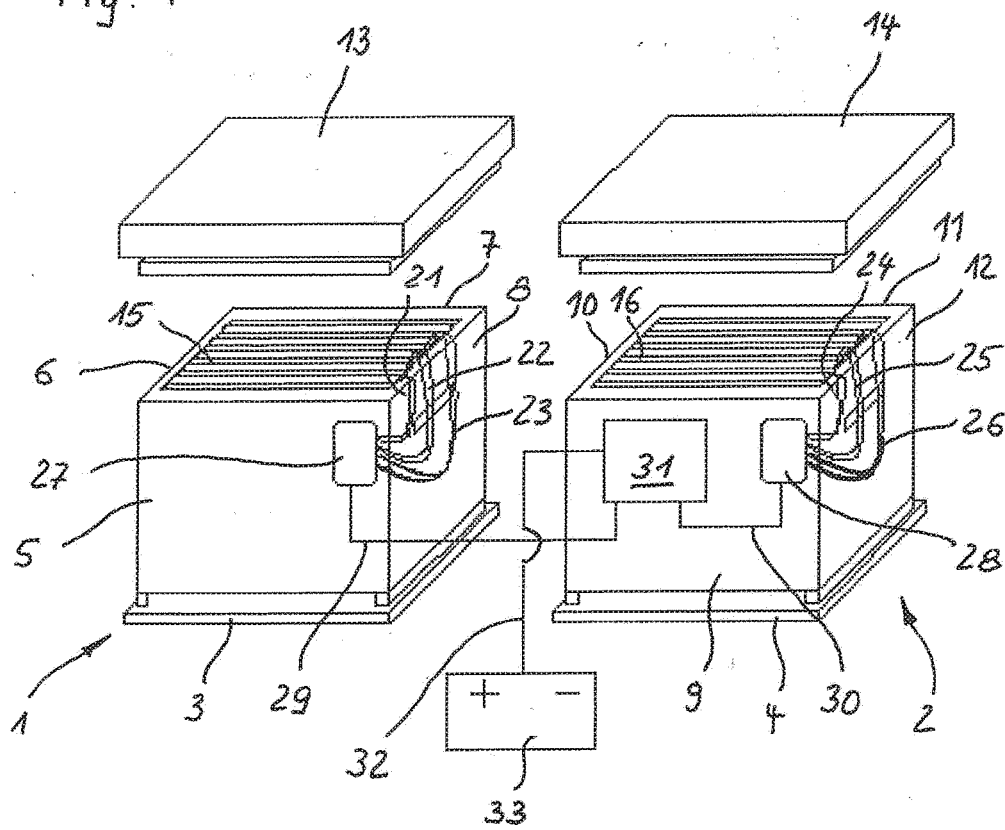


Fig. 2

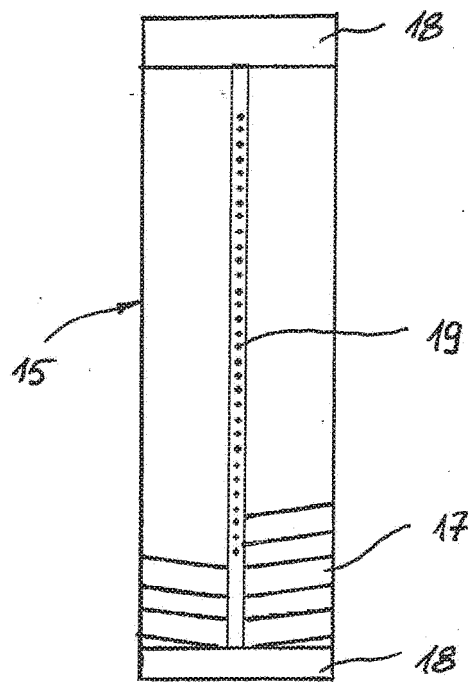


Fig. 3

