



(51) International Patent Classification:

A01M 1/02 (2006.01) A01M 5/06 (2006.01)

A01M 1/14 (2006.01)

(21) International Application Number:

PCT/DK2024/050125

(22) International Filing Date:

27 May 2024 (27.05.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PA202330071 07 June 2023 (07.06.2023) DK

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,

KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE

(54) Title: PEST DETECTOR

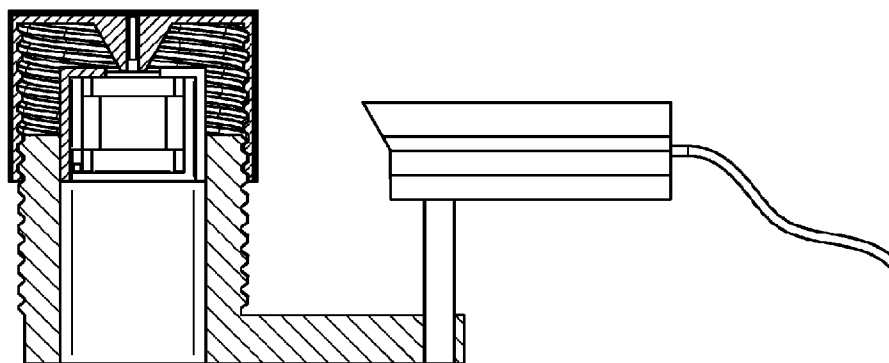


FIG. 10

(57) Abstract: The invention relates to a detector for detecting objects such as pests (for instance thrips and/or whiteflies) or pollen, applying only a single motor to capture images of the catch surface of the detector. To this end, the detector is equipped with an axial thread, permitting both the rotation and vertical movement of the catch surface, thereby facilitating the exposure of the cylindrical catch surface to the connected digital camera.



# PATENT APPLICATION

**Title of the invention: PEST DETECTOR**

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## PEST DETECTOR

### FIELD OF THE INVENTION

The present invention relates to a pest detector for usage in various fields, such as agriculture, for instance in greenhouses, or food and grain storage.

### BACKGROUND OF THE INVENTION

Currently, in order to detect, capture and monitor pests, for instance thrips in greenhouses, catch plates equipped with sticky surfaces are applied. In larger greenhouses, the catch plates are typically set up in a matrix like structure, such that the density is one catch plate per, for example, 20 m<sup>2</sup> of productive greenhouse area.

After a certain duration, for instance a week, the catch plates are to some degree covered with pests and are currently inspected by means of magnifying glasses and/or microscopes, in order to determine which kind of pests have been gathered and in order to estimate their quantity.

This procedure is currently carried out manually and the practice is a time consuming endeavor, often leading to failure to perform thorough inspection. Additionally, trend information and even location of attacks are often not recorded.

this often leads to

- significant, sometimes catastrophic losses in yields due to pest attacks
- over consumption of pesticides (for conventional farming)
- over consumption of beneficial animals (ecological farming)
- resulting waste of energy
- resulting excessive emission of CO<sub>2</sub>

therefore, ultimately, the current state of the Art results in substantial financial losses and often considerable pollution of the environment.

### OBJECT OF THE INVENTION

It is the object of the present invention that pest detection and monitoring is conducted automatically and with sufficiently high accuracy that any pest attacks can be detected early, making interventions less costly, ensuring lower production losses, calling for less application of pesticides and therefore leading to lower pollution of the environment.

### SUMMARY OF THE INVENTION

The invention takes images of pests on parts of its exterior surface, equivalents to catch plates, hereafter denominated catch surface.

Since several types of pests, for instance thrips, whiteflies, can be small in size, sometimes less than one millimeter in length, the images must be of high resolution and of sufficient clarity to allow correct identification of, for instance, the subspecies of pests caught on the catch surface, potentially calling for specific pest treatment. This practically necessitates segmenting the catch surface 3 and taking for instance 50 segment images per catch surface, such that the entire surface can be captured in high resolution, in close proximity of the captured pests, yielding highest possible, warp-free image resolution (pixels per area).

In a straightforward solution, the camera could be traversed over a flat catch plate surface, for instance by the use of two motors, one traversing in each direction of the plane wherein the catch plate lies.

This usage of two motors would imply greater physical size and cost than if a single motor could be applied, and it would imply considerable mechanical complexity, allowing for two traversing mechanisms.

The present solution resolves this situation such that only a single motor 12 must be applied to record images of essentially the entire surface.

The image capturing process may begin with the catch surface set to its lowest position (FIG. 1). As the rotating central body and the catch surface attached to it turn, they are, due to the threads, (5 and 15) elevated such that essentially all of the vertical as well as the circumferential dimension of the catch surface surface is gradually exposed to the camera.

In operation, the catch surface is turned step-wise, each step corresponding to the width captured by the camera. Likewise, the steepness of the thread is determined by the fact that after one turn, the camera should depict essentially a hitherto uncovered area above the area covered by the camera one turn previous.

Upon the catch surface reaching its maximal vertical position, the image capturing is completed. The number of captured images, and therefore the number of steps, directly relates to the desired image resolution (pixels per area).

After the images are captured, the detection unit connects to a local wifi network and uploads the images and other relevant information to a computer hosting or in connection with a neural network trained specifically to detect pests and/or other objects of interests, for instance, but not limited to, thrips, whiteflies or pollen particles.

In the case of application of a multitude of detector units, when the units are equipped with positioning sensors, such as GPS sensors, a software program can be constructed to, via a graphical user interface, produce heat maps of the pest density. This would produce an easily accessible visual indication of state-at-hand to the controller.

#### BRIEF DISCUSSION OF THE FIGURES

FIG. 1 shows, from an upper view, an embodiment of the detector 1 with attached camera 2, in its collapsed state, where the rotating central body and the catch surface is lowered as much as possible. The current rotational position of the catch surface 3 can be inferred from the position of the marker 4.

FIG. 2 shows, from an upper view, an embodiment of the detector with attached camera, in its extended state, where the rotating central body and the catch surface is elevated as much as possible. The thread 5 on the stationary central body 9 is here clearly visible.

FIG. 3 shows, from a low view, an embodiment of the detector with attached camera, in its collapsed state, where the rotating central body and the catch surface is lowered as much as possible. The slide groove in the stationary central body 6 is visible, as is the sliding assembly 7. Also depicted is the supporting surface 14 of the detector.

FIG. 4 shows, from a low view, an embodiment of the detector with attached camera, in its extended state, where the rotating central body and the catch surface is elevated as much as possible. The slide groove in the stationary central body 6 is here clearly visible.

FIG. 5 shows, from an upper view, an embodiment of the detector with attached camera, in its collapsed state, where the rotating central body and the catch surface is lowered as much as possible and where the indicated cone 8 represents the volume covered by the view angles of the camera, roughly indicating the area of the catch surface covered by the camera in the current position. Notably, the camera in this position covers an extreme high area of the catch surface.

FIG. 6 shows, from a low view, an embodiment of the detector with attached camera, in its extended state, where the rotating central body and the catch surface is elevated as much as possible and where the indicated cone 8 represents the volume covered by the view angles of the camera, roughly indicating the area of the catch surface covered by the camera in the current position. Notably, the camera in this position covers an extreme low area of the catch surface.

FIG. 7 shows an exploded view of an embodiment of the detector from a top view, revealing the key components: a stationary central body 9 equipped with a slide groove 6, a thread 5 and being connected to a

radially positioned inward facing camera 2, a rotating central body 10, a central sliding body 11, a motor 12 having an output shaft 13, and a catch surface 3.

FIG. 8 shows an exploded view of an embodiment of the detector from a low view, revealing the key components: a stationary central body 9 equipped with a slide groove 6, a thread 5 and being connected to a radially positioned inward facing camera 2, a rotating central body 10 equipped with a thread 15, a central sliding body 11, a motor 12 having an output shaft 13, and a catch surface 3.

FIG. 9 shows a cut through an embodiment of the detector, revealing the key components: a stationary central body 9 equipped with a slide groove 6, a thread 5 and being connected to a radially positioned inward facing camera 2, a rotating central body 10 where the catch surface 3 is positioned in the lowest possible position, also showing the motor 12 and output shaft 13, here connected to the rotating central body, a central sliding body 11, here fastened to the motor.

FIG. 10 shows the same embodiment as shown in FIG. 11, albeit in the state where the catch surface 3 is positioned in the highest possible position.

FIG. 11 shows an alternative embodiment 16 where a sliding axle 14 connected to the axle of the motor is visible, in a top view with collapsed detector

FIG. 12 shows the same alternative embodiment in a low view where the detector is maximally extended.

FIG. 13 shows the alternative embodiment in a top exploded view where the sliding axle 14 is clearly visible, as is the slide groove 15 allowing torque transfer.

FIG. 14 shows the alternative embodiment in a low exploded as view where the sliding through axle 14 is clearly visible, as is the slide groove 15 allowing torque transfer.

FIG. 15 shows the alternative embodiment in a cut through view, where the embodiment is in it collapsed, most compact state. It is seen that in this embodiment, the motor shaft 13 is mounted into the sliding axle.

FIG. 16 shows the alternative embodiment in a cut through view, where the embodiment is in it extended, most expanded state. It is seen that in this embodiment, the motor shaft 13 is mounted into the sliding axle.

## DESCRIPTIONS OF TWO EMBODIMENTS

In an embodiment of the invention, figures 11 though 16, the stationary central body 17 is equipped with an outer thread 5 and connected via a motor-driven through-shaft 14 to an exterior rotating central body 18, which is equipped with a threaded inner surface 19 and where a catch surface 3 is mounted upon the exterior rotating central body 10, and where the stationary central body 17 is equipped with a radially mounted camera 2 such that, as the motor drive 12 is actuated, the surface of the catch plate is rotated as well as vertically actuated axially along the central axis of the stationary central body, exposing the catch plate surface to the camera.

In an advantageous embodiment of the invention, figures 1 through 10, the motor is 3, instead of on a stationary central body, mounted on a rotation fixed and axial sliding body 11, sliding within a slide groove 6 within the stationary central body 9, the motor shaft 13 in turn coupled to and driving the exterior rotating central body 10. This embodiment has the advantage that the motor is situated further away from the supporting surface (for instance a table) and therefore any liquid (water, etc) that may be flooding the surface whereupon the detector is placed. Additionally, this embodiment has the advantage that it can be realized in a more compact and simple to produce form, since no extendable drive axis is needed. FIG. 1 shows the compactness that this embodiment can achieve in its collapsed form, where FIG. 2 shows the maximal vertical dimension of the embodiment.

The threads are shown in the figures to be external to the stationary central body and internal to the rotating central body. In alternative embodiments, the thread on the stationary central body could be internal and the thread on the rotating central body could be external.

To sum up, the invention however embodied, provides a detection unit for detecting pests, for instance thrips or whiteflies by relatively simple mechanical means, applying a threaded rotating and extending mechanism ensuring the best possible image resolution for the least possible financial expenditure. The invention has the additional advantage that the exterior dimensions of the detector can be kept small. This allows the detector to not consume more space than a regular pot plant, making placement of the detector unproblematic for greenhouse workers.

Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms “comprising” or “comprises” do not exclude other possible elements or steps. In addition, the mentioning of references such as “a” or “an” etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

## CLAIMS

- 1) A pest detection device 1 comprising of
- a stationary central body 9 equipped with a thread 5, a slide groove 6 and being connected to a radially positioned inward facing digital camera 2
  - an exterior rotating central body 10 equipped with a thread 15
  - a motor 12 having a drive axle 13
  - a sliding body 11 whereupon the motor is fastened
  - a cylindrical catch surface 3 mounted on the exterior rotating central body

where:

the motor is mounted rotational fixed and moves as part of a rotational constrained axial sliding assembly of motor and sliding body sliding axially within the slide groove of the stationary central body and where the axle of the motor is connected to the exterior rotating central body such that as the motor drive is actuated, the surface of the catch plate is rotated as well as vertically actuated axially along the central axis of the stationary central body, continually exposing the catch plate surface to the camera.

- 2) A pest detection device as in claim 1 where, instead, the axle of the motor is connected to the stationary central body and where the slide groove is in the exterior rotating central body

- 3) A pest detection according any of the aforementioned claims but in the embodiment 16 comprising of
- a stationary central body 17 equipped with a thread 5 and being connected to a radially positioned inward facing digital camera 2
  - a rotating central body 18 equipped with a thread opposing the thread of the stationary central body
  - a motor 12 having a drive axle 13
  - a sliding axle 14 connected to the motor and the rotating central body
  - having a motor 12 mounted thereto, the drive axle 13 of said motor being rotational connected to the rotating central body situated within the slide groove
  - a cylindrical catch surface 3

where:

the stationary central body is connected via the motor-driven through-shaft to the exterior rotating central body and where a catch surface is mounted upon the exterior rotating central body, such that as the motor drive is actuated, the surface of the catch plate is rotated as well as vertically actuated axially along the central axis of the stationary central body, continually exposing the catch plate surface to the camera

- 4) A pest detection device as in claim 4 where, instead, the drive axle of the motor being rotational connected to the rotating central body it is connected to the stationary central body.

- 5) Device according any of the aforementioned claims where the device is equipped with a digital processing unit

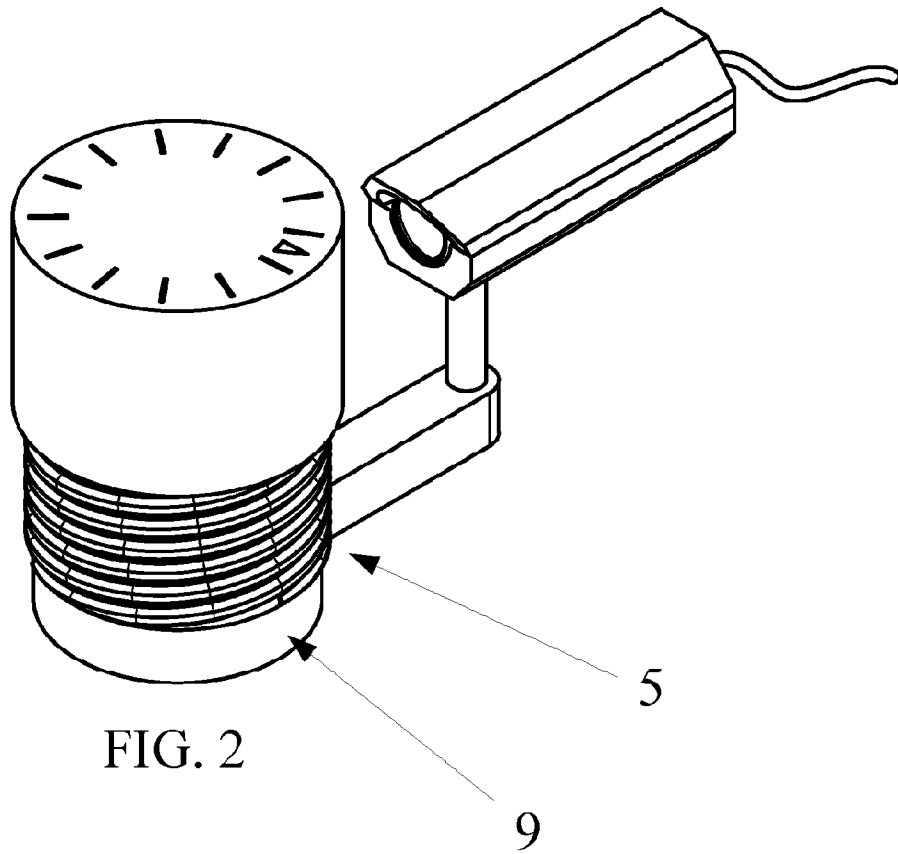
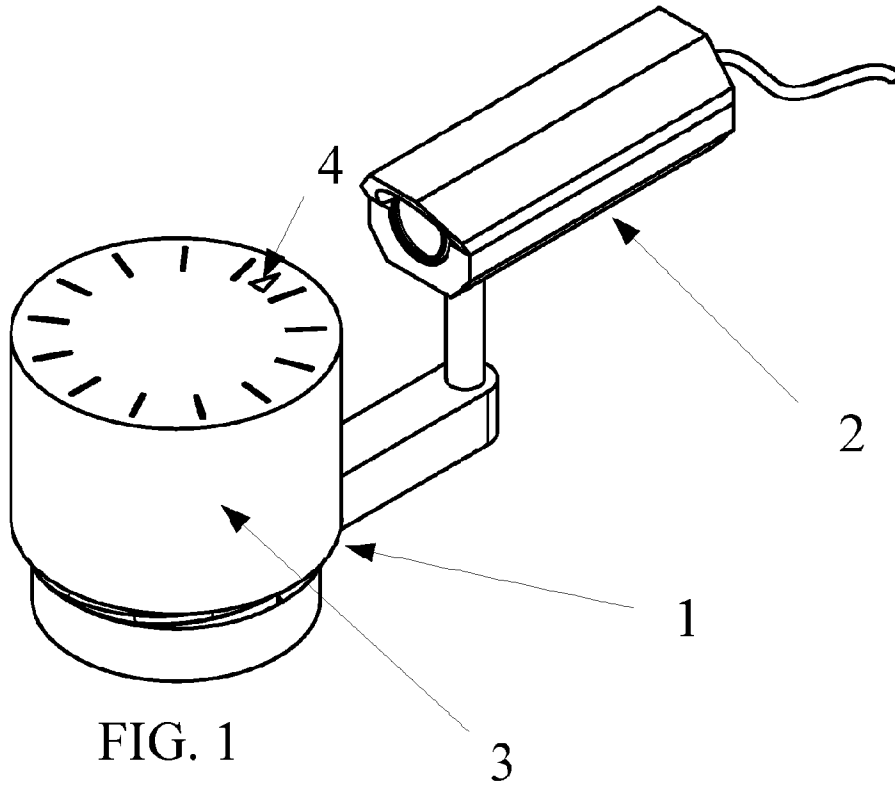
- 6) Device according any of the aforementioned claims where the device is equipped with a WiFi and/or Bluetooth connectable device, allowing for wireless transmission of the captured images

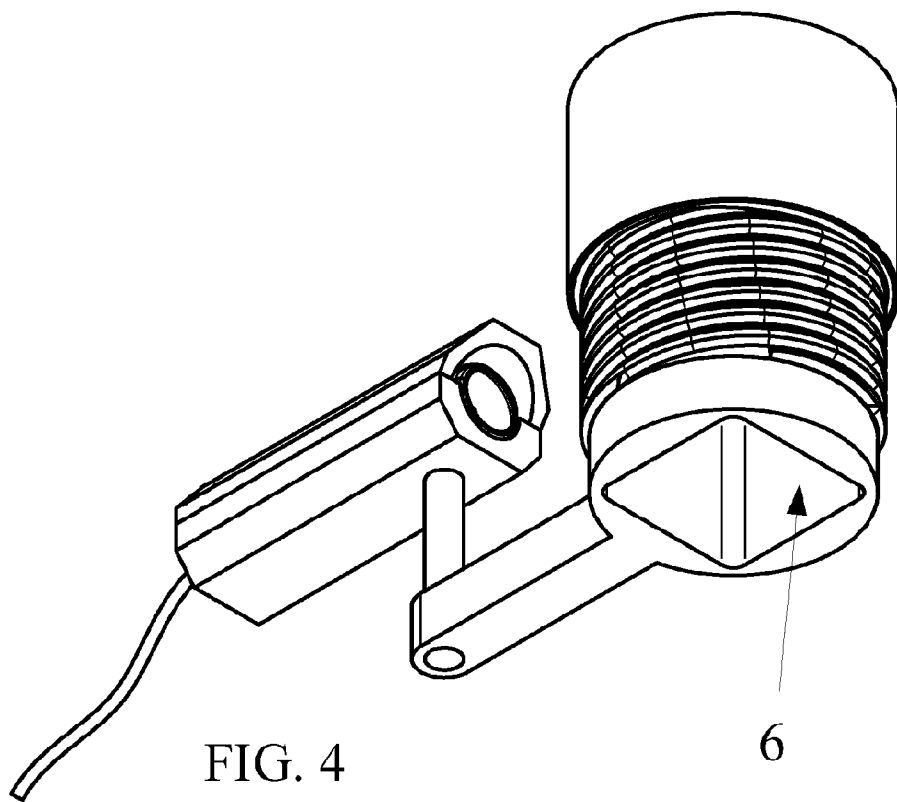
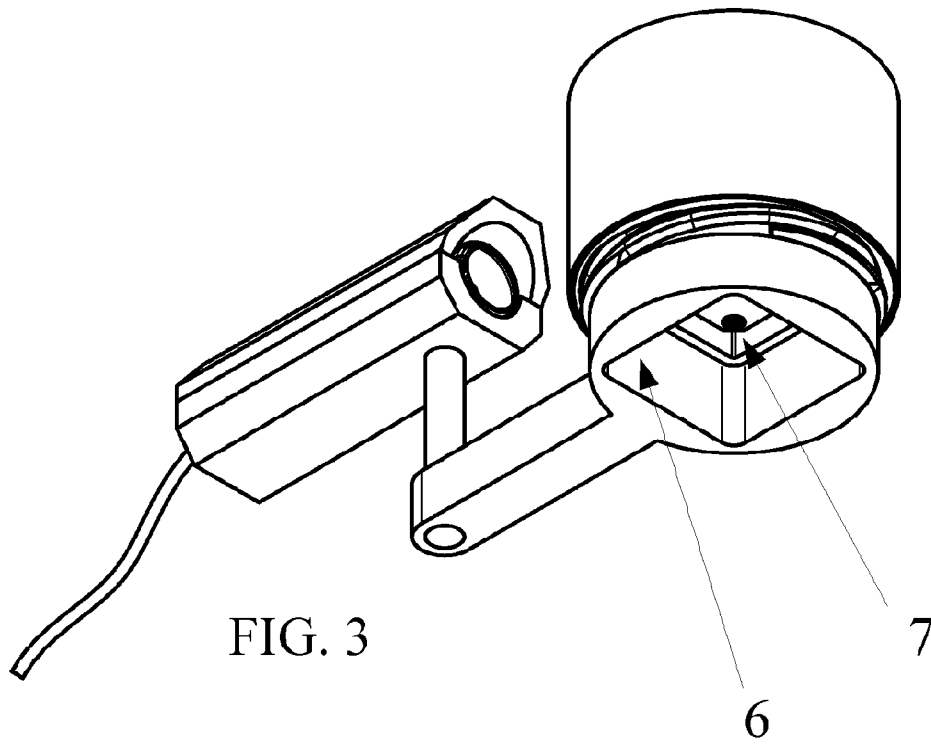
- 7) Device according any of the aforementioned claims where the device is equipped with an LED light source, illuminating the area of the catch plate to be recorded by the camera

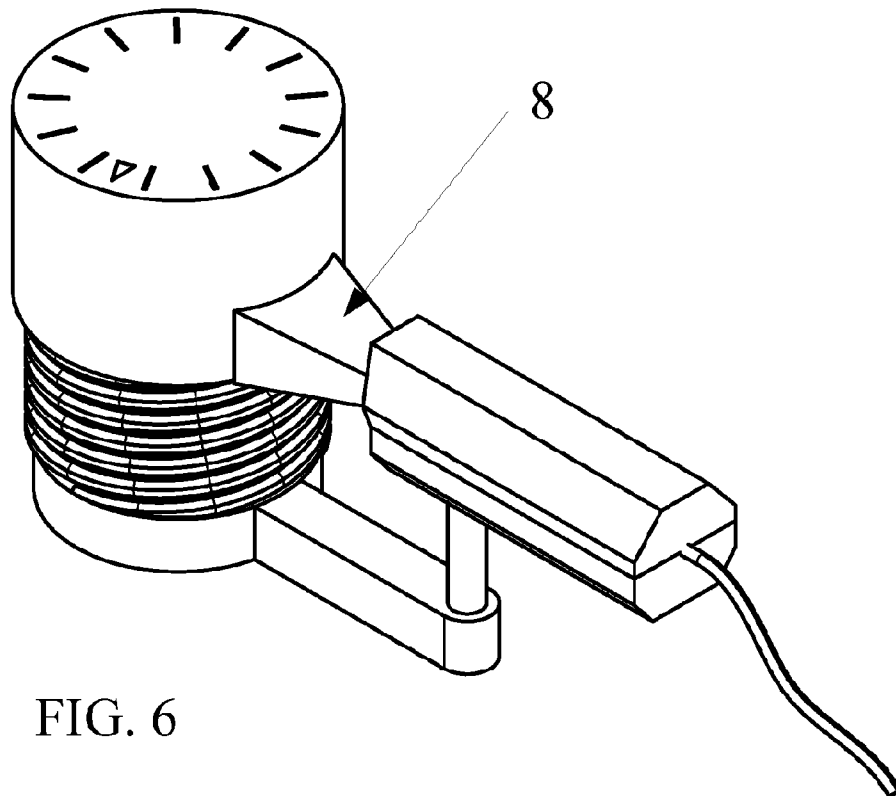
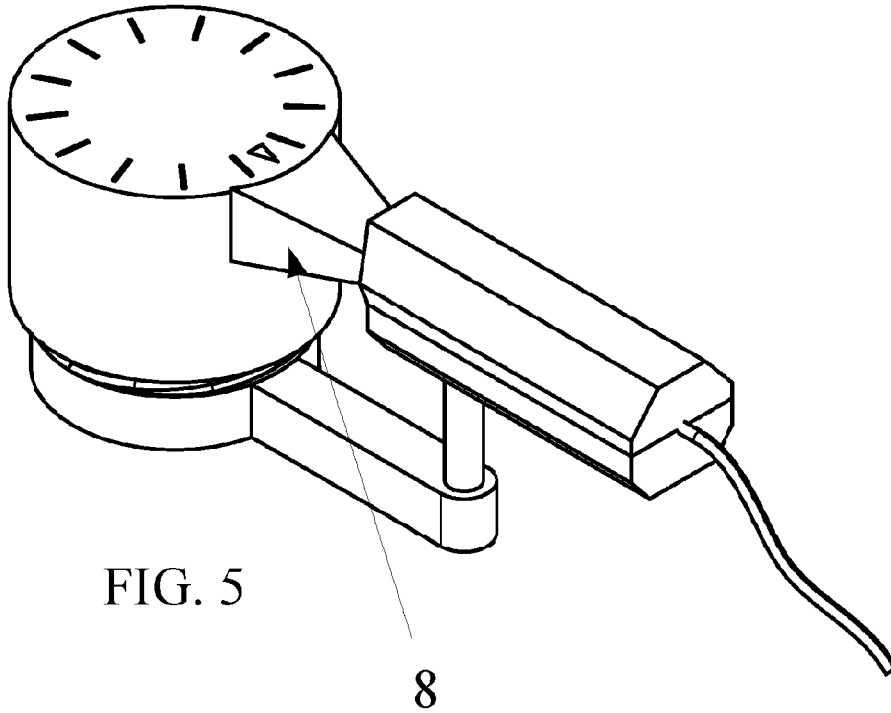
- 8) Device according any of the aforementioned claims where the device is equipped with an GPS position sensor, connected to a processing unit connected to WiFi or Bluetooth

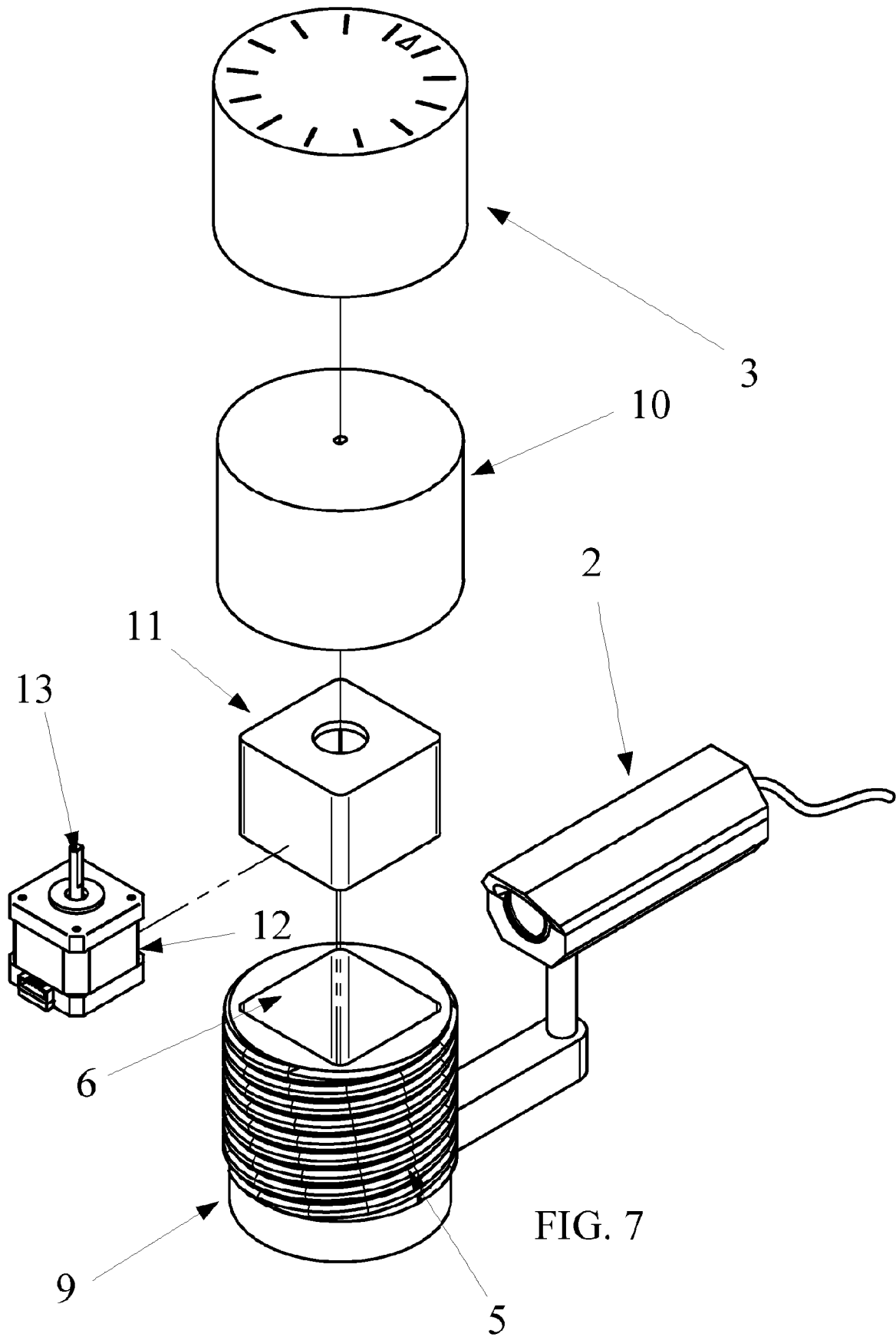
- 9) Device according any of the aforementioned claims where the device is equipped with a battery or wired power connection or connected to a solar panel

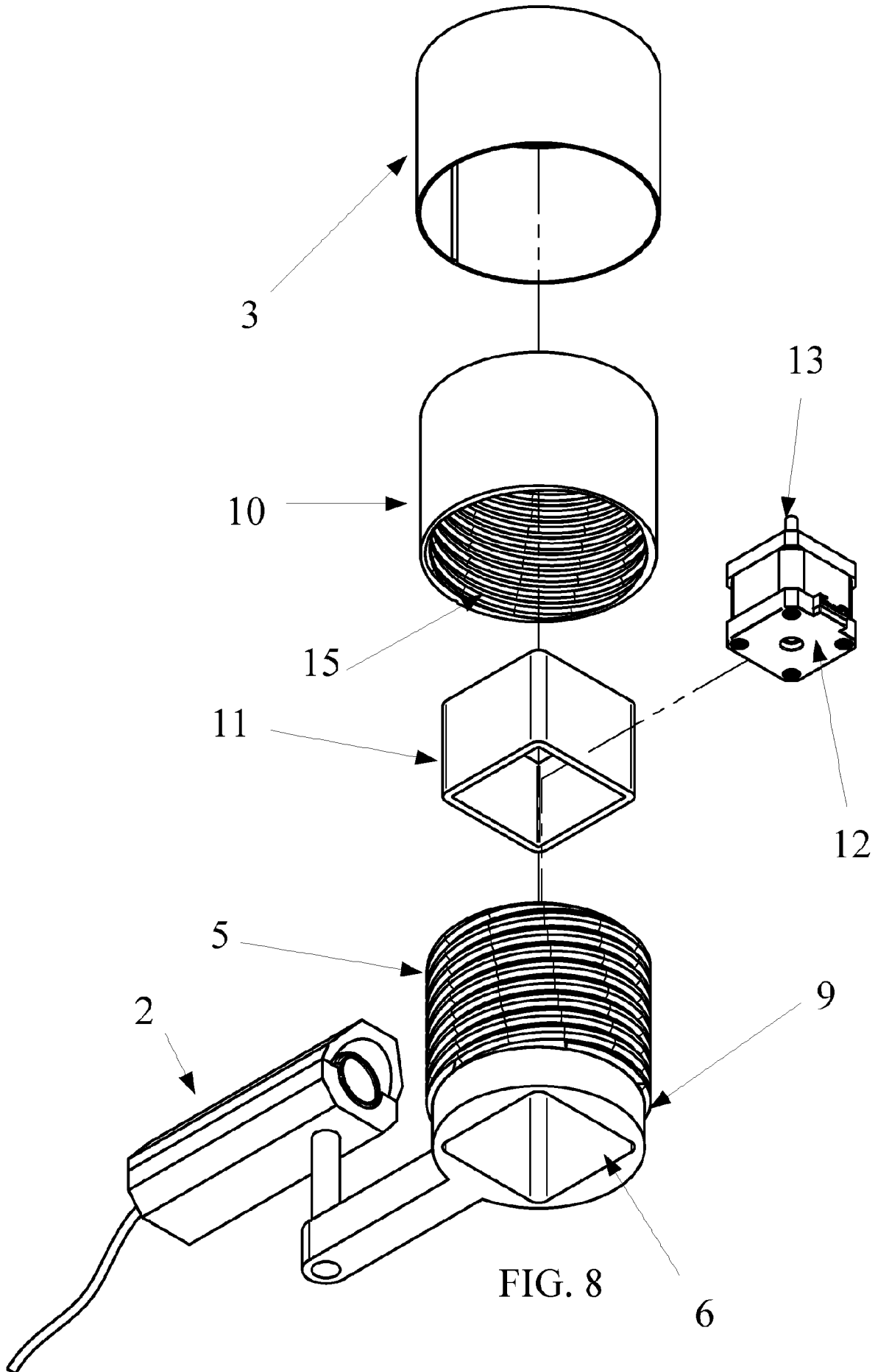
- 10) Device according any of the aforementioned claims where an adhesive is applied to the catch surface











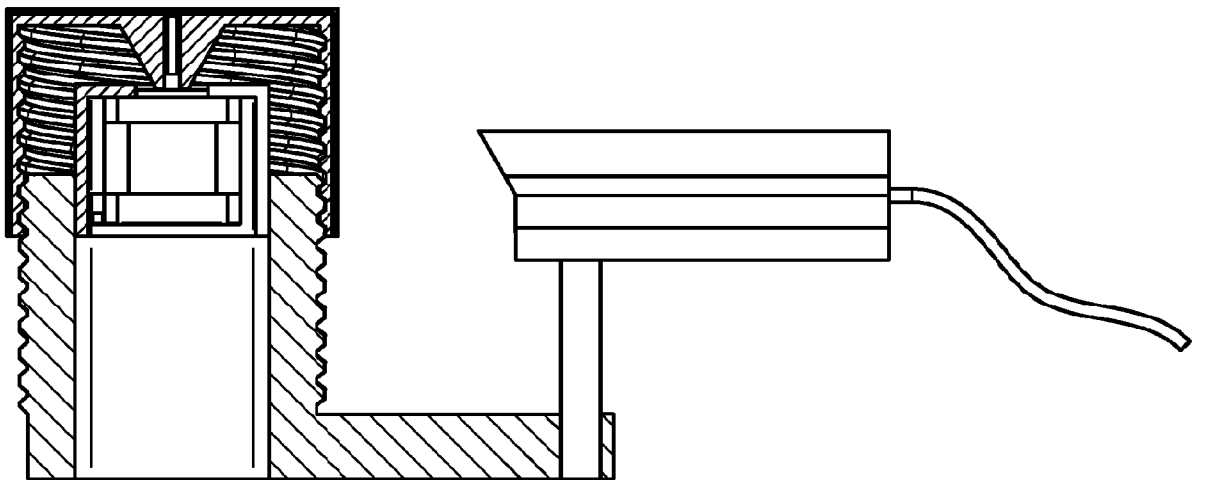
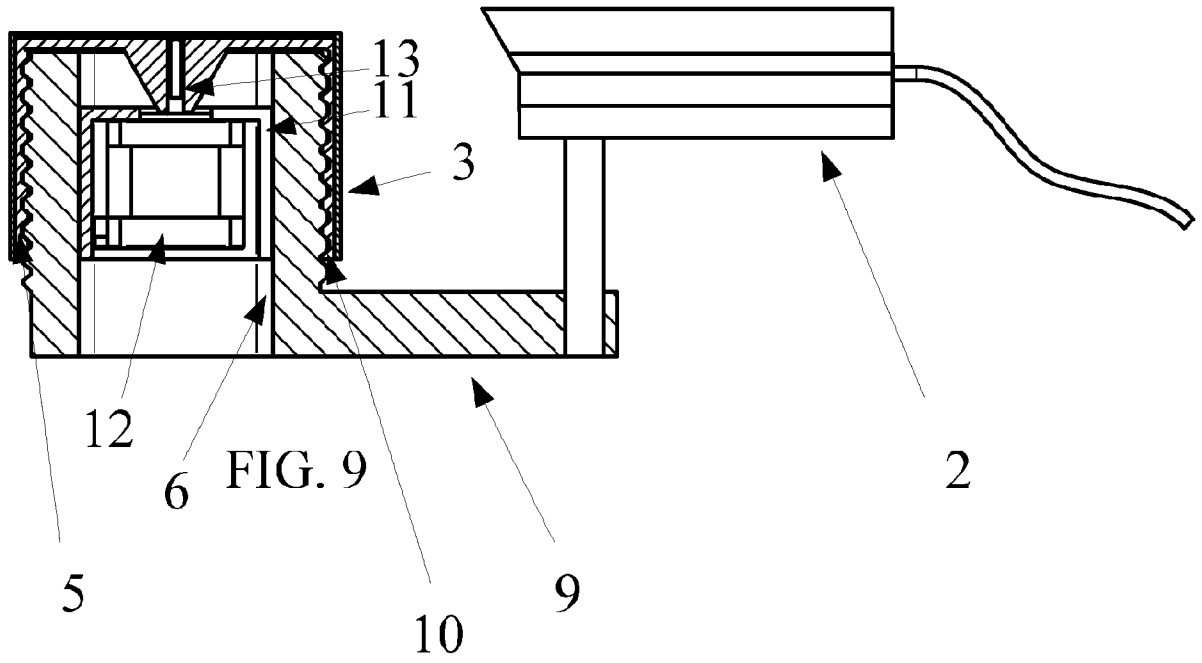
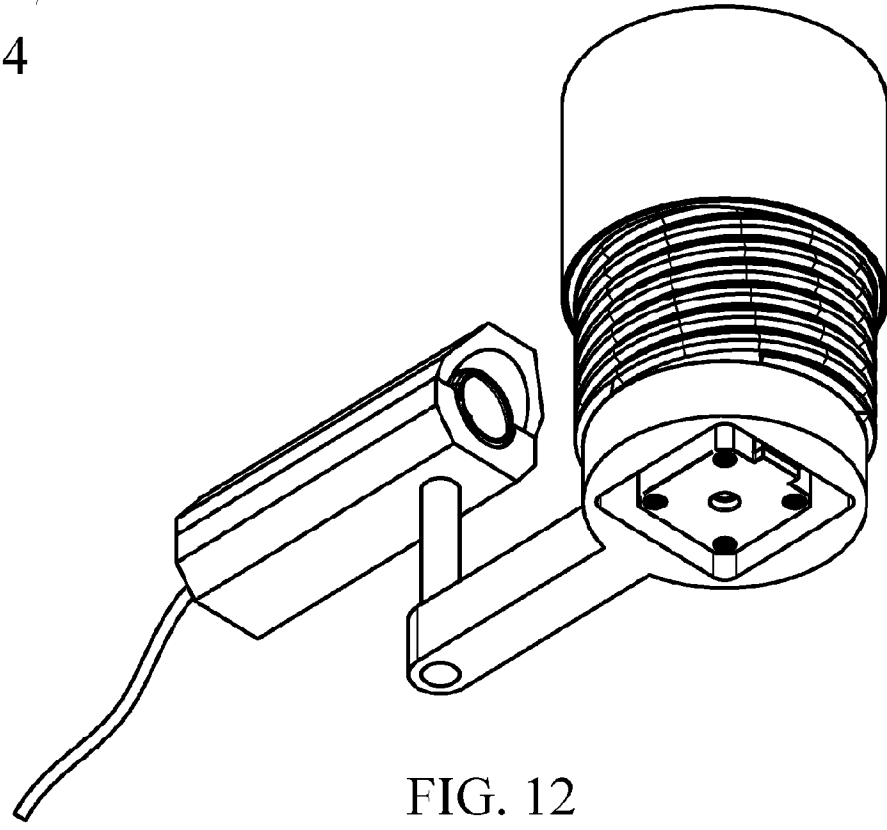
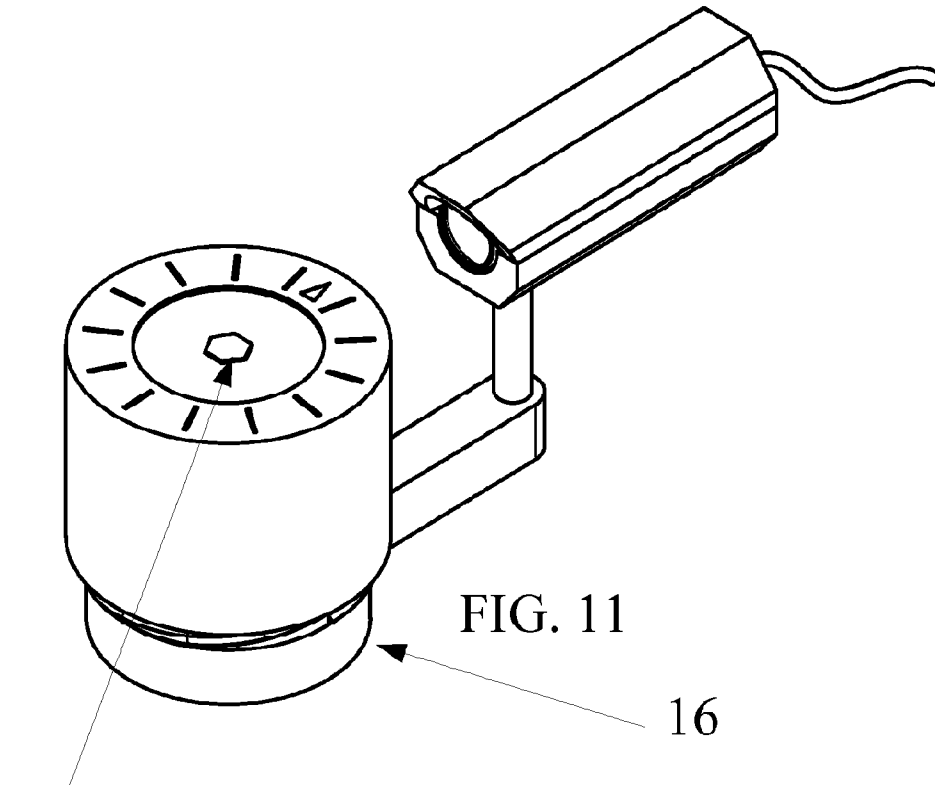
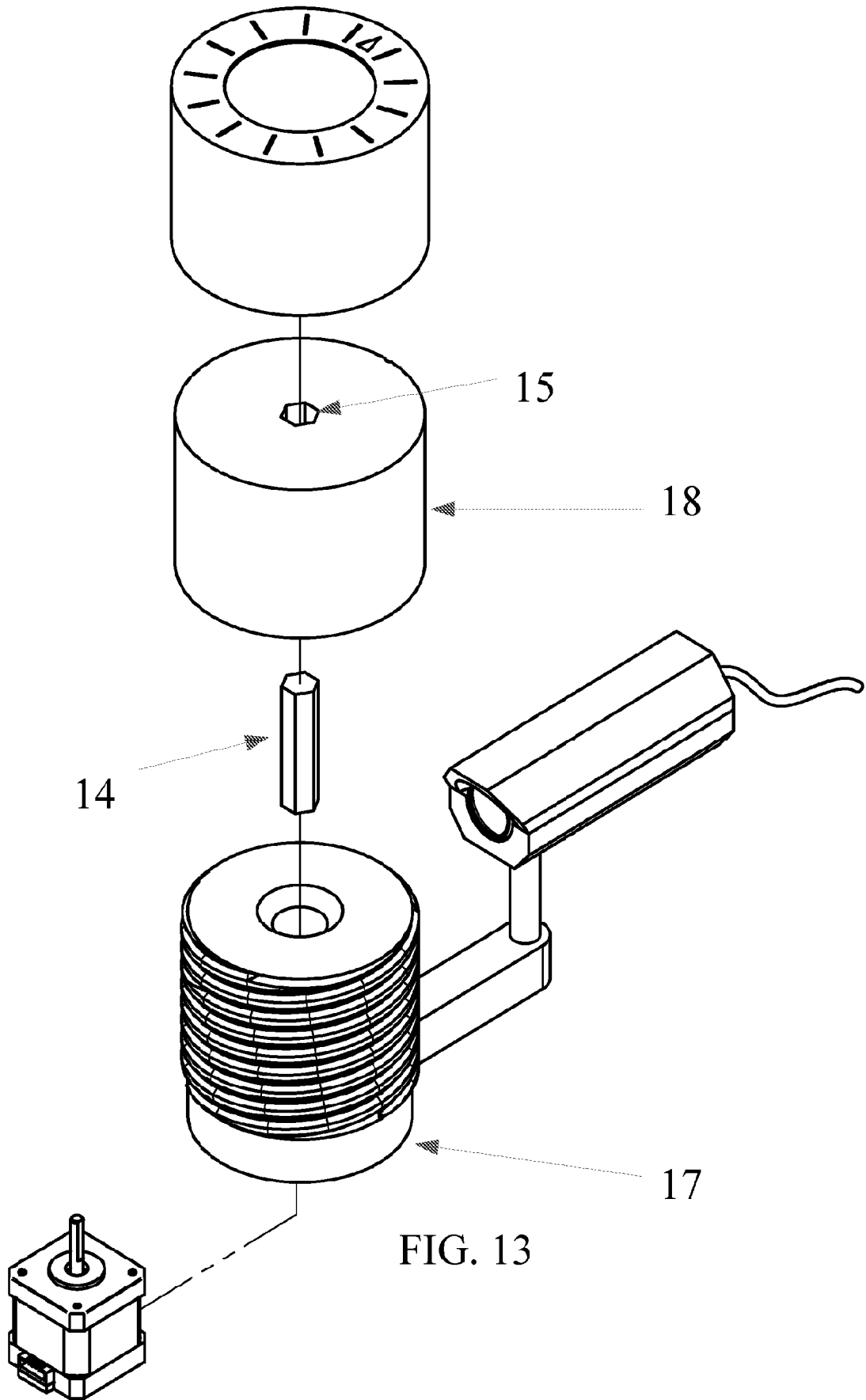


FIG. 10





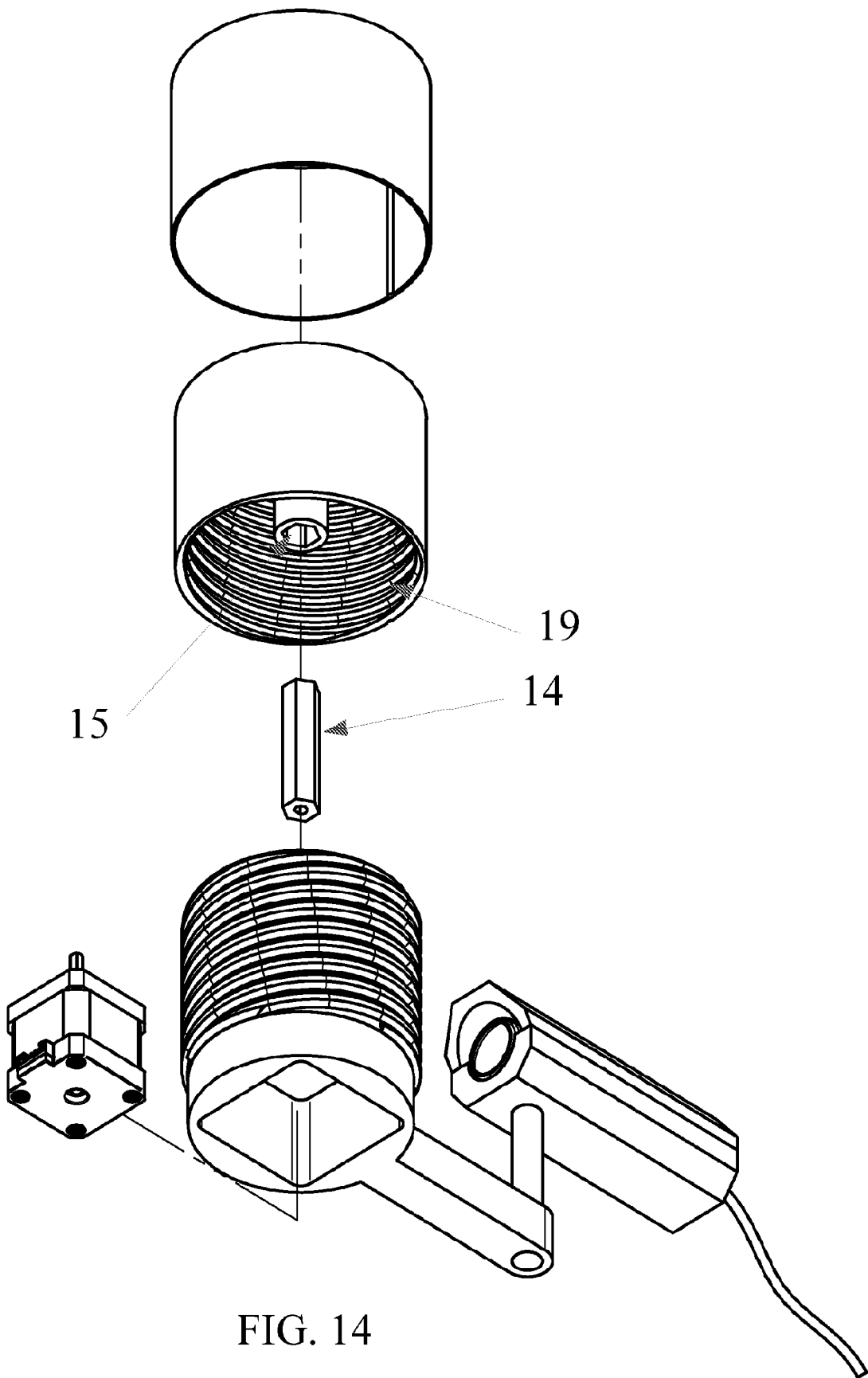


FIG. 14

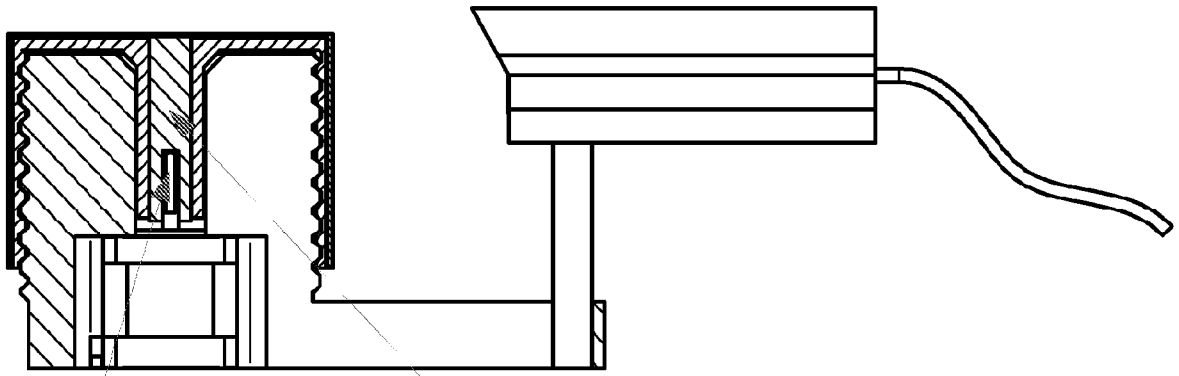
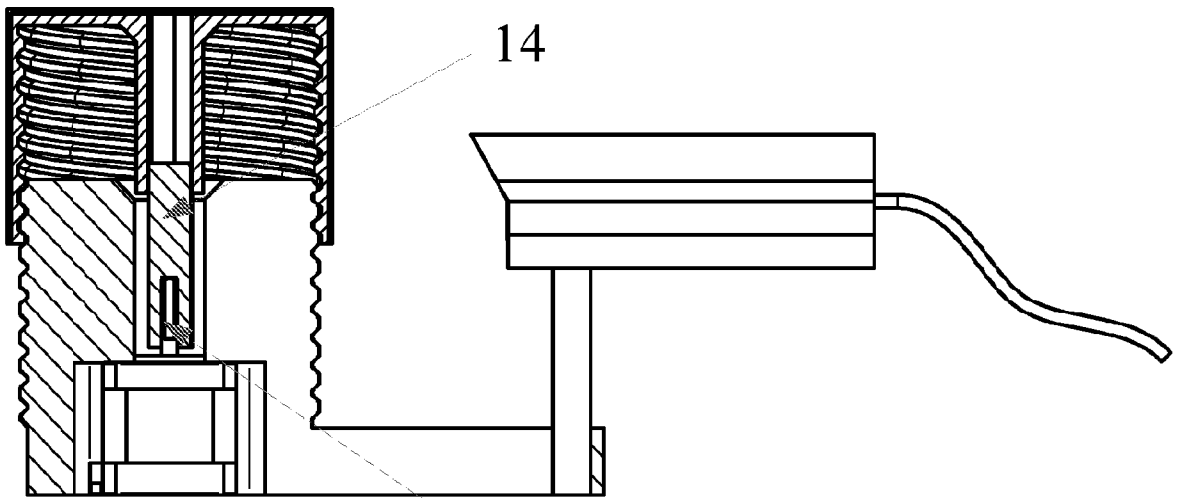


FIG. 15

14

13



14

FIG. 16

13

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/DK2024/050125

A. CLASSIFICATION OF SUBJECT MATTER																
IPC: see extra sheet																
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: A01M																
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																
SE, DK, FI, NO classes as above																
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																
KIME																
C. DOCUMENTS CONSIDERED TO BE RELEVANT																
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.														
A	CN 115443958 A (UNIV HUAZHONG AGRICULTURAL), 9 December 2022 (2022-12-09); figures 1-5; WPI-abstract --	1, 3, 5-10														
A	CN 104813993 A (UNIV CHINA MINING), 5 August 2015 (2015-08-05); figure 1; WPI-abstract --	1, 3, 5-10														
A	CN 218736759 U (BEIJING ECOMAN BIOTECH CO LTD ET AL), 28 March 2023 (2023-03-28); figures 1-4; WPI-abstract --	1, 3, 5-10														
A	CN 116058347 A (HENAN YUNFEI TECH DEVELOPMENT CO LTD), 5 May 2023 (2023-05-05); figures 1-3; WPI-abstract --	1, 3, 5-10														
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.																
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"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</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"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</td> </tr> <tr> <td>"D" document cited by the applicant in the international application</td> <td>"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</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"&amp;" document member of the same patent family</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td></td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			* Special categories of cited documents:	"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	"A" document defining the general state of the art which is not considered to be of particular relevance	"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	"D" document cited by the applicant in the international application	"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	"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another 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	
* Special categories of cited documents:	"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															
"A" document defining the general state of the art which is not considered to be of particular relevance	"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															
"D" document cited by the applicant in the international application	"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															
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family															
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another 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																
Date of the actual completion of the international search 11-09-2024		Date of mailing of the international search report 11-09-2024														
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INTERNATIONAL SEARCH REPORT

International application No.  
PCT/DK2024/050125

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2020172235 A1 (UNIV JOHNS HOPKINS), 27 August 2020 (2020-08-27); abstract; paragraphs [0038]-[0040]; figures 1-2 --	1, 3, 5-10
A	CN 110742047 A (UNIV SOUTHWEST), 4 February 2020 (2020-02-04); figures 6-9; WPI-abstract -- -----	1, 3, 5-10

**Continuation of:** second sheet

**International Patent Classification (IPC)**

**A01M 1/02** (2006.01)

**A01M 1/14** (2006.01)

**A01M 5/06** (2006.01)

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/DK2024/050125

**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.: **2, 4**  
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:  
  

See next page

.../...
  
- 3.  Claims Nos.:  
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 additional 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 additional fees, this Authority did not invite payment of additional fees.
- 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 restricted 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.

**Continuation of: Box No. II**

Claim 2 does not meet the requirement of Article 6 PCT since the matter for which protection is sought is not clearly defined. Claim 2 cannot be connected to claim 1 because claim 1 states that "a stationary central body 9 equipped with a thread 5, a slide groove 6" and "the axle of the motor is connected to the exterior rotating central body" while claim 2 states that "the axle of the motor is connected to the stationary central body and where the slide groove is in the exterior rotating central body". The slide groove (6) and the axle (13) of the motor (12) cannot be arranged in/connected to both the stationary central body (9) and the exterior rotating central body (10) at the same time.

Further, there is no embodiment in the description that describes a pest detection device having the axle (13) of the motor (12) being connected to the stationary central body (9) and the slide groove (6) being in the exterior rotating central body (10) instead of having the axle (13) of the motor (12) being connected to the rotating central body (10) and the slide groove (6) being in the stationary central body (9).

Consequently, it is not clear how a pest detection device having the axle of the motor being connected to the stationary central body and the slide groove being in the exterior rotating central body would look like.

Claim 4 does not meet the requirement of Article 6 PCT since the matter for which protection is sought is not clearly defined. Claim 4 cannot be connected to claims 1 or 3 because claims 1 and 3 state that the drive axle (13) of the motor (12) is rotational connected to the rotating central body (10, 18), while claim 4 states that the drive axle of the motor is rotational connected to the stationary central body (9, 17). The drive axle (13) of the motor cannot be connected to both the rotating central body (10, 18) and the stationary central body (9, 17) at the same time.

Further, there is no embodiment in the description that describes a pest detection device having the drive axle of the motor being rotational connected to the stationary central body (9, 17) instead of having the drive axle (13) of the motor (12) being rotational connected to the rotating central body (10, 18). Consequently, it is not clear how a pest detection device having the drive axle of the motor being rotational connected to the stationary central body would look like.

Claim 4 cannot be connected to itself (claim 4).

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

PCT/DK2024/050125

CN	115443958 A	09/12/2022	NONE			
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