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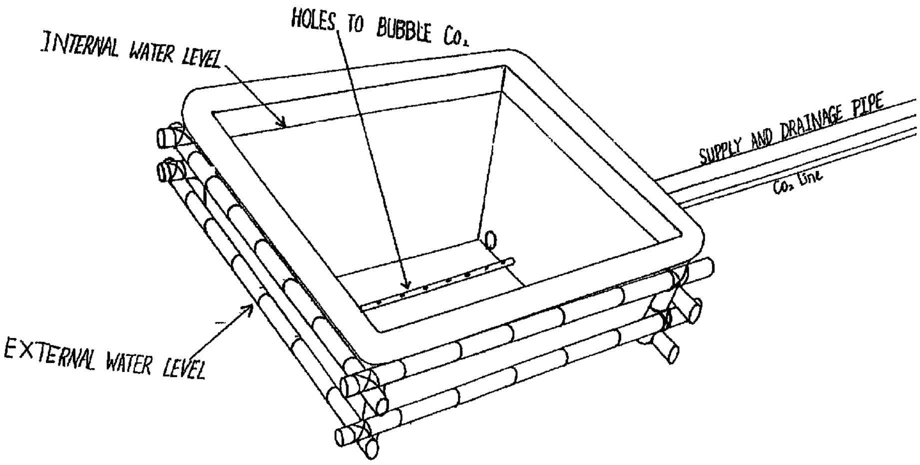
Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(U))*
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report*

(54) **Title:** GROWING ALGAE IN A BODY OF WATER CONTAINED IN AN OPEN OR CLOSED CONTAINER THAT FLOATS ON ANOTHER LARGER BODY OF WATER



(57) **Abstract:** A method and apparatus for cultivating aquatic algae by containing and promoting the growth of aquatic algae within a structure floating on waters such as the sea or a lake.

WO 2008/105649 A1

Growing Algae In A Body Of Water Contained In An Open Or Closed Container That Floats On Another Larger Body Of Water

Field of Invention

This invention relates to a method and apparatus for cultivating aquatic algae by containing and promoting the growth of aquatic algae within a structure floating on waters such as the sea or a lake in a manner that reduces the cost of operation and the use of land.

Background of Invention

The use of algae is well known in numerous industries. For instance, they can be consumed and utilized as gelling, suspending, stabilizing and emulsifying agents in food, cosmetic and paint industries. In agriculture, algae can be added to poultry feed or applied as fertilizers for crops. Some algae have specific medicinal and health properties. For example they are a good source of omega 3. Algae can also produce oil that can be used to make biodiesel and bio mass that can be burnt to produce electricity.

Algae that grow naturally in the oceans and lakes support the aquatic food chain of life as they are the primary producers of food and oxygen for aquatic creatures and thus are the basis of life in water and the fisheries industries. Current efforts of growing algae commercially are all concentrated in growing them in ponds on land or in enclosed containers also on land.

The object of this invention is to grow algae in self contained structures floating on the sea or on any body of water where the water required for the growth is contained within the floating structure by a sheet of plastic, rubber or any other suitable material impervious to water. The water required for growth can be open at the top or totally enclosed with only a controlled outlet for venting excess (carbon dioxide) CO_2 rich air pumped into the structure.

Further object of the invention is to reduce the cost of growing algae by taking advantage of the energy in tides and waves. Another object of the invention is to use the lower variation of temperature of the sea to maximize the growth of algae. Yet another object of this invention is to integrate a series of processes in such a manner as to maximize efficiency and reduce cost.

Summary of The Invention

One aspect of the present invention is to use the tides in such a manner that saves on pumping costs. For example, when it is high tide the water growing the algae can be allowed to flow down slope to land that is at the low tide level and similarly at low tide new algae from the nursery can flow down slope from the high tide level on land to the floating structures in the sea. This eliminates a major cost of farming algae on land.

A second aspect of the present invention is to provide a structure that allows for and utilizes the waves in the sea to continuously churn the water in the floating structures and the algae growing in it as continuous churn exposes all the algae in turn to the sun which promotes the growth of algae naturally. This eliminates another major cost of growing algae on land while improving the mixing process.

A third aspect of the present invention is to provide a floating structure within which is an area for the growth of algae which is separated from the surrounding area. This can be open at the top or totally enclosed except for a valve to allow for excess air or CO_2 to escape.

A fourth aspect of the present invention is to use the ash from burning the algae and minerals concentrated from sea water by waste heat to supply nutrients to the plants.

A fifth aspect of the present invention is to use the sea to maintain a low variation of temperature in the growth medium by using the milder temperature variation of the sea and a large area for heat exchange surface of the containers in the floating structures.

Further, the seas will provide readily available areas, especially where land is scarce and/or expensive, for growing algae to produce superior quantities of biodiesel as compared to terrestrial crops grown for the same purpose. Another advantage of the present invention is that the cultivation of algae in the seas is that it does not compete with the use of the land needed to produce food crops.

Brief Description of The Drawings

The objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when taken together with the accompanying drawings in which:

Figure 1 shows one embodiment of a floating structure in a body of water. hi this example the frame work for the floating structure is constructed from bamboo or any other suitable material with the material forming the container being plastic, rubber lined fabric or any other suitable material. The supply lines from the shore for both CO_2 and water containing the algae are also shown. The number of supply lines can be decided as required. For example, if it is necessary to have a supply line to deliver the algae from the nursery separate from the harvesting line, this can be done.

Figure 2 shows base station protected by a dyke on the shore with the nursery at or above the high tide mark. From here the water containing the desirable species of algae are allowed to flow down slope at low tide to the offshore structures where the algae will grow. A CO_2 line is also shown and this supplies CO_2 to the algae growing in the offshore structures. When the level of algae growth is sufficient to harvest, they are allowed to flow down slope at high tide to settling ponds located at or below the low tide mark as shown. .

Figure 3 shows one method of increasing buoyancy by increasing the number of bamboo poles facing the incoming waves.

Detailed Description of The Preferred Embodiments

A base station will be built on the sea shore behind a dyke so that the base station slopes from a level higher than the high tide mark to a level that is similar to or lower than the low tide mark. These levels in fact follow the natural sea shore line so no earth works are required to do the slope.

The algae nursery will be on land at a level at or higher than the high tide level and the water containing the algae will be allowed to flow down slope to the floating structures at low tide. Each separate floating structure will in turn be filled from the nursery.

The growth farms will be on floating structures consisting of a frame of any material like bamboo, wood or hollow plastic that can float and hold a film of plastic, rubber, rubberized cloth or other such material in such a way that it forms a pool impervious to water separated from the surrounding water. This pool can be covered or open.

One example of such a structure is where the frame is a square of 20 meters each side or any other size with the film attached to the inside or the outside of the frame in such a way that it forms a container into which water could be poured. These will be held to the ocean floor and in most cases to each other by any one of several currently known methods to prevent them floating away.

As these structures will constantly be colliding into each other due to the wave motion, they will have to be made robust enough and have their sides made to absorb shocks by for instance hanging old tyres on all sides.

When it is time to harvest, the water and algae will be allowed to flow at high tide to settling ponds behind the dyke which will be at a level similar to or lower than the low tide level.

The harvested algae will have their oil extracted and the residue can be used in one of several ways including, for medical and health purposes, as a food source for humans, fish and other animals, for fermentation to produce ethanol as a fuel, for anaerobic digestion to produce methane or for straight use as a fuel in electricity production. The oil, which is similar to fish oil has many uses and can also be used to make biodiesel.

In one embodiment, the residue may be used for fermentation to produce ethanol which can be used in the biodiesel production process plus for sale as a petroleum substitute and the residue from that may be burnt to produce electricity and then the ash that remains can be used as fertilizer for the algae and the excess heat can be used to evaporate salt water to obtain more nutrients for the algae. The CO_2 produced in the fermentation process is very pure and of excellent quality may be fed to the growing algae.

The electricity produced can be used for all the operations on land like harvesting, oil extraction and biodiesel production. The excess electricity can be sold to the grid.

The size, shape and structure of the floating structures can be designed so that the level of stirring can be optimized. For example, if more stirring is required the buoyancy of the side facing the incoming waves can be increased by adding more bamboo members or other flotation device to that side so that the side lifts more with each wave. Another way to change the stirring is to adjust the length of the floating structure along the path the wave travels. For example, the stirring level changes according to whether the length of the structure is equal to some whole number of wave length of the sea waves or is some number plus half a wave length.

Both fresh water and sea water algae can be grown in the floating structures on the sea. In fact fresh water algae would grow well in the sea as there will be no contamination from other species of fresh water algae or even sea water algae in the fresh water. Contamination of desirable species grown is a major problem with land based algae farms.

Closed systems on land are sometimes used so that the desirable species growing in these containers are protected from contamination and replacement by more aggressive and undesirable local species. One of the major problems of such closed systems is that they are similar to glass houses and trap the heat of the sun. This raises the temperature of the growth medium inside affecting the growth of the algae. By having a large heat exchange area with excellent contact with the surrounding sea water, the temperature of the growth medium and thus the algae inside is kept much more conducive to the growth of the algae.

Claims

1. A method for cultivating aquatic algae using an apparatus to contain the aquatic algae which floats on a body of water.

2. The method according to Claim 1 wherein the apparatus consists of a frame made of buoyant materials to hold a film that is impervious to water.

3. The method according to Claim 2 wherein the aquatic algae is able to flow into the apparatus during low tide and into a base station during high tide using the difference in levels.

4. The method according to Claim 2 wherein the apparatus is fed with a supply of air that is rich in carbon dioxide.

5. The method according to Claims 1 and 2 wherein the apparatus has the means to control the exposure of the aquatic algae to sunlight.

6. The method according to Claim 5 wherein the contents of the apparatus may be agitated by the movements of the currents or waves of the body of water.

7. The method according to Claim 6 wherein the apparatus is closed or has one or more openings.

8. The method according to Claim 3 wherein the base station may be in the form of settling ponds and/or nursery ponds.

9. The method according to claims 1, 2 and 7 wherein the algae species grown are protected from contamination and invasion by unwanted algae species.

10. The method according to claims 1, 2 and 7 wherein the temperature variation of the growing algae is minimized.

11. The method according to claims 1, 2 and 7 wherein the amount of stirring of the growing algae may be varied.

12. An apparatus for cultivating aquatic algae according to the methods claimed in Claims 1, 2, 7, 9, 10 and 11.

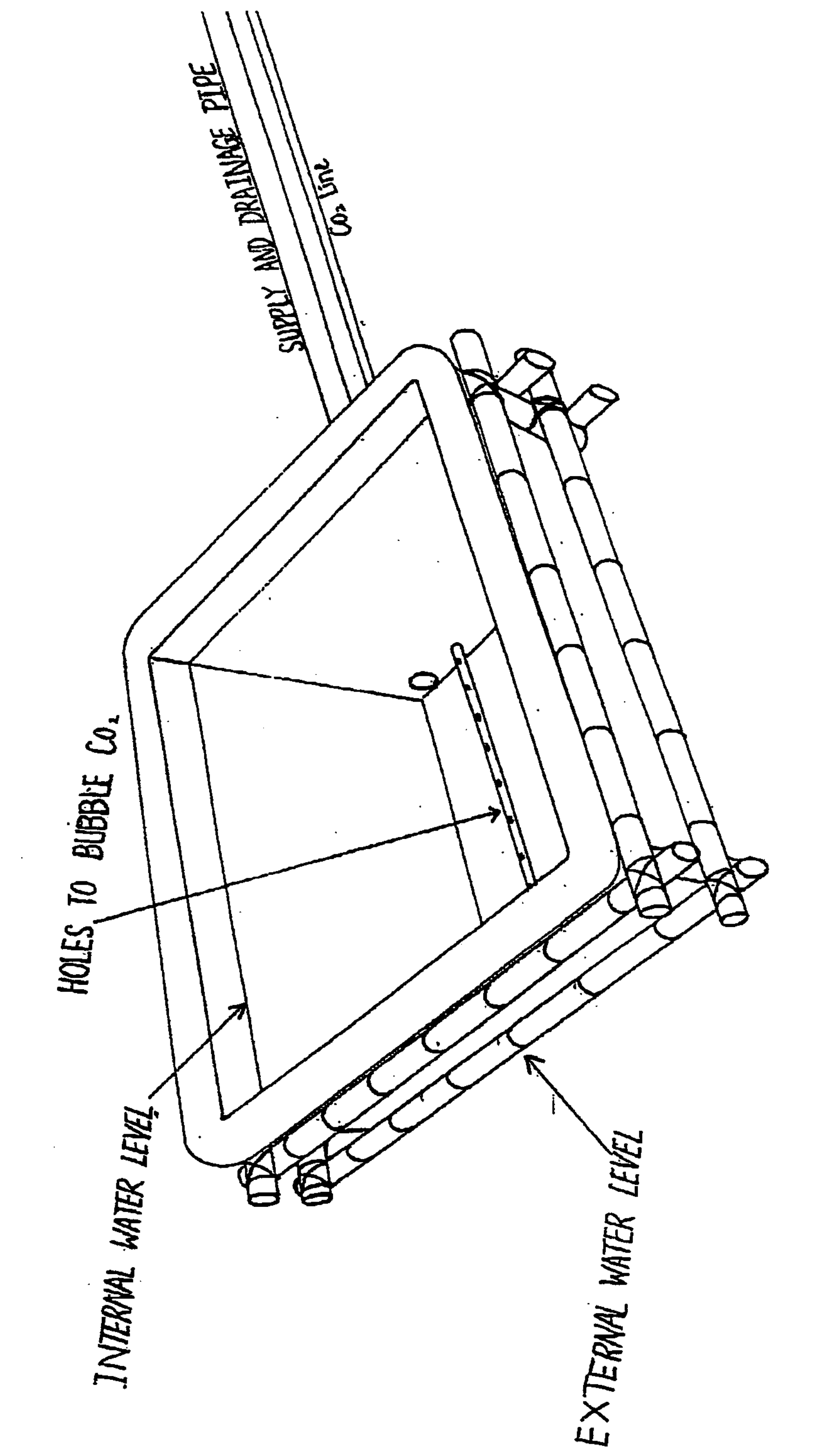

SUPPLY AND DRAINAGE PIPE
Co₂ Line
HOLES TO BUBBLE Co₂
INTERNAL WATER LEVEL
EXTERNAL WATER LEVEL

FIGURE 1

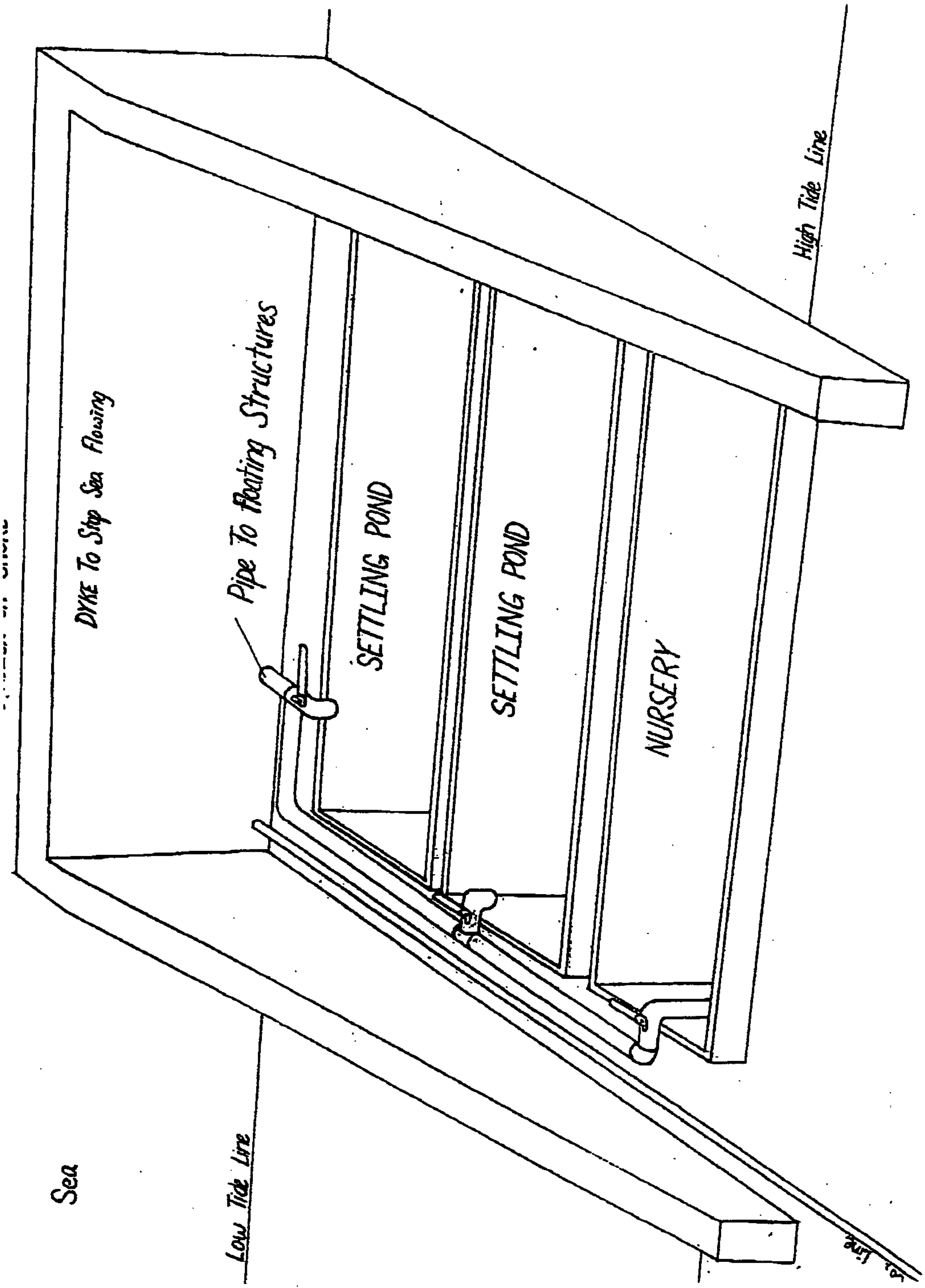

DYKE To Stop Sea Flowing
Pipe To Floating Structures
SETTLING POND
SETTLING POND
NURSERY
High Tide Line
Low Tide Line
Sea

FIGURE 2

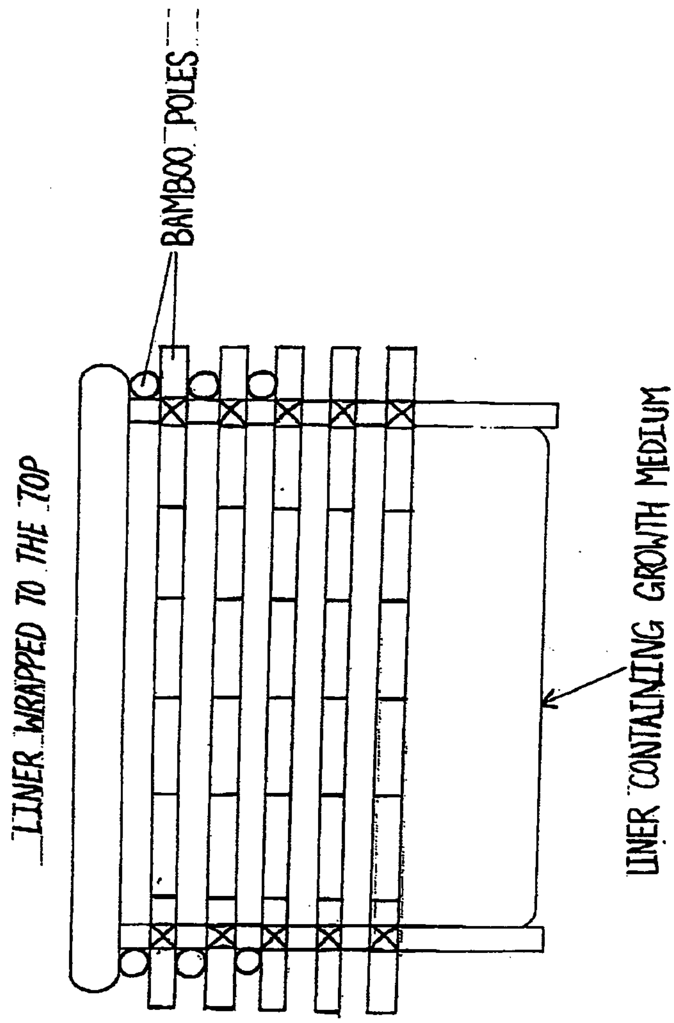

BAMBOO POLES
LINER WRAPPED TO THE TOP
LINER CONTAINING GROWTH MEDIUM

FIGURE 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2008/000009

A. CLASSIFICATION OF SUBJECT MATTER

AOlG 33/02(2006. 01)i, AOlG 33/00(2006. 01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 AOlG 33/00, AOlG 33/02, C12M 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) & keyword algae, float, and buoy

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X Y A	JP 05-236935 A (MITSUI ENG et al) 17 Sep 1993 See paragraph 3 - paragraph 16, claim 1 and figures 1-3	1-2, 5-7, 9-12 4 3, 8
Y A	US 4,324,068 A (MYRON L ANTHONY) 13 Apr 1982 See column 1, line 58 - column 3, line 44, claims 1, 6 and figure 1	4 1-3, 5-12
A	JP 07-000062 A (SHJMURA KENICHJ et al) 06 Jan 1995 See pages 2-6, claims 1-2 and figure 24	1-12
A	JP 09-000095 A (MITSUBISHI HEAVY IND LTD) 07 Jan 1997 See paragraph 8 - paragraph 21, claims 1-4 and figure 1	1-12

☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 JUNE 2008 (02 06 2008)	02 JUNE 2008 (02.06.2008)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No 82-42-472-7140

Authorized officer

Chio Jun Ho

Telephone No 82-42-481-5569

INTERNATIONAL SEARCH REPORT

International application No

PCT/MY2008/000009

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons

1 ☐ Claims Nos
because they relate to subject matter not required to be searched by this Authority, namely

2 ☐ Claims Nos
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically

3 ☒ Claims Nos 5, 9-12
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6 4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows

1 ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims

2 ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee

3 ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos

4 ☐ No required additional search fees were timely paid by the applicant Consequently, this international search report is restπcted to the invention first mentioned in the claims, it is covered by claims Nos

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation

☐ No protest accompanied the payment of additional search fees

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCTVMY2008/000009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 05-236935 A	17.09.1993	JP5236935A2	17.09.1993
US 4,324,068 A	13.04.1982	None	
JP 07-000062 A	06.01.1995	JP2797039B2	17.09.1998
		JP7000062A2	06.01.1995
JP 09-000095 A	07.01.1997	JP9000095A2	07.01.1997