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(72) Inventors:
 • **CALVIÑO CANCELA, María**
36005 Vigo (Pontevedra) (ES)
 • **MARTÍN HERRERO, Julio**
36310 Vigo (Pontevedra) (ES)
 • **VEGA GONZÁLEZ, Enrique**
15895 Ames (A Coruña) (ES)

(71) Applicant: **Ovapiscis, S. A.**
27278 Baleira (Lugo) (ES)

(74) Representative: **Pons**
Glorieta Ruben Dario 4
28010 Madrid (ES)

(54) **DEVICE FOR THE CLASSIFICATION OF TROUT EGGS AND ASSOCIATED METHOD**

(57) The invention relates to a device for the classification of trout eggs and to a classification method which eliminates the eggs that are dead or smaller than the size that has been established as suitable for the homogeneity of the batch, before the step of rearing in fish farms, wherein the device comprises means for suction (8) and blowing (10) and illumination points (9) in which the dif-

ferentiation, based on the transparency or opacity of the eggs, is determined by an artificial vision system comprising a control unit (12) that sends orders to the suction (8) and blowing (10) means in accordance with the data obtained from images of the eggs captured by high-capacity industrial cameras (11).

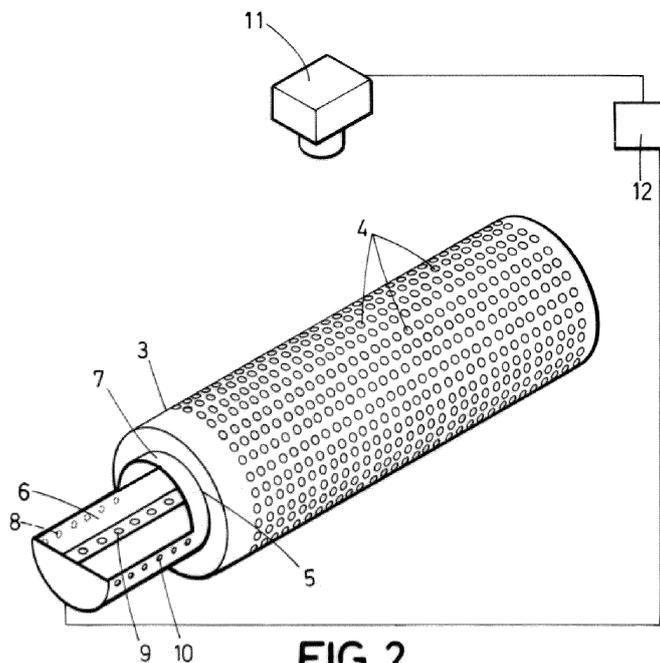


FIG. 2

Description**OBJECT OF THE INVENTION**

[0001] The present invention belongs to the technical field of the separation and classification of solids, specifically classification according to optical properties, and particularly relates to a device for classifying trout eggs.

BACKGROUND OF THE INVENTION

[0002] Trout, which belong to the *Salmonidae* family, is the most widely grown species in fish farms. Within its production cycle, the egg incubation phase encompasses the stage covering fertilisation to the eclosion of trout fry.

[0003] During this process, in some cases fertilisation is not successful and the eggs die. These dead eggs can be identified by their whitish and opaque appearance, which is due to the entrance of water through the micropile to the yolk, causing precipitation of the albumin contained therein. It is necessary to detect and remove these dead eggs as soon as possible, in order to prevent them from being invaded by fungi of the genus *Saprolegnia* and parasitising the live eggs as well, thereby producing substantial economic loss.

[0004] A device for classifying trout eggs is known in the state of the art which allows the dead eggs, responsible for the aforementioned problems, to be discarded. Said device basically comprises a product receiver tank, a perforated drum or roller that rotates at constant speed, suction and blowing means and an optical classification system based on LED lights and photodetectors. The basic operating method is based on supplying the system with a flow containing a mixture of eggs and water that flows towards the rotary drum and is housed in cavities made in the surface by means of a suctioning created in the interior, in order to subsequently verify its optical properties by means of photodetectors to determine whether the eggs are alive or dead and finally activate electrovalves that give way to a water jet that expels the dead eggs towards a receiver tank conditioned to receive said type of eggs.

[0005] The rotary drum has a series of hemispherical cavities destined for housing the eggs distributed over its outer surface. A fixed part is disposed in the inner cavity of the drum, being semicylindrical in shape and positioned coaxially thereto, which longitudinally divides said inner cavity into two halves, one free and another occupied by the semicylindrical part. The free chamber in the upper half of the drum cavity is vacuum-operated, by means of a vacuum motor, while the part that occupies the other half is equipped with a line of LED lights, disposed coincident with the positions of the semispherical cavities in the drum, and two lines of electrovalves, equally coincident with the drum's cavities, but more advanced in the rotation cycle, that govern the action of blowing members and suction members. In this manner, the drum

cavities suck during their passage through the upper half of the cycle, and have the possibility of blowing during the lower half of the cycle through the activation of the electrovalves.

5 [0006] Opposite the line of LED lights, on the outer part of the drum, there is a line of photodetectors behind which a printed circuit board with logic gates, controlled by potentiometers, with output to LCD screens that display the result of the measurement, is disposed. The machine is completed by a constant rotation speed motor for the drum and a transformer with its corresponding general switch for connection to the mains.

10 [0007] Continuing with the description of the operation, it must be considered that the horizontal diametrical plane of the drum, which rotates at a constant speed of approximately 30 r.p.m., coincides approximately with the bottom of the receiver tank. When the water flow containing the eggs to be classified reaches the drum surface it penetrates it, passing through the holes made therein, whereupon the eggs are retained in said orifices and fixed therein due to the vacuum created in the inner chamber of the drum. The drum is progressively loaded with eggs while rotating until, when it has reached a certain position, the line of cavities is interposed between the line of LED lights disposed on the inner semicylindrical fixed part of the drum and the line of photodetectors, on the outer part. The different opacity of the eggs makes it possible, based on the thresholds determined by the corresponding potentiometers, to decide whether or not there is an egg in each cavity of the line and whether or not it is opaque or translucent, i.e. "bad" or "good" for marketing purposes. In accordance with this decision, it is activated for each cavity throughout the corresponding line of electrovalves, with the retarding adequate to drum rotation speed, which activates the blowing means such that the bad eggs are expelled into a tank at the outlet of its cavity on passing through the line of blowing means, which expel a jet of water that pushes the eggs to be eliminated.

20 25 30 35 40 [0008] The main drawback of this device is due to the nature of the measurements made since, on being based on the variation in light received in the photodiodes in accordance with the different degree of opacity of the eggs, makes these measurements highly sensitive to the correct alignment of the photodiodes with the LEDs and the egg housing cavities. In addition, this device is capable of discriminating and counting live and dead eggs, but not of detecting those having a size less than that considered critical and which determines the homogeneity of the batch of fry obtained.

DESCRIPTION OF THE INVENTION

45 50 55 [0009] The object of the invention consists of a device for classifying trout eggs and its associated process, resulting from the improvements implemented in the aforementioned system to reduce the drawbacks expounded, to which end the detection system based on photodiodes is replaced by another based on artificial vision.

[0010] The transparency or opacity of the eggs with respect to the light emitted by the LED lights, and their diameter, is evaluated by a system based on artificial vision and composed of said light sources, at least two industrial high-speed linear cameras with their corresponding optical units and filters, an image capture system and a control unit that processes the information received with respect to both transmittance parameters, determining if said values correspond to viable or inviable eggs, and to the measurement of the diameter of the eggs, comparing it with the values determined as critical, whereupon it sends an order to the electrovalves such that, when the line of egg housings which has been evaluated by the artificial vision system coincides in its rotation with the line of electrovalves, they emit a compressed air flow the expels the dead eggs or eggs having an inadequate size for the housings of the drum surface and conducts them towards an inviable egg outlet channel.

[0011] The egg classification process based on the artificial vision system therefore comprises the following stages:

- Projection of light through the housings of the drum that houses the eggs and, therefore, through the eggs, while said drum rotates at a constant speed,
- Capture, by the camera, of a moving image of the projection, wherein said image comprises geometries, sizes and colours corresponding to the eggs and remittance of the images to each control unit for processing thereof,
- Establishment of grey threshold and size values based on which it is determined that the egg must be discarded,
- Comparison of the colour of the egg image unit with the grey threshold to determine if it is smaller than the established size, thereby determining if the egg is defective, and comparison of the size of the egg image unit with the size threshold, in order to determine if it is smaller than the established size, thereby determining whether or not it should be eliminated to preserve batch homogeneity, and
- Remittance of an order from the control unit to the electrovalve disposed opposite the position occupied by the defective egg for actuation thereof, which determines the blowing and projection of the defective egg towards the defective egg storage tank.

[0012] Additionally, and by way of intermediate steps between the stages of image capture and establishment of a grey threshold value, the following actions can be included:

- Determination in the control unit of the relative position of each egg based on the coordinates of the

captured image,

- Decomposition of the captured image into image units, where each image unit corresponds to an egg, associating a greyscale thereto, and
- Processing for the detection of image unit outlines corresponding to the eggs.

[0013] With the device thus described a solution is obtained for classifying trout eggs, based on artificial vision and advanced digital electronics, which allows the inspection of all the eggs automatically and with optimised operation times, differentiating between live and dead eggs, and of those whose size is smaller than that established as lower tolerance threshold, through which, in short, a high-quality and homogeneous product is obtained by means of a reliable and efficient process.

DESCRIPTION OF THE DRAWINGS

[0014] In order to complement the description being made and with the object of helping to better understand the characteristics of the invention, in accordance with a preferred embodiment thereof, said description is accompanied, as an integral part thereof, by a set of drawings where, in an illustrative and non-limiting manner, the following has been represented:

Figure 1 shows a perspective view of the device for classifying trout eggs, wherein its main elements can be observed.

Figure 2 shows a perspective view of the hollow rotary perspective, with hemispherical cavities for housing the eggs and the semicircular support in its interior, wherein the relative position of the camera and the control unit of the artificial vision system can be observed.

PREFERRED EMBODIMENT OF THE INVENTION

[0015] Following is a detailed explanation, based on the aforementioned figures, of a preferred embodiment of the object of the present invention.

[0016] The described device for classifying trout eggs comprises an external chassis (1) having the appearance shown in figure 1, preferably embodied in a lightweight and resistant plastic material such as polypropylene, which supports and houses the other components of the device. Said components are described below, following the logical work flow of the device.

[0017] The trout eggs to be classified are introduced in the device through a loading area or receiver tank (2) disposed on the upper part of the chassis (1), where they are mixed with a continuous water flow that conducts them perpendicularly towards a cylindrical and rotary drum (3), disposed in a horizontal position transverse to

the chassis (1), said drum (3) having a series of evenly spaced cavities or housings (4), as shown in figure 2, disposed in transverse and parallel lines. The egg housings (4) have an essentially hemispherical shape, with a central orifice at the bottom of the hemisphere. The drum (3) is a roller having an essentially hollow cylindrical shape, preferably manufactured from plastic material such as polyacetal to prevent corrosion problems, whereupon the water flow with eggs is incident, said eggs being retained in the housings (4), said water flowing towards the inner cavity (5) of the drum (3), wherefrom it will subsequently be expelled. The drum is disposed in the device such that its horizontal diametrical plane coincides approximately with the bottom of the receiver tank (2).

[0018] A semicylindrical support (6) disposed coaxially to the drum (3) and fixed with respect thereto is introduced in the inner cavity (5) of the drum (3), covered by a lid (7), also semicylindrical, as shown in figure 2. Said support (6) contains a pneumatic part in charge of supplying either underpressurised air to retain the eggs in the housings (4) of the drum (3) or overpressurised air to expel them by means of a water jet, and an electrical part, consisting of a lighting system, preferably high-efficiency white LEDs. The support (6) therefore houses the following elements: a line of suction means (8) for centering each egg in the housing (4) and removing excess water, a line of lights (9), preferably high-efficiency white LEDs, said lines being coincident with the line of housings (4) on the drum (3) surface, and a line of blowing means (10) for expelling the eggs. Both the line of suction means (8) and the line of blowing means (10) are governed by electrovalves disposed in the interior of the support (6).

[0019] The water flow containing unclassified trout eggs is therefore incident upon the drum (3) surface, whereupon the eggs are fixed in the housings (4), while the conducting fluid flows towards the inner cavity (5) of the drum (3), wherefrom it is removed through a drainage channel. The fixation of the eggs in the housings (4) is secured through a vacuum or suction pressure exerted by the line of suction means (8), which also remove the excess water.

[0020] The rotation of the drum (3), with the eggs housed in cavities (4) on its surface, continues until reaching a certain position wherein the line of cavities (4) is disposed opposite the line of lights (9) disposed on the fixed support (6), which backlights the eggs through diffusers disposed on the lid (7). Two industrial high-speed linear cameras (11), disposed parallel and pertaining to an artificial vision system in charge of discriminating the viable eggs from the inviable eggs to be eliminated, capture a moving image of the backlighting projection, whereupon each one of the two cameras captures the image corresponding to half the line of cavities (4), said image comprising geometries and colours corresponding to the eggs, said images being sent to a control unit (12) that performs the following sequence of actions:

- Determination of the relative position of each egg in the cavities (4) based on the image coordinates,
- Decomposition of the image captured into image units, wherein each image unit corresponds to an egg, to which both a greyscale and an egg diameter value are associated,
- Establishment of grey threshold and size values based on which it is determined whether or not the egg should be discarded,
- Comparison with a unit that controls (12) the colour of the egg image unit with the grey threshold to determine whether or not it is an egg darker than the established grey threshold value, thereby determining whether or not the egg is defective, and comparison of the size of the egg image unit with the size threshold, in order to determine whether or not it is smaller than the established size, thereby determining whether or not it should be eliminated to preserve batch homogeneity, and
- Remittance of an order from the control unit (12) to the electrovalves in order for these to activate the line of blowing means (10) when disposed opposite the position occupied by the defective egg, said blowing means (10) creating a pressurised air flow that projects the egg towards the defective egg storage tank.

[0021] Once the dead eggs or eggs having some type of malformation, the remaining healthy eggs become detached from their housings (4) on the drum (3) surface at a later point in its rotation, and flow towards a conduit that transports them towards an outflow receptacle.

[0022] The general actuation of the device is performed by means of an electric motor with an intermediate gear and pinion system for transmitting the movement from the motor axle to the drum (3) axis. The forced overpressure for the water jet to expel the defective eggs or those smaller than the required size is achieved by connection to a compressor.

Claims

1. A device for classifying trout eggs which comprises, mounted on an external chassis (1):
 - a receiver tank (2) for receiving the eggs to be classified,
 - a hollow rotary drum (3) disposed opposite the receiver tank (2) preferably having hemispherical housings (4) made on its surface to house the eggs to be classified, said drum (3) comprising disposed in its inner cavity (5):
 - a fixed semicylindrical support (6) disposed co-

axially to the drum (3), covered by a lid (7), which comprises in its interior a line of suction means (8), a line of lights (9) and a line of blowing means (10), wherein both the line of suction means (8) and the line of blowing means (10) are governed by electrovalves,

characterised in that it additionally comprises an artificial vision system which, in turn, comprises at least two industrial high-speed linear cameras disposed opposite the line of housings (4) of the drum (3) and a control unit (12) connected to the cameras (11) that receives information on the images captured by said cameras (11) and sends orders to the electrovalves that govern the line of suction means (8) and the line of blowing means (10).

2. A process for classifying trout eggs, which uses the device described in claim 1, **characterised in that** it comprises the following sequence of actions:

- projection of light from the line of lights (9) from the rear part, said light penetrating diffusers disposed on the lid (7) and through the rear of the housings (4) of the drum (3) that houses the eggs and, therefore, through the eggs, while said drum (3) rotates at a constant speed,
- capture, by means of the cameras (11), of a moving image of the projection, wherein said image comprises geometries and colours corresponding to the eggs and remittance of the images to a control unit (12) for processing thereof,
- establishment in the control unit (12) of grey threshold and size values on the basis of which the eggs to be discarded are determined,
- comparison in the control unit (12) of the colour of the egg image unit with the grey threshold to determine if it is darker than the established grey threshold, thereby defining whether or not the egg is defective, and comparison of the size of the egg image unit with the size threshold, in order to determine if it is smaller than the established size, thereby deciding whether it should be eliminated to preserve batch homogeneity, and
- remittance of an order from the control unit (12) to the electrovalves that govern the line of blowing means (10) so that, when disposed opposite the position occupied by the housings (4) that contain defective eggs, said line of blowing means (10) creates an air current that projects the egg towards the defective egg storage tank.

3. The process for classifying trout eggs, according to claim 2, **characterised in that** it additionally comprises, between the stage of capture of a moving image by the cameras (11) and that of establishment of a grey threshold value in the control unit (12), the

following action stages:

- determination of the relative position of each egg in the control unit (12) based on the coordinates of the captured image,
- decomposition of the captured image into image units, wherein each image unit corresponds to an egg, associating a greyscale thereto, and
- processing for the detection of image unit outlines corresponding to the eggs.

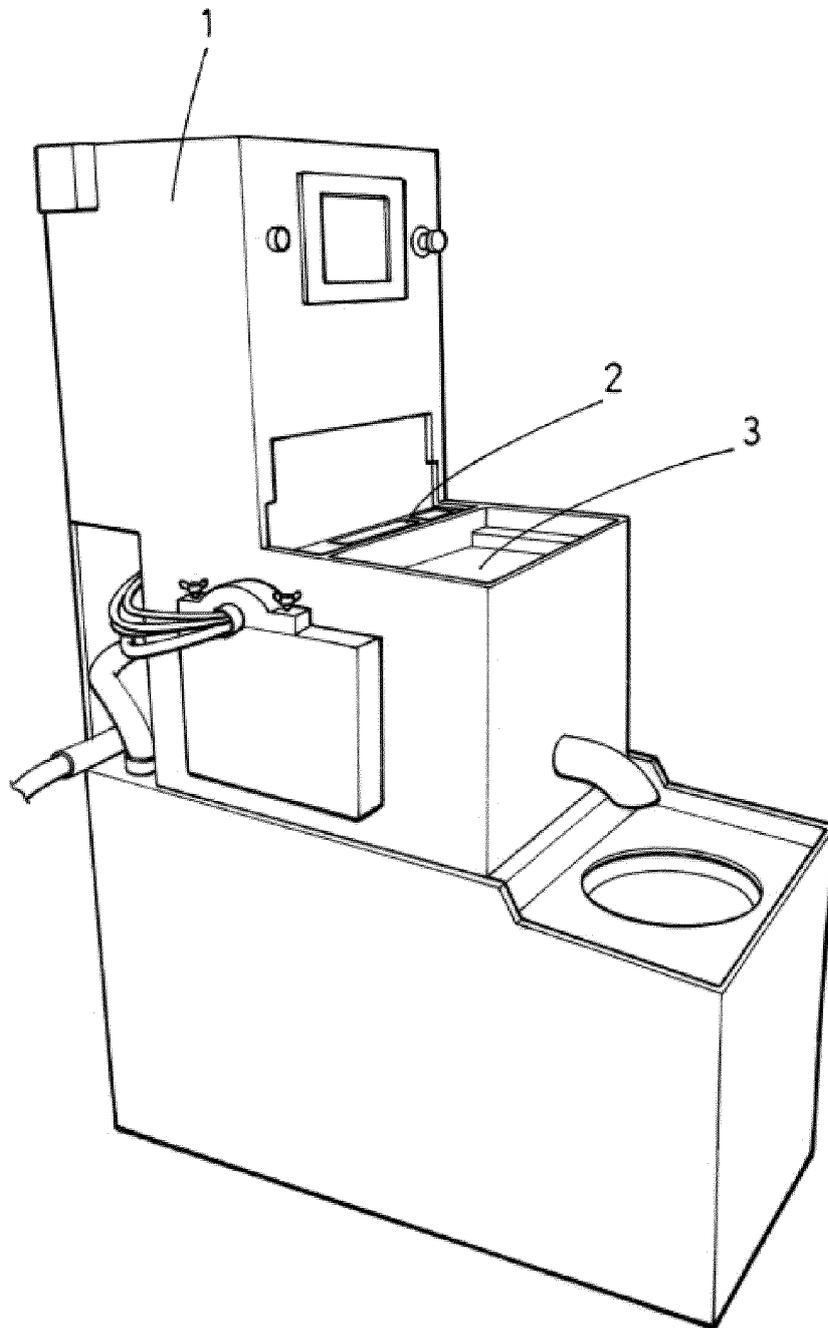
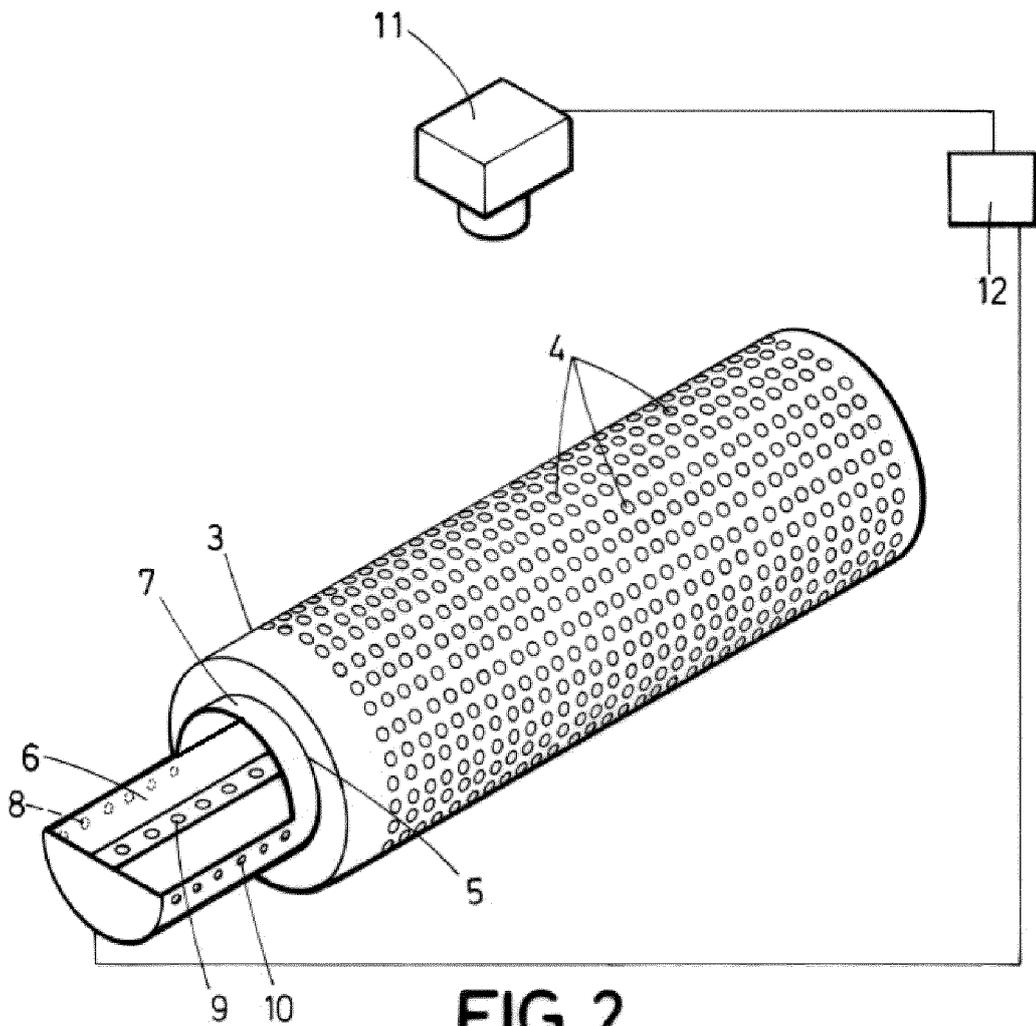


FIG.1



INTERNATIONAL SEARCH REPORT

International application No
PCT/ES2015/070702

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A. CLASSIFICATION OF SUBJECT MATTER
INV. B07C5/342
ADD.

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

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B07C

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

15

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

EPO-Internal, WPI Data

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 482 060 A (TACHIBANA MASATAKA [JP]) 13 November 1984 (1984-11-13) abstract; figures -----	1-3

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Further documents are listed in the continuation of Box C. See patent family annex.

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* Special categories of cited documents :

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18 May 2016

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Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Wich, Roland

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/ES2015/070702

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4482060	A	NONE	
