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(71) Applicant(s)
Ferranti-Thomson Sonar Systems U K Limited

(Incorporated in the United Kingdom)

Dolphin House, Ashurst Drive, Bird Hall Lane, Cheadle Heath, STOCKPORT, Cheshire, SK3 0XB, United Kingdom

(72) Inventor(s)
James Harvey Smith

(74) Agent and/or Address for Service
D N Bradley
4 Gorsey Brow, Romiley, STOCKPORT, Cheshire, SK6 3BQ, United Kingdom

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GB 1351519 A EP 0604742 A1 WO 95/00016 A1
WO 94/17657 A1 US 5076208 A US 4922468 A
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(54) Reducing parasite infestation in aquatic creatures

(57) A method for reducing parasite infestation or damage to aquatic creatures includes means for generating transitional cavitational events in the medium surrounding the creatures so as to produce biological changes which affect their development cycle and life expectancy. In the case of the treatment of fish, suitable apparatus may, according to one embodiment, comprise an array (11) of transducers (12) located around a circle so as to define a treatment zone and driven by a drive circuit (13) to produce high energy intensities in the water. A trigger device may be used to detect the presence of the fish and may also be used to count the fish. Other, more static, aquatic creatures may be treated by moving the apparatus relative to the creatures so that the creatures pass through the treatment zone of the apparatus.

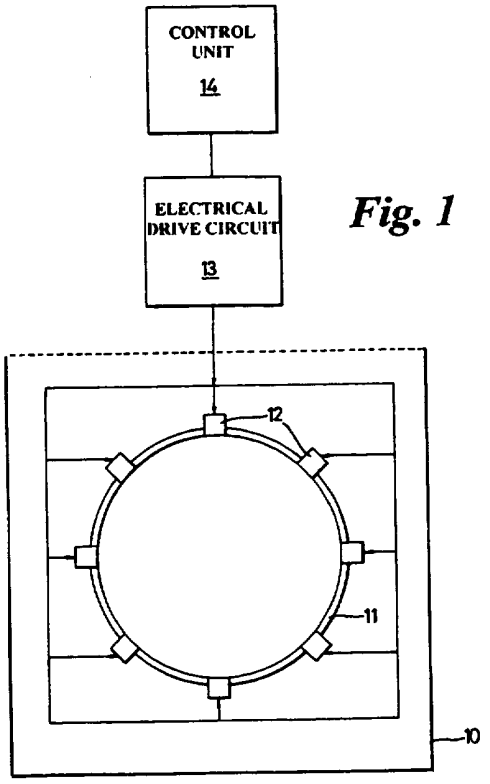

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

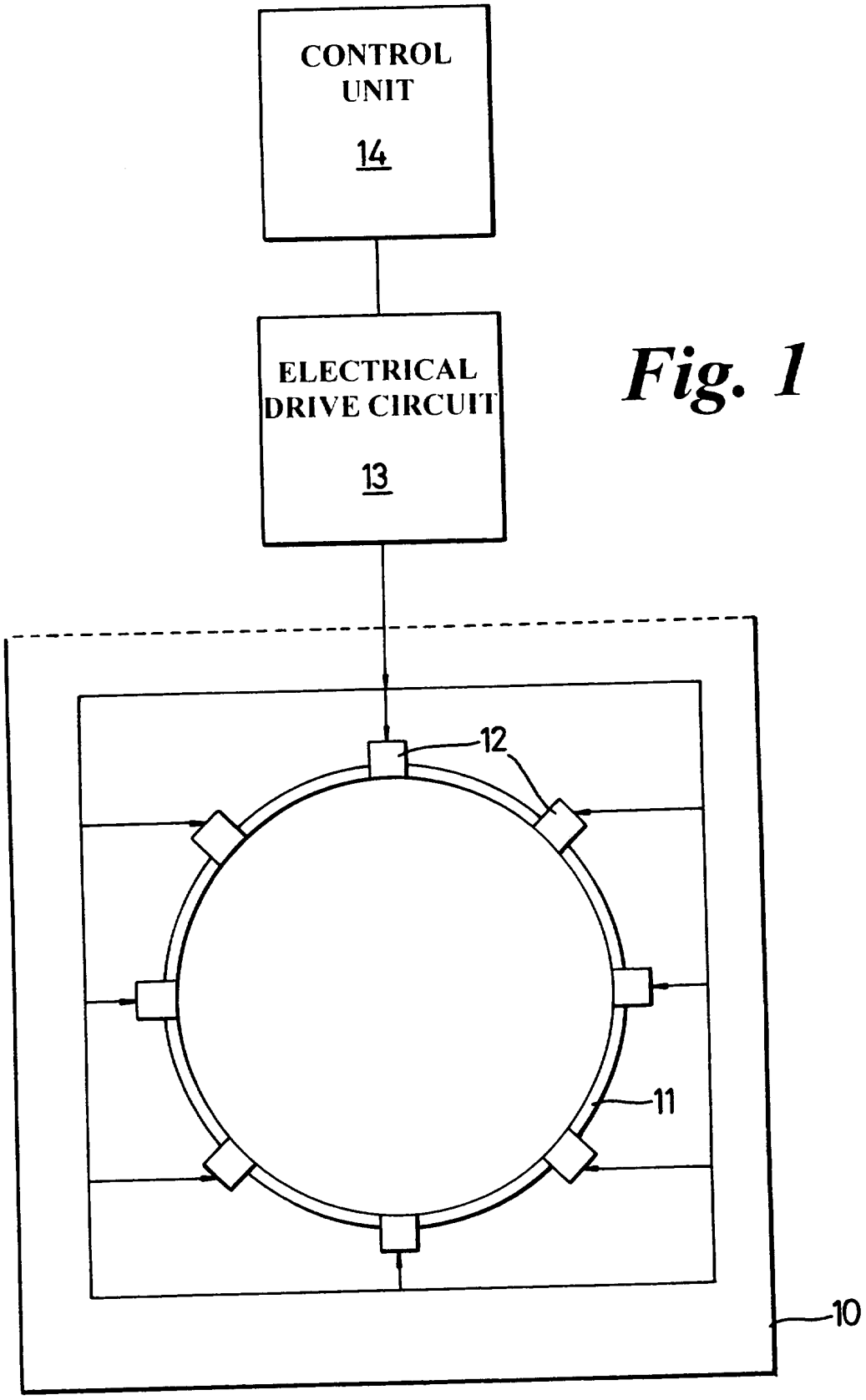

Fig. 1

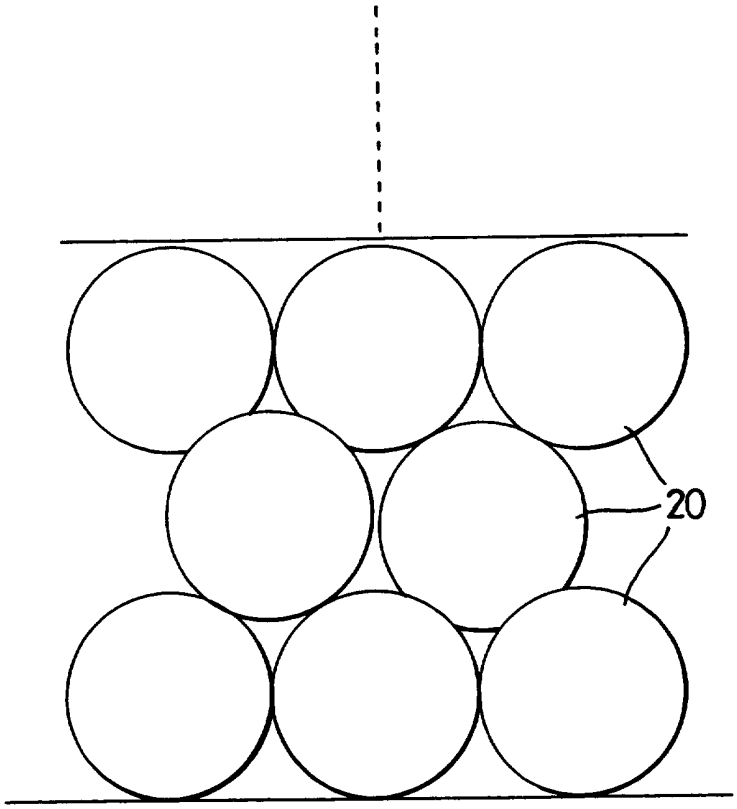

Fig. 2

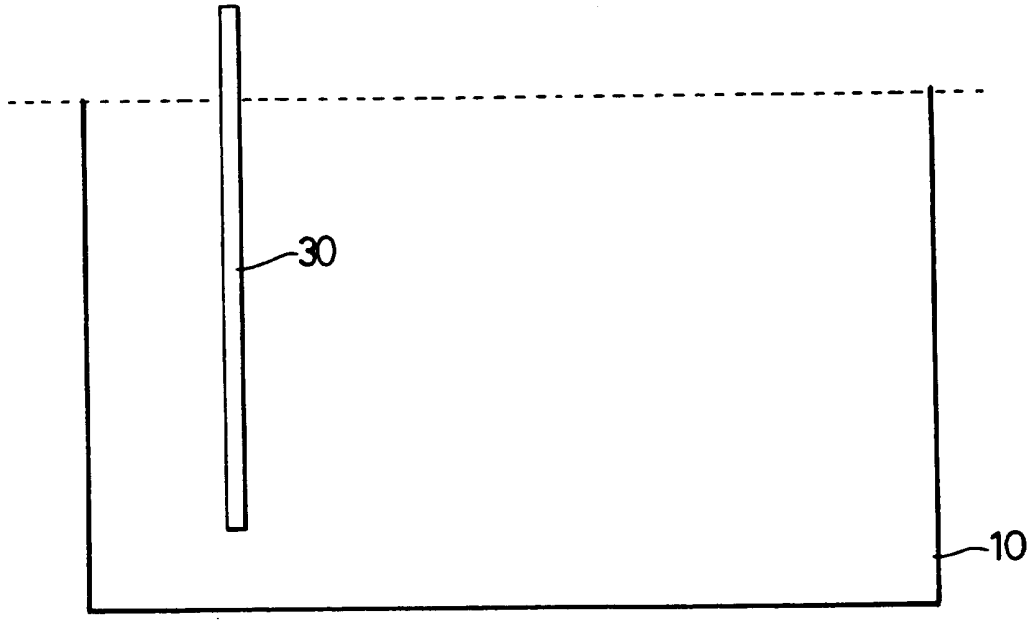

Fig. 3

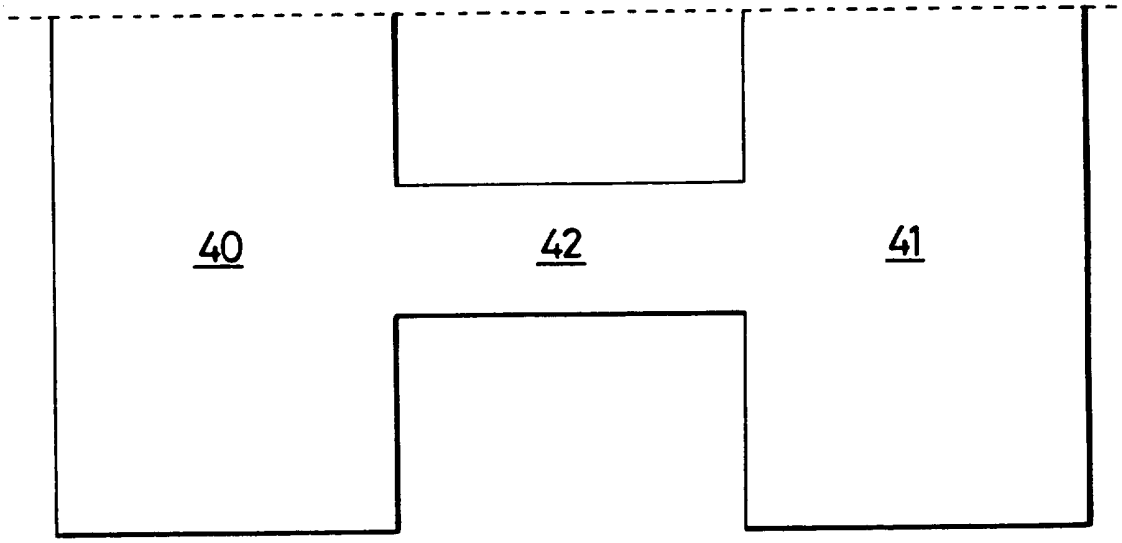

Fig. 4

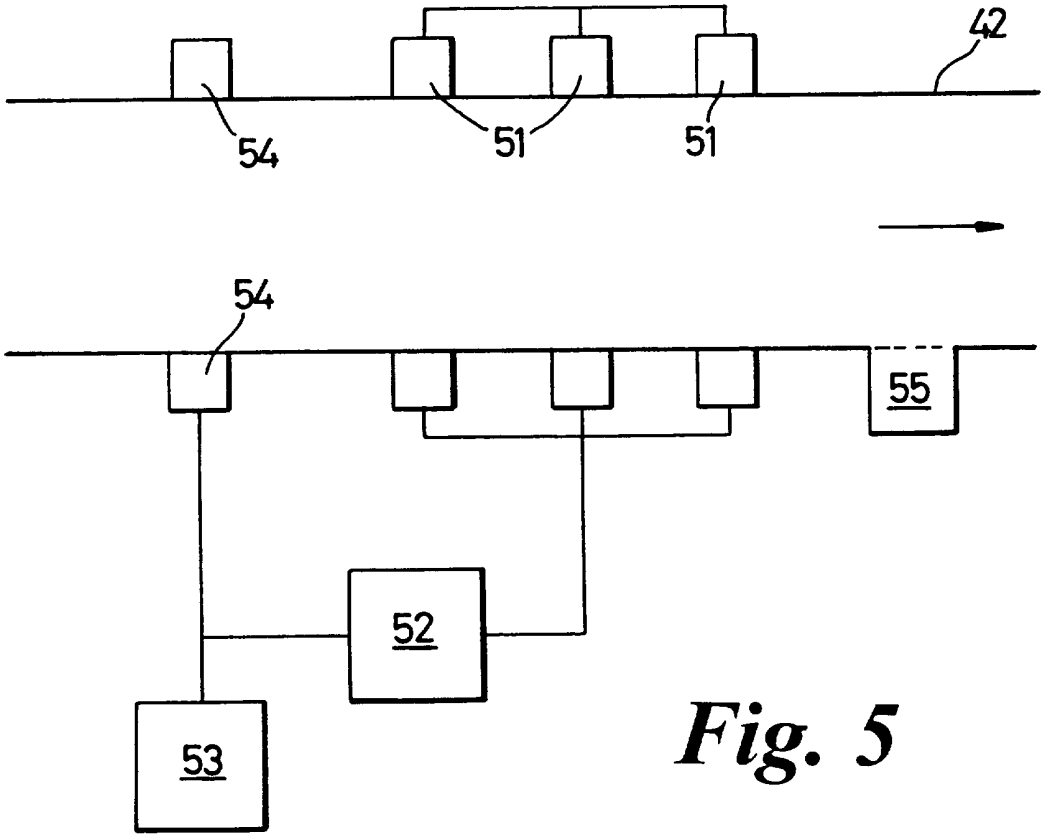

Fig. 5

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METHOD AND APPARATUS FOR REDUCING PARASITE INFESTATION OR DAMAGE TO AQUATIC CREATURES

During the year 1991, aquaculture as an industry produced at least 14 million tonnes of produce. A percentage of this production was fin fish, cultured in floating cage structures at sea. The stocks held in these cage structures usually have a long growing cycle, typically 12 to 24 months, during which they are at risk of attack from marine pests, particularly ecto-parasites. Investigation has revealed that, at least in the case of salmon, two common parasites are Lepeophtheirus Salmonis and Caligus Elongatus. These parasites cause damage to the fish ranging from damage to the tissue and fins, which affect the appearance and hence market value of the fish, to causing the death of the infested fish.

Current practice generally involves the use of chemicals to control these parasites. Such chemical treatments are indiscriminate as they may affect marine life inside or adjacent to the cage structures. Environmental and financial considerations make it desirable to find some other method of treatment.

It is an object of the invention to provide a method and apparatus for reducing parasite infestation or damage to aquatic creatures which does not have an adverse environmental impact.

According to the present invention there is provided a method of reducing parasitic infestation or damage to aquatic creatures which includes subjecting the parasites to transient cavitational events so as to produce adverse biological changes affecting their development and life expectancy.

Also according to the invention there is provided apparatus for reducing parasite infestation and damage to aquatic creatures, which apparatus includes means for producing transient cavitational events in the fluid surrounding the creatures.

The expressions "parasite" is used to include not only the parasite itself but also the eggs or larvae of such parasites.

The expression "biological changes" is used to include actual physical damage caused to the parasites by the transient cavitational

events, as well as effects which affect the normal life cycle of the parasite.

The expression "transient cavitational event" is used to describe the collapse of microscopic bubbles or cavities originating from micronuclei present either within the biological tissue or naturally present or "seeded" in the surrounding fluid medium. This results in the creation of temperature changes, shock waves or fluid shear forces and other mechanical effects which can either internally or externally cause biological changes.

The invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic diagram of one form of apparatus suitable for applying the invention in a fish farm environment;

Figure 2 is an alternative embodiment of the apparatus of Figure 1;

Figure 3 shows a general view of apparatus according to a second embodiment of the invention;

Figure 4 is a general view of apparatus according to a third embodiment of the invention; and

Figure 5 shows part of the apparatus of Figure 4 in greater detail.

Referring now to Figure 1, this shows one form of apparatus suitable for applying the invention in a fish farm situation. An enclosure 10 contains an array 11 of individual transducers 12 arranged in a configuration such as a circle so as to define a treatment zone represented by the volume of fluid within the array. The transducers 12 are connected to an electrical drive circuit 13 controlled by a control unit 14. The arrangement of the transducers is such as to maximise the energy intensity within the treatment zone and thereby optimise the generation of transient cavitational events in the volume of fluid forming the treatment zone. Treatment of the fish is based on the passage of fish through the treatment zone, preferably through the aperture defined by the array of transducers. Other array configurations may be used and the array of transducers may be movable so as to be easily removed from the enclosure or placed in different positions within the enclosure.

As an alternative to the single array of transducers shown in Figure 1, the transducers may be arranged in a multiple array with a

plurality of circles (or other configurations) 20 such as that shown in Figure 2. Such an arrangement may be arranged to occupy the full width of the enclosure containing the fish so that they are more likely to pass through the treatment zone whilst swimming normally around the enclosure.

Figure 3 illustrates a second embodiment of the invention which therefore simply provides one or more posts 30 within the enclosure 10 containing the fish, close to which an infested fish may position itself to promote treatment. The post, which may be solid or may be a hollow tube through which the fish may pass, is provided with one or more transducers to generate the transient cavitational events in the fluid immediately surrounding the post. In such an embodiment the use of some form of fish detector will enable the transducer to operate only when a fish is in the vicinity of the post, thus saving energy.

It will be apparent that the post of the second embodiment just described may be movable, so that the treatment region may be moved at will.

A further embodiment of the invention is illustrated in Figures 4 and 5. Figure 4 shows two cage structures 40 and 41 and a conduit or tube 42 connecting the two cages. The fish stock to be treated is initially contained in one of the cages, say cage 40, and is transferred to the other cage 41 through the conduit 42, part of which forms the treatment zone in which treatment takes place. The conduit may be a tube or pipe totally submerged in the fluid medium or may be an open channel communicating with the fluid surface. The conduit will be of such a size as to allow the passage of all sizes of fish expected to be treated but narrow enough to prevent many fish passing through at one time. This will also result in uniformity of treatment of the fish, which is desirable.

Figure 5 shows the treatment area of one form of the apparatus of Figure 4 in greater detail. The conduit 42, which may be of any suitable size or cross-section appropriate to the creatures being treated, may conveniently be part of a water circulation system so that the fish are induced to move through it, though other means of achieving fish movement, such as a conventional fish pump, may be used. Spaced along and around that part of the conduit 42 forming the treatment zone are a number of transducers 51, each connected to a suitable drive circuit

52, controlled and monitored by a control unit 53. The arrangement of transducers is such as to optimise the generation of transient cavitational events in the volume of fluid through which each fish passes during treatment. In order to save energy it may be preferred to use a triggered system in which transient cavitational events are generated only when a fish is present in the treatment zone. This requires the addition of a detector or trigger 54, located before the transducers 51 in the normal direction of movement of the fish. This is connected to the transducer drive circuit 52 in order to trigger the drive circuit into operation at the appropriate time and for a predetermined period of time. If the conduit 42 is made of solid material it may be useful to provide a filter or trap 55 to remove any parasites which may become dislodged from the fish as a result of the treatment.

One subsidiary advantage of the triggered form of the apparatus just described is that the trigger pulses may also be applied to a counter forming part of the control unit 53 to count the fish passing through the treatment zone.

By way of example, energy may be generated by transducers operating at a frequency typically in the range from 1kHz to 100kHz, a frequency of 20kHz to 40kHz being appropriate. A single frequency or a randomly generated series of frequencies within a fixed bandwidth may be adopted to drive the transducers which produce transient cavitational events. A randomly generated series of frequencies around the resonant frequency of the transducers will ensure the ,movement of the associated standing wave field. The duration of the treatment will largely depend upon the period for which the fish remain within the treatment zone. An energy intensity level typically greater than about 0.01 watts per square centimetre is required to generate transient cavitational events in an aqueous fluid medium. However, the actual electrical input power levels required to achieve the required energy intensity within the treatment zone will be dependent upon the embodiment adopted as well as factors such as the number and mass of the creatures to be treated and the volume of fluid comprising the treatment zone. The energy level is chosen so that the cavitational activity affects the parasites whilst not harming the fish. By way of example only, the structure illustrated

in Figure 1 may comprise a 2 metre diameter circular array of 40 equally-spaced transducers each rated at 100 watts.

The treatment described above may act in a variety of ways. Transient cavitational events may preferentially impact, internally or externally, upon the parasites to such an extent that they suffer actual physical damage affecting their viability and development and may become detached from the fish either due to the actual physical damage or as a result of a behavioural response. In addition, it has been observed that transient cavitational events affect the biological development of the parasites, damaging eggs which have not fully developed or hatched, thereby rendering them non-viable and affecting the development cycle of the living parasites. This may result in a general reduction in the current or future parasite population.

It will be necessary to repeat the treatment at intervals to prevent re-infestation of the treated fish, particularly if the fish are in an open-sea environment where there is the possibility of new parasites entering the enclosures.

The techniques described above may be applied equally well to fish farmed in a fresh water environment, such as trout, or to fish in captivity for any reason, farmed or not.

The invention may be applied to other forms of aquatic creature, such as shellfish or crustaceans.

Claims

1. A method of reducing parasite infestation or damage to aquatic creatures which includes subjecting the parasites to transient cavitational events so as to produce adverse biological changes affecting their development and life expectancy.

2. A method as claimed in Claim 1 in which the transient cavitational events are generated in the fluid medium surrounding the creatures.

3. A method as claimed in either of Claims 1 or 2 which causes at least some of the parasites to become detached from the aquatic creatures.

4. A method as claimed in any one of Claims 1 to 3 in which the transient cavitational events are generated by the application of high energy intensities to a treatment zone of the fluid medium containing the creatures.

5. A method as claimed in Claim 4 in which the aquatic creatures are subjected to high energy intensities at frequencies in the range 1kHz to 100kHz.

6. A method as claimed in any one of the preceding claims in which the aquatic creatures are fish.

7. A method of reducing parasite infestation or damage to aquatic creatures substantially as herein described with reference to the accompanying drawings.

8. Apparatus for reducing parasite infestation or damage to aquatic creatures, which apparatus includes means for generating transient cavitational events in the parasites and means for moving the apparatus relative to the aquatic creatures so as to produce biological changes which affect the development cycle and life expectancy of the parasites.

9. Apparatus as claimed in Claim 8 in which the transient cavitational events are generated in the fluid medium surrounding the creatures.

10. Apparatus as claimed in either of Claims 8 or 9 in which the means for generating transient cavitational events includes transducer means and drive means for supplying electrical energy to the transducers.

11. Apparatus as claimed in Claim 10 in which the transducers operate at a frequency in the range 1kHz to 100kHz.

12. Apparatus as claimed in any one of Claims 8 to 11 in which the aquatic creatures are fish, the apparatus including a plurality of

transducers arranged so as to define a treatment zone through which the fish may pass.

13. Apparatus as claimed in any one of Claims 8 to 11 in which the aquatic creatures are fish, the apparatus including a conduit linking two enclosed volumes in which the fish pass from one enclosed volume to the other through the conduit, the conduit carrying the said transducers arranged such that the energy generated in the fluid medium is directed towards the fish passing through the conduit.

14. Apparatus as claimed in any one of Claims 8 to 11 in which the aquatic creatures to be treated are fish, the apparatus comprising a member for immersion in the fluid medium containing the fish and carrying the means for generating the transitional cavitational events.

15. Apparatus as claimed in any one of Claims 12 to 14 which includes a trigger device responsive to the presence of a fish to cause the transducers to generate transient cavitational events for a predetermined period of time.

16. Apparatus as claimed in Claim 15 which includes a counter responsive to the operation of the trigger device to count the fish being treated.

17. Apparatus as claimed in any one of Claims 8 to 16 which includes carrier means in which the means for generating transient cavitational events are carried and means for moving the carrier means relative to the aquatic creatures to be treated.

18. Apparatus for reducing parasite infestation or damage to aquatic creatures substantially as herein described with reference to the accompanying drawings.

The Patent Office

Application No:	GB 9701640.6	**Examiner:**	R F PHAROAH
Claims searched:	1-18	**Date of search:**	22 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A1A: A9; A5G: GD

Int Cl (Ed.6): A01K:61/00,63/04; A61L 2/02

Other: Online: w.p.i.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1351519 A	(MARINE PROTEIN) see page6 lines 44-63	8
X	EP 0604742 A1	(MALMAROS) see page 2 lines 1-6	1,8
X	WO 95/00016 A1	(AIRMAR) see page 9 lines 3-21	1,8
X	WO 94/17657 A1	(JACKMAN) see page 4 lines 1-5	1,8 at least
X	US 5076208 A	(ZOHAR) see column 2 line 49 onwards	1,8
X	US 4922468 A	(MENEZES) see column 6 lines 17-32	1,8
X	US RE. 31779	(ALLIGER)see column 5 lines 54-57	1,8

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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