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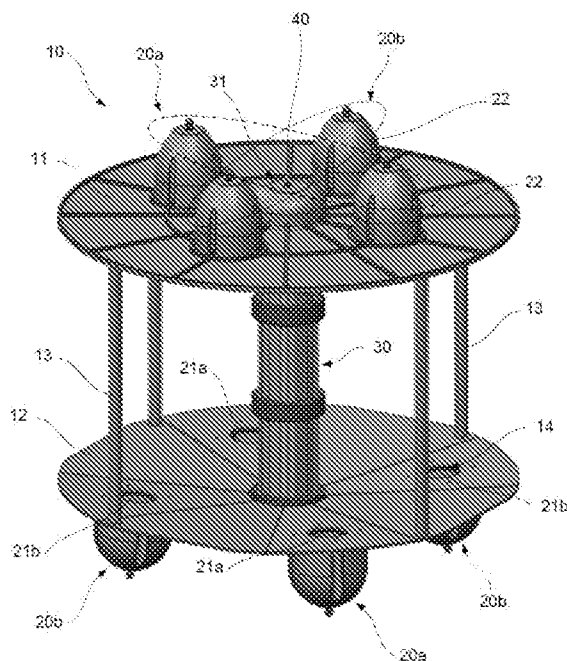
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(54)	Title	COMBATING FREE SWIMMING LICE AND OTHER ECTOPARASITES IN THE WATER OF A FISH FARM
(56)	References Cited:	WO 2017/044985 A2, US 2008/0257830 A1, WO 2018/115826 A1 SOLVANG-GARTEN, T. ET AL, "Lyd og ultralyd mot lakselus?", Norsk fiskeoppdrett, No 1 Januar 2017, Årgang 42, side 54-59, [Hentet 2020.01.31 fra internett] (https://www.sintef.no/globalassets/sintef-ocean/pdf/nf_2017_n1-p-54-59-ultralyd.pdf) NODLAND, E., "Har troa på at ultralyd kan bidra til mindre lus", 2015.09.17, iLaks.no [Hentet 2020.01.31 fra Internett] (https://ilaks.no/har-troa-pa-at-ultralyd-kan-bidra-til-mindre-lus/) DE 202017000372 U1, NO 337292 B1, GB 2286756 A, WO 2018/062999 A1
(57)	Abstract	

Device and method for combating free swimming lice and other ectoparasites in the water of a fish farm, wherein the free swimming lice and other ectoparasites are attracted by using at least one light source and combating the attracted free swimming lice and other ectoparasites by ultrasonic means.



COMBATING FREE SWIMMING LICE AND OTHER ECTOPARASITES IN THE WATER OF A FISH FARM

The present invention is related to a device for combating free swimming lice and other ectoparasites in the water of a fish farm, according to the preamble of claim 1.

- 5 The present invention is also related to a method for combating free swimming lice and other ectoparasites in the water of a fish farm, according to the preamble of claim 13.

Background

10 It is a known fact that the culture of fish in fish farms brings along sea lice (Family Caligidae) that are small marine copepods that live and feed on salmons and other fish. Sea lice are ectoparasites, attaching to outside of fish on skin, fins, or gills.

It is a well-known fact that there is a desire to reduce the amount of lice and other ectoparasites in fish farms to a minimum and many different approaches have over the years been suggested and tested.

- 15 Sea lice can cause serious fin damage, skin loss, constant bleeding, and deep open wounds. Open wounds allow diseases and other parasites to enter the fishes' bodies. Sea lice can parasitize both farmed and wild salmon, and are a major concern for both the farming industry and for salmon conservation efforts.

- 20 A widely used method is the use of chemicals and drugs to treat salmon after an outbreak of sea lice occurs. This method is costly and such treatment often involves potential environmental impacts, as well as human health concerns of using chemicals remain uncertain.

Other methods that have been used are closed fish farms, laser, sound, light, as well as mechanical cleaning/treatment.

The closest prior art to the present invention is found in the below discussed publications.

- 25 Examples of using ultrasound has been known for many years and e.g. described in DE202019001007U1, WO18099504A1, WO17199019A1, US2017094950A, EP2962556B1 and

WO9417657A1, which all are related to the use of a tube or similar the fish have to pass through to be affected by the ultrasound.

WO15159757A1 discloses a marine product aquaculture device having a simple structure, uniformly emitting ultrasonic waves, increasing the resistance of the fish, crustaceans, and shellfish that are being cultivated, and improving survival rates; and an aquaculture method therefor. The marine product aquaculture device comprises: a container positioned so as to be movable either on the surface of or in water in which marine products are being cultivated; and ultrasonic vibrators attached to the container. The container moves across the water surface or through the water and emits ultrasonic waves on to the marine products. The ultrasonic vibrators are piezoelectric vibrators having a resonance frequency of 0.3-10 MHz. A plurality of ultrasonic vibrators are provided in one container, the ultrasonic emission direction of each ultrasonic vibrator is different, and the ultrasonic emission surface is inclined 3-45 degrees to the water surface.

In WO13095153A1 is described a system and method for inhibiting one or more parasites to infest and/or attach to one or more aquatic animals includes an acoustic arrangement for generating an acoustic image in a vicinity of the acoustic arrangement within an aquatic environment accommodating said one more aquatic animals and/or parasites.

From WO13051725A1 is known ultrasonic oscillation terminals installed in a fish tank. The ultrasonic oscillation terminals and an oscillator are connected. Ultrasound waves are generated in the fish tank, and body surface parasites on the farmed fish in the fish tank are removed.

US2008257830A discloses a method of treating a target area with an ultrasound wave pattern, including: providing an ultrasound apparatus having an ultrasound wave generator operatively attached to a plurality of transducers, coupled to an immersible support and configured to emit an ultrasound wave; immersing the apparatus into a water environment; positioning the apparatus proximate to a target area to treat at least one in situ organism; and emitting a pattern of ultrasound waves from the transducers, the pattern of ultrasound waves additive in effect and emitted onto the target area to threat an in situ underwater organism.

In WO18115826A1 is described a method of injuring or killing an aquatic ectoparasite comprises exposing the aquatic ectoparasite to an aqueous solution comprising hydrogen peroxide and exposing the aquatic ectoparasite to sound waves.

A common disadvantage of the latter prior art solutions is that they are ineffective due to they are emitting ultrasound waves into a large area of the fish farm. This will result in that the intensity of

the ultrasound waves and due to the large area they are emitted over, the possibility to hit lice is very low.

A further disadvantage of the prior art solutions is that they are not arranged to attract lice and other ectoparasites to increase the efficiency of the use of the ultrasound.

- 5 Another disadvantage with the prior art solutions is that the extensive use of ultrasonic technology is high energy consuming and may affect sea mammals such as whales and dolphins.

From WO 2017/044985 A2 is known a method and device for removing sea lice from salmon with use of a salmon herding passage tube, with ultrasound transducers on the periphery thereof, in a number sufficient to provide ultrasound treatment of the salmon being herded therethrough at a
10 normal herding rate and at a sufficiently high enough frequency to kill the sea lice. The method and device also include removal of the lice from a salmon cage or enclosure with feeding fish into an enclosure having ultrasound transducers situated on the inner periphery thereof and providing an attraction such as a white light, which attracts noxious parasitic aquatic organisms and applying ultrasound from the electronic transducers within the enclosure. The solution will be limited to
15 combating parasites that is in the enclosure and will thus require free-swimming parasites to be attracted into the enclosure before combating them with ultrasound, something that will not be an effective approach on free-swimming parasites. There is further a considerable limitation of attracting free-swimming parasites by the use of light, as light will only be visible at the end openings of the enclosure, which will be of minor area.

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Objects

The main object of the present invention is to provide a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm partly or entirely solving the mentioned disadvantages of prior art.

- 25 It is further an object of the present invention to provide a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm that is able to attract free swimming lice and other ectoparasites in the water of a fish farm.

An object of the present invention is to provide a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm that is able to combat lice and other
30 ectoparasites before they are affecting the fish.

It is further an object of the present invention to provide a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm that is more effective than prior art solutions.

- 5 An object according to the present invention is to provide a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm that is controllable both as regards the attraction of the lice and other ectoparasites and the combating thereof.

It is an object of the present invention to provide a device for combating free swimming lice and other ectoparasites in the water of a fish farm that does not require installation of additional equipment in the fish farm.

- 10 An object of the present invention is to provide a device and method for combating free swimming lice and other ectoparasites wherein the ultrasonic energy is confined at desired area/volume of the fish farm.

Another object of the present invention is to provide a device and method for combating free swimming lice and other ectoparasites which is energy saving compared to prior art solutions.

- 15 It is an object of the invention to provide a device and method for combating free swimming lice and other ectoparasites that reduces the affection from ultrasonic energy on sea mammals such as whales and dolphins.

Further objects of the present invention will appear from the following description, claims and attached drawings.

20

The invention

A device for combating free swimming lice and other ectoparasites in the water of a fish farm according to the present invention is disclosed in claim 1. Preferable features of the device are disclosed in the dependent claims.

- 25 A method for combating free swimming lice and other ectoparasites in the water of a fish farm according to the present invention is disclosed in claim 13. Preferable features of the method are disclosed in the dependent claims.

The present invention provides a device and method for combating free swimming lice and other ectoparasites in the water of a fish farm. Further, the present invention provides a device and method for attracting free swimming lice and other ectoparasites in the water and combating the attracted free swimming lice and other ectoparasites in the water before they are affecting fish in the fish farm, thus removing the lice and other ectoparasites at as early stage as possible.

The present invention will thus reduce or completely remove the need for treatment of affected fish from lice and other ectoparasites, which is expensive, as well as considerably reduce the risk of diseases arising in a fish farm.

The device and method for combating free swimming lice and other ectoparasites in the water of a fish farm according to the present invention is based on at least one light source for attracting the free swimming lice and other ectoparasites in the water and the use of ultrasonic means for combating the attracted lice and other ectoparasites.

The device according to the present invention further comprises an upper disc and lower disc spaced apart in longitudinal direction of the device with a desired distance from each other in longitudinal direction of the device defining a limited volume for combating attracted lice and other ectoparasites for the device.

According to the present invention at least one of the mentioned discs exhibit a parabolic or inclined surface, at least at sections of the surface, facing the other disc.

The at least one light source is arranged to emit light in circumferential direction thereof and has an extending in longitudinal direction between the mentioned discs. The at least one light source is preferably a controllable light source, but may also be a fixed light source.

The ultrasonic means is according to the present invention formed by at least one first ultrasound unit and at least one second ultrasound unit arranged to both the upper and lower discs emitting ultrasonic waves towards the facing respective disc.

According to the present invention the first ultrasound unit comprises at least one ultrasonic transducer operable to generate a first ultrasound signal from a first operation frequency f_1 and the second ultrasound unit comprises at least one ultrasonic transducer operable to generate a second ultrasound signal from a second operation frequency f_2 , wherein the second operation frequency f_2 is different from the first operation frequency f_1 , providing generation of a heterodyned signal

from the first and second ultrasound signals for propagation in the volume between the mentioned discs.

In accordance with a further embodiment of the device according to the present invention the device comprises at least one ultrasonic generator operable to generate electrical energy to drive the mentioned first and second ultrasonic transducers, wherein the electrical energy comprising the at least two different frequencies including the first operation frequency f_1 and a second operation frequency f_2 . In an alternative embodiment, separate ultrasonic generators are used for the mentioned first and second operation frequencies.

According to one embodiment of the device according to the present invention the at least one ultrasonic generator is adjustable for voltage and control current.

In accordance with a further embodiment of the device according to the present invention the at least one ultrasonic generator is capable of performing a frequency sweep of the at least one of the first f_1 and second f_2 operation frequencies to tune at least one of first f_1 and second f_2 resonant frequencies of the at least one first and second ultrasonic transducers, respectively.

According to a further embodiment of the device according to the present invention it comprises a control device controlling characteristics of the signals generated by the at least one ultrasonic generator.

In accordance with a further embodiment of the device according to the present invention, the characteristics of the signals controlled by the control device include at least one of an amplitude and a timing.

According to one embodiment of the device according to the present invention, the first operation frequency f_1 is between about 20 and about 30 kHz inclusively.

In accordance with one embodiment of the device according to the present invention, the second operation frequency f_2 is between about 30 and about 50 kHz inclusively.

According to one embodiment of the device according to the present invention, the first operation frequency f_1 and the second operation frequency f_2 are distinct from one another.

In accordance with a one embodiment of the device according to the present invention the first ultrasound unit comprises at least two first ultrasonic transducers and that the second ultrasound unit comprises at least two second ultrasonic transducers, wherein the first ultrasonic transducers

of the first ultrasound unit and the second ultrasonic transducers of the second ultrasound unit are arranged in one or both of: an inline configuration whereby one or both of the first ultrasonic transducers and the second ultrasonic transducers are linearly aligned with one another; and a triangular configuration whereby adjacent ones of the first ultrasonic transducers or the second ultrasonic transducers are disposed diagonally across from one another.

A method for combating free swimming lice and other ectoparasites in the water of a fish farm according to the present invention comprises attracting free swimming lice and other ectoparasites by illuminating light by means of at least one light source and ultrasonically combating the attracted lice and other ectoparasites.

10 The method according to the present invention it comprises combating the attracted lice and other ectoparasites by generating a first ultrasound signal of at least one first ultrasonic transducer from a first operation frequency f_1 and a generating a second ultrasound signal of at least one second ultrasonic transducer from a second operation frequency f_2 , such that a heterodyned signal is generated from the first and second ultrasound signals for combating the attracted lice and other
15 ectoparasites.

In accordance with a further embodiment of the method according to the present invention it comprises performing a frequency sweep of the at least one of the first f_1 and second f_2 operation frequencies to tune at least one of first f_1 and second f_2 resonant frequencies of the at least one first and second ultrasonic transducers, respectively.

20 According to one embodiment of the method according to the present invention, it comprises using a first operation frequency f_1 that is between about 20 and about 30 kHz inclusively.

In accordance with one embodiment of the method according to the present invention, it comprises using a second operation frequency f_2 that is between about 30 and about 50 kHz inclusively.

25 According to one embodiment of the method according to the present invention, it comprises using a first operation frequency f_1 and second operation frequency f_2 that are distinct from one another.

Further preferable features and advantageous details of the present invention will appear from the following example description, claims and attached drawings.

Example

The present invention will now be described in further details with references to the attached drawings, where:

Fig. 1a-b are principle drawings of a device for combating free swimming lice and other ectoparasites in the water of a fish farm according to the present invention, seen inclined from above and below, respectively, and

Fig. 2 is a block diagram of the device according to the present invention.

Reference is first made to Figures 1a-b, which are principle drawings of a device 10 for combating free swimming lice and other ectoparasites in the water of a fish farm according to an example embodiment of the present invention.

The device 10 according to the present invention comprises an upper 11 and lower 12 mainly circular discs spaced apart from one another in longitudinal direction of the device 10, wherein at least one of the discs 11, 12 exhibit a parabolic or inclined surface, at least at sections of the surface, facing the other disc 11,12.

The upper 11 and lower disc 12 are spaced apart in longitudinal direction of the device 10 by means of numerous vertical rods 13 extending between the discs 11, 12 for fixation of the discs 11, 12 to each other with a desired distance from each other in longitudinal direction of the device 10, wherein the vertical rods 13 preferably are arranged close to exterior circumference of the discs 11, 12. The interior surface, i.e. the surface of the upper 11 and lower 12 disc facing each other is provided with or formed by an ultrasound reflecting material.

The device 10 further comprises at least one first ultrasound unit 20a and at least one second ultrasound unit 20b arranged to both the upper 11 and lower 12 discs. The first ultrasound unit 20a comprises at least one ultrasonic transducer 21a operable to generate a first ultrasound signal from a first operation frequency f_1 and the second ultrasound unit 20b comprises at least one ultrasonic transducer 21b operable to generate a second ultrasound signal from a second operation frequency f_2 , wherein the second operation frequency f_2 is different from the first operation frequency f_1 , providing generation of a heterodyned signal from the first and second ultrasound signals for propagation in the volume between the mentioned discs 11, 12.

The at least one of the first ultrasonic transducers 21a and the second ultrasonic transducers 21b e.g. comprise a piezoelectric ultrasonic transducer.

The ultrasound units 20a and 20b may comprise more than one ultrasonic transducer 21a-b, respectively, wherein the ultrasonic transducers 21a-b, respectively. According to the present invention the first ultrasonic transducers 21a of the first ultrasound unit 20a and the second ultrasonic transducers 21b of the second ultrasound unit 20b are arranged in one or both of: an inline configuration whereby one or both of the first ultrasonic transducers 21a and the second ultrasonic transducers 21b are linearly aligned with one another; and a triangular configuration whereby adjacent ones of the first ultrasonic transducers 21a or the second ultrasonic transducers 21b are disposed diagonally across from one another.

In Figures 1a-b and are shown an embodiment where adjacent first ultrasonic transducers 21a of the first ultrasound unit 20 are arranged diagonally across each other about a longitudinal center axis of the device 10, and adjacent second ultrasonic transducers 21b of the second ultrasound unit 20b are arranged diagonally across each other about a longitudinal center axis of the device 10, in this way form an alternating pattern of the first ultrasonic transducers 21a and the second ultrasonic transducers 21b in circumferential direction of the discs 11, 12.

The upper 11 and lower 12 discs are for this provided with through holes 14 for receiving and accommodating emitting end of the ultrasonic transducers 21a-b of the respective ultrasound unit 20a-b. The ultrasound units 20a-b are arranged to respective discs 11, 12 by means of housings 22 at the surface not facing the other disc 11, 12 such that the ultrasonic transducers 21a-b, respectively, thereof are positioned in the mentioned through holes 14 and pointing towards the other disc 11, 12 with the emitting end.

According to the present invention the first 20a and second 20b ultrasound units are arranged in a configuration where they are displaced in relation to each other in the respective disc 11, 12 and displaced in relation to first 20a and second 20b ultrasound units in the opposite disc 11, 12 such that the ultrasonic transducers 21a-b of the respective discs 11, 12 are not directly facing each other such that they will not cancel each other out.

Alternatively, the ultrasonic transducers 21a-b are arranged with an angle in relation to the vertical plane such that they emit in different planes in relation to each other to avoid the same.

According to the present invention the device 10 further comprises at least one controllable light source 30, extending in longitudinal direction between the mentioned discs 11, 12, preferably

arranged in the center of the discs 11, 12 and accommodated and fixed in through holes 15 arranged in center of the discs 11, 12 and housings 31 at exterior sides of the discs 11, 12. The at least one controllable light source 30, e.g. comprising LED, is arranged to emit a desired light in circumferential direction of the controllable light source 30. Due to the light source 30 being controllable the illuminated light thereof may be adjusted for optimal attraction according to the present condition in the water of the fish farm, as well as be adjusted to attract the lice and other ectoparasites in different development stages that requires different/adjusted light for attraction.

According to the present invention, the two or more distinct ultrasonic transducers 21a-b arranged to both the upper 11 and lower 12 disc provide super-positioning of two or more excited frequencies. The result is the effect of heterodyning. Super-positioning of two or more frequencies results in generating about double the amount of the vibration frequencies. By this is achieved four frequencies vibrating a lice or other ectoparasites positioned between the mentioned discs 11, 12, namely both original frequencies plus the sum ($f_3=f_1+f_2$) and difference ($f_4=f_1-f_2$) between the two frequencies. As a result, this broadens the number of lice and other ectoparasites the device 10 according to the present invention is capable to combat. Further, by combining (superposing) different frequencies, such as a relatively lower and a relatively higher frequency, the effective range and intensity/effect of combating is increased, due to the lower frequency carrying the superposed high frequency to greater distances than the high frequency would be able to travel as a single frequency wave.

According to a further embodiment of the present invention the at least one first and second ultrasound units 20a-b are controlled by continuous guided wave ultrasound mode vibration, which may be antisymmetric, to emit with a parallel second frequency ultrasound wave that results in heterodyning which produces two additional frequencies out of the initial two frequencies. By combining guided wave ultrasound with the effect of heterodyning, the lice or other ectoparasites can be vibrated not only with one single frequency, but with four distinct frequencies, thus permitting combating a much wider range of lice and other ectoparasites. Each lice and other ectoparasite has its specific resonance frequency, also depending on evolution, on which it is particularly vulnerable against damage by ultrasonic impact. By quadrupling the number of frequencies used, embodiments of the present invention may combat a much broader variety of lice and other ectoparasites, as can be found in fish farms throughout the world marine environment.

The device 10 according to the present invention provides a solution with reduced leakage of ultrasonic energy into the water due to the use of the discs 11, 12, as well as the heterodyning, and thus a greatly enhanced effect of the ultrasonic vibrations is achieved. As a result, a considerable

higher kill rate of lice and other ectoparasites is achieved by the present invention, compared to prior art solutions.

As mentioned above, the first 22a and second ultrasonic transducers 21a-b of the first 20a and second 20b ultrasound units are operated at different frequencies. E.g. the operation frequency f1 of the first ultrasonic transducer 21a is between about 20 and about 30 kHz inclusively, while the operation frequency f2 of the second ultrasonic transducer 21b is between about 30 and about 50 kHz inclusively, or vice versa.

In some embodiments, the first operation frequency f1 and the second operation frequency f2 are distinct from one another.

Reference is now made to Figure 2, which is a block diagram of the device according to the present invention.

The device 10 according to the present invention will further be provided with a control device 100 provided with means and/or software for controlling the at least one light source 30 and the ultrasound units 20a-n. The control device 100 is provided with means/and or software for controlling characteristics of the signals generated by an ultrasonic generator 22 controlling the ultrasonic transducers 21a-b of the ultrasound units 20a-n.

The ultrasonic generator 22 is operable to generate electrical energy to drive the at least one first 21a and second 21b ultrasonic transducers connected to the ultrasonic generator 22, wherein the electrical energy including at least two different frequencies including the first operation frequency f1 and the second operation frequency f2. The first operation frequency f1 operates the mentioned at least one first ultrasonic transducer 21a such that it is operable to generate a first ultrasound signal from the first operation frequency f1, while the second operation frequency f2 operates the mentioned at least one second ultrasonic transducers 21b such that it is operable to generate a second ultrasound signal from the second operation frequency f2, such that a heterodyned signal is generated from the first and second ultrasound signals for propagation in the area between the mentioned discs 11, 12.

According to an embodiment of the present invention where the first ultrasound unit 20a and second ultrasound unit 20b comprise two or more ultrasonic transducers 21a-2, respectively, the respective first ultrasonic transducers 21a and second ultrasonic transducers 21b are electrically connected in parallel to the ultrasonic generator 22.

According to one embodiments of the present invention, the characteristics of the signals controlled by the control device 100 include at least one of an amplitude and a timing.

In accordance with another embodiment of the present invention, one or more of a voltage and a control current of the ultrasonic generator 22 is adjustable.

5 According to a further embodiment of the present invention, the ultrasonic generator 22 is operable to perform a frequency sweep of at least one of the first f_1 and second f_2 operation frequencies to tune at least one of first f_1 and second f_2 resonant frequencies of the at least one first and second ultrasonic transducers 21a-b, respectively. In certain embodiments, the frequency sweep is less than about 3 kHz. In certain other embodiments, the sweep is less than about 5 kHz.

10 According to some embodiments, the frequency sweep comprises transmitting electrical signals about a resonant frequency of at least one of the first ultrasonic transducers 21a or the second ultrasonic transducers 21b.

In some embodiments, the electrical signals are transmitted continuously and simultaneously during a combat interval.

15 The control device 100 can further be provided with wired or wireless communication means 101 for communication with an external device 110, such as a control panel or control system, for adjusting the settings of the device 10. The control device 100 may further be arranged to issue an alarm on the external device 110 in response to failure of any one of the ultrasonic transducers 21a-b or light source 30.

20 According to the present invention is thus provided a device for combating free swimming lice and other ectoparasites that may be submerged in the water in a fish farm or in the vicinity of the fish farm. Even though the main use will be arranging the device according to the present invention in the fish farm it may also be arranged in the vicinity if one take into consideration the current in the area around the fish farm, and thus be able to combat free swimming lice and other ectoparasites
25 before it enters the fish farm.

According to a further embodiment, multiple devices according to the present invention are arranged in the fish farm and/or in the vicinity outside the fish farm.

If using several devices according to the present invention they may also be arranged to attract and combat different types of free swimming lice and other ectoparasites.

The device 10 for combating lice and other ectoparasites according to the present invention works by that the controllable light source 30 is used to attract free swimming lice and other ectoparasites in a fish farm, which then may be combat with the above described ultrasound units 20a-b.

5 Due to at least one of the discs 11, 12 are provided with a parabolic or inclined surface the ultrasound signals will propagate several times back and forth between the mentioned discs 11, 12, wherein the signal path will be reflected with an angle deviating from the incoming angle of the signal each time the signal hits the parabolic or inclined surface.

10 The ultrasound units 20a-b will be preferably be operated in an on/off scheme, wherein the controllable light source 30 is allow to attract lice and other ectoparasites for a given time period before the ultrasound units 20a-b are activated for a given time period for combating the lice and other ectoparasites attracted, whereupon the ultrasound units are shut off, allowing other free swimming lice and other ectoparasites to be attracted for a given time period before the ultrasound units 20a-b again are activated, and so on.

15 The control device 100 will further be arranged to an internal or external power source 120 (Figure 2) for powering of the components of the device 10. The power source 120 may be further be provided with energy harvesting means and an energy storage.

The device 10 will further be provided with a lifting hook 40 or similar, see Figure 1, enabling the device 10 to be suspended to a lifting device in connection with the fish farm enabling movement of the device 10 in the fish farm.

20 The device 10 will have a natural ballast such that it will not float in the water, but will submerged when positioned in the water, whereupon a lifting device may be used to control the submerged position to a desired position in the fish farm.

25 Accordingly, the present invention does not attack lice and other ectoparasites already present in fish in the fish farm, but is a solution that will prevent the lice or other ectoparasistes in the water from attacking the fish by attracting it and combating it before it attacks the fish. Accordingly, the present invention will prevent the existence of the water of the fish farm and thus preventing lice and other ectoparasistes from affecting the fish farmed therein.

By the present invention is achieved high effect and intensity over a limited area in the fish farm and further and increased kill rate of lice and other ectoparasistes compared to prior art solutions.

By the present invention is a provided a solution that may be arranged in a fish farm without requiring any additional means than a support wire and which may be moved around in the fish farm, as well as submerged to a desired depth.

5 **Modifications**

In an alternative embodiment, several of the devices according to the present invention may be arranged together in an assembly arranged below each other.

Claims

1. Device (10) for combating lice and other ectoparasites in the water of a fish farm, wherein the device comprises ultrasonic means for combating the lice and other ectoparasites, wherein the device (10) comprises at least one light source (30) and at least one ultrasound unit (20a-b),
5 **characterized in** that the device (10) comprises:

- an upper disc (11) and lower disc (12) spaced apart in longitudinal direction of the device (10) by vertical rods (13) extending between the discs (11, 12) for fixation of the discs (11, 12) to each other with a desired distance from each other in longitudinal direction of the device (10), wherein at least one of the discs (11, 12) exhibit a parabolic or inclined surface, at least at sections of the
10 surface, facing the other disc (11, 12), wherein the at least one light source (30) is extending in longitudinal direction between the mentioned discs (11, 12) and emitting light in circumferential direction thereof, and

- at least one first ultrasound unit (20a) comprising at least one ultrasonic transducer (21a) operable to generate a first ultrasound signal from a first operation frequency (f1) and at least one
15 second ultrasound unit (20b) comprises at least one ultrasonic transducer (21b) operable to generate a second ultrasound signal from a second operation frequency (f2) arranged to both the upper (11) and lower (12) discs emitting ultrasound signals towards the facing respective disc (11, 12), wherein the second operation frequency (f2) is different from the first operation frequency (f1), providing generation of a heterodyned signal from the first and second ultrasound signals for
20 propagation in the volume between the mentioned discs (11, 12).

2. Device according to claim 1, **characterized in** that the first (20a) and second (20b) ultrasound units are arranged in a configuration where they are displaced in relation to each other in the respective disc (11, 12) and displaced in relation to first (20a) and second (20b) ultrasound units in the opposite disc (11, 12) or the ultrasonic transducers (21a-b) are arranged with an angle in relation to the
25 vertical plane such that they emit in different planes in relation to each other.

3. Device according to claims 1-2, **characterized in** that the device (10) comprises at least one ultrasonic generator (22) operable to generate electrical energy to drive the mentioned first (21a) and second (21b) ultrasonic transducers, wherein the electrical energy comprising at least two different frequencies including the first operation frequency (f1) and a second operation frequency
30 (f2).

4. Device according to claim 3, **characterized in** that the at least one ultrasonic generator (22) is adjustable for voltage and control current.
5. Device according to claim 3, **characterized in** that the at least one ultrasonic generator (22) is capable of performing a frequency sweep of the at least one of the first (f1) and second (f2) operation frequencies to tune at least one of first (f1) and second (f2) resonant frequencies of the at least one first and second ultrasonic transducers (21a-b), respectively.
6. Device (10) according to any preceding claim, **characterized in** that the device (10) comprises a control device (100) controlling characteristics of the signals generated by the at least one ultrasonic generator (22).
- 10 7. Device (10) according to claim 6, **characterized in** that the characteristics of the signals controlled by the control device (100) include at least one of an amplitude and a timing.
8. Device (10) according to claim 1, **characterized in** that the first operation frequency (f1) is between about 20 and about 30 kHz inclusively.
9. Device according to claim 1, **characterized in** that the second operation frequency (f2) is between about 30 and about 50 kHz inclusively.
- 15 10. Device according to claim 1, **characterized in** that the first operation frequency (f1) and the second operation frequency (f2) are distinct from one another.
11. Device according to any preceding claim, **characterized in** that the first ultrasound unit (20a) comprises at least two first ultrasonic transducers (21a) and that the second ultrasound unit (20b) comprises at least two second ultrasonic transducers (21b), wherein the first ultrasonic transducers (21a) of the first ultrasound unit (20a) and the second ultrasonic transducers (21b) of the second ultrasound unit (20b) are arranged in one or both of: an inline configuration whereby one or both of the first ultrasonic transducers (21a) and the second ultrasonic transducers (21b) are linearly aligned with one another; and a triangular configuration whereby adjacent ones of the first ultrasonic transducers (21a) or the second ultrasonic transducers (21b) are disposed diagonally across from one another.
- 20 25 12. Device according to claim 1, **characterized in** that the at least one light source (30) is a controllable light source and controllable by a control device (100).

13. Method for combating free swimming lice and other ectoparasites in the water of a fish farm using a device according to any of the claims 1-12, wherein it comprises attracting free swimming lice and other ectoparasites by illuminating light by means of at least one light source (30) and ultrasonically combating the attracted lice and other ectoparasites, **characterized in** that it
- 5 comprises combating the attracted lice and other ectoparasites by generating a first ultrasound signal of at least one first ultrasonic transducer (21a) from a first operation frequency (f1) and a generating a second ultrasound signal of at least one second ultrasonic transducer (21b) from a second operation frequency (f2), such that a heterodyned signal is generated from the first and second ultrasound signals for combating the attracted lice and other ectoparasites.
- 10 14. Method according to claim 13, **characterized in** that it comprises performing a frequency sweep of the at least one of the first (f1) and second (f2) operation frequencies to tune at least one of first (f1) and second (f2) resonant frequencies of the at least one first and second ultrasonic transducers (21a-b), respectively.
- 15 15. Method according to claim 13, **characterized in** that it comprises using a first operation frequency (f1) that is between about 20 and about 30 kHz inclusively.
16. Method according to claim 13, **characterized in** that it comprises using a second operation frequency (f2) that is between about 30 and about 50 kHz inclusively.
17. Method according to claim 13, **characterized in** that it comprises using a first operation frequency (f1) and second operation frequency (f2) that are distinct from one another.

Patentkrav

1. Anordning (10) for bekjempelse av lus og andre ektoparasitter i vannet til et fiskeoppdrettsanlegg, hvori anordningen omfatter ultrasoniske midler bekjempelse av lus og andre ektoparasitter, hvori
5 anordningen (10) omfatter minst en lyskilde (30) og minst en ultralydenhet (20a-b), **karakterisert ved** at anordningen (10) omfatter:
 - en øvre skive (11) og en nedre skive (12) adskilt i lengderetning av anordningen (10) ved vertikale stag (13) hvilke strekker seg mellom skivene (11, 12) for festing av skivene (11, 12) til hverandre med en ønsket avstand fra hverandre i lengderetning av anordningen (10), hvori minst en av skivene (11,
10 12) oppviser en parabolisk eller skrå overflate, i det minste ved seksjoner av overflaten, hvilken vender mot den andre skiven (11, 12), hvori den minst ene lyskilden (30) strekker seg i lengderetning mellom de nevnte skivene (11, 12) og emitterer lys i omkretsretning derav, og
 - minst en første ultralydenhet (20a) hvilken omfatter minst en ultralydtransduser (21a) drivbar for å generere minst et første ultralydsignal fra en første driftsfrekvens (f1) og minst en andre
15 ultralydenhet (20b) hvilken omfatter minst en andre ultralydtransduser (21b) drivbar for å generere et andre ultralydsignal fra en andre driftsfrekvens (f2) innrettet til både den øvre (11) og nedre (12) skiven hvilke emitterer ultralydsignaler mot respektive motstående skiver (11, 12), hvori den andre driftsfrekvensen (f2) er forskjellig fra den første driftsfrekvensen (f1), hvilket tilveiebringer generering av et heterodynt signal fra de første og andre ultralydsignalene for propagering inn i
20 volumet mellom de nevnte skivene (11, 12).
2. Anordning i samsvar med krav 1, **karakterisert ved** at de første (20a) og andre (20b) ultralydenhetene er innrettet i en konfigurasjon hvor de er forskjøvet i forhold til hverandre i den respektive skiven (11, 12) og forskjøvet i forhold til første (20a) og andre (20b) ultralydenheter i den motsatte skiven (11, 12) eller ultralydtransduserne (21a-b) er innrettet med en vinkel i forhold til
25 vertikalplanet slik at de emitterer i ulike plan i forhold til hverandre.
3. Anordning i samsvar med krav 1-2, **karakterisert ved** at anordningen (10) omfatter minst en ultrasonisk generator (22) drivbar for å generere elektrisk energi for drift av de nevnte første (21a) og andre (21b) ultralydtransduserne, hvori den elektriske energien omfatter minst to ulike frekvenser inkludert den første driftsfrekvensen (f1) og andre driftsfrekvensen (f2).
- 30 4. Anordning i samsvar med krav 3, **karakterisert ved** at den minst ene ultrasoniske generatoren (22) er justerbar for spenning og styring av strøm.

5. Anordning i samsvar med krav 3, **karakterisert ved** at den minst ene ultrasoniske generatoren (22) er i stand til å utføre frekvenssveiping av minst den ene av den første (f1) og andre (f2) driftsfrekvensen for å tune minst en av den første og henholdsvis andre ultralydtransduseren (21a-b).
- 5 6. Anordning i samsvar med et av de foregående krav, **karakterisert ved** at anordningen (10) omfatter en styringsenhet (100) hvilken styrer karakteristikken til signalene generert av den minst ene ultralydgeneratoren (22).
7. Anordning i samsvar med krav 6, **karakterisert ved** at karakteristikken til signalene styrt ved styringsenheten (100) omfatter minst en amplitude og en tidsinnstilling.
- 10 8. Anordning i samsvar med krav 1, **karakterisert ved** at den første driftsfrekvensen (f1) er mellom omtrent 20 og til og med omtrent 30 kHz .
9. Anordning i samsvar med krav 1, **karakterisert ved** at den andre driftsfrekvensen (f2) er mellom omtrent 30 og til og med omtrent 50 kHz.
10. Anordning i samsvar med krav 1, **karakterisert ved** at den første driftsfrekvensen (f1) og den
15 andre driftsfrekvensen (f2) er distinkte fra hverandre.
11. Anordning i samsvar med et av de foregående krav, **karakterisert ved** at den første ultralydenheten (20a) omfatter minst to første ultralydtransdusere (21a) og at den andre ultralydenheten (20b) omfatter minst to andre ultralydtransdusere (21b), hvori de første ultralydtransduserne (21a) til den første ultralydenheten (20a) og de andre ultralydtransduserne
20 (21b) til den andre ultralydenheten (20b) er innrettet i en eller begge av: en skråstilt konfigurasjon hvorved en eller begge av de første ultralydtransduserne (21a) og de andre ultralydtransduserne (21b) er lineært innrettet med hverandre; og en triangulær konfigurasjon hvorved nærliggende av de første ultralydtransduserne (21a) eller andre ultralydtransduserne (21b) er fordelt diagonalt overfor hverandre.
- 25 12. Anordning i samsvar med krav 1, **karakterisert ved** at den minst ene lyskilden (30) er en styrbar lyskilde og styrbar ved en styringsenhet.
13. Fremgangsmåte for bekjempelse av fritt svømmende lus og andre ektoparasitter i vannet til et fiskeoppdrettsanlegg ved bruk av en anordning i samsvar med ett av kravene 1-12, hvori den omfatter å tiltrekke seg fritt svømmende lus og andre ektoparasitter ved hjelp av minst en lyskilde

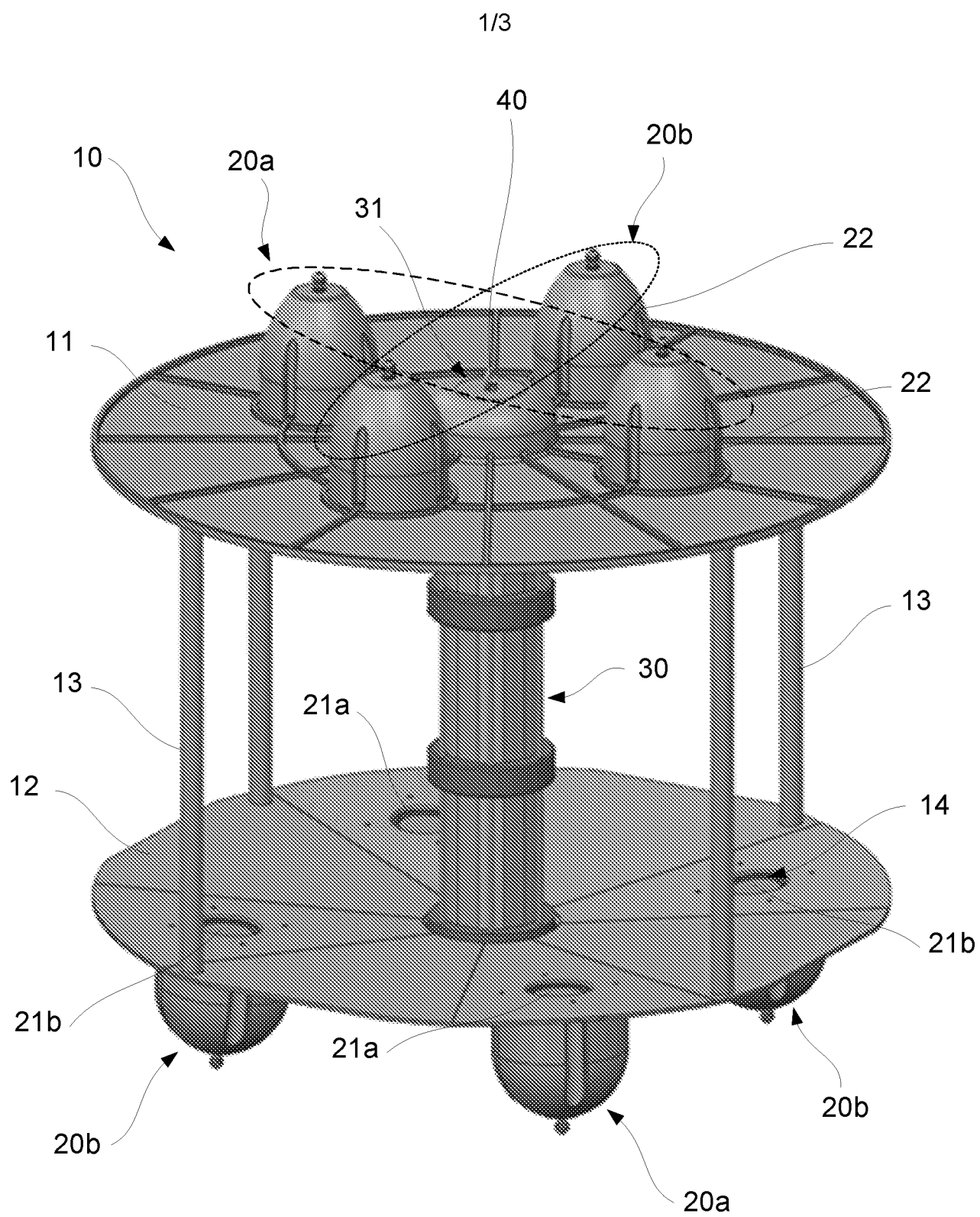
(30) og ultrasonisk bekjempelse av den tiltrukke lusen og andre ektoparasitter, **karakterisert ved** at den omfatter bekjempelse av den tiltrukke lusen og andre ektoparasitter ved generering av at første ultralydsignal til minst en første ultralydtransduser (21a) fra en første driftsfrekvens (f_1) og generering av et andre ultralydsignal til minst en andre ultralydtransduser (21b) fra en andre driftsfrekvens (f_2), slik at et heterodynt signal er generert fra de første og andre ultralydsignalene for bekjempelse av den tiltrukke lusen og andre ektoparasitter.

14. Fremgangsmåte i samsvar med krav 13, **karakterisert ved** at den omfatter utføring av et frekvenssveip av den minst ene av de første (f_1) og andre (f_2) driftsfrekvensene for å tune minst en av første (f_1) og andre (f_2) resonansfrekvenser til den minst ene første og henholdsvis andre ultralydtransduseren (21a-b).

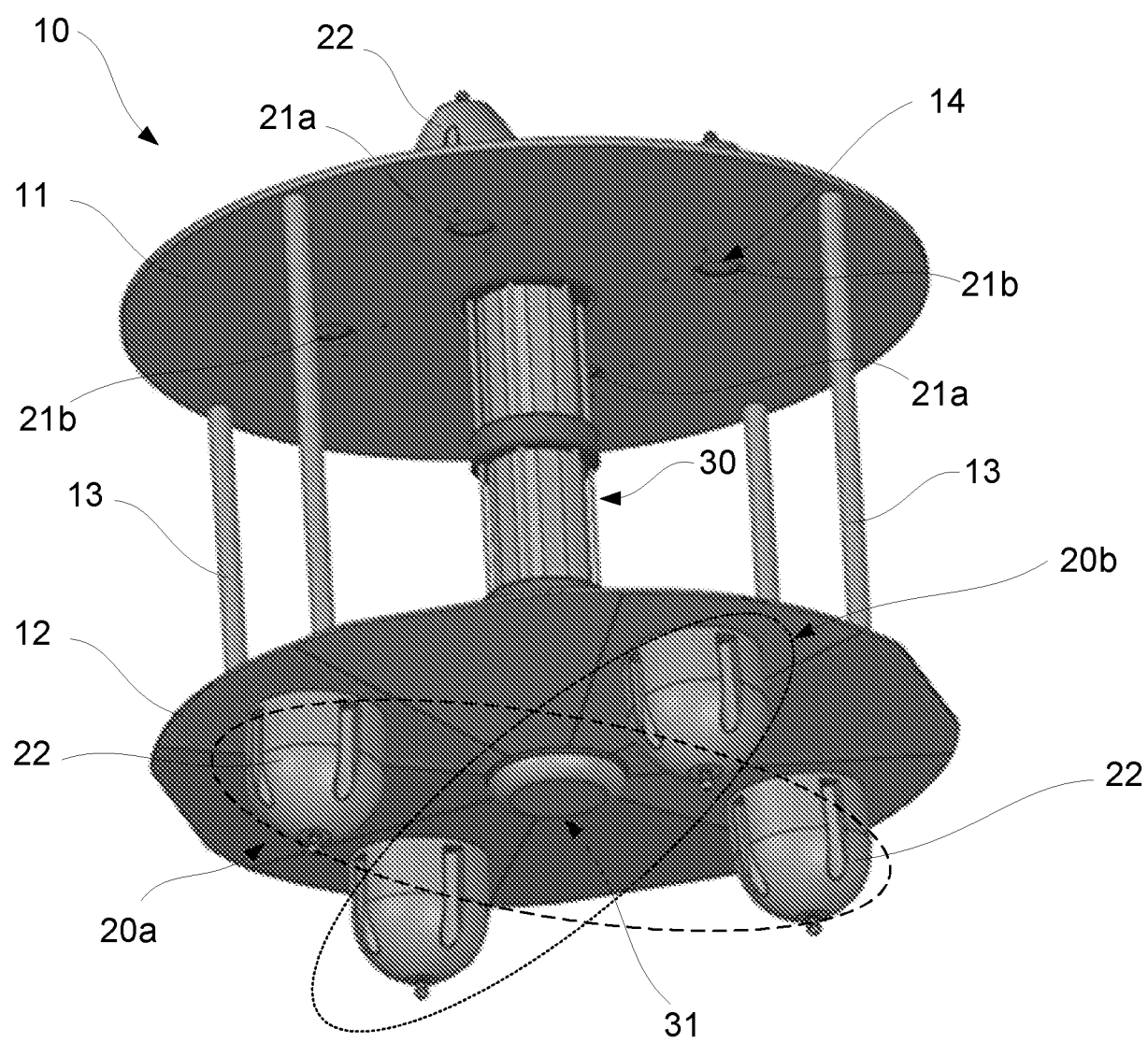
15. Fremgangsmåte i samsvar med krav 13, **karakterisert ved** at den omfatter bruk av en første driftsfrekvens (f_1) som er mellom omtrent 20 og til og med omtrent 30 kHz.

16. Fremgangsmåte i samsvar med krav 13, **karakterisert ved** at den omfatter bruk av en andre driftsfrekvens (f_2) som er mellom omtrent 30 og til og med omtrent 50 kHz.

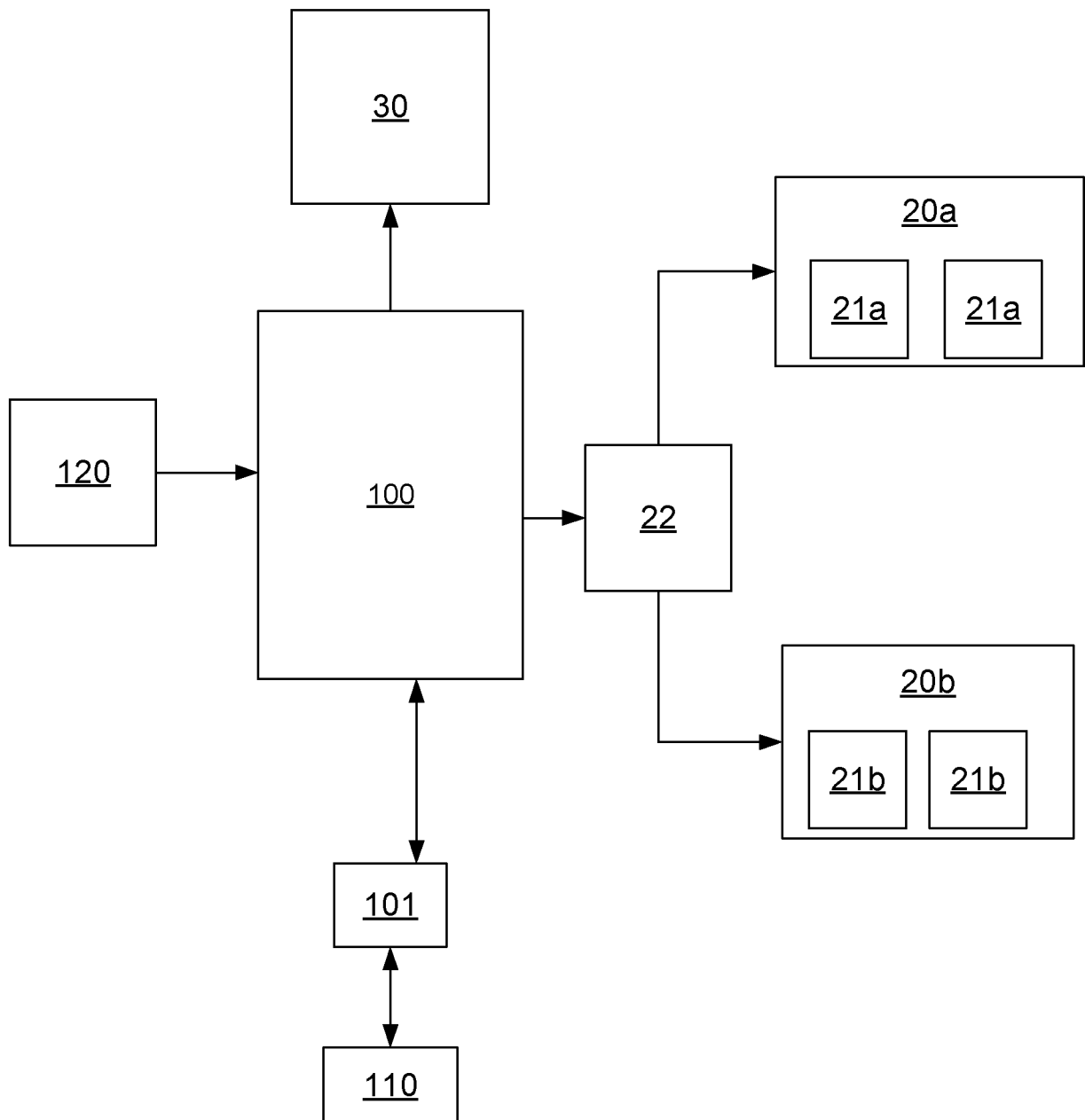
17. Fremgangsmåte i samsvar med krav 13, **karakterisert ved** at den omfatter bruk av en første driftsfrekvens (f_1) og andre driftsfrekvens (f_2) som er distinkte fra hverandre.

**Fig. 1a.**

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**Fig. 1b.**

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**Fig. 2.**