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(54) **DEVICE FOR IN-SITU MEASUREMENT OF SUBSTANCE MIGRATION AND TRANSFORMATION ON SEDIMENT-WATER INTERFACE**

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G01N 15/04 (2006.01)
G01N 33/24 (2006.01)

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CPC ***G01N 1/12*** (2013.01); ***G01N 15/04*** (2013.01); ***G01N 33/246*** (2013.01)

(58) **Field of Classification Search**
CPC G01N 1/12; G01N 15/04; G01N 33/246
USPC 73/864.33
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,011,239 B1 * 9/2011 Chadwick G01N 33/18 210/785
2021/0208033 A1 * 7/2021 Wang G01N 1/14

* cited by examiner

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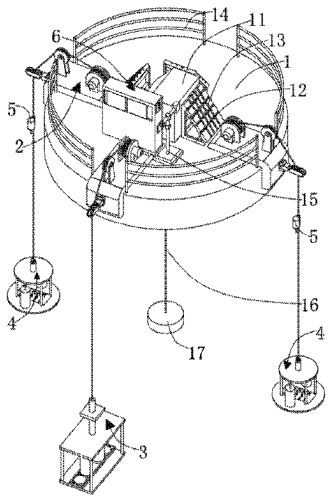
(57) **ABSTRACT**

A device for in-situ measurement of substance migration and transformation on a sediment-water interface includes a floating platform. Three take-up and pay-off components are fixedly connected to the edge of a top surface of the floating platform. Each take-up and pay-off component comprises an L-shaped base, a cable take-up and pay-off assembly, vertical rods, a guide sheave wheel, an adjustment assembly and a first cable. Two DGT samplers are fixedly connected to bottom ends of two three take-up and pay-off components. Water quality monitoring sensors are fixedly connected to the two first cables fixedly connected to the two DGT samplers, respectively. A sediment collector is fixedly connected to a bottom end of the other take-up and pay-off component. Sampling can be performed in-situ directly through DGT flat plates to avoid the impact of environmental changes.

10 Claims, 9 Drawing Sheets



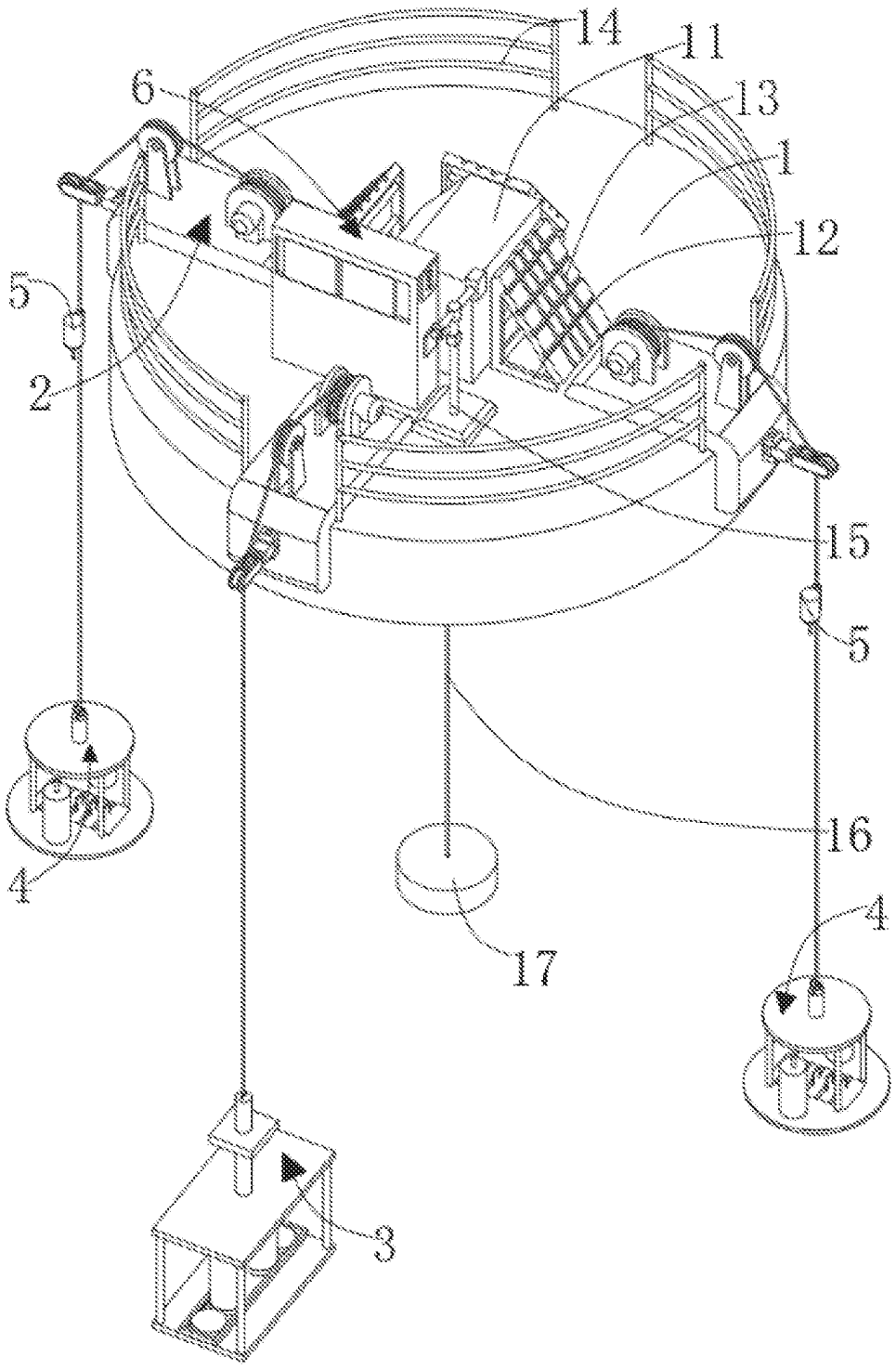


FIG. 1

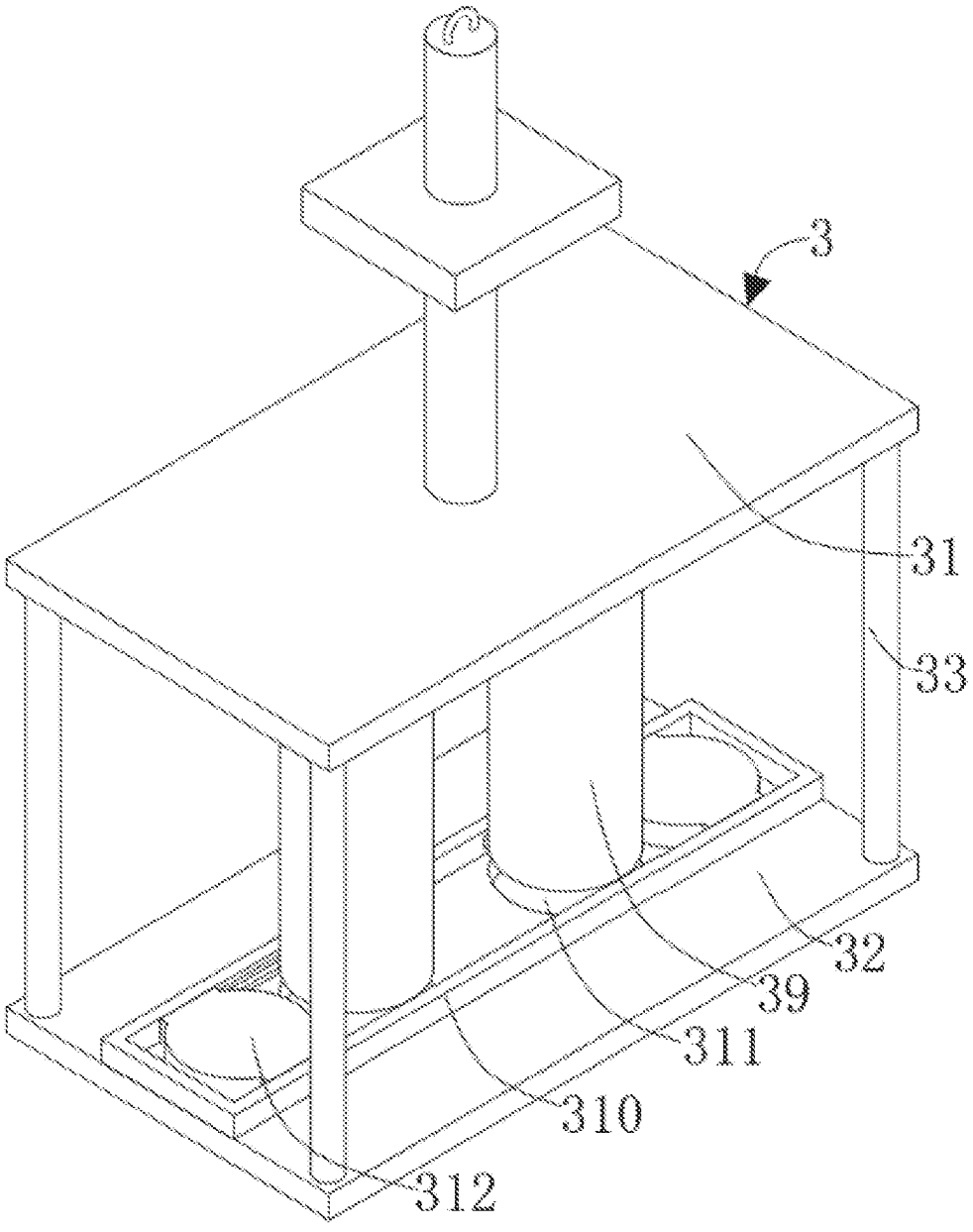


FIG. 2

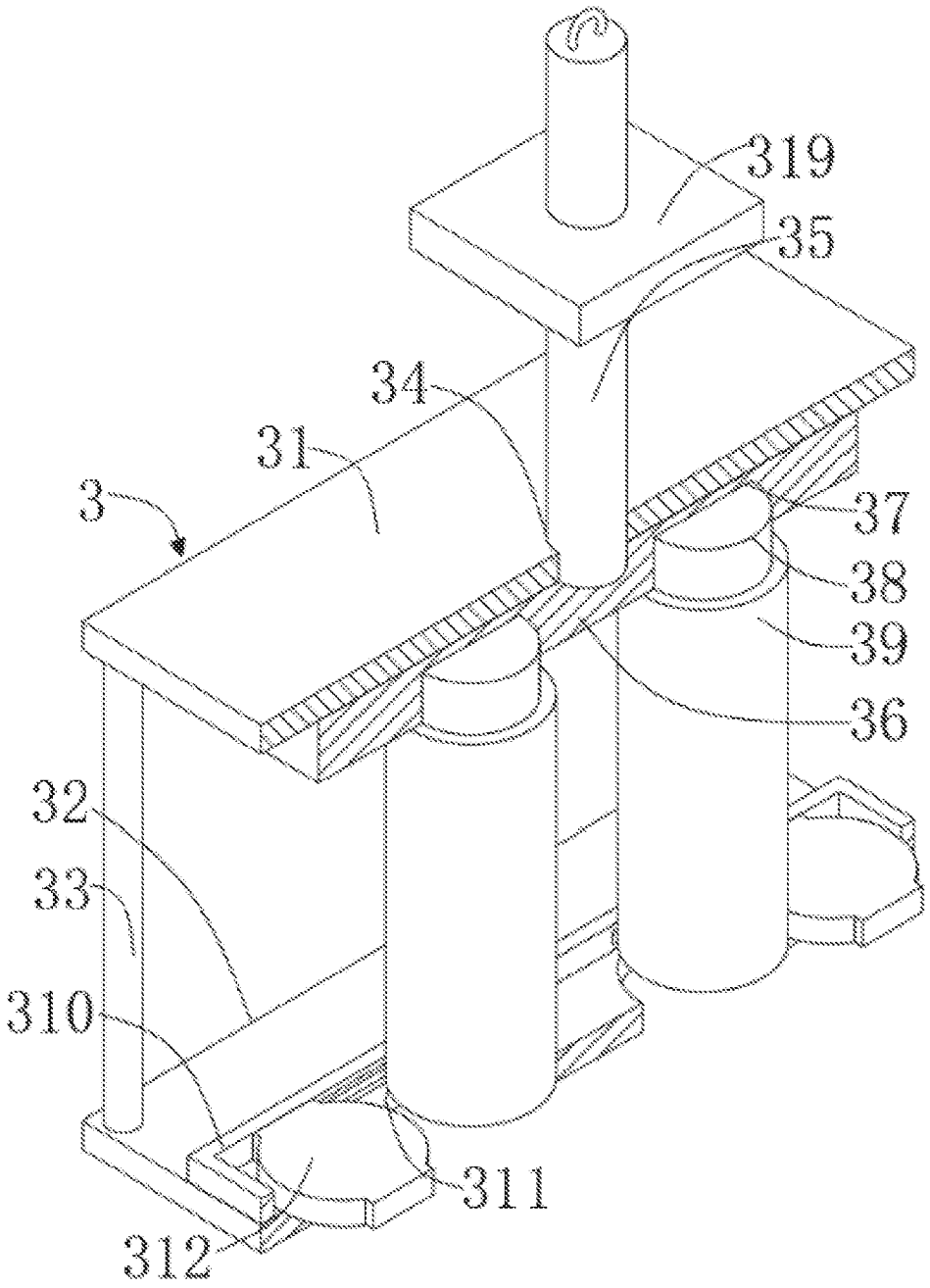


FIG. 3

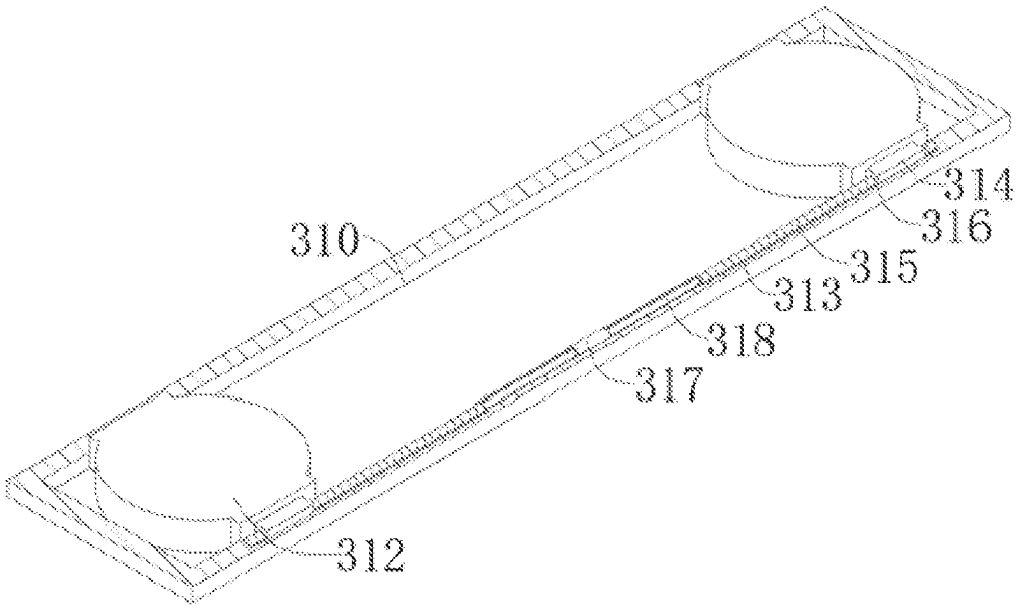


FIG. 4

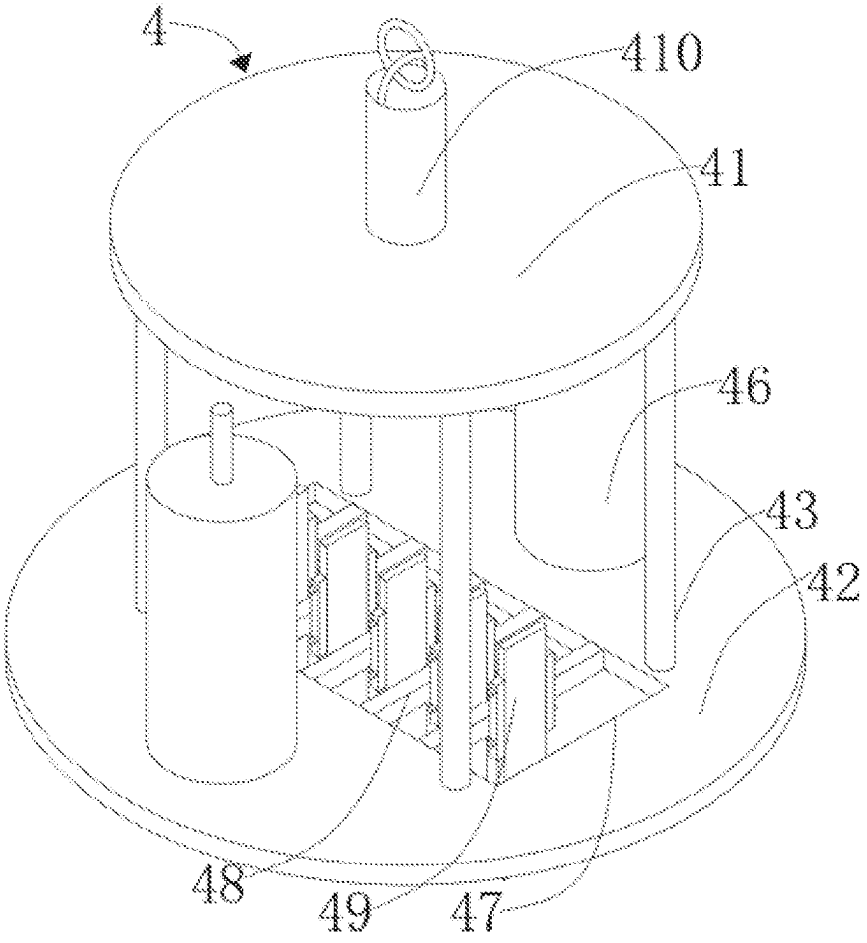


FIG. 5

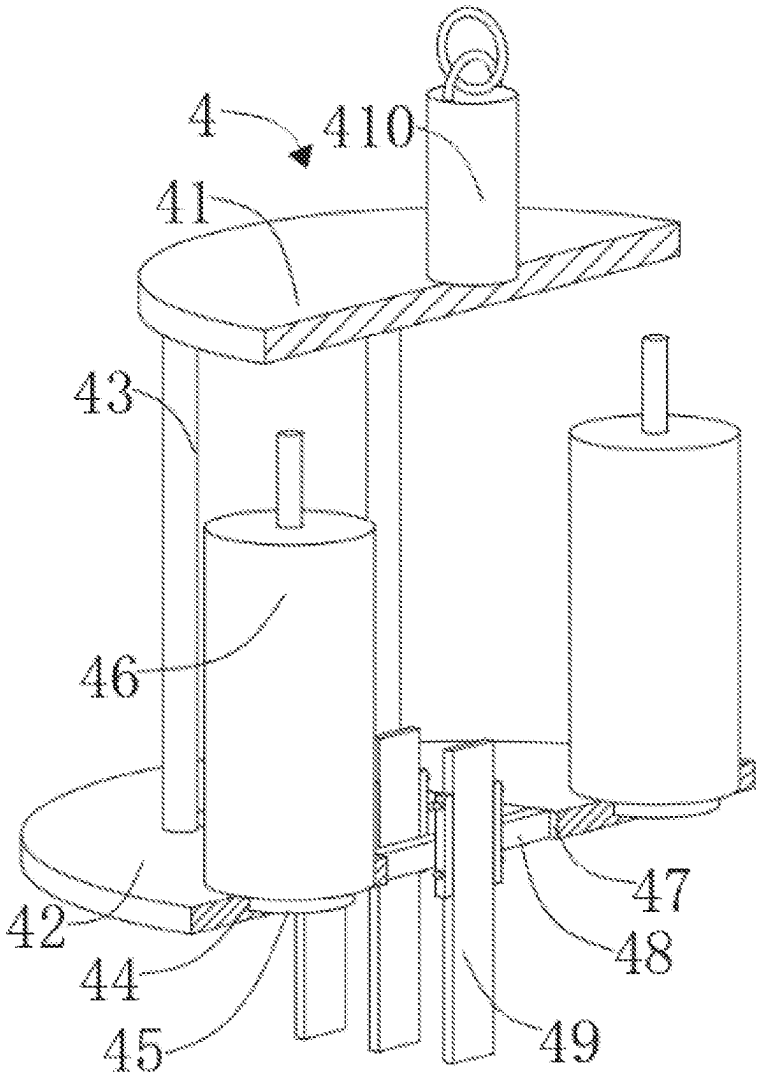


FIG. 6

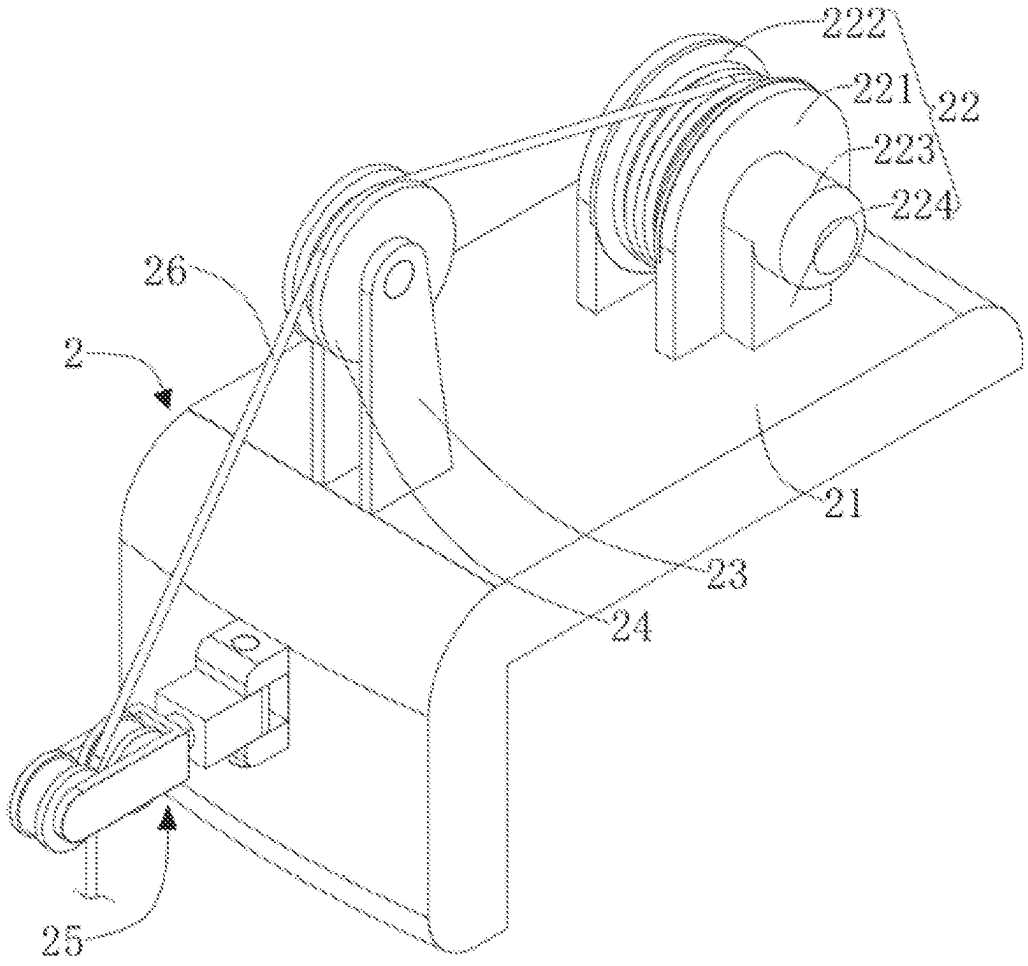


FIG. 7

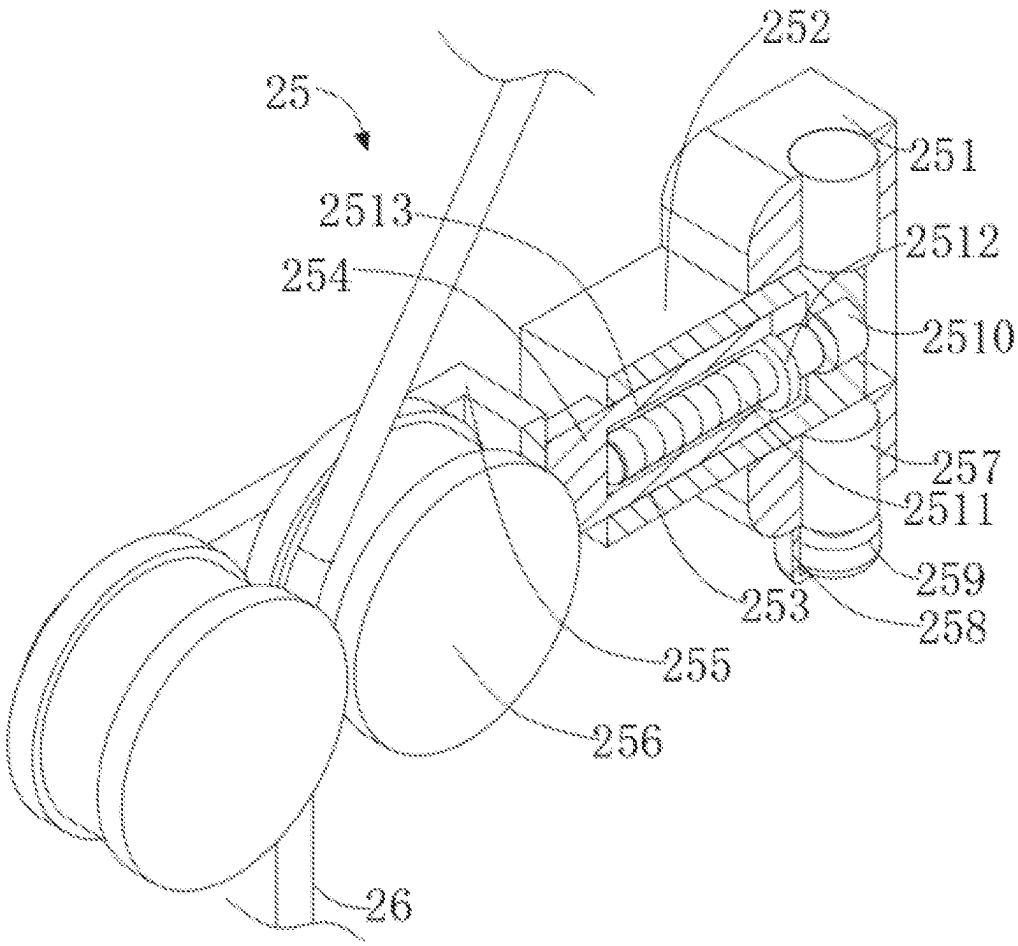


FIG. 8

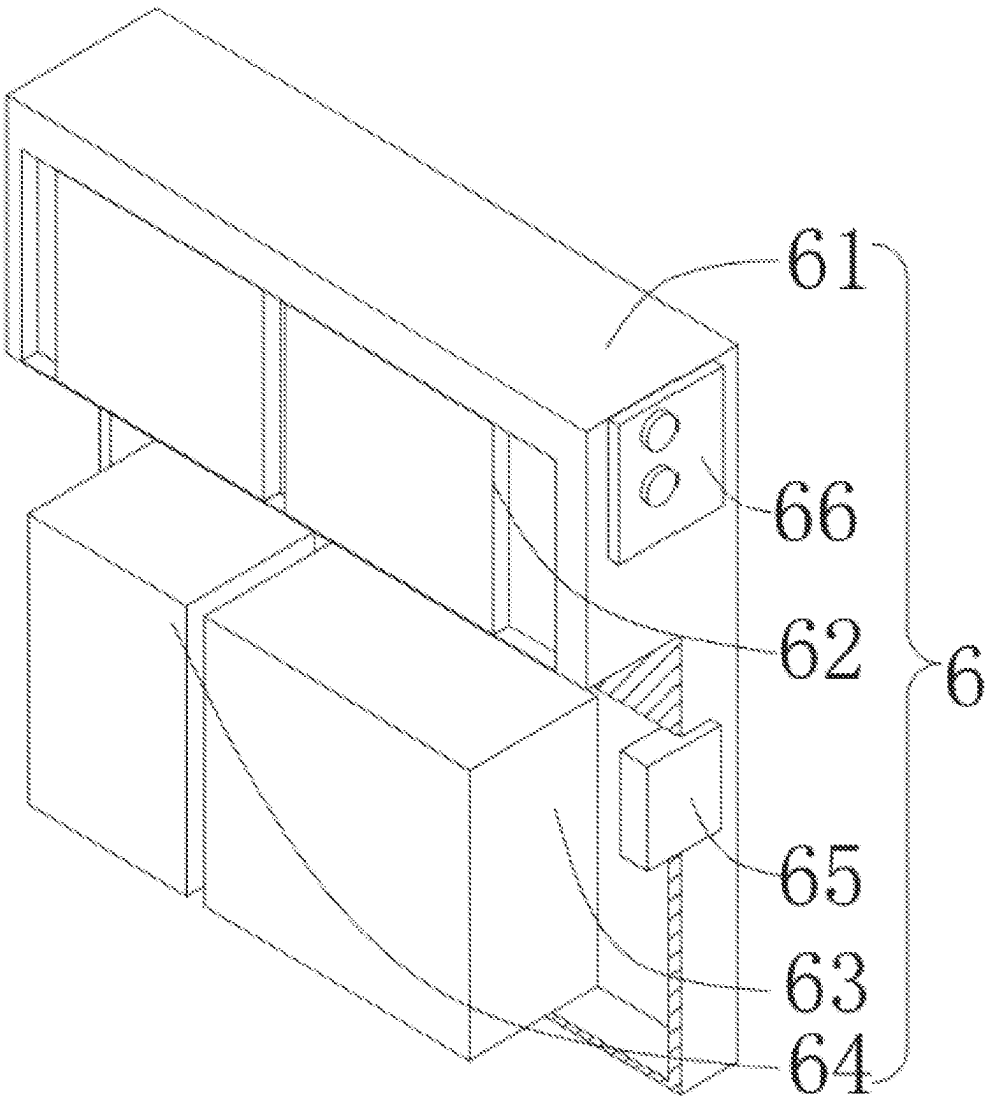


FIG. 9

DEVICE FOR IN-SITU MEASUREMENT OF SUBSTANCE MIGRATION AND TRANSFORMATION ON SEDIMENT-WATER INTERFACE

BACKGROUND OF THE INVENTION

1. Technical Field

The invention relates to the technical field of environmental science and engineering, in particular to a device for in-situ measurement of substance migration and transformation on a sediment-water interface.

2. Description of Related Art

With the growth of the global population and the rapid development of the economy, more and more pollutants are discharged into water, leading to water pollution. Exogenous input and endogenous release are two main provenance bases causing the rise of the pollutant concentration. The exogenous input is mainly from the emission of industrial and agricultural production as well as urban life. The endogenous release leads to a water pollution source due to the migration and transformation of corresponding pollutants in sediments and upward release under the action of diffusive gradients in thin-films (DGT), resuspension and bioturbation. At present, with the effective promotion of water ecological environment management, the exogenous input will be effectively controlled eventually, and the endogenous release becomes the main obstacle of water ecological restoration. Existing researches have shown that pollutants released by accumulated sediments in rivers may cause long-term pollution of water even if exogenous pollution is effectively controlled, which indicates the importance of endogenous pollution control. The change of any tiny organisms, chemical reactions and physical environments will have a complex impact on the sediment-water interface where pollutant migration and transformation occur. So, it can provide basic data support for endogenous pollution control to figure out pollutant migration features on the sediment-water interface. DGT, as a technique for in-situ measurement of the ion diffusion flux or the ion concentration in a medium, obtains the concentration of ions by quantitatively measuring and calculating the ions penetrating through a diffusive film with a certain thickness within a specific time based on Fick's first law of diffusion. With the development of DGT, it has been widely used for studying environmental hot issues, including the acquisition of information of metal cations and anions, organic matter and nano-particles, and can be used to study the physical and chemical behaviors and bio-availability of various substances in environmental media in conjunction with an effective mathematic model. At present, the migration and transformation of pollutants on the sediment-water interface are studied typically by collecting surface sediment samples to carry out a simulation experiment or collecting cylindrical samples and then inserting the cylindrical samples in DGT flat plates in a laboratory to capture target particles. However, such a method has the following drawbacks:

This experimental method can measure the diffusion flux and release rate of endogenous pollutants in case of variable water quantity or variable environmental factors. But, it cannot simulate changes caused by the field environment such as wind disturbance or water disturbance and cannot reflect accurate in-situ data of samples, which is not beneficial to research.

In view of this, a device for in-situ measurement of substance migration and transformation on a sediment-water interface is proposed to solve the above-mentioned problems.

BRIEF SUMMARY OF THE INVENTION

The objective of the invention is to provide a device for in-situ measurement of substance migration and transformation on a sediment-water interface to solve the problems mentioned in the description of related Art.

To fulfill the above objective, the invention provides the following technical solution: a device for in-situ measurement of substance migration and transformation on a sediment-water interface comprises a floating platform, wherein three take-up and pay-off components are fixedly connected to an edge of a top surface of the floating platform, each of the take-up and pay-off components comprises an L-shaped base, a cable take-up and pay-off assembly, vertical rods, a guide sheave wheel, an adjustment assembly and a first cable, two DGT samplers are fixedly connected to bottom ends of two of the three take-up and pay-off components, water quality monitoring sensors are fixedly connected to the two first cables fixedly connected to the two DGT samplers, respectively, and a sediment collector is fixedly connected to a bottom end of the other take-up and pay-off component;

The sediment collector comprises a top plate and a bottom plate, four first connecting pillars are vertically and fixedly connected between the top plate and the bottom plate, a sliding hole is vertically formed in the center of the top plate, a fixing rod is vertically and slidably connected into the sliding hole, a counterweight plate is fixedly connected to a bottom end of the fixing rod located below the top plate, two first threaded holes are formed in a bottom surface of the counterweight plate, first studs are threadedly connected into the first threaded holes, two sampling tubes are fixedly connected to bottom ends of the two first studs respectively, two sampling through-holes are vertically formed in the bottom plate and are located at identical vertical positions of the two sampling tubes, and bottom ends of the sampling tubes are open;

Each of the DGT samplers comprises a top circular plate and a bottom circular plate, four second connecting pillars are fixedly connected between the top circular plate and the bottom circular plate, two second threaded holes are formed in top surfaces of two sides of the bottom circular plate respectively, two second studs are threadedly connected into the two second threaded holes respectively, and two DGT flat plates are fixedly connected to top ends of the two second studs respectively.

Preferably, a square frame is fixedly connected to a top surface of the bottom plate and is located on an outer side of the two sampling through-holes, two sealing plates are slidably connected two inner sides of the square frame respectively, a top end of the fixing rod is fixedly connected to a bottom end of the first cable, and a stop plate is horizontally and fixedly connected to the fixing rod located above the top plate.

Preferably, two sliding grooves are formed in an inner wall of the square frame, two sliding blocks are slidably connected into the two sliding grooves respectively, the two sliding blocks are fixedly connected to the two sealing plates respectively, a double-shaft gear motor is fixedly connected into the square frame and is located between the two sliding grooves, two shaft levers are fixedly connected to two shaft ends of the double-shaft gear motor, two first lead screws are

rotatably connected into the two sliding grooves respectively, first threaded sleeves are fixedly connected into the sliding blocks, the first lead screws are threadedly connected to the first threaded sleeves, ends of the two shaft levers are fixedly connected to ends of the two first lead screws respectively, and threads on the two first lead screws are in opposite directions.

Preferably, a bottom opening is formed in the bottom circular plate and is located between the two DGT flat plates, multiple cross-bars are horizontally and fixedly connected into the bottom opening, multiple vertical counterweight plates are vertically and fixedly connected to the multiple cross-bars respectively, a connecting post is fixedly connected to the center of a top surface of the top circular plate, and a top end of the connecting post is fixedly connected to the first cable.

Preferably, a power distribution box and a central control unit are fixedly connected to the top surface of the floating platform, a second cable is vertically and fixedly connected to the center of a bottom surface of the floating platform, a balancing weight is fixedly connected to a bottom end of the second cable, the central control unit comprises a shell fixedly connected to the top surface of the floating platform, a touch display screen is fixedly connected to one side of a top surface of the shell, a host computer and a transmission module are fixedly connected into the shell, and a wiring board and a control panel are fixedly connected to a side wall of the shell.

Preferably, four fences are vertically and fixedly connected to the edge of the top surface of the floating platform, three oblique support frames are fixedly connected to the top surface of the floating platform and are located around the power distribution box, three photovoltaic panels are fixedly connected to the three oblique support frames respectively, and an automatic meteorological station is fixedly connected to the top surface of the floating platform.

Preferably, the L-shaped base is fixedly connected to an edge of the floating platform, the cable take-up and pay-off assembly is fixedly connected to an end of a top surface of the L-shaped base, the adjustment assembly is horizontally and fixedly connected to a side, away from the cable take-up and pay-off assembly, of the L-shaped base, the cable take-up and pay-off assembly comprises two vertical plates fixedly connected to the top surface of the L-shaped base, a reel is rotatably connected between top ends of the two vertical plates, a motor support is fixedly connected to the top surface of the L-shaped base, a first gear motor is fixedly connected to the motor support, a shaft end of the first gear motor is fixedly connected to a shaft end of the reel, the first cable is wound on the reel, and an end of the first cable is fixedly connected to the reel.

Preferably, the two vertical rods are vertically and fixedly connected to the top surface of the L-shaped base and are located between the cable take-up and pay-off assembly and the adjustment assembly, a guide sheave wheel is rotatably connected between top ends of the two vertical rods, and the first cable is in contact with a top surface of the guide sheave wheel.

Preferably, the adjustment assembly comprises a bracket fixedly connected to a side wall of the L-shaped base, a horizontal rod is horizontally and rotatably connected to an end, away from the L-shaped base, of the bracket, a sliding notch is formed in an end, away from the bracket, of the horizontal rod, a sliding column is horizontally and slidably connected into the sliding notch, an adjustment plate is fixedly connected to an end, away from the horizontal rod, of the sliding column, two adjustment sheave wheels are rotatably connected to the adjustment plate, and the first cable passes between the two adjustment sheave wheels.

Preferably, two shaft columns are fixedly connected to a top surface and a bottom surface of an end of the horizontal rod respectively, the shaft columns are rotatably connected to a side wall of the bracket, a motor shell is fixedly connected to a bottom surface of the bracket, a second gear motor is fixedly connected into the motor shell, a shaft end of the second gear motor is fixedly connected to an end of one of the two shaft columns, a third gear motor is fixedly connected into the horizontal rod and is located at a position close to the bracket, a second lead screw is horizontally and rotatably connected into the sliding notch, a cavity is formed in an end, close to the horizontal rod, of the sliding column, a second threaded sleeve is fixedly connected to an end of the cavity, the second lead screw is threadedly connected to the second threaded sleeve, and an end of the second lead screw is located in the cavity.

Compared with the prior art, the invention has the following beneficial effects:

In the invention, sampling can be performed in-situ directly through the DGT flat plates to avoid the impact of environmental changes, such that data is more accurate and can more truly reflect the condition of the samples in the actual environment; and in-situ observation, and collection and analysis of cylindrical samples can be performed at the same time, and the pollutant migration and transformation mechanism can be better studied according to these two types of data.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a structural view of a main part in Embodiment 1 and Embodiment 2 of the invention;

FIG. **2** is a structural view of a sediment collector in Embodiment 1 and Embodiment 2 of the invention;

FIG. **3** is a sectional structural view of the sediment collector in Embodiment 1 and Embodiment 2 of the invention;

FIG. **4** is a sectional structural view of a square frame in Embodiment 2 of the invention;

FIG. **5** is a structural view of a DGT sampler in Embodiment 1 and Embodiment 2 of the invention;

FIG. **6** is a sectional structural view of the DGT sampler in Embodiment 1 and Embodiment 2 of the invention;

FIG. **7** is a structural view of a take-up and pay-off component in Embodiment 3 of the invention;

FIG. **8** is a sectional structural view of an adjustment assembly in Embodiment 3 of the invention;

FIG. **9** is a sectional structural view of a central control unit in Embodiment 2 of the invention.

In the figures: **1**, floating platform; **2**, take-up and pay-off component; **3**, sediment collector; **4**, DGT sampler; **5**, water quality monitoring sensor; **6**, central control unit; **11**, power distribution box; **12**, oblique support frame; **13**, photovoltaic panel; **14**, fence; **15**, automatic meteorological station; **16**, second cable; **17**, balancing weight; **21**, L-shaped base; **22**, cable take-up and pay-off assembly; **23**, vertical rod; **24**, guide sheave wheel; **25**, adjustment assembly; **26**, first cable; **221**, vertical plate; **222**, reel; **223**, first gear motor; **224**, motor support; **251**, bracket; **252**, horizontal rod; **253**, sliding notch; **254**, sliding column; **255**, adjustment plate; **256**, adjustment sheave wheel; **257**, shaft column; **258**, motor shell; **259**, second gear motor; **2510**, third gear motor; **2511**, second lead screw; **2512**, second threaded sleeve; **2513**, cavity; **31**, top plate; **32**, bottom plate; **33**, first

connecting pillar; **34**, sliding hole; **35**, fixing rod; **36**, counterweight plate; **37**, first threaded hole; **38**, first stud; **39**, sampling tube; **310**, square frame; **311**, sampling through-hole; **312**, sealing plate; **313**, sliding groove; **314**, sliding block; **315**, first lead screw; **316**, first threaded sleeve; **317**, double-shaft gear motor; **318**, shaft lever; **319**, stop plate; **41**, top circular plate; **42**, bottom circular plate; **43**, second connecting pillar; **44**, second threaded hole; **45**, second stud; **46**, DGT flat plate; **47**, bottom opening; **48**, cross-bar; **49**, vertical counterweight plate; **410**, connecting post; **61**, shell; **62**, touch display screen; **63**, host computer; **64**, transmission module; **65**, wiring board; **66**, control panel.

DETAILED DESCRIPTION OF THE INVENTION

The technical solutions of the embodiments of the invention will be clearly and completely described below in conjunction with the accompanying drawings of the embodiments of the invention. Obviously, the following embodiments are merely illustrative ones, and are not all possible ones of the invention. All other embodiments obtained by those ordinarily skilled in the art based on the following ones without creative labor should also fall within the protection scope of the invention.

Embodiment 1

Referring to FIG. **1**-FIG. **3** and FIG. **5**-FIG. **6**, the invention provides the following technical solution: a device for in-situ measurement of substance migration and transformation on a sediment-water interface comprises a floating platform **1**, wherein three take-up and pay-off components **2** are fixedly connected to the edge of a top surface of the floating platform **1**, each take-up and pay-off component **2** comprises an L-shaped base **21**, a cable take-up and pay-off assembly **22**, vertical rods **23**, a guide sheave wheel **24**, an adjustment assembly **25** and a first cable **26**, two DGT samplers **4** are fixedly connected to bottom ends of two take-up and pay-off components **2**, water quality monitoring sensors **5** are fixedly connected to the two first cables **26** fixedly connected to the two DGT samplers **4**, respectively, and a sediment collector **3** is fixedly connected to a bottom end of the other take-up and pay-off component **2**;

The sediment collector **3** comprises a top plate **31** and a bottom plate **32**, wherein four first connecting pillars **33** are vertically and fixedly connected between the top plate **31** and the bottom plate **32**, a sliding hole **34** is vertically formed in the center of the top plate **31**, a fixing rod **35** is vertically and slidably connected into the sliding hole **34**, a counterweight plate **36** is fixedly connected to a bottom end of the fixing rod **35** located below the top plate **31**, two first threaded holes **37** are formed in a bottom surface of the counterweight plate **36**, first studs **38** are threadedly connected into the first threaded holes **37**, two sampling tubes **39** are fixedly connected to bottom ends of the two first studs **38**, respectively, two sampling through-holes **311** are vertically formed in the bottom plate **32** and are located at identical vertical positions of the two sampling tubes **39**, and bottom ends of the sampling tubes **39** are open; when the sediment collector **3** is used for collecting sediments, the first cable **26** is laid down through the take-up and pay-off component **2**, the bottom plate **32** of the sediment collector **3** reaches the bottom at first, then the first cable **26** is further laid down, the two sampling tubes **39** descend stably and slowly under the action of the gravity of the counterweight plate **36** to be pressed into the sediments and are kept static for 5-10 minutes, and when the sampling tubes **39** are completely inserted into the sediments, samples enter the sampling tubes **39**; then, the first cable **26** is pulled upwards, the sampling tubes **39** rise synchronously, at this moment, bottoms of the sampling tubes **39** are sealed by sealing plates **312**, and the first cable **26** is further pulled upwards to retrieve the sediment collector **3**;

Each DGT sampler **4** comprises a top circular plate **41** and a bottom circular plate **42**, four second connecting pillars **43** are fixedly connected between the top circular plate **41** and the bottom circular plate **42**, two second threaded holes **44** are formed in top surfaces of two sides of the bottom circular plate **42** respectively, two second studs **45** are threadedly connected into the two second threaded holes **44** respectively, and two DGT flat plates **46** are fixedly connected to top ends of the two second studs **45** respectively; and when the DGT sampler **4** is used for sampling, the first cable **26** is laid down, the bottom circular plate **42** is placed on a sediment-water interface by means of vertical counterweight plates **49**, and bottom ends of the vertical counterweight plates **49** are inserted into the sediments until they reach the bottom, wherein the number of the DGT flat plates **46** can be increased according to the types of collected pollutants; and the DGT sampler **4** is retrieved 24 hours later, and the DGT flat plates **46** are detached from the DGT sampler **4**.

Embodiment 2

Refer to FIG. **1**-**6** and FIG. **9** which illustrate Embodiment 2 of the invention. In Embodiment 2 which is based on Embodiment 1, a square frame **310** is fixedly connected to a top surface of the bottom plate **32** and is located on an outer side of the two sampling through-holes **311**, two sealing plates **312** are slidably connected to two inner sides of the square frame **310** respectively, a top end of the fixing rod **35** is fixedly connected to a bottom end of the first cable **26**, and a stop plate **319** is horizontally and fixedly connected to the fixing rod **35** located above the top plate **31**.

Two sliding grooves **313** are formed in an inner wall of the square frame **310**, two sliding blocks **314** are slidably connected into the two sliding grooves **313** and are fixedly connected to the two sealing plates **312** respectively, a double-shaft gear motor **317** is fixedly connected into the square frame **310** and is located between the two sliding grooves **313**, two shaft levers **318** are fixedly connected to two shaft ends of the double-shaft gear motor **317** respectively, two first lead screws **315** are rotatably connected into the two sliding grooves **313** respectively, first threaded sleeves **316** are fixedly connected into the sliding blocks **314**, the first lead screws **315** are threadedly connected to the first threaded sleeves **316**, ends of the two shaft levers **318** are fixedly connected to ends of the two first lead screws **315** respectively, threads on the two first lead screws **315** are in opposite directions, the double-shaft gear motor **317** drives the two first lead screws **315** to rotate, so as to drive the two sealing plates **312** to move through the first threaded sleeves **316**, and after sampling is finished, the bottoms of the sampling tubes **39** are sealed by the sealing plates **312**.

A bottom opening **47** is formed in the bottom circular plate **42** and is located between the two DGT flat plates **46**, multiple cross-bars **48** are horizontally and fixedly connected into the bottom opening **47**, multiple vertical counterweight plates **49** are vertically and fixedly connected to the multiple cross-bars **48** respectively, a connecting post **410** is fixedly connected to the center of a top surface of the top circular plate **41**, and a top end of the connecting post **410** is fixedly connected to the first cable **26**.

A power distribution box **11** and a central control unit **6** are fixedly connected to the top surface of the floating platform **1**, a second cable **16** is vertically and fixedly connected to the center of a bottom surface of the floating platform **1**, a balancing weight **17** is fixedly connected to a bottom end of the second cable **16**, the central control unit **6** comprises a shell **61** fixedly connected to the top surface of the floating platform **1**, a touch display screen **62** is fixedly connected to one side of a top surface of the shell **61**, a host computer **63** and a transmission module **64** are fixedly connected into the shell **61**, a wiring board **65** and a control panel **66** are fixedly connected to a side wall of the shell **61**, and the control panel **66** is used for controlling the take-up and pay-off components **2** and the double-shaft gear motor **317** in the sediment collector **3**.

Four fences **14** are vertically and fixedly connected to the edge of the top surface of the floating platform **1**, three oblique support frames **12** are fixedly connected to the top surface of the floating platform **1** and are located around the power distribution box **11**, three photovoltaic panels **13** are fixedly connected to the three oblique support frames **12** respectively, and an automatic meteorological station **15** is fixedly connected to the top surface of the floating platform **1** and is used for recording meteorological data such as wind speed, wind direction, air temperature, air humidity, air pressure, and rainfall.

Embodiment 3

Refer to FIG. **7**-FIG. **8** which illustrate Embodiment 3 of the invention. In Embodiment 3 which is based on the above two embodiments, the L-shaped base **21** is fixedly connected to the edge of the floating platform **1**, the cable take-up and pay-off assembly **22** is fixedly connected to the end of a top surface of the L-shaped base **21**, the adjustment assembly **25** is horizontally and fixedly connected to a side, away from the cable take-up and pay-off assembly **22**, of the L-shaped base **21**, the cable take-up and pay-off assembly **22** comprises two vertical plates **221** fixedly connected to the top surface of the L-shaped base **21**, a reel **222** is rotatably connected between top ends of the two vertical plates **221**, a motor support **224** is fixedly connected to the top surface of the L-shaped base **21**, a first gear motor **223** is fixedly connected to the motor support **224**, a shaft end of the first gear motor **223** is fixedly connected to a shaft end of the reel **222**, the first cable **26** is wound on the reel **222**, and the end of the first cable **26** is fixedly connected to the reel **222**.

Two vertical rods **23** are vertically and fixedly connected to the top surface of the L-shaped base **21** and are located between the cable take-up and pay-off assembly **22** and the adjustment assembly **25**, the guide sheave wheel **24** is rotatably connected between top ends of the two vertical rods **23**, and the first cable **26** is in contact with a top surface of the guide sheave wheel **24**.

The adjustment assembly **25** comprises a bracket **251** fixedly connected to a side wall of the L-shaped base **21**, a horizontal rod **252** is horizontally and rotatably connected to an end, away from the L-shaped base **21**, of the bracket **251**, a sliding notch **253** is formed in an end, away from the bracket **251**, of the horizontal rod **252**, a sliding column **254** is horizontally and slidably connected into the sliding notch **253**, an adjustment plate **255** is fixedly connected to an end, away from the horizontal rod **252**, of the sliding column **254**, two adjustment sheave wheels **256** are rotatably connected to the adjustment plate **255**, and the first cable **26** passes between the two adjustment sheave wheels **256**.

Two shaft columns **257** are fixedly connected to a top surface and a bottom surface of an end of the horizontal rod **252** respectively and are rotatably connected to a side wall of the bracket **251**, a motor shell **258** is fixedly connected to a bottom surface of the bracket **251**, a second gear motor **259** is fixedly connected into the motor shell **258**, a shaft end of the second gear motor **259** is fixedly connected to the end of one shaft column **257**, a third gear motor **2510** is fixedly connected into the horizontal rod **252** and is located at a position close to the bracket **251**, a second lead screw **2511** is horizontally and rotatably connected into the sliding notch **253**, a cavity **2513** is formed in an end, close to the horizontal rod **252**, of the sliding column **254**, a second threaded sleeve **2512** is fixedly connected to an end of the cavity **2513**, a second lead screw **2511** is threadedly connected to the second threaded sleeve **2512**, an end of the second lead screw **2511** is located in the cavity **2513**, the second gear motor **259** drives the adjustment plate **255** to swing horizontally, and the third gear motor **2510** drives the sliding column **254** to slide to change the horizontal length of the adjustment plate **255**, such that the position where the first cable **26** is laid can be slightly adjusted to perform sampling at a designated position more accurately.

Embodiment 4

When the device is used for collecting sediments, the first cable **26** is laid down through the take-up and pay-off component **2**, the bottom plate **32** of the sediment collector **3** reaches the bottom first, then the first cable **26** is further laid down, the two sampling tubes **39** descend stably and slowly under the action of the gravity of the counterweight plate **36** to be pressed into the sediments and are kept static for 5-10 minutes, and when the sampling tubes **39** are completely inserted into the sediments, samples enter the sampling tubes **39**; then, the first cable **26** is pulled upwards, the sampling tubes **39** rise synchronously, at this moment, the bottoms of the sampling tubes **39** are sealed by the sealing plates **312**, the first cable **26** is further pulled upwards to retrieve the sediment collector **3**, and the sampling tubes **39** are detached from the sediment collector to obtain the samples. When the DGT flat plates **46** are used for collection, the first cable **26** is laid down, the bottom circular plate **42** is placed on a sediment-water interface by means of the vertical counterweight plates **49**, and the bottom ends of the vertical counterweight plates **49** are inserted into the sediments until they reach the bottom, wherein the number of the DGT flat plates **46** can be increased according to the types of collected pollutants; and the DGT sampler **4** is retrieved 24 hours later, and the DGT flat plates **46** are detached from the DGT sampler **4**. In the invention, sampling can be performed in-situ directly through the DGT flat plates **46** to avoid the impact of environmental changes, such that data is more accurate and can more truly reflect the condition of the samples in the actual environment; and in-situ observation, and collection and analysis of cylindrical samples can be performed at the same time, and the pollutant migration and transformation mechanism can be better studied according to these two types of data.

Although the embodiments of the invention have been illustrated and described above, those ordinarily skilled in the art should understand that various changes, amendments, substitutions and transformations can be made without departing from the principle and spirit of the invention. The scope of the invention should be defined by the claims and their equivalents.

What is claimed is:

1. A device for in-situ measurement of substance migration and transformation on a sediment-water interface, comprising: a floating platform, wherein: three take-up and pay-off components are fixedly connected to an edge of a top surface of the floating platform, each of the take-up and pay-off components comprises an L-shaped base, a cable take-up and pay-off assembly, vertical rods, a guide sheave wheel, an adjustment assembly and a first cable, two Diffusive Gradients in Thin-Films (DGT) samplers are fixedly connected to bottom ends of two of the three take-up and pay-off components, water quality monitoring sensors are fixedly connected to the two first cables fixedly connected to the two DGT samplers, respectively, and a sediment collector is fixedly connected to a bottom end of the other take-up and pay-off component; the sediment collector comprises a top plate and a bottom plate, four first connecting pillars are vertically and fixedly connected between the top plate and the bottom plate, a sliding hole is vertically formed in a center of the top plate, a fixing rod is vertically and slidably connected into the sliding hole, a counterweight plate is fixedly connected to a bottom end of the fixing rod located below the top plate, two first threaded holes are formed in a bottom surface of the counterweight plate, first studs are threadedly connected into the first threaded holes, two sampling tubes are fixedly connected to bottom ends of the two first studs respectively, two sampling through-holes are vertically formed in the bottom plate and are located at identical vertical positions of the two sampling tubes, and bottom ends of the sampling tubes are open, each of the DGT samplers comprises a top circular plate and a bottom circular plate, four second connecting pillars are fixedly connected between the top circular plate and the bottom circular plate, two second threaded holes are formed in top surfaces of two sides of the bottom circular plate respectively, two second studs are threadedly connected into the two second threaded holes respectively, and two DGT flat plates are fixedly connected to top ends of the two second studs respectively.

2. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 1, wherein a square frame is fixedly connected to a top surface of the bottom plate and is located on an outer side of the two sampling through-holes, two sealing plates are slidably connected two inner sides of the square frame respectively, a top end of the fixing rod is fixedly connected to a bottom end of the first cable, and a stop plate is horizontally and fixedly connected to the fixing rod located above the top plate.

3. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 2, wherein two sliding grooves are formed in an inner wall of the square frame, two sliding blocks are slidably connected into the two sliding grooves respectively, the two sliding blocks are fixedly connected to the two sealing plates respectively, a double-shaft gear motor is fixedly connected into the square frame and is located between the two sliding grooves, two shaft levers are fixedly connected to two shaft ends of the double-shaft gear motor, two first lead screws are rotatably connected into the two sliding grooves respectively, first threaded sleeves are fixedly connected into the sliding blocks, the first lead screws are threadedly connected to the first threaded sleeves, ends of the two shaft levers are fixedly connected to ends of the two first lead screws respectively, and threads on the two first lead screws are in opposite directions.

4. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 1, wherein a bottom opening is formed in the bottom circular plate and is located between the two DGT flat plates, multiple cross-bars are horizontally and fixedly connected into the bottom opening, multiple vertical counterweight plates are vertically and fixedly connected to the multiple cross-bars respectively, a connecting post is fixedly connected to a center of a top surface of the top circular plate, and a top end of the connecting post is fixedly connected to the first cable.

5. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 1, wherein a power distribution box and a central control unit are fixedly connected to the top surface of the floating platform, a second cable is vertically and fixedly connected to a center of a bottom surface of the floating platform, a balancing weight is fixedly connected to a bottom end of the second cable, the central control unit comprises a shell fixedly connected to the top surface of the floating platform, a touch display screen is fixedly connected to one side of a top surface of the shell, a host computer and a transmission module are fixedly connected into the shell, and a wiring board and a control panel are fixedly connected to a side wall of the shell.

6. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 5, wherein four fences are vertically and fixedly connected to the edge of the top surface of the floating platform, three oblique support frames are fixedly connected to the top surface of the floating platform (1) and are located around the power distribution box, three photovoltaic panels are fixedly connected to the three oblique support frames respectively, and an automatic meteorological station is fixedly connected to the top surface of the floating platform.

7. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 1, wherein the L-shaped base is fixedly connected to an edge of the floating platform, the cable take-up and pay-off assembly is fixedly connected to an end of a top surface of the L-shaped base, the adjustment assembly is horizontally and fixedly connected to a side, away from the cable take-up and pay-off assembly, of the L-shaped base, the cable take-up and pay-off assembly comprises two vertical plates fixedly connected to the top surface of the L-shaped base, a reel is rotatably connected between top ends of the two vertical plates, a motor support is fixedly connected to the top surface of the L-shaped base, a first gear motor is fixedly connected to the motor support, a shaft end of the first gear motor is fixedly connected to a shaft end of the reel, the first cable is wound on the reel, and an end of the first cable is fixedly connected to the reel.

8. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 7, wherein the two vertical rods are vertically and fixedly connected to the top surface of the L-shaped base and are located between the cable take-up and pay-off assembly and the adjustment assembly, a guide sheave wheel is rotatably connected between top ends of the two vertical rods, and the first cable is in contact with a top surface of the guide sheave wheel.

9. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim 7, wherein the adjustment assembly comprises a bracket fixedly connected to a side wall of the L-shaped base, a horizontal rod is horizontally and rotatably

connected to an end, away from the L-shaped base, of the bracket, a sliding notch is formed in an end, away from the bracket, of the horizontal rod, a sliding column is horizontally and slidably connected into the sliding notch, an adjustment plate is fixedly connected to an end, away from the horizontal rod, of the sliding column, two adjustment sheave wheels are rotatably connected to the adjustment plate, and the first cable passes between the two adjustment sheave wheels.

10. The device for in-situ measurement of substance migration and transformation on a sediment-water interface according to claim **9**, wherein two shaft columns are fixedly connected to a top surface and a bottom surface of an end of the horizontal rod respectively, the shaft columns are rotatably connected to a side wall of the bracket (**251**), a motor shell is fixedly connected to a bottom surface of the bracket, a second gear motor is fixedly connected into the motor shell, a shaft end of the second gear motor is fixedly connected to an end of one of the two shaft columns, a third gear motor is fixedly connected into the horizontal rod and is located at a position close to the bracket, a second lead screw is horizontally and rotatably connected into the sliding notch, a cavity (is formed in an end, close to the horizontal rod, of the sliding column, a second threaded sleeve is fixedly connected to an end of the cavity, the second lead screw is threadedly connected to the second threaded sleeve, and an end of the second lead screw is located in the cavity.

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