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(71) Applicants:
- **Pingmei Jiangong Group Special Drilling Engineering Co., Ltd**
  Zhengzhou, Henan 450002 (CN)
- **Shanghai Shuqi Mechanical-Electrical Engineering Inc.**
  Shanghai 200120 (CN)

(72) Inventors:
- **LIAO, Weiyong**
  Zhengzhou, Henan 450002 (CN)
- **HU, Guijun**
  Zhengzhou, Henan 450002 (CN)
- **WANG, Haibo**
  Zhengzhou, Henan 450002 (CN)

(54) FORCED TYPE DRILLING SLUDGE-FLUID SEPARATOR

(57) A forced drilling sludge-fluid separator, comprising a sludge-fluid kinetic energy attenuation tank (1), a sedimented sludge tank (3) and a sedimented sludge conveying device (4) which are arranged from top to bottom and communicated in sequence; the separator further comprises a mud pipe (5) for feeding drilling sludge and fluid, a grid plate (2) used for re-attenuating and splitting the kinetic energy of the drilling sludge and fluid and screening large pieces of drilling sludge, a refluxing tank (7) used for conveying the separated drilling fluid back to a drilled well, and a hydrocyclone desilting device for further desilting. According to the separator, the processes of sludge sedimentation, sludge removing and desilting in the drilling operation are finished in the same equipment simultaneously, and the separator has the advantages of compact structure, small volume, safety and reliability, and easiness in operation.

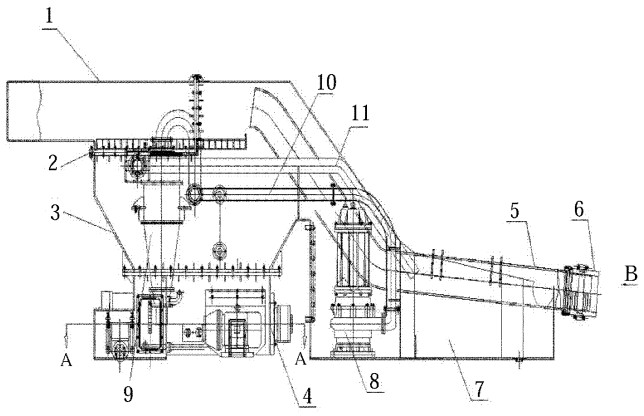

FIG. 1

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Description

[0001] The disclosure relates to the technical field of engineering drillers, and more particularly to a device for forcedly separating slag from fluid from well drilling.

[0002] In the related art, the separation of slag from fluid in a flushing fluid of a large engineering driller primarily includes conducting settlement on a mud settling pond and mounting a gravel pump and a hydrocyclone unit independently on the periphery as well to separate sand in the flushing fluid in an auxiliary manner. Although the method can play a certain separating role, the method is not ideal in separating effect and has many disadvantages, for example, a huge site is needed in a drilling scene to arrange various devices. In particular, as far as overwater drilling operation is concerned, it is quite difficult to implement the conventional method.

[0003] Chinese Patent Publication No. CN209195306U discloses a closed circulation system for a drilling fluid of small and medium size drilling machines. Although optimizing the drilling fluid circulation system, the system is complex and bulky, and parts are disposed dispersedly. The system only has settling and desanding functions and cannot separate fine particles in the drilling fluid, is unsatisfactory in separating and deslagging effect, and cannot be suitable for some occasions with special requirements.

[0004] Aiming at problems existing in the related art, the disclosure provides a device for forcedly separating slag from fluid from well drilling which overcomes the defect that a conventional drilling fluid and slag separating device occupies much area in a drilling construction process, and the device for forcedly separating slag from fluid from well drilling of the disclosure is compact in structure, small in size and convenient to operate.

[0005] To achieve the above purpose, the disclosure provides a device for forcedly separating slag from fluid from well drilling, the device comprising a slag and fluid kinetic energy attenuation box, a sediment box, a sediment conveying apparatus, a mud pipe, a grid and a return trough. The slag and fluid kinetic energy attenuation box, the sediment box and the sediment conveying apparatus are disposed from top to bottom and communicate with each other in sequence; the slag and fluid kinetic energy attenuation box is a hollow box body with one end being opened and the other end being closed; one end of the mud pipe is connected to an outlet pipe of a drilling machine of a drilling reverse circulation system and the other end of the mud pipe is located at an opened end of the slag and fluid kinetic energy attenuation box; the grid is disposed between the slag and fluid kinetic energy attenuation box and the sediment box and is used for re-attenuating kinetic energy of drilling slag and fluid, dividing the drilling slag and fluid and screening bulky drilling slag; and the return trough communicates with an overflow port of the sediment box, and an outlet of the return trough is used for outputting the separated drilling fluid to return to a drilled well.

[0006] Further, the device further comprises a hydraulic cyclone desanding apparatus. The hydraulic cyclone desanding apparatus comprises a hydrocyclone and a submersible gravel pump. The submersible gravel pump is disposed in the return trough, a mud inlet of the hydrocyclone is connected to a mud outlet of the submersible gravel pump via a fluid inlet pipe, and a fluid outlet pipe of the hydrocyclone is led to an outlet of the return trough.

[0007] Specifically, a lower portion of the slag and fluid kinetic energy attenuation box is connected to an upper portion of the sediment box integrally, a mud outlet of the slag and fluid kinetic energy attenuation box corresponds to a mud inlet of the sediment box, and the grid is horizontally fixed in the slag and fluid kinetic energy attenuation box c or in the sediment box.

[0008] Preferably, to optimize the dividing and screening effects and guarantee the strength of the grid, the grid is a steel grid. However, the grid can be selected and used flexibly according to an actual situation and is not limited to the steel grid.

[0009] Preferably, the sediment conveying apparatus is a spiral conveyor.

[0010] Specifically, an upper portion of the spiral conveyor is connected to a bottom of the sediment box integrally, a sediment inlet of the spiral conveyor corresponds to a sediment outlet of the sediment box, and an outlet end of the spiral conveyor is provided with a gate.

[0011] Compared with the related art, the following advantages are associated with the device for forcedly separating slag from fluid from well drilling of the disclosure: it is unnecessary to arrange the independent mud settling pond, and the slag and fluid kinetic energy attenuation box, the sediment box and the sediment conveying apparatus are disposed in a centralized manner, and thereby, the occupied area of the device for forcedly separating slag from fluid from well drilling is decreased greatly, and the device for forcedly separating slag from fluid from well drilling is compact in structure and convenient to operate. According to the disclosure, first, kinetic energy of the drilling slag and fluid sent out from the mud pipe is attenuated greatly by using the slag and fluid kinetic energy attenuation box for the convenience of subsequent effective operation of sediment, and then the drilling slag and fluid are filtered preliminarily by using the grid, and thus, sedimentation and deslagging are conducted by using the sediment box and drilling slag is discharged by the sediment conveying apparatus. As far as operation with higher requirement on the drilling fluid returned to the drilled well is concerned, fine grains of sand can be further removed by using the hydrocyclone, and thereby, a better separating effect is achieved. According to the disclosure, as rock slag sedimentation, deslagging and desanding steps in drilling operation are accomplished in one device, the device for forcedly separating slag from fluid from well drilling has the advantages of being compact in structure, small in size, good in separating effect, easy to operate and the like, and is particularly suitable for overwater drilling operation and oper-

ating occasions with small areas of operation.

FIG. 1 is an integral structural schematic diagram of a device for forcedly separating slag from fluid from well drilling of the disclosure;

FIG. 2 is a structural schematic diagram of the sediment conveying apparatus in FIG. 1;

FIG. 3 is a structural schematic diagram of the grid in FIG. 1.

[0012] Detailed description of the disclosure will be made below in combination with FIGS. 1-3. As shown in FIG. 1, the disclosure provides a device for forcedly separating slag from fluid from well drilling, comprising the slag and fluid kinetic energy attenuation box 1, the sediment box 3 and the sediment conveying apparatus 4 which are disposed from top to bottom and communicate with each other in sequence.

[0013] The slag and fluid kinetic energy attenuation box 1 is a hollow box body with one end being opened and the other end being closed, the closed end of the slag and fluid kinetic energy attenuation box is used for blocking the drilling slag and fluid, such that the kinetic energy of the drilling slag and fluid is attenuated greatly for the convenience of subsequent treatment, the opened end of the slag and fluid kinetic energy attenuation box is provided with a mud pipe 5, one end of the mud pipe 5 is connected to an outlet pipe (shown at B in FIG. 1) of the drilling machine of the drilling reverse circulation system and the other end of the mud pipe, i.e., the tail end of the mud pipe is disposed at the opened end of the slag and fluid kinetic energy attenuation box 1. The position of the tail end of the mud pipe is kept stable by way of being fixedly connected to the slag and fluid kinetic energy attenuation box 1 or in any other proper ways. The lower portion of the slag and fluid kinetic energy attenuation box 1 is connected to the upper portion of the sediment box 3 integrally, and the mud outlet of the slag and fluid kinetic energy attenuation box 1 corresponds to a mud inlet of the sediment box 3. Preferably, the inlet end of the mud pipe 5 can be abutted to the mud pipe of the drilling machine via a quick connector 6, such that the device can be disassembled and assembled quickly under the premise of guaranteeing a sealing requirement. Further, according to actual conditions, the inlet end of the mud pipe 5 and the outlet pipe of the drilling machine can be connected by other common connecting and assembling ways, which fails within the scope of protection of the disclosure.

[0014] Further, the grid 2 is disposed between the slag and fluid kinetic energy attenuation box 1, and the drilling slag and fluid blocked by the slag and fluid kinetic energy attenuation box 1 returns to the grid below the slag and fluid kinetic energy attenuation box 1, such that the device has the functions of further attenuating the kinetic energy of the drilling slag and fluid, dividing the drilling slag and fluid and screening and filtering the bulky drilling slag. The so-called grid in the disclosure is disposed between the slag and fluid kinetic energy attenuation box and the sediment box, which means that the grid can play roles of screening and filtering the bulky drilling slat between the slag and fluid kinetic energy attenuation box and the sediment box. Preferably, the grid 2 is horizontally fixed in the slag and fluid kinetic energy attenuation box 1 or the sediment box 3. Certainly, the grid can be also disposed on a junction surface between the slag and fluid kinetic energy attenuation box and the sediment box under a circumstance of guaranteeing sealing property. In the embodiment, in order to optimize the dividing and screening effects, the grid 2 is preferably the steel grid. As shown in FIG. 3, the steel grid is a specially-made large particle ore slag screening device which can attenuate the fluid kinetic energy of the rock slag mud, such that fluid flows are divided into many square grids and are forced to move downwards, and meanwhile, large rocks can be filtered, such that normal work of the sediment conveying apparatus 4 is guaranteed. It should be noted that the arrangement position of the grid 2 can be adjusted correspondingly according to the actual condition, and type and material can be also selected flexibly according to the actual condition but are not limited to form of the embodiment.

[0015] Further, the disclosure further comprises the return trough 7 and the hydraulic cyclone desanding apparatus. The return trough 7 communicates with the overflow port of the sediment box 3, the drilling slag and fluid overflowing from the overflow port flow into the return trough 7, the outlet of the return trough 7 is used for outputting the separated drilling fluid to return to the drilled well, and a box body of the sediment box 3 is connected to a box body of the return trough 7 integrally.

[0016] As shown in FIG. 1, the hydraulic cyclone desanding apparatus comprises the hydrocyclone 9 and the immersible gravel pump 8. The immersible gravel pump 8 is disposed in the return trough 7, and preferably, the immersible gravel pump 8 is disposed at the overflow port, close to the sediment box 3, in the return trough 7, and a base of the immersible gravel pump is fixedly connected with the return trough 7. A mud inlet of the hydrocyclone 9 is connected to a mud outlet of the immersible gravel pump 8 via the fluid inlet pipe 10, and the fluid outlet pipe 11 of the hydrocyclone 9 is led to the outlet of the return trough 7. The immersible gravel pump 8 inhales the settled drilling slag and fluid from the bottom of the return trough 7 and pumps the drilling slag and fluid into the hydrocyclone 9 for further separating treatment. The hydraulic cyclone desanding apparatus is used for separating fine grains of sand in the drilling fluid for returning after settling and screening bulky drilling slag, such that the returned drilling fluid is better in quality. As far as operation with low requirement on the returned drilling fluid is concerned, the hydraulic cyclone desanding apparatus can be omitted.

[0017] The working principle of the hydrocyclone 9 is

as follows: by way of centrifugal settling separation, the drilling slag and fluid enter into a cylinder portion from the fluid inlet pipe 10 to form a rotational flow, and the rotational flow is separated as a result of different densities or granularities under the action of an inertial centrifugal force. The hydrocyclone 9 can separate and discharge fine sand in the drilling slag and fluid and can grade, separate and concentrate multiple mud which is not mutually soluble. The separated drilling slag and fluid are led to the outlet of the return trough 7 and return to the drilled well together with the rest of deslagged drilling slag and fluid. Preferably, the hydrocyclone 9 and the device for forcedly separating slag from fluid are mounted integrally. As shown in FIG. 1, the hydrocyclone 9 can be fixed to an outer side surface of the sediment box 3. According to the actual condition, the arrangement position of the hydrocyclone can be adjusted properly, and all equivalent substitute modes shall fall within the scope of the protection of the disclosure.

[0018] Preferably, in the embodiment, the sediment conveying apparatus 4 is the spiral conveyor. FIG. 2 is an A-A section view of the sediment conveying apparatus and detailed description will be made below on the spiral conveyor in combination with FIG. 2.

[0019] The spiral conveyor primarily comprises a closed trough 12, a spiral, a driving mechanism and a gate 15. The upper portion of the spiral conveyor is connected to the bottom of the sediment box 3 integrally, and the sediment inlet of the spiral conveyor corresponds to the sediment outlet of the sediment box 3. Specifically, the upper end of the closed trough 12 is connected to the bottom of the sediment box 3 integrally. The spiral primarily comprises a spiral blade 14 and a spiral driving shaft 13, and the spiral blade 14 is disposed about the spiral driving shaft 13. The driving device of the spiral driving shaft primarily comprises a driving motor 17 and a sealed bearing box 16, and the spiral driving shaft 13 is connected to an output shaft of the driving motor 17 via a universal coupling 19. Preferably, in the embodiment, the driving motor 17 is a low-speed large-torque hydraulic motor and has the advantages of large driving torque, overload protection, small volume and the like. In other embodiments, other types of driving motors can be also adopted. Preferably, the sealed bearing box 16 is a specified floating seal ring which can prevent settled high-hardness grinding rock slag from immersing into a bearing cavity to damage a bearing. In other embodiments, the sealed bearing box can be also in other types to meet the requirements. The spiral conveyor is a sophisticated conveying apparatus, and the driving mechanism and other details of the spiral conveyor are no longer described in detail herein.

[0020] The outlet end of the spiral conveyor is provided with the gate 15 driven by a gate driving apparatus to open and close. The gate driving apparatus is a common driving apparatus in the field and is no longer described in detail herein. For example, the gate driving apparatus can be in form of a hydraulic oil cylinder or an electric apparatus and the like, which shall fall within the scope of protection of the disclosure.

[0021] Usually, under an action of a power and control system matched with the disclosure, the power and control system controls the hydrocyclone, the immersible gravel pump and the spiral driving shaft driving apparatus and the gate driving apparatus of the spiral conveyor to work respectively when it is needed to desand and deslag. During discharge, the gate is opened, and at a downtime, the gate is closed, and therefore, leakage of the mud is prevented.

[0022] The working principle of the disclosure is as follows: the drilling slag and fluid (pulp slag and fluid) of the drilling reverse circulation system lifted to a ground drilling machine via a drill pipe is connected to the mud pipe, and is sprayed to a closed end of the slag and fluid kinetic energy attenuation box from the outlet end of the mud pipe to be blocked, the jet kinetic energy is attenuated greatly and returns reversely to the steel grid below the slag and fluid kinetic energy attenuation box to be divided, the fluid flow velocity is further attenuated, and the drilling slag and fluid fall into the sediment box below the steel grid uniformly and naturally after passing through the steel grid. The drilling slag in the drilling slag and fluid is settled in the sediment box, the spiral conveyor discharges the drilling slag, and the settled and separated drilling slag and fluid overflow from the overflow port in the upper portion of the sediment box and enters into the return trough. The immersible gravel pump absorbs the drilling slag and fluid from the bottom of the return trough and pumps the drilling slag and fluid to the hydrocyclone, the hydrocyclone separates fine sand in the drilling slag and fluid, is then led to the outlet of the return trough and returns to the drilling machine together with the rest of deslagged drilling fluid. The device provided by the disclosure can separate large particle drilling slag from the drilling fluid, and part of fine particle sand can be also separated continuously, such that cyclic utilization is achieved.

[0023] It will be obvious to those skilled in the art that changes and modifications may be made, and therefore, the aim in the appended claims is to cover all such changes and modifications.

Claims

1. A device for forcedly separating stag from fluid from well drilling, the device comprising: a slag and fluid kinetic energy attenuation box, a sediment box, a sediment conveying apparatus, a mud pipe, a grid, and a return trough;
   wherein:
   the slag and fluid kinetic energy attenuation box, the sediment box and the sediment conveying apparatus are disposed from top to bottom and communicate with each other in sequence; the slag and fluid kinetic energy attenuation box is a hollow box body

with one end being opened and the other end being closed; one end of the mud pipe is connected to an outlet pipe of a drilling machine of a drilling reverse circulation system and the other end of the mud pipe is located at an opened end of the slag and fluid kinetic energy attenuation box; the grid is disposed between the slag and fluid kinetic energy attenuation box and the sediment box and is used for re-attenuating kinetic energy of drilling slag and fluid, dividing the drilling slag and fluid and screening bulky drilling slag; and the return trough communicates with an overflow port of the sediment box, and an outlet of the return trough is used for outputting the separated drilling fluid to return to a drilled well.

2. The device of claim 1, further comprising a hydraulic cyclone desanding apparatus; wherein the hydraulic cyclone desanding apparatus comprises a hydrocyclone and a submersible gravel pump; the submersible gravel pump is disposed in the return trough; a mud inlet of the hydrocyclone is connected to a mud outlet of the submersible gravel pump via a fluid inlet pipe, and a fluid outlet pipe of the hydrocyclone is led to an outlet of the return trough.

3. The device of claim 2, wherein a lower portion of the slag and fluid kinetic energy attenuation box is connected to an upper portion of the sediment box integrally, a mud outlet of the slag and fluid kinetic energy attenuation box corresponds to a mud inlet of the sediment box, and the grid is horizontally fixed in the slag and fluid kinetic energy attenuation box c or in the sediment box.

4. The device of claim 3, wherein the grid is a steel grid.

5. The device of claim 4, wherein the sediment conveying apparatus is a spiral conveyor.

6. The device of claim 5, wherein an upper portion of the spiral conveyor is connected to a bottom of the sediment box integrally, a sediment inlet of the spiral conveyor corresponds to a sediment outlet of the sediment box, and an outlet end of the spiral conveyor is provided with a gate.

7. The device of any one of claims 2-6, wherein the hydrocyclone is fixed to an outer side surface of the sediment box.

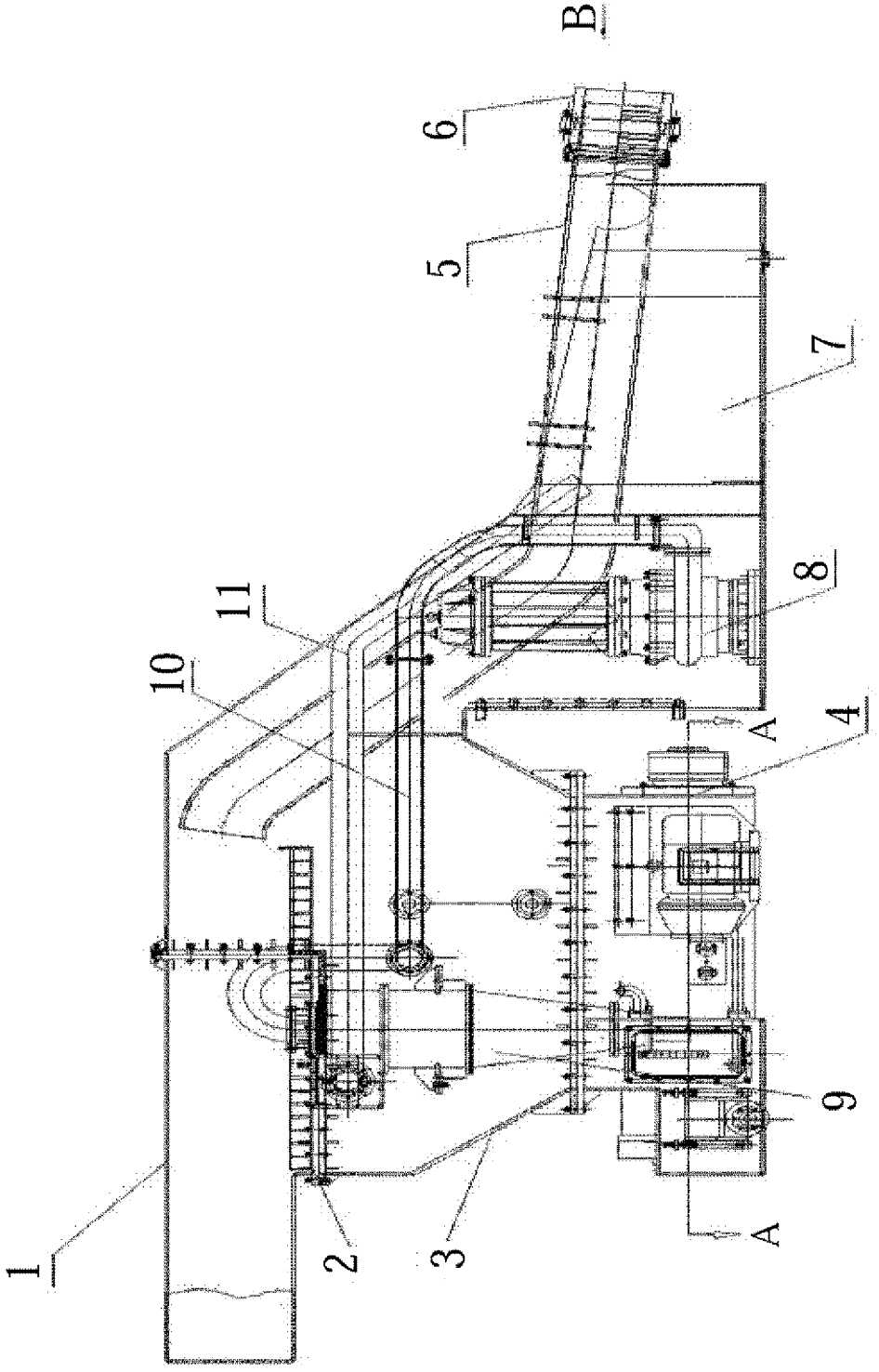

FIG. 1

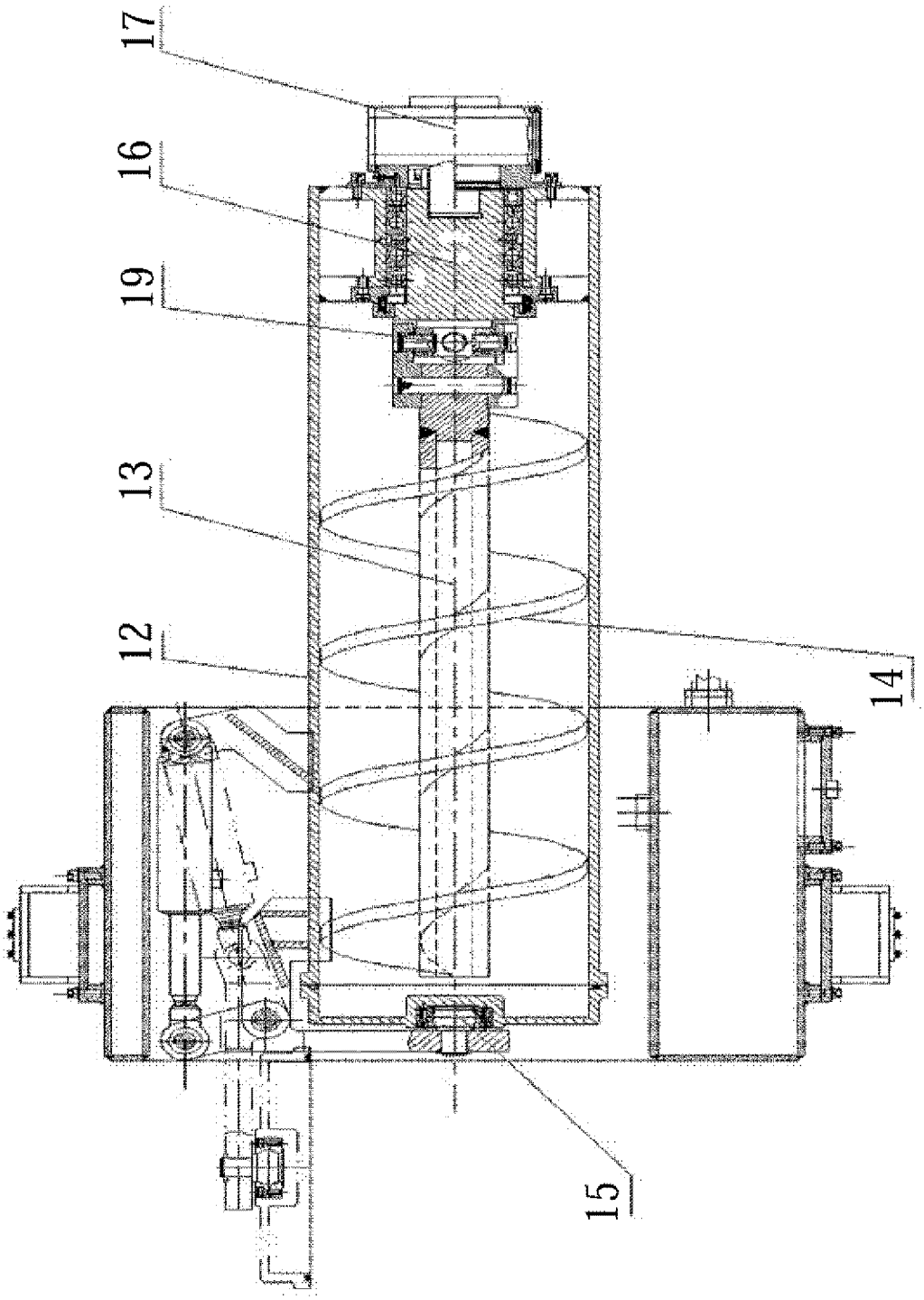

FIG. 2

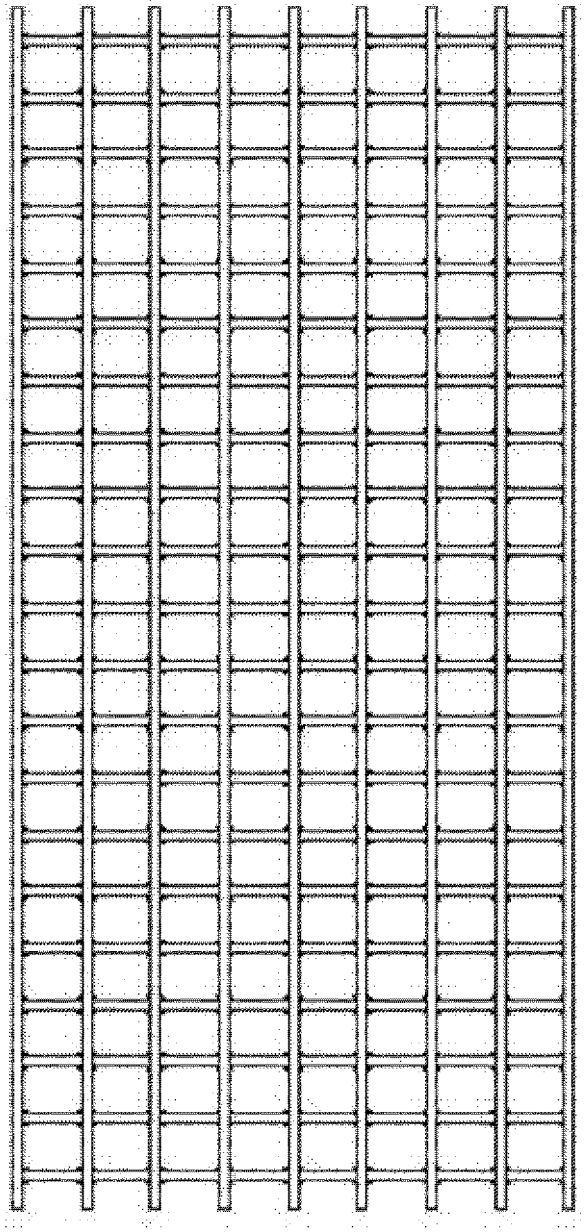

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/093837

A. CLASSIFICATION OF SUBJECT MATTER

E21B 21/06(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B

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

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

CNABS, SIPOABS, DWPI, CNKI, VEN: 分离, 泥浆, 格板, 筛分, 旋流, 泵, 再利用, 动能衰减, seperate, mud, slurry, grid, screen, cyclone, pump, rechaim, recycle, reduce

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2020	**03 September 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/093837

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/093837

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