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(54) NON-BLASTING TUNNEL BORING MACHINE AND BORING METHOD

(57) The disclosure relates to the technical field of tunnel excavation, in particular to a non-blasting tunnel boring machine and a tunneling method. The tunneling machine comprises a vehicle-mounted device (1), a rotational driving device (2), a translation device (40), a working disc (3), a foundation trench excavation device (4), a drilling and splitting device (5), a hazard removal device (50), a dust suppression device (6) and a material feeding device (7). The rotational driving device (2) is arranged on the vehicle-mounted device (1), the working disc (3) is connected with the rotational driving device (2), the rotational driving device (2) drives the working disc (3) to rotate around a center of the working disc, the foundation trench excavation device (4) is arranged on the working disc (3), the drilling and splitting device (5) comprises a drilling machine (51) and a rock splitter (52) both arranged on the working disc (3), the drilling machine (51) is suitable for drilling a hole in a tunnel face in an annular crack arrest groove, the rock splitter (52) is suitable for splitting the tunnel face, the hazard removal device (50) is

arranged on the working disc (3), the dust suppression device (6) is arranged on the vehicle-mounted device (1), and the material feeding device (7) is used for receiving and conveying materials dropped during excavation.

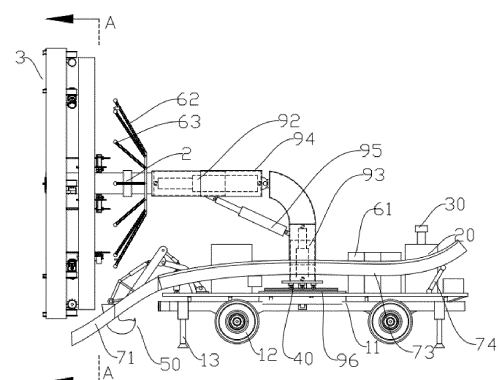


FIG 3

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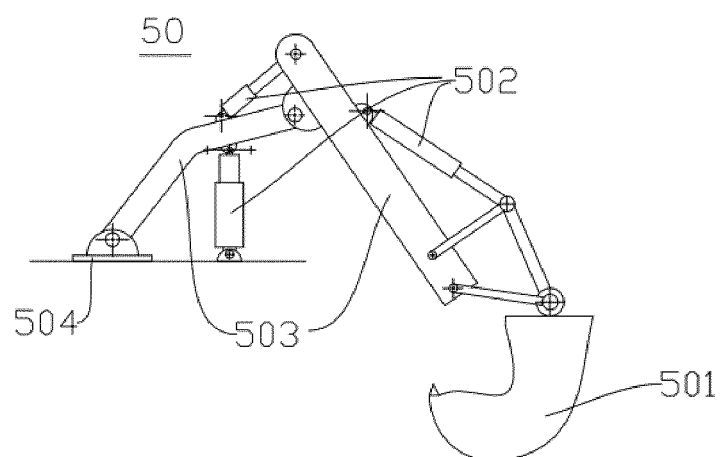


FIG. 11

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of tunnel excavation, and particularly relates to a non-blasting tunnel boring machine and a boring method.

BACKGROUND

[0002] In the construction field of tunnel excavation, blasting excavation is mostly used for hardrock tunnel construction, but under complex environments, particularly when the hardrock tunnel passes through a city, a plurality of buildings (structures) needing to be protected are usually arranged above the tunnel. In this case, blasting vibration generated by tunnel construction can generate adverse effects on surrounding buildings (structures), and noise caused by blasting is also very large.

[0003] As a non-blasting tunnel boring method that has been applied now, TBM has high device purchasing and use fees, high requirements for access roads and tunnel geology, and limited application scope. The present disclosure innovatively provides a low-cost non-blasting tunnel boring machine and a tunneling method. The present disclosure can not only efficiently complete the tunneling construction of tunnels, open cut and other occasions, but also has the characteristics of simplicity, convenience, economy and high efficiency, is very in line with the requirements of diversified tunneling construction, has very wide application prospect, and is worthy of further popularization and application.

SUMMARY

[0004] Therefore, a technical problem to be solved by the present disclosure is to overcome the defects in the prior art that blasting vibration generated by tunnel construction causes adverse effects on surrounding buildings (structures), and noise caused by blasting is also very large at the same time, so as to provide a non-blasting tunnel tunneling machine and a tunneling method without needing blasting construction and having low noise, high cost performance, strong adaptability and flexibility.

[0005] In order to solve the above problem, the present disclosure provides a non-blasting tunnel boring machine, including: a vehicle-mounted device; a rotational driving device arranged on the vehicle-mounted device; a translation device arranged on the vehicle-mounted device and connected with the rotational driving device, wherein the translation device drives the rotational driving device to move away from or towards a tunnel face; a working disc in transmission connection with the rotational driving device, wherein the rotational driving device drives the working disc to rotate around a center of the working disc; a foundation trench excavation device ar-

ranged on the working disc, wherein the foundation trench excavation device is suitable for being matched with the tunnel face, and the working disc drives the foundation trench excavation device to rotate to excavate an annular crack arrest groove in the tunnel face; a drilling and splitting device including a drilling machine and a rock splitter both arranged on the working disc, wherein the drilling machine is suitable for drilling a hole in the tunnel face in the annular crack arrest groove, and the rock splitter is suitable for being matched with the drilled hole to split the tunnel face; a hazard removal device arranged on the vehicle-mounted device and suitable for spalling crushed stones split on the tunnel face; a dust suppression device arranged on the vehicle-mounted device and suitable for suppressing generated dust; and a material feeding device arranged on the vehicle-mounted device, wherein the material feeding device is located below the working disc and used for receiving and conveying materials dropped during excavation.

[0006] Alternatively, the foundation trench excavation device includes: a grooving cutter hole arranged on the working disc; a cutterhead assembly connected with the working disc; and a grooving cutter suitable for being matched with the tunnel face, wherein the cutterhead assembly is in transmission connection with the grooving cutter to drive the grooving cutter to extend out of or retract into the grooving cutter hole.

[0007] Alternatively, the cutterhead assembly includes: a reversible motor fixedly arranged on the working disc; a screw gear connected with the reversible motor; a cutterhead screw arranged in the grooving cutter hole and connected with the grooving cutter, wherein the cutterhead screw is engaged with the screw gear; and a threaded sleeve fixedly arranged in the grooving cutter hole, wherein the cutterhead screw is in threaded fit in the threaded sleeve.

[0008] Alternatively, the grooving cutter is set as an arc-shaped tool, and a convex arc surface of the arc-shaped tool is arranged deviating from the center of the working disc.

[0009] Alternatively, a plurality of foundation trench excavation devices are provided at intervals along a circumferential direction of the working disc.

[0010] Alternatively, the working disc includes: a front plate an edge of which is provided with the foundation trench excavation device; a rear plate located behind the front plate, wherein the drilling and splitting device is arranged on the rear plate, and the drilling and splitting device extends to the front of the front plate to match with the tunnel face; a central shaft in disk one end of which is connected with both a center of the front plate and a center of the rear plate, and the other end of which is in transmission connection with the rotational driving device; and a support boom one end of which is connected with the translation device and the other end of which is connected to the rotational driving device.

[0011] Alternatively, the rear plate includes: an annular

sleeve sleeved on a periphery of the central shaft in disk; and connecting rods connected with both the central shaft in disk and the annular sleeve, wherein a plurality of connecting rods are provided and are arranged at intervals along a circumferential direction of the central shaft in disk, and the drilling and splitting device is arranged on the connecting rod.

[0012] Alternatively, the drilling and splitting device further includes a splitting frame, one side of the splitting frame is provided with the drilling machine, the other side of the splitting frame is provided with the rock splitter, and the splitting frame is movably arranged on the connecting rod.

[0013] Alternatively, the non-blasting tunnel boring machine further includes: a shifting device connected with the splitting frame to drive the splitting frame to move along a length direction of the connecting rod; and/or a sliding mechanism arranged on the splitting frame, wherein the sliding mechanism is connected with the drilling machine and/or the rock splitter to drive the drilling machine and/or the rock splitter to slide along the splitting frame.

[0014] Alternatively, the shifting device includes: a rack arranged along the length direction of the connecting rod; a travel motor arranged on the splitting frame; and a traveling gear mechanism in transmission connection with the travel motor, wherein the traveling gear mechanism is engaged with the rack, and the travel motor drives the traveling gear mechanism to rotate to drive the splitting frame to move along the length direction of the connecting rod.

[0015] Alternatively, the connecting rod includes two I-shaped plates arranged relatively at intervals, a front surface and a back surface of the I-shaped plate are both provided with the rack, and the traveling gear mechanism includes: a synchronous driving shaft arranged between the two I-shaped plates relatively arranged at intervals, wherein the synchronous driving shaft is connected with the travel motor, and the synchronous driving shaft is provided with a first synchronizing gear and a second synchronizing gear arranged at intervals; traveling screws including an inner traveling screw arranged on the back surface of the I-shaped plate and an outer traveling screw arranged on the front surface of the I-shaped plate, wherein the inner traveling screw is engaged with the first synchronizing gear and the outer traveling screw is engaged with the second synchronizing gear; and the inner traveling screw is rotatably arranged on the splitting frame, two ends of the inner traveling screw are provided with inner traverse gears, the inner traverse gears are engaged with the racks on the back surfaces of the two I-shaped plates, two ends of the outer traveling screw are provided with outer traverse gears, and the outer traverse gears are engaged with the racks on the front surfaces of the two I-shaped plates.

[0016] Alternatively, the traveling gear mechanism further includes a synchronous bushing in loose fit with a periphery of the synchronous driving shaft, wherein the

synchronous bushing is located between the first synchronizing gear and the second synchronizing gear; and a guide support beam fixedly connected with the synchronous bushing at an included angle, wherein two ends of the guide support beam are both provided with a guide support wheel, the guide support wheel at one end is in rolling contact with a vertical plate of one I-shaped plate, and the guide support wheel at the other end is in rolling contact with a vertical plate of the other I-shaped plate.

[0017] Alternatively, the drilling and splitting device further includes a first lateral frame and a second lateral frame, the first lateral frame and the second lateral frame are respectively connected to two sides of the splitting frame, the drilling machine is movably arranged on the first lateral frame, the rock splitter is movably arranged on the second lateral frame, and the sliding mechanism is connected with both the drilling machine and the rock splitter to drive the drilling machine to slide along the first lateral frame and drive the rock splitter to slide along the second lateral frame.

[0018] Alternatively, the first lateral frame and the second lateral frame are both hinged with the splitting frame, and one sides of the first lateral frame, the second lateral frame and the splitting frame far away from the central shaft in disk are all provided with an opening, the sliding mechanism includes a first double-piston actuator arranged at the opening of the splitting frame, one piston rod of the first double-piston actuator penetrates through the opening of the first lateral frame and is hinged with the drilling machine, and the other piston rod of the first double-piston actuator penetrates through the opening of the second lateral frame and is hinged with the rock splitter; and the drilling and splitting device further includes a first locking mechanism and a second locking mechanism, the first locking mechanism is suitable for locking the first lateral frame and the drilling machine, and the second locking mechanism is suitable for locking the second lateral frame and the rock splitter, and the first double-piston actuator drives both the first lateral frame and the second lateral frame to rotate away from the center of the working disc around a hinge point relative to the splitting frame to fold the drilling and splitting device.

[0019] Alternatively, the first lateral frame is provided with a first limit slide hole in a direction far away from the splitting frame, a drill bit of the drilling machine passes through the first limit slide hole, and the drilling machine is driven by the first double-piston actuator to slide along the first limit slide hole; and/or, the second lateral frame is provided with a second limit slide hole in the direction far away from the splitting frame, a splitting head of the rock splitter passes through the second limit slide hole, and the rock splitter is driven by the second double-piston actuator to slide along the second limit slide hole.

[0020] Alternatively, the first locking mechanism and the second locking mechanism are both arranged in an electromagnetic attraction type locking structure.

[0021] Alternatively, the dust suppression device includes: a water tank arranged on the vehicle-mounted

device; a water spray pipe connected with the water tank; and an atomizing nozzle connected with the water spray pipe, wherein the atomizing nozzle is arranged towards the tunnel face.

[0022] Alternatively, the non-blasting tunnel boring machine further includes a dust detection device, and the dust detection device is suitable for detecting a dust index to turn on the dust suppression device when the dust index reaches a preset value.

[0023] Alternatively, the material feeding device includes: a hopper arranged below the working disc; a mucking machine arranged in the hopper to drive a material to be transmitted in the hopper; and a belt conveyor arranged on the vehicle-mounted device, wherein the belt conveyor is connected with the hopper.

[0024] Alternatively, the material feeding device further includes an luffing driving cylinder, the luffing driving cylinder is arranged on the vehicle-mounted device, one end of the belt conveyor close to the mucking machine is rotatably connected with the vehicle-mounted device, and the luffing driving cylinder is hinged with one end of the belt conveyor far away from the mucking machine to drive one end of the belt conveyor far away from the mucking machine to ascend and descend.

[0025] Alternatively, the mucking machine includes at least two material scraping gears arranged at intervals, the material scraping gear is rotatably arranged in the hopper, and a grinding gap is formed between the adjacent material scraping gears to crush the material.

[0026] Alternatively, the support boom includes: a longitudinal arm vertically arranged on the translation device; and a transverse arm arranged transversely, wherein one end of the transverse arm is connected with the longitudinal arm, and the other end of the transverse arm is connected with the rotational driving device.

[0027] Alternatively, the support boom further includes: a longitudinal arm telescopic cylinder vertically arranged on the translation device, wherein the longitudinal arm telescopic cylinder is connected with the longitudinal arm to drive the longitudinal arm to move vertically; and/or, a transverse arm telescopic cylinder arranged between the transverse arm and the longitudinal arm to drive the transverse arm to move transversely.

[0028] Alternatively, the transverse arm telescopic cylinder is hinged with the longitudinal arm, the support boom further includes a boom luffing cylinder, one end of the boom luffing cylinder is hinged with an outer wall of the longitudinal arm telescopic cylinder, the other end of the boom luffing cylinder is hinged with an outer wall of the transverse arm telescopic cylinder, and the boom luffing cylinder drives the transverse arm telescopic cylinder and the transverse arm to entirely rotate up and down around a hinge point relative to the longitudinal arm.

[0029] Alternatively, the support boom further includes a regulating turntable, the regulating turntable is rotatably arranged on the vehicle-mounted device, the translation device is arranged on the regulating turntable, and the regulating turntable drives the translation device to rotate

around a center of the translation device.

[0030] Alternatively, the vehicle-mounted device is further provided with a boom support, wherein the boom support is suitable for supporting the transverse arm.

[0031] Alternatively, the non-blasting tunnel boring machine further includes a main cab and an secondary cab oppositely arranged at two ends of the vehicle-mounted device respectively, and the boom support is arranged at a top of the secondary cab and a side edge of the vehicle-mounted device.

[0032] Alternatively, the vehicle-mounted device includes: a vehicle-mounted platform, wherein the vehicle-mounted platform is provided with a support boom and the material feeding device; and wheels arranged at a bottom of the vehicle-mounted platform.

[0033] Alternatively, the vehicle-mounted device further includes storable support legs, wherein the support legs are arranged at the bottom of the vehicle-mounted platform and suitable for supporting the vehicle-mounted platform.

[0034] Alternatively, the translation device includes: a translation mount arranged at a bottom of the support boom;

translation rails arranged on the regulating turntable along a length direction of the vehicle-mounted platform, wherein the translation mount is movably connected to the translation rails; and a translation driving unit in transmission connection with the translation mount to drive the translation mount to move along the translation rail.

[0035] Alternatively, two translation rails are arranged at intervals in parallel, a bottom of the translation mount is provided with two rows of traveling wheels at intervals, the two rows of traveling wheels are respectively matched on the two translation rails, and the traveling wheel is in transmission connection with the translation driving unit.

[0036] Alternatively, the non-blasting tunnel boring machine further includes an anti-roll rod, wherein the anti-roll rod is connected between the two rows of traveling wheels.

[0037] Alternatively, the hazard removal device includes: a hazard removal bucket suitable for being matched with the tunnel face; a driving cylinder hinged to the vehicle-mounted platform, wherein the driving cylinder is hinged with the hazard removal bucket to drive the hazard removal bucket to swing; and a folding arm hinged to the vehicle-mounted platform, wherein the folding arm is hinged with both the driving cylinder and the hazard removal bucket, and the driving cylinder drives the folding arm to be folded or unfolded to drive the hazard removal bucket to be accommodated or extended.

[0038] Alternatively, the driving cylinder includes a main cylinder, an secondary cylinder and a hopper cylinder, the folding arm includes a main hopper arm and an secondary hopper arm, one end of the main cylinder is hinged to the vehicle-mounted platform, the other end of

the main cylinder is hinged to a middle of the main hopper arm, one end of the secondary cylinder is hinged to the middle of the main hopper arm, the other end of the secondary cylinder is hinged to the secondary hopper arm, the bottom of the main hopper arm is hinged to the vehicle-mounted platform, a top of the main hopper arm is hinged to a middle of the secondary hopper arm, one end of the hopper cylinder is hinged with one end of the secondary hopper arm close to the main hopper arm, the other end of the hopper cylinder is hinged with both one end of the secondary hopper arm far away from the main hopper arm and the hazard removal bucket, and one end of the secondary hopper arm far away from the hopper cylinder is hinged with the hazard removal bucket.

[0039] Alternatively, the hazard removal device further includes a rotating hopper rotatably arranged on the vehicle-mounted platform, wherein a bottom of the main hopper arm is hinged to the rotating hopper, a bottom of the main cylinder is connected to the vehicle-mounted platform by ball hinge and/or a top of the main cylinder is connected to the main hopper arm by ball hinge, and the rotating hopper drives the main hopper arm and a structure thereon to rotate together.

[0040] Alternatively, the non-blasting tunnel boring machine further includes a camera, a laser generator and a sweeping structure which are all arranged on the working disc, wherein the laser generator is suitable for emitting a laser beam to the tunnel face, and the laser beam is aligned with a pre-calibrated point on the tunnel face through the camera to position the working disc, the sweeping structure includes an oscillating brush motor and a dust brush, and an oscillating hinge of the oscillating brush motor is connected with the dust brush to drive the dust brush to oscillate and sweep the camera and the laser generator.

[0041] The present disclosure further provides a tunneling method using the non-blasting tunnel boring machine according to the present disclosure, including the following steps of: using a vehicle-mounted device to drive a rotational driving device, a translation device and a working disc to move to a tunnel face; using the translation device to drive the rotational driving device and the working disc to synchronously move to regulate a distance between the working disc and the tunnel face; using the rotational driving device to drive the working disc to rotate around a center of the working disc to further drive a foundation trench excavation device on the working disc to rotate and enable the foundation trench excavation device to excavate an annular crack arrest groove on the tunnel face; starting a drilling machine on the working disc to drill a hole on the tunnel face in the annular crack arrest groove; using a rock splitter to be matched with the drilled hole to split the tunnel face; using a hazard removal device matched with the tunnel face to peel off crushed stones split on the tunnel face; using a material feeding device to receive and convey materials dropped during excavation; and starting a dust suppression

device to suppress dust generated by excavation.

[0042] Alternatively, before using the rotational driving device to drive the working disc to rotate around the center of the working disc, the method further includes the steps of: using a longitudinal arm telescopic cylinder to regulate a height of the working disc; and using a transverse arm telescopic cylinder to regulate a distance between the working disc and the tunnel face to keep the working disc in contact with the tunnel face.

[0043] Alternatively, the tunneling method further includes the steps of: using a boom luffing cylinder to regulate an up-and-down inclination angle of the working disc; and using a regulating turntable and the translation device to together regulate a left-and-right inclination angle of the working disc to keep the working disc parallel to the tunnel face.

[0044] The present disclosure has the following advantages.

1. According to the non-blasting tunnel boring machine of the present disclosure, the rotational driving device drives the working disc to rotate around the center of the working disc, and then drives the foundation trench excavation device on the working disc to rotate, so that the foundation trench excavation device excavates the annular crack arrest groove on the tunnel face, the drilling machine drills the hole on the tunnel face in the annular crack arrest groove, the rock splitter matches with the drilled hole to split the tunnel face, the hazard removal device vibrates with the tunnel face to shake off the crushed stones on the tunnel face, the material feeding device receives and conveys the materials dropped during excavation, and the dust suppression device suppresses the dust generated by excavation.

Therefore, the non-blasting tunnel boring machine of the present disclosure realizes the drilling and splitting construction of the tunnel face through the matching of the foundation trench excavation device, the drilling machine, the rock splitter and the hazard removal device, so as to realize the non-blasting tunnel boring construction, which requires no bursting during the whole construction process, has low noise, and will not generate vibration influence on buildings (structures) around the tunnel. Moreover, the material feeding device can convey the materials generated by excavation in time, so that material accumulation is reduced, construction continuity and efficiency are improved, and the dust suppression device can suppress the generated dust, improve a construction environment and reduce environmental pollution.

2. According to the non-blasting tunnel boring machine of the present disclosure, the foundation trench excavation device includes the grooving cutter hole, the cutterhead assembly and the grooving cutter, wherein the grooving cutter hole is arranged on the working disc, the cutterhead assembly is ar-

ranged on a back surface of the working disc, the grooving cutter is arranged in the grooving cutter hole, and the cutterhead assembly is in transmission connection with the grooving cutter to drive the grooving cutter to extend out of or retract into the grooving cutter hole. With such arrangement, the cutterhead assembly can drive the grooving cutter to extend out of the grooving cutter hole, so that the grooving cutter abuts against the tunnel face. In this case, the rotation of the working disc drives the grooving cutter to rotate, so that the grooving cutter can be opened with the annular crack arrest groove on the tunnel face. After the annular crack arrest groove is opened, the cutterhead assembly drives the grooving cutter to retract into the grooving cutter hole, so that the grooving cutter is separated from the tunnel face. A length of the grooving cutter extending out of the grooving cutter hole is controlled by the cutterhead assembly, and an opening depth of the annular crack arrest groove can also be controlled to satisfy different construction requirements.

3. According to the non-blasting tunnel boring machine of the present disclosure, the grooving cutter is set as an arc-shaped tool, and the convex arc surface of the arc-shaped tool is arranged deviating from the center of the working disc, so that the arc-shaped tool can sweep away interference such as protruding rocks on a side surface of a hole wall of the annular crack arrest groove while cutting the tunnel face.

4. According to the non-blasting tunnel boring machine of the present disclosure, the cutterhead assembly includes the reversible motor, the screw gear, the cutterhead screw and the threaded sleeve, wherein the reversible motor is arranged on the working disc, the screw gear is connected with the reversible motor, the cutterhead screw is arranged in the grooving cutter hole and connected with the grooving cutter, the cutterhead screw is engaged with the screw gear, the threaded sleeve is fixedly arranged in the grooving cutter hole, and the cutterhead screw is in threaded fit in the threaded sleeve. With the arrangement above, when the reversible motor rotates forward, the screw gear is driven to rotate forward. Because the screw gear is engaged with the cutterhead screw, the cutterhead screw is driven to rotate forward, while the cutterhead screw is in threaded fit in the threaded sleeve, and the threaded sleeve is fixed, so that the cutterhead screw rotates forward and moves along an axial direction of the threaded sleeve, and finally the grooving cutter is driven to rotate out of the grooving cutter hole and match with the tunnel face, so that the tunnel face is opened with the annular crack arrest groove with sufficient depth. When the reversible motor rotates backward, the screw gear is driven to rotate backward, thus driving the cutterhead screw to rotate backward, and meanwhile, the cutterhead

screw moves along the axial direction of the threaded sleeve, driving the grooving cutter on the cutterhead screw to retract into the grooving cutter hole and separate from the tunnel face. Therefore, through the above arrangement, the grooving cutter can be driven to extend out of or retract into the grooving cutter hole through the cutterhead screw, and the grooving cutter can also be driven to rotate around itself through the cutterhead screw, so as to open the annular crack arrest groove with sufficient depth on the tunnel face.

5. According to the non-blasting tunnel boring machine of the present disclosure, the plurality of foundation trench excavation devices are provided at intervals along the circumferential direction of the working disc. According to this arrangement, the plurality of foundation trench excavation devices provided can improve an excavation rate of the annular crack arrest groove on one hand. On the other hand, because the plurality of foundation trench excavation devices are arranged at intervals along the circumferential direction of the working disc, even if a part of the foundation trench excavation devices cannot abut against the tunnel face because the working disc is not completely in parallel contact with the tunnel face, another part (one or more) of the foundation trench excavation devices can always abut against the tunnel face to carry out the grooving construction of the annular crack arrest groove. Therefore, requirements on a matching accuracy between the working disc and the tunnel face can be reduced.

6. According to the non-blasting tunnel boring machine of the present disclosure, both the drilling machine and the rock splitter may move along the length direction of the connecting rod through the splitting frame. With such arrangement, when the working disc rotates, the drilling machine and the rock splitter are driven to rotate annularly, so that the drilling machine is opened with a plurality of drilled holes along the circumferential direction of the tunnel face, and at the same time, the drilling machine can be opened with a plurality of drilled holes along a radial direction of the working disc through the movement of the drilling machine along the length direction of the connecting rod, and the rock splitter can split different positions of the tunnel face following opened positions of the drilled holes. Therefore, this arrangement can realize all-round drilling and splitting construction of the tunnel face in the circumferential direction and the radial direction.

7. The non-blasting tunnel boring machine of the present disclosure further includes the shifting device and/or the sliding mechanism. The shifting device is connected with the splitting frame to drive the splitting frame to move along the length direction of the connecting rod. The sliding mechanism is arranged on the splitting frame, and the sliding me-

chanism is connected with the drilling machine and/or the rock splitter to drive the drilling machine and/or the rock splitter to slide along the splitting frame. Therefore, when the drilling machine and/or the rock splitter needs to move along the length direction of the connecting rod, it is realized by the driving of the shifting device, and when the drilling machine and/or the rock splitter needs to slide along the splitting frame, it is realized by the driving of the sliding mechanism, so as to realize flexible control of the movement of the drilling machine and the rock splitter, and realize flexible drilling and splitting construction.

8. According to the non-blasting tunnel boring machine of the present disclosure, the shifting device includes the rack arranged in the length direction of the connecting rod, the travel motor and the traveling gear mechanism. The travel motor is arranged on the splitting frame, the traveling gear mechanism is in transmission connection with the travel motor, the traveling gear mechanism is engaged with the rack, and the travel motor can drive the traveling gear mechanism to rotate to drive the splitting frame to move along the length direction of the connecting rod. With such arrangement, the travel motor rotates to drive the traveling gear mechanism to rotate. As the traveling crack arrest groove is engaged with the rack, the traveling gear mechanism moves along the rack, thereby driving the splitting frame and the drilling machine and the rock splitter thereon to move along the length direction of the connecting rod, so as to realize drilling and splitting operations on different positions in the radial direction of the tunnel face.

9. According to the non-blasting tunnel boring machine of the present disclosure, the traveling gear mechanism includes the synchronous driving shaft and the traveling screw, wherein the synchronous driving shaft is arranged between two I-shaped plate arranged relatively at intervals, the synchronous driving shaft is connected with the travel motor, and the synchronous driving shaft is provided with the first synchronizing gear and the second synchronizing gear arranged at intervals. The traveling screw includes the inner traveling screw arranged on the back surface of the I-shaped plate and the outer traveling screw arranged on the front surface of the I-shaped plate. The inner traveling screw is engaged with the first synchronizing gear, the outer traveling screw is engaged with the second synchronizing gear, and the inner traveling screw is rotatably arranged on the drilling machine or the rock splitter. The two ends of the inner traveling screw are provided with the inner traverse gears, and the inner traverse gears are engaged with the racks on the back surfaces of the two I-shaped plates. The two ends of the outer traveling screw are provided with the outer traverse gears, and the outer traverse gears are engaged with the racks on the front sur-

faces of the I-shaped plates.

According to the arrangement above, when the drilling machine or the rock splitter needs to move along the length direction of the connecting rod, the travel motor drives the synchronous driving shaft to rotate, so as to drive the first synchronizing gear and the second synchronizing gear on the synchronous driving shaft to rotate synchronously. Because the first synchronizing gear is engaged with the inner traveling screw, the second synchronizing gear is engaged with the outer traveling screw, the inner traveling screw and the outer traveling screw are driven to rotate synchronously. As the inner traverse gears at the two ends of the inner traveling screw are engaged with the racks on the back surfaces of the I-shaped plates, and the outer traverse gears at the two ends of the outer traveling screw are engaged with the racks on the front surfaces of the I-shaped plates, the inner traverse gear moves along the racks on the back surfaces of the I-shaped plates and the outer traverse gear moves along the racks on the front surfaces of the I-shaped plates. Since the travel motor and the inner traveling screw are both arranged on the drilling machine or the rock splitter, the movement of the inner traverse gear and the outer traverse gear along the racks can synchronously drive the drilling machine or the rock splitter to move along the racks (i.e., consistent with the length direction of the connecting rod), so as to realize drilling and splitting operations on different positions of the tunnel face.

10. The non-blasting tunnel boring machine of the present disclosure further includes the synchronous bushing and the guide support beam, the synchronous bushing is in loose fit with the periphery of the synchronous driving shaft, and the synchronous bushing is located between the first synchronizing gear and the second synchronizing gear. The guide support beam is fixedly connected with the synchronous bushing at an included angle, and the two ends of the guide support beam are both provided with the guide support wheel, wherein the guide support wheel at one end is in rolling contact with the vertical plate of one I-shaped plate, and the guide support wheel at the other end is in rolling contact with the vertical plate of the other I-shaped plate.

According to the arrangement above, the synchronous bushing is in loose fit with the periphery of the synchronous driving shaft, so that the rotation of the synchronous driving shaft is not affected. Meanwhile, the synchronous bushing and the guide support beam can be kept not to rotate integrally, so that the stability is good. Meanwhile, when the guide support beam moves together with the synchronous bushing, the guide support wheels at the two ends of the guide support beam roll on the I-shaped plates at the two sides, which further supports the whole traveling gear mechanism, and the guide support

wheels can also reduce a moving resistance. In addition, the guide support wheels at the two ends of the guide support beam play a balanced role in supporting the whole traveling gear mechanism, which means that, when the working disc rotates (i.e., when the connecting rod rotates along the circumferential direction), stable matching between the traveling gear mechanism and the rack can be ensured, and a situation that the traveling gear mechanism is separated from the rack because the working disc rotates to one side can be avoided, thus ensuring normal and reliable operation of the whole mechanism.

11. According to the non-blasting tunnel boring machine of the present disclosure, the dust suppression device may include the water tank, the water spray pipe and the atomizing nozzle, wherein the water tank is arranged on the vehicle-mounted device, the water spray pipe is connected with the water tank, the atomizing nozzle is connected with the water spray pipe, and the atomizing nozzle is arranged towards the tunnel face. The water in the water tank flows to the atomizing nozzle through the water spray pipe, and is atomized and sprayed by the atomizing nozzle, so as to suppress the dust generated by excavation and prevent safety of construction personnel and device from being affected after the dust diffuses in the tunnel or closed space.

12. According to the non-blasting tunnel boring machine of the present disclosure, the material feeding device includes the hopper, the mucking machine and the belt conveyor. The hopper is arranged below the working disc, the mucking machine is arranged in the hopper to drive the materials to be transmitted in the hopper, the belt conveyor is arranged on the vehicle-mounted device, and the belt conveyor is connected with the hopper. The material generated by excavation falls into the hopper, and the mucking machine drives the materials to be transmitted to the belt conveyor along the hopper, and then conveyed out by the belt conveyor, thus avoiding material accumulation.

13. According to the non-blasting tunnel boring machine of the present disclosure, the mucking machine includes at least two material scraping gears arranged at intervals, the material scraping gear is rotatably arranged in the hopper, and the grinding gap is formed between the adjacent material scraping gears to crush the materials. The rotation of the material scraping gear drives the transmission of the materials in the hopper, and meanwhile, the adjacent material scraping gears can squeeze and crush the materials entering the grinding gap and further crush the larger rocks and other materials, which is convenient for the transmission of materials with small particles and does not occupy a transmission space.

14. According to the non-blasting tunnel boring machine of the present disclosure, the material feeding

device further includes the luffing driving cylinder, the luffing driving cylinder is arranged on the vehicle-mounted device, one end of the belt conveyor close to the mucking machine is rotatably connected with the vehicle-mounted device, and the luffing driving cylinder is hinged with one end of the belt conveyor far away from the mucking machine to drive one end of the belt conveyor far away from the mucking machine to ascend and descend. With the arrangement of the luffing driving cylinder, the luffing driving cylinder can drive one end of the belt conveyor far away from the mucking machine to ascend or descend, so as to adapt to the use of transport carts with different heights and enhance applicability of the belt conveyor.

15. The non-blasting tunnel boring machine of the present disclosure further includes the support boom, the support boom includes the longitudinal arm and the transverse arm, the longitudinal arm is vertically arranged on the translation device, and the transverse arm is arranged transversely, wherein one end of the transverse arm is connected with the longitudinal arm, and the other end of the transverse arm is connected with the rotational driving device. The support boom is suitable for supporting the working disc, and the support boom is arranged in the form of connecting the longitudinal arm and the transverse arm, wherein the longitudinal arm facilitates to open a vertical distance between the working disc and the vehicle-mounted device, while the transverse arm facilitates to open a horizontal distance between the working disc and the vehicle-mounted device, so as to arrange the working disc in a proper position.

16. According to the non-blasting tunnel boring machine of the present disclosure, the support boom further includes the longitudinal arm telescopic cylinder and/or the transverse arm telescopic cylinder, wherein the longitudinal arm telescopic cylinder is vertically arranged on the translation device, the longitudinal arm telescopic cylinder is connected with the longitudinal arm to drive the longitudinal arm to move vertically, and the transverse arm telescopic cylinder is arranged between the transverse arm and the longitudinal arm to drive the transverse arm to move transversely. The telescoping of the longitudinal arm telescopic cylinder drives the longitudinal arm to move vertically, so as to regulate the height of the working disc and meet the construction requirements of different heights; the telescoping of the transverse arm telescopic cylinder drives the transverse arm to move transversely, so as to drive the working disc to regulate a lateral position to meet the requirements of different use scenarios.

17. According to the non-blasting tunnel boring machine of the present disclosure, the transverse arm telescopic cylinder is hinged with the longitudinal arm, the support boom further includes the boom

luffing cylinder, one end of the boom luffing cylinder is hinged with the outer wall of the longitudinal arm telescopic cylinder, the other end of the boom luffing cylinder is hinged with the outer wall of the transverse arm telescopic cylinder, and the boom luffing cylinder can drive the transverse arm telescopic cylinder and the transverse arm to entirely rotate up and down around the hinge point relative to the longitudinal arm. With the arrangement of the boom luffing cylinder, the extension of the piston rod of the boom luffing cylinder can push the transverse arm telescopic cylinder and the transverse arm to entirely rotate upward around the hinge point relative to the longitudinal arm, so as to drive the whole working disc to swing upward; the shortening of the piston rod of the boom luffing cylinder can pull the transverse arm telescopic cylinder and the transverse arm to entirely rotate downward around the hinge point relative to the longitudinal arm, so as to drive the whole working disc to swing downward, thus regulating the up-and-down inclination angle of the working disc and improve parallelism of matching between the working disc and the tunnel face.

18. According to the non-blasting tunnel boring machine of the present disclosure, the support boom further includes the regulating turntable, the regulating turntable is rotatably arranged on the vehicle-mounted device, the translation device is arranged on the regulating turntable, and the regulating turntable drives the translation device to rotate around the center of the translation device. The movement of the translation device can drive the regulating turntable and the components on the regulating turntable to move together to regulate the distance between the working disc and the tunnel face, and the rotation of the regulating turntable can drive the longitudinal arm telescopic cylinder and the structures such as the longitudinal arm connected thereon, the transverse arm and the working disc to rotate integrally, so as to further regulate the left-and-right inclination angle of the working disc and improve the parallelism of matching between the working disc and the tunnel face. Therefore, the up-and-down inclination angle of the working disc is regulated by using the boom luffing cylinder, and the left-and-right inclination angle of the working disc is regulated by using the regulating turntable, so that the working disc can be kept parallel to the tunnel face, and then the working disc can be driven to move transversely towards the working disc by using an expansion rod of the transverse arm, so that the working disc can be in parallel contact with the tunnel face to facilitate construction operation.

19. The tunneling method using the non-blasting tunnel boring machine of the present disclosure includes the following steps of: using the vehicle-mounted device to drive the rotational driving device, the translation device and the working disc to move

to the tunnel face; using the translation device to drive the rotational driving device and the working disc to synchronously move to regulate the distance between the working disc and the tunnel face; using the rotational driving device to drive the working disc to rotate around the center of the working disc to further drive the foundation trench excavation device on the working disc to rotate and enable the foundation trench excavation device to excavate the annular crack arrest groove on the tunnel face; starting the drilling machine on the working disc to drill the hole on the tunnel face in the annular crack arrest groove; using the rock splitter to be matched with the drilled hole to split the tunnel face; using the hazard removal device matched with the tunnel face to peel off the crushed stones split on the tunnel face; using the material feeding device to receive and convey the materials dropped during excavation; and starting the dust suppression device to suppress the dust generated by excavation. As the tunneling method using the non-blasting tunnel boring machine of the present disclosure has the same technical effects as these of the non-blasting tunnel boring machine of the present disclosure, the details will not be repeated here.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] In order to illustrate the technical solutions in the specific embodiments of the present disclosure or in the related art more clearly, the drawings used in the description of the specific embodiments or the prior art will be briefly described below. Obviously, the drawings in the following description are merely some embodiments recorded in the present disclosure. For those of ordinary skills in the art, other drawings may also be obtained based on these drawings without going through any creative work.

FIG. 1 illustrates a side view of a non-blasting tunnel boring machine according to the embodiments of the present disclosure;

FIG. 2 illustrates a three-dimensional schematic diagram of a non-blasting tunnel boring machine according to the embodiments of the present disclosure;

FIG. 3 illustrates a front view of the non-blasting tunnel boring machine according to the embodiments of the present disclosure;

FIG. 4 illustrates a top view of the non-blasting tunnel boring machine according to the embodiments of the present disclosure;

FIG. 5 illustrates a schematic structural diagram of direction A-A in FIG. 3;

FIG. 6 illustrates a schematic structural diagram of direction B-B in FIG. 5;

FIG. 7 illustrates a schematic structural diagram of direction C-C in FIG. 5;

FIG. 8 illustrates a schematic structural diagram of direction D-D in FIG. 5;

FIG. 9 is an enlarged structural diagram of a portion E in FIG. 1;

FIG. 10 illustrates a schematic structural diagram of a translation device of the non-blasting tunnel boring machine according to the embodiments of the present disclosure; and

FIG. 11 illustrates a schematic structural diagram of a hazard removal device of the non-blasting tunnel boring machine according to the embodiments of the present disclosure.

Reference numerals:

[0046] 1 - vehicle-mounted device; 11 - vehicle-mounted platform; 12 - wheel; 13 - support leg; 2 - rotational driving device; 3 - working disc; 31 - front plate; 311 - grooving cutter hole; 32 - rear plate; 321 - central shaft in disk; 322 - annular sleeve; 33 - connecting rod; 331 - rack; 4 - foundation trench excavation device; 41 - cutterhead assembly; 411 - screw gear; 412 - cutterhead screw; 413 - threaded sleeve; 42 - grooving cutter; 5 - drilling and splitting device; 51 - drilling machine; 511 - splitting frame; 512 - first lateral frame; 5121 - first limit slide hole; 514 - first locking mechanism; 5141 - suction cup; 5142 - electromagnetic clamping device; 515 - first double-piston actuator; 52 - rock splitter; 6 - dust suppression device; 61 - water tank; 62 - water spray pipe; 63 - atomizing nozzle; 64 - dust detection device; 7 - material feeding device; 71 - hopper; 72 - mucking machine; 73 - belt conveyor; 74 - luffing driving cylinder; 8 - shifting device; 81 - travel motor; 82 - traveling gear mechanism; 821 - synchronous driving shaft; 8211 - first synchronizing gear; 8212 - second synchronizing gear; 8213 - locking nut; 822 - inner traveling screw; 8221 - inner traverse gear; 823 - outer traveling screw; 8231 - outer traverse gear; 83 - guide support beam; 831 - guide support wheel; 9 - support boom; 91 - longitudinal arm; 92 - transverse arm; 93 - longitudinal arm telescopic cylinder; 94 - transverse arm telescopic cylinder; 95 - boom luffing cylinder; 96 - regulating turntable; 10 - main cab; 20 - secondary cab; 30 - boom support; 40 - translation device; 401 - translation mount; 4011 - traveling wheel; 402 - translation rail; 403 - translation driving unit; 404 - anti-roll rod; 50 - hazard removal device; 501 - hazard removal bucket; 502 - driving cylinder; 503 - folding arm; and 504 - rotating hopper.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0047] The following clearly and completely describes the technical solutions of the present disclosure with reference to the drawings. Apparently, the described embodiments are merely some but not all of the embodiments of the present disclosure. Based on the embodiments of the present disclosure, all other embodiments obtained by those of ordinary skills in the art without going

through any creative work shall fall within the protection scope of the present disclosure.

[0048] In the description of the present disclosure, it should be noted that, the orientation or positional relationship indicated by the terms "upper", "lower", "left", "right", "vertical", "horizontal", "inner", "outer" and the like is based on the orientation or positional relationship shown in the drawings, only for the convenience of describing the present disclosure and simplifying the description, and does and not indicate or imply that the indicated device or element must have a specific orientation, or be constructed and operated in a specific orientation. Therefore, the terms should not be construed as limiting the present disclosure. Moreover, the terms "first", "second" and "third" are used for descriptive purposes only and cannot be understood as indicating or implying relative importance.

[0049] In the description of the present disclosure, it should be noted that terms such as "installation", "connected" and "connection", etc., should be understood broadly, for example, the connection may be fixed connection, or detachable connection or integral connection; may be mechanical connection, and may also be electrical connection; and may be direct connection, may also be indirect connection through an intermediate medium, and may also be internal communication of two elements. The specific meaning of the above terms the present disclosure, can be understood in a specific case by those of ordinary skills in the art.

[0050] In addition, the technical features involved in different embodiments of the present disclosure described below can be combined with each other as long as they do not constitute conflicts with each other.

[0051] As shown in FIG. 1 to FIG. 11, this embodiment discloses a non-blasting tunnel boring machine, including a vehicle-mounted device 1, a rotational driving device 2, a translation device 40, a working disc 3, a foundation trench excavation device 4, a hazard removal device 50, a positioning device, a drilling and splitting device 5, a dust suppression device 6 and a material feeding device 7. The rotational driving device 2 is arranged on the vehicle-mounted device 1. The translation device 40 is arranged on the vehicle-mounted device 1 and is connected with the rotational driving device 2. The translation device 40 can drive the rotational driving device 2 to move away from or towards a tunnel face. The working disc 3 is in transmission connection with the rotational driving device 2. The rotational driving device 2 can drive the working disc 3 to rotate around a center of the working disc. The foundation trench excavation device 4 is arranged on the working disc 3, and the foundation trench excavation device 4 is suitable for coordinating with the tunnel face. The working disc 3 can drive the foundation trench excavation device 4 to rotate to excavate an annular crack arrest groove in the tunnel face. The drilling and splitting device 5 includes a drilling machine 51 and a rock splitter 52 both arranged on the working disc 3, the drilling machine 51 is suitable for

drilling a hole in the tunnel face in the annular crack arrest groove, and the rock splitter 52 is suitable for being matched with the drilled hole to split the tunnel face. The hazard removal device 50 is arranged on the vehicle-mounted device 1, suitable for spalling crushed stones split on the tunnel face to the ground, and carrying out hazard removal operation at the same time. The dust suppression device 6 is arranged on the vehicle-mounted device 1 and suitable for suppressing generated dust. The material feeding device 7 is arranged on the vehicle-mounted device 1, and the material feeding device 7 is located below the working disc 3 and used for receiving and conveying materials dropped during excavation.

[0052] According to the non-blasting tunnel boring machine of the present disclosure, the rotational driving device 2 drives the working disc 3 to rotate around the center of the working disc, and then drives the foundation trench excavation device 4 on the working disc 3 to rotate, and thereby the foundation trench excavation device 4 excavates the annular crack arrest groove on the tunnel face, the drilling machine 51 drills the hole on the tunnel face in the annular crack arrest groove, the rock splitter 52 matches with the drilled hole to split the tunnel face, the hazard removal device 50 vibrates with the tunnel face to peel off the crushed stones on the tunnel face, the material feeding device 7 receives and conveys the materials dropped during excavation, and the dust suppression device 6 suppresses the dust generated by excavation.

[0053] Therefore, the non-blasting tunnel boring machine of the present disclosure according to the embodiment realizes the drilling and splitting construction of the tunnel face through the coordinating of the foundation trench excavation device 4, the drilling machine 51, the rock splitter 52 and the hazard removal device 50, thereby realizing the non-blasting tunnel boring construction. throughout the construction process, there is no need to blast, resulting in low noise and no vibration influence on buildings (structures) around the tunnel, and it is flexible, economical, and efficient. Moreover, the material feeding device 7 can convey the materials generated by excavation in time, thereby reducing material accumulation and improving construction continuity and efficiency. The dust suppression device 6 can suppress the generated dust, thereby improving a construction environment and reducing environmental pollution.

[0054] The non-blasting tunnel boring machine is described in detail below with reference to the drawings in the specification.

[0055] The vehicle-mounted device 1 may specifically be a trolley. It can drive the whole non-blasting tunnel boring machine to move by the traveling of the trolley, thereby realizing continuous tunnel construction, which is very convenient. The trolley may be wheeled or crawler type. the wheeled type is preferred in the present disclosure.

[0056] in some embodiments, as shown in FIG. 1 to FIG. 3, the vehicle-mounted device 1 includes a vehicle-

mounted platform 11 and wheels 12, wherein the vehicle-mounted platform 11 is provided with a support boom 9, the hazard removal device 50 and the material feeding device 7, and the wheels 12 are arranged at a bottom of the vehicle-mounted platform 11. The vehicle-mounted platform 11 and the structure on the vehicle-mounted platform are driven to move by the rotation of the wheels 12, thereby realizing the traveling of the whole non-blasting tunnel boring machine and continuous tunnel construction.

[0057] Specifically, the vehicle-mounted platform 11 may be a supporting plate arranged transversely, and a plurality of wheels 12 are arranged around a bottom of the supporting plate, and each wheel 12 may be driven independently. Thus, when the working disc 3 is aligned with the tunnel face, slight forward and backward movements can be made by the wheels 12 on one side, while the wheels 12 at the other side remain stationary, which may realize better regulation and alignment of the tunnel face by combining with other adjustment method described in the present disclosure, thereby improving stability of supporting the vehicle-mounted platform 11.

[0058] Further, the vehicle-mounted device 1 further includes storable support legs 13, wherein the support legs 13 are arranged at the bottom of the vehicle-mounted platform 11 and suitable for supporting the vehicle-mounted platform 11. When the vehicle-mounted platform 11 moves, the support legs 13 are in a storage state to avoid interference to the movement of the vehicle-mounted platform 11. When the vehicle-mounted platform 11 stops moving, before the construction commences, the support legs 13 are extended outward to support the vehicle-mounted platform 11, ensuring stable stress on the vehicle-mounted platform and smooth construction.

[0059] For example, the storable support leg 13 may be a rotary supporting rod, which means that the supporting rod is rotatably connected with the bottom of the vehicle-mounted platform 11, and the supporting rod can be stored or unfolded through rotation. Alternatively, the storable support leg 13 may also be a telescopic supporting rod, which means that the supporting rod can be stored or unfolded through the telescoping of the supporting rod, which is not particularly limited in some embodiments.

[0060] The rotational driving device 2 may be in a form of matching a rotating motor, a reduction box and a rotating shaft, and the rotating shaft is connected with the center of the working disc 3 to drive the rotating shaft to rotate through the rotation of the rotating motor, thereby driving the working disc 3 to rotate around the center of the working disc.

[0061] in some embodiments, the working disc 3 includes a front plate 31, a rear plate 32, a central shaft in disk 321 and a support boom 9. An edge of the front plate 31 is provided with the foundation trench excavation device 4, the rear plate 32 is located behind the front plate 31, and the drilling and splitting device 5 is arranged

on the rear plate 32. The drilling and splitting device 5 can extend to the front of the front plate 31 to cooperate with the tunnel face. One end of the central shaft in disk 321 is both connected with a center of both the front plate 31 and the rear plate 32, while the other end of the central shaft in disk is in transmission connection with the rotational driving device 2. One end of the support boom 9 is connected with the translation device 40, while the other end of the support boom is connected to the rotational driving device 2. This arrangement is necessary because that the drilling machine 51 and the rock splitter 52 of the drilling and splitting device 5 are relatively long, and in order not to affect a grooving operation of the working disc 3, it is necessary to mount the drilling and splitting device 5 on rear of the rear plate 32. The central shaft in disk 321 is in transmission connection with the rotational driving device 2.

[0062] The rear plate 32 includes an annular sleeve 3222 and connecting rods 33. The annular sleeve 3222 is sleeved on a outer circumference of the central shaft in disk 321, and the connecting rods 33 are connected with both the central shaft in disk 321 and the annular sleeve 3222, wherein there are a plurality of connecting rods 33 and the connecting rods 33 are arranged at intervals along a circumferential direction of the central shaft in disk 321, and the drilling and splitting device 5 is arranged on the connecting rod 33. With such arrangement, the central shaft in disk 321 and the annular sleeve 3222 are integrated through the connecting rod 33, which ensures a structural strength of the entire rear plate 32. Compared with a fully solid working disc 3, the arrangement can reduce a weight of the working disc 3 and a load of the vehicle-mounted device 1. Specifically, after the drilling machine 51 completes drilling, the working disc 3 can be aligned and cooperated with the drilled hole by the drilling and splitting device 5 arranged on the connecting rod 33 without rotating.

[0063] Specifically, the central shaft in disk 321 and the rotating shaft of the rotational driving device 2 may be connected by various ways, such as key connection, internal and external geers, and the like. The annular sleeve 322 is annular, and there is a gap between the annular sleeve and the central shaft in disk 321. The connecting rod 33 is arranged in the gap, and one end of the connecting rod 33 is connected with an outer wall of the central shaft in disk 321 by various ways such as keys or internal and external gears, and the other end of the connecting rod is fixedly connected with an inner wall of the annular sleeve 322.

[0064] in some embodiments, the drilling and splitting device 5 further includes a splitting frame 511. One side of the splitting frame 511 is provided with the drilling machine 51, the other side of the splitting frame is provided with the rock splitter 52, and the splitting frame 511 is movably arranged on the connecting rod 33. Both the drilling machine 51 and the rock splitter 52 can be arranged on the splitting frame 511 synchronously for that the drilling machine 51 and the rock splitter 52 can co-

ordinate and work together efficiently. The movement of the splitting frame 511 along the connecting rod 33 can enable synchronous movement of both the drilling machine 51 and the rock splitter 52. With such arrangement, when the working disc 3 rotates, it drives the drilling machine 51 to rotate annularly, thereby creating a plurality of drilled holes along the circumferential direction of the tunnel face. Meanwhile, the drilling machine 51 on the drilling and splitting device 5 can drill a plurality of drilled holes along a radial direction of the working disc 3 through simultaneous zoned operation of multiple the drilling and splitting device 5 or movement along the length direction of the connecting rod 33, and the rock splitter 52 can split different positions of the tunnel face following positions of the drilled holes. Thus the arrangement can achieve the overall drilling and splitting construction of the tunnel face along the circumferential direction and the radial direction.

[0065] In some embodiments, it is also possible to arrange two drilling machines 51 on left and right sides of the same splitting frame 511 as required, and similarly, two rock splitters 52 may be arranged on the left and right sides of the same splitting frame 511 as required.

[0066] A rack 331 is arranged on the connecting rod 33 along the length direction of the connecting rod 33. Specifically, the connecting rod 33 includes two I-shaped plates relatively arranged at intervals, and a front surface and a back surface of the I-shaped plate are both provided with the rack 331.

[0067] It should be noted that the front surface of the I-shaped plate is one surface of the I-shaped plate deviating from the vehicle-mounted device 1, and the back surface of the I-shaped plate is one surface of the I-shaped plate towards the vehicle-mounted device 1.

[0068] The foundation trench excavation device 4 is suitable for abutting against the tunnel face, and the rotation of the working disc 3 drives the foundation trench excavation device 4 to rotate by 360 degrees with the center of the working disc 3 (i.e. around the central shaft in disk 321) as a base point, thereby opening the annular crack arrest groove on the tunnel face, and the annular crack arrest groove delineates an excavation area on the tunnel face for improving accuracy of construction.

[0069] It should be noted that the tunnel face is a section of a tunnel to be excavated, and the tunnel excavation construction can be realized by drilling, splitting and other construction operations on the section.

[0070] For a specific structure, as shown in FIG. 1, FIG. 4 and FIG. 5, in some embodiments, the foundation trench excavation device 4 includes a grooving cutter hole 311, a cutterhead assembly 41 and a grooving cutter 42, wherein the grooving cutter hole 311 is arranged on the working disc 3, the cutterhead assembly 41 is arranged on a back surface of the working disc 3, the grooving cutter 42 is arranged in the grooving cutter hole 311, and the cutterhead assembly 41 is in transmission connection with the grooving cutter 42 to drive the grooving cutter 42 to extend out of or retract into the grooving

cutter hole 311. With such arrangement, the cutterhead assembly 41 can drive the grooving cutter 42 to extend out of the grooving cutter hole 311, thereby enabling the grooving cutter 42 abutting against the tunnel face. When the working disc 3 rotates, it drives the grooving cutter 42 to rotate, thereby opening the annular crack arrest groove on the tunnel face by the grooving cutter 42. After the annular crack arrest groove is opened, the cutterhead assembly 41 drives the grooving cutter 42 to retract into the grooving cutter hole 311, thereby separating the grooving cutter 42 from the tunnel face. Additionally, by controlling a length of the grooving cutter 42 extending out of the grooving cutter hole 311 by the cutterhead assembly 41, an depth of the annular crack arrest groove can also be controlled to satisfy various construction requirements.

[0071] The grooving cutter hole 311 is arranged on the annular sleeve 322 of the working disc 3, and it is an annular hole. Arranging the grooving cutter 42 within the grooving cutter hole 311 can not only limit and guide the grooving cutter 42, but also protect the grooving cutter 42 retracted into the grooving cutter hole 311, reducing collision with other components.

[0072] In some embodiments, the grooving cutter 42 is configured as an arc-shaped blade, with a convex arc surface of the arc-shaped blade away from the center of the working disc 3. The arrangement allows the arc-shaped blade to sweep away interference such as protruding rocks on a sidewall of the annular crack arrest groove while cutting the tunnel face.

[0073] In some embodiments, the cutterhead assembly 41 includes a reversible motor, a screw gear 411, a cutterhead screw 412 and a threaded sleeve 413. The reversible motor is arranged on the working disc 3, and the screw gear 411 is connected to the reversible motor. The cutterhead screw 412 is arranged in the grooving cutter hole 311 and connected to the grooving cutter 42. The cutterhead screw 412 engages with the screw gear 411, while the threaded sleeve 413 is fixedly arranged in the grooving cutter hole 311. The cutterhead screw 412 is threadably engaged with the threaded sleeve 413, allowing for vertical movement through screw rotation.

[0074] With the arrangement above, when the reversible motor rotates forward, it drives the screw gear 411 to rotate forward. Because the screw gear 411 is engaged with the cutterhead screw 412, it causes the cutterhead screw 412 to rotate forward. As the cutterhead screw 412 is threadably engaged with the threaded sleeve 413 and the threaded sleeve 413 is fixed, the rotation of the cutterhead screw 412 results in its axial movement along the threaded sleeve 413. and finally, it drives the grooving cutter 42 to rotate and extend out of the grooving cutter hole 311 and engage with the tunnel face for creating the annular crack arrest groove with sufficient depth in the tunnel face. When the reversible motor rotates in reverse, it drives the screw gear 411 to rotate in reverse direction, thus causing the cutterhead screw 412 to rotate in reverse and the cutterhead screw 412 to move axially along

the threaded sleeve 413. This retracts the grooving cutter 42 on the cutterhead screw 412 back into the grooving cutter hole 311, separating it from the tunnel face. Therefore, the above arrangement can not only drive the grooving cutter 42 to extend out of or retract into the grooving cutter hole 311 through the cutterhead screw 412 but also enable the grooving cutter 42 to rotate around itself through the cutterhead screw 412, facilitating the creation of the annular crack arrest groove with sufficient depth on the tunnel face.

[0075] Specifically, the reversible motor can rotate forward and backward to change a moving direction of the grooving cutter 42, which can enable the grooving cutter 42 to extend out of or retract into the grooving cutter hole 311. Since the reversible motor is a prior art, the details are not repeated here.

[0076] The screw gear 411 is connected to an output shaft of the reversible motor in a reliable way such as key or interference fit to synchronously rotate forward or backward along with the reversible motor.

[0077] An end part of the cutterhead screw 412 is reliably connected to the grooving cutter 42 through methods such as threading, pin-key coupling, etc. Specifically, the cutterhead screw 412 is a cylindrical rod, and a periphery of the cylindrical rod is provided with a spiral groove which is engaged with the screw gear 411.

[0078] The threaded sleeve 413 is a hollow cylindrical sleeve, and an inner wall of the cylindrical sleeve is provided with a spiral line that matches the spiral groove on the cutterhead screw 412.

[0079] In some embodiments, in terms of quantity, a plurality of foundation trench excavation devices 4 are provided and arranged at intervals along the circumferential direction of the working disc 3. With the arrangement, the plurality of foundation trench excavation devices 4 can, on one hand, improve an excavation rate of the annular crack arrest groove. On the other hand, since the plurality of foundation trench excavation devices are arranged at intervals along the circumferential direction of the working disc 3, even if a part of the foundation trench excavation devices 4 cannot abut against the tunnel face since the working disc 3 is not completely in parallel contact with the tunnel face, another part (one or more) of the foundation trench excavation devices 4 can always abut against the tunnel face to carry out the grooving construction of the annular crack arrest groove. Therefore, it reduces requirement for precise alignment accuracy between the working disc 3 and the tunnel face.

[0080] It is further explained that there are a plurality of foundation trench excavation devices 4 at intervals along the circumferential direction of the working disc 3. When the working disc 3 is not completely in parallel contact with the tunnel face, the foundation trench excavation devices 4 on the working disc 3 far away from an inclined side of the tunnel face cannot abut against the tunnel face, while the foundation trench excavation devices 4 on the working disc 3 towards the inclined side of the tunnel face abut against the tunnel face to carry out excavation

construction of the annular crack arrest groove.

[0081] The present disclosure incorporates various structural components (such as, the vehicle-mounted device 1, the translation device 40 and the rotational driving device 2) that work in coordination to ensure that the working disc 3 can be regulated to be parallel to the tunnel face. It can be understood that even when the working disc 3 is not completely parallel to the tunnel face, the rotation of the working disc 3 driving the foundation trench excavation device 4 to rotate can still achieve opening of part of the annular crack arrest groove with a groove edge of the annular crack arrest groove being not vertical. However, it does not affect an overall working effect of drilling and splitting.

[0082] The drilling machine 51 is used for drilling a hole in the tunnel face, and the rock splitter 52 is used for being inserted into the drilled hole to split the tunnel face, so as to realize drilling and cracking construction of the tunnel face.

[0083] In order to realize the movement of the drilling machine 51 and the rock splitter 52 along the length direction of the connecting rod 33, the embodiment further includes a shifting device 8. The shifting device 8 is connected to the splitting frame 511 to drive the splitting frame 511 to move along the length direction of the connecting rod 33. Therefore, when each drilling and splitting device 5 needs to move along the length direction of the connecting rod 33, the drilling and splitting device 5 can be driven to move through the shifting device 8, thereby achieving controlling of the movement of the drilling machine 51 and the rock splitter 52 on the drilling and splitting device 5.

[0084] A sliding mechanism is further included, which is arranged on the splitting frame 511. The sliding mechanism is connected to the drilling machine 51 and/or the rock splitter 52 to drive the drilling machine 51 and/or the rock splitter 52 to slide along the splitting frame 511.

[0085] In terms of a specific structural arrangement, the shifting device 8 includes a travel motor 81 and a traveling gear mechanism 82, wherein the travel motor 81 is arranged on the splitting frame 511, the traveling gear mechanism 82 is in transmission connection with the travel motor 81. The traveling gear mechanism 82 is engaged with the rack 331, and the travel motor 81 can drive the traveling gear mechanism 82 to rotate to drive the splitting frame 511 to move along the length direction of the connecting rod 33. With such arrangement, the travel motor 81 rotates to drive the traveling gear mechanism 82 to rotate. As the traveling gear mechanism 82 is engaged with the rack 331, the traveling gear mechanism 82 moves along the rack 331, thereby driving the splitting frame 511 and the drilling machine 51 and the rock splitter 52 thereof to move along the length direction of the connecting rod 33, which can realize drilling and splitting operations on different positions in the radial direction of the tunnel face.

[0086] Specifically, the travel motor 81 may also rotate forward and backward. The forward and backward rota-

tion of the travel motor 81 can drive the traveling gear mechanism 82 to rotate clockwise or counterclockwise, thereby causing the drilling machine 51 or the rock splitter 52 moving back and forth along the length direction of the connecting rod 33, which can realize continuous drilling or splitting operation on the tunnel face.

[0087] In some embodiments, the traveling gear mechanism 82 includes a synchronous driving shaft 821 and a traveling screw, wherein the synchronous driving shaft 821 is arranged between two I-shaped plate arranged relatively at intervals. The synchronous driving shaft 821 is connected to the travel motor 81, and the synchronous driving shaft 821 is provided with a first synchronizing gear 8211 and a second synchronizing gear 8212 arranged at intervals. The traveling screw includes an inner traveling screw 822 arranged on the back surface of the I-shaped plate and an outer traveling screw 823 arranged on the front surface of the I-shaped plate. The inner traveling screw 822 is engaged with the first synchronizing gear 8211, the outer traveling screw 823 is engaged with the second synchronizing gear 8212. The inner traveling screw 822 is rotatably arranged on the splitting frame 511. Two ends of the inner traveling screw 822 are provided with the inner traverse gears 8221, and the inner traverse gears 8221 are engaged with the racks 331 on the back surfaces of the two I-shaped plates. Two ends of the outer traveling screw 823 are provided with the outer traverse gears 8231, and the outer traverse gears 8231 are engaged with the racks 331 on the front surfaces of the I-shaped plates.

[0088] According to the arrangement above, when the drilling machine 51 or the rock splitter 52 needs to move along the length direction of the connecting rod 33, the travel motor 81 drives the synchronous driving shaft 821 to rotate to drive the first synchronizing gear 8211 and the second synchronizing gear 8212 on the synchronous driving shaft 821 to rotate synchronously. Because the first synchronizing gear 8211 is engaged with the inner traveling screw 822 and the second synchronizing gear 8212 is engaged with the outer traveling screw 823, the inner traveling screw 822 and the outer traveling screw 823 are driven to rotate synchronously. As the inner traverse gears 8221 at the two ends of the inner traveling screw 822 are engaged with the racks 331 on the back surfaces of the I-shaped plates, and the outer traverse gears 8231 at the two ends of the outer traveling screw 823 are engaged with the racks 331 on the front surfaces of the I-shaped plates, the inner traverse gear 8221 moves along the racks 331 on the back surfaces of the I-shaped plates and the outer traverse gear 8231 moves along the racks 331 on the front surfaces of the I-shaped plates. Since the travel motor 81 and the inner traveling screw 822 are both arranged on the splitting frame 511, the movement of the inner traverse gear 8221 and the outer traverse gear 8231 along the racks 331 can synchronously drive the splitting frame 511 and the drilling machine 51 or the rock splitter 52 thereon to move along the racks 331 (i.e., consistent with the length direction of

the connecting rod 33), which can realize drilling and splitting operations on different positions of the tunnel face.

[0089] Specifically, the synchronous driving shaft 821 is connected to an output shaft of the travel motor 81 in a reliable way such as key or inner and outer gears, thereby ensuring synchronous rotation of the two. The synchronous driving shaft 821 penetrates through the gap between the I-shaped plates, and the two ends of the synchronous driving shaft extend out of the gap between the I-shaped plates.

[0090] The first synchronizing gear 8211 and the second synchronizing gear 8212 are both helical teeth. The inner traveling screw 822 and the outer traveling screw 823 are provided with spiral grooves in the circumferential direction, and the helical teeth are matched with the spiral grooves. It can be understood that the engagement between the second synchronizing gear 8212 and the outer traveling screw 823 can also improve engagement tightness between the outer traverse gear 8231 and the rack 331, and prevent the outer traverse gear 8231 from disengaging from the rack 331.

[0091] In some embodiments, in order to improve matching reliability of the first synchronizing gear 8211 and the second synchronizing gear 8212 with the inner traveling screw 822 and the outer traveling screw 823, the synchronous driving shaft 821 is further provided with a locking nut 8213, and the locking nut 8213 abuts against the second synchronizing gear 8212, causing the second synchronizing gear 8212 being tightly engaged with the outer traveling screw 823, thereby ensuring the tight matching reliability of the whole traveling gear mechanism 82 with the rack 331.

[0092] Further, in some embodiments the traveling gear mechanism 82 further includes a synchronous bushing and a guide support beam 83, wherein the synchronous bushing is coordinated and connected with the synchronous driving shaft 821 through a bearing. Moreover, the synchronous bushing and the bearing are located at fixed positions between the first synchronizing gear 8211 and the second synchronizing gear 8212. By arranging a bearing mounting groove on the synchronous driving shaft 821, it can ensure that the synchronous bushing and the bearing cannot slide up and down on the synchronous driving shaft 821, but can only rotate and connect at the fixed position of the synchronous driving shaft 821. The guide support beam 83 is fixedly connected to the synchronous bushing at an included angle, and two ends of the guide support beam 83 are provided with guide support wheels 831, wherein the guide support wheel 831 at one end is in rolling contact with a vertical plate of one I-shaped plate, and the guide support wheel 831 at the other end is in rolling contact with a vertical plate of the other I-shaped plate.

[0093] The arrangement above enables the synchronous bushing to fit snugly around the outer circumference of the synchronous driving shaft 821, not impeding the rotation of the synchronous driving shaft 821 while main-

taining the overall non-rotation and excellent stability of the synchronous bushing and the guide support beam 83. Meanwhile, when the guide support beam 83 moves together with the synchronous bushing, the guide support wheels 831 at the two ends of the guide support beam 83 roll on the I-shaped plates at either sides, providing further support to the whole traveling gear mechanism 82. And the guide support wheels 831 can also reduce a moving resistance. In addition, the guide support wheels 831 at the two ends of the guide support beam 83 play a balanced role in supporting the whole traveling gear mechanism 82, ensuring stable engagement between the traveling gear mechanism 82 and the rack 331 when the working disc 3 rotates (i.e., when the connecting rod 33 rotates along the circumferential direction). It can prevent the traveling gear mechanism 82 from deviating to one side and separating from the rack 331 due to the rotation of the working disc 3, thereby ensuring normal and reliable operation of the whole mechanism.

[0094] The synchronous bushing is a hollow cylinder, the bearing is arranged between the synchronous bushing and the synchronous driving shaft 821, an inside of the synchronous bushing is tightly coordinated and connected with an outer ring of the bearing, and the synchronous driving shaft 821 is tightly coordinated and connected with an inner ring of the bearing, allowing the synchronous driving shaft 821 to rotate inside the synchronous bushing under the drive of the travel motor 81, while the synchronous bushing remains stationary.

[0095] The guide support beam 83 is arranged perpendicularly intersecting with the synchronous bushing, and the two can be reliably fixed together by welding, bolts, etc. The guide support wheels 831 are rotatably arranged at the two ends of the guide support beam 83. When the guide support beam 83 moves with the synchronous bushing, it drives the guide support wheels 831 at the two ends to roll along an inner wall of the I-shaped plate.

[0096] The drilling and splitting device 5 further includes a first lateral frame 512 and a second lateral frame. The first lateral frame 512 and the second lateral frame are respectively connected to two sides of the splitting frame 511, the drilling machine 51 is movably arranged on the first lateral frame 512, the rock splitter 52 is movably arranged on the second lateral frame. The sliding mechanism is connected to both the drilling machine 51 and the rock splitter 52 to drive the drilling machine 51 to slide along the first lateral frame 512 and drive the rock splitter 52 to slide along the second lateral frame. The arrangement can drive the drilling machine 51 and the rock splitter 52 on the two sides to slide along the first lateral frame 512 and the second lateral frame through the sliding mechanism, thereby driving the drilling machine 51 on the first lateral frame 512 or the rock splitter 52 on the second lateral frame to move. It is convenient for synchronous drilling and splitting of the tunnel face and improves drilling or splitting operation efficiency.

[0097] The splitting frame 511, the first lateral frame 512, and the second lateral frame are all three-sided steel structures with one side open. The first lateral frame 512 and the second lateral frame are respectively connected with the drilling machine 51 and the rock splitter 52, which means that the preferred way is that one end is connected with the drilling machine 51 and the other end is connected with the rock splitter 52. The arrangement facilitates better procedural integration of the drilling operation and the splitting operation.

[0098] The first lateral frame 512 and the second lateral frame are both hinged with the splitting frame 511, and one sides of the first lateral frame 512, the second lateral frame and the splitting frame 511 far away from the central shaft in disk 321 are all provided with an opening. The sliding mechanism includes a first double-piston actuator 515 arranged at the opening of the splitting frame 511. One piston rod of the first double-piston actuator 515 penetrates through the opening of the first lateral frame 512 and is hinged with the drilling machine 51, while the other piston rod of the first double-piston actuator penetrates through the opening of the second lateral frame and is hinged with the rock splitter 52. The drilling and splitting device 5 further includes a first locking mechanism 514 and a second locking mechanism. The first locking mechanism 514 is suitable for locking the first lateral frame 512 and the drilling machine 51, and the second locking mechanism is suitable for locking the second lateral frame and the rock splitter 52. The first double-piston actuator 515 can drive both the first lateral frame 512 and the second lateral frame to rotate relative to the splitting frame 511 around a hinge point, away from the center of the working disc 3, thereby achieving the folding of the drilling and splitting device 5. The first double-piston actuator 515 may drive the drilling machine 51 and the splitting frame 511 to slide along the first lateral frame 512 and the second lateral frame as required to regulate working positions of the drilling machine 51 and the rock splitter 52. Thus, it can achieve the folding of of the drilling and splitting device 5 and facilitate unhindered movement of the drilling and splitting device 5 along the connecting rod 33 by locking the first lateral frame 512 to the drilling machine 51 through the first locking mechanism 514, locking the second lateral frame to the rock splitter 52 through the second locking mechanism, and driving both the first lateral frame 512 and the second lateral frame to rotate relative to the splitting frame 511 around a hinge point, away from the center of the working disc 3 through the first double-piston actuator 515.

[0099] Preferably, both the first locking mechanism 514 and the second locking mechanism are designed as an electromagnetic attraction-based locking structure. It can lock or release the first lateral frame 512 from the drilling machine 51, as well as the second lateral frame from the rock splitter 52 through the electromagnetic attraction type locking structure, which provide convenient control and excellent stability.

[0100] For example, the electromagnetic attraction

type locking structure may specifically include a suction cup 5141 and an electromagnetic clamping device 5142. One of the suction cup 5141 and the electromagnetic clamping device 5142 is arranged on the drilling machine 51 and the other is arranged on the first lateral frame 512. Alternatively, one of the suction cup 5141 and the electromagnetic clamping device 5142 is arranged on the rock splitter 52 and the other is arranged on the second lateral frame. The arrangement can control electromagnetic suction and fixation between the first lateral frame 512 and the drilling machine 51 or between the second lateral frame and the rock splitter 52 by simply switching the power supply on or off for the electromagnetic clamping device 5142.

[0101] Specifically, tracks are laid on the inner lower bottom plates of both the first lateral frame 512 and the second lateral frame. A trolley at the bottoms of the drilling machine 51 and the rock splitter 52 is provided with traveling wheels 4011, which can move along the tracks under the drive of the first double-piston actuator 515. The trolley penetrates through the piston rod and is fixedly connected to a base. The suction cup 5141 is arranged on the base near a baffle plate of the lateral frame, and correspondingly, the electromagnetic suction assemblies 5142 are continuously arranged inside of the lateral frame, thereby causing the drilling machine 51 or the rock splitter 52 to be positionally fixed by sucking with the suction cup 5141 when necessary. Additionally, a sliding sleeve is also arranged above the sliding sleeve by penetrating the axis, and the sliding sleeve is rotatably connected to a vertical axis. The sliding sleeve is connected to the piston rod of the first double-piston actuator 515 through the hinge point. As the first double-piston actuator 515 extends or retracts, and the first lateral frame 512 or the second lateral frame rotates around the first double-piston actuator 515 through the hinge point, the sliding sleeve will rotate around the vertical axis under the drive of the piston rod to accommodate change in angle. An upper part of the splitting frame 511 or a second middle frame is provided with a first limit slide hole 5121. The vertical axis of the drilling machine 51 or the rock splitter 52 is sleeved with the upper guide traveling wheel 4011, which can slide along the first limit slide hole 5121 under the drive of the first double-piston actuator 515 in the first limit slide hole 5121 via the upper guide traveling wheel 4011. Simultaneously, the traveling wheel 4011 connected with a lower part of the vertical axis slides synchronously on the tracks, realizing the entire movement of the shifting device 8, and consequently driving the entire movement of the drilling machine 51 or the rock splitter 52.

[0102] A sliding rail device is further included, wherein the sliding rail device is a set of devices that drive the drilling machine 51 or the rock splitter 52 to slide back and forth along the sliding rails. The sliding rail device is connected to the shifting device 8 through an upper mounting arm and a lower mounting arm. Specifically, the upper mounting arm is connected to a vertical axis of

the shifting device 8, the lower mounting arm is fixedly connected to a side edge of the trolley through a long groove hole on a back side structure of the first lateral frame 512 or the second lateral frame. The upper mounting arm and the lower mounting arm are respectively fixedly connected to one side of a cylinder body of the sliding cylinder, the other side of the cylinder body of the sliding cylinder is connected to a fixed guide groove through a fixed bracket, and the fixed guide groove and a sliding guide groove embedded in the fixed guide groove can move relative to each other. One end of the sliding guide groove is connected to a piston rod of the sliding cylinder, enabling the sliding guide groove to slide back and forth on the fixed guide groove when driven by the sliding cylinder.

[0103] A driving device is further included, wherein the driving device is used for driving the drilling machine 51 or the rock splitter 52 to perform drilling or splitting operations. On the other side of the sliding guide groove, a motor for driving the drilling machine 51 or the rock splitter 52 to move is arranged, and the motor drives a turbine to rotate through a motor shaft. Both the drilling machine 51 and the rock splitter 52 adopt a driving screw structure at the upper portion. When the motor drives the turbine to be engaged with the driving screw to move, the motor can facilitate the driving screw to rotate rapidly while moving forward or backward. The drilling machine 51 or the rock splitter 52 is connected to the sliding guide groove through a guide sleeve and double pivots of the guide sleeve, which enable the sliding guide groove to not only support weight and working impact of the drilling machine or the rock splitter but also the entire move backward and forward. The guide sleeves are different in structure. The guide sleeve is preferably in a form of a groove structure with a big-half circumference enclosure and a small-half circumference opening. An inside of the groove structure is provided with an internal thread in threaded matching with the driving screw for engaging movement. A lower part of the guide sleeve is fixedly connected with a motor housing through a bracket, and an opening part of the guide sleeve is engaged with a thread on the driving screw by the turbine. The guide sleeve is in a form of a fully enclosed hollow cylinder structure, and an outside of the guide sleeve is connected with the sliding cylinder through a bracket. Through the supporting and driving of the guide sleeve and the double pivots of the guide sleeve, stable support and operation of the drilling machine 51 or the rock splitter 52 during the working process can be well ensured. Structures of upper sliding screws of the drilling machine 51 and the rock splitter 52 are basically the same, but lower structures of the drilling machine 51 and the rock splitter 52 are different due to different functions to be realized. The lower part of the drilling machine 51 is a drilling rod structure, one end of the drilling rod connected with the driving screw is a sleeve structure embedded with a thread, and a lower end part of the driving screw is an external thread structure. A width and a pitch of the thread are matched with

that of an internal thread at an end part of the drilling rod, so that the driving screw can be screwed with the thread at the end part of the drilling rod to realize reliable connection. A screwing direction of a connecting thread between the driving screw and the drilling rod is consistent with a forward engaging direction of the turbine and the driving screw, so that the threaded connection between the driving screw and the drilling rod can be ensured to be tighter and tighter during the continuous drilling of the driving screw and the drilling rod driven by the turbine, and the drilling rod and the driving screw will not be loosened. The lower structure of the rock splitter 52 consists of a wedge cylinder, an air inlet, an air outlet, a wedge and a female rod, or the like. A top of the wedge cylinder is in a form of an internal thread connecting sleeve which is sealed and separated from a cylinder body. Threaded connection methods and principles of the rock splitter 52 and the upper and lower parts of the drilling machine 51 are the same. The wedge cylinder can be in a form of an air cylinder, a hydraulic cylinder, or the like. The air inlet and the air outlet are respectively connected with air inlet and outlet pipes or liquid inlet and outlet pipes to drive a piston of the wedge cylinder to move in the cylinder body. The piston rod is connected with the wedge. An end part of a lower opening of the wedge cylinder is fixedly connected with two half-edge female rods with gaps in a middle. The gap between the two half-edge female rods is larger at the end close to the wedge cylinder and smaller at the end far away from the wedge cylinder. As a width of the wedge is larger than a gap at a front end of the female rod, when the wedge cylinder drives the piston rod to push the wedge cylinder to move forward, the two half-edge female rods are propped open by the wedge, and the two half-edge female rods are squeezed outward. If the wedge cylinder is driven in a hole, an effect of hole wall cracking will be presented, and an effect of static crushing operation will be realized.

[0104] Furthermore, since the gap between adjacent connecting rods 33 gradually decreases from the annular sleeve 322 to the central shaft in disk 321, when the drilling and splitting device 5 moves along the length direction of the connecting rod 33 and moves to the vicinity of the central shaft in disk 321, the gap between adjacent connecting rods 33 becomes smaller, which easily leads to interference between the drilling and splitting device 5 and the adjacent connecting rod 33, thus affecting the normal use of the drilling machine 51 and the rock splitter 52. Therefore, the drilling and splitting device 5 of the embodiment can be folded, and the drilling and splitting device 5 can adapt to a reduced working space when being folded, so as to meet multi-scenario use requirements.

[0105] It can be understood that when the first locking mechanism 514 is released, the first double-piston actuator 515 can not only drive the drilling machine 51 and the rock splitter 52 on the two sides to move linearly, but also only drive the drilling machine 51 or the rock splitter

52 on one side to move unilaterally, so as to regulate the working position of the drilling machine 51 or the rock splitter 52. After moving to a new position, the drilling machine or the rock splitter can be fixed in a new position through the electromagnetic clamping device 5142, so as to ensure the stability and reliability of the construction process and realize drilling or splitting operations on different positions of the tunnel face.

[0106] A cylinder body of the first double-piston actuator 515 is provided with baffles, and each baffle cavity is provided with an independent air (liquid) inlet, so that the single cylinder can move independently. Since the structure and the principle of the first double-piston actuator 515 belong to the prior art, they will not be described here.

[0107] Further, the first lateral frame 512 is provided with a first limit slide hole 5121 in a direction far away from the splitting frame 511, and the drilling machine 51 passes through the first limit slide hole 5121. The drilling machine 51 can slide along the first limit slide hole 5121 driven by the first double-piston actuator 515. The arrangement of the first limit slide hole 5121 can guide and limit the movement of the drilling machine 51 and improve movement stability and accuracy of the drilling machine 51.

[0108] The first limit slide hole 5121 is set as a long hole, and a rotating rod of the drilling machine 51 penetrates through the long hole in a sliding way. When the first double-piston actuator 515 drives the drilling machine 51 to move linearly, the drilling rod of the drilling machine slides along the long hole.

[0109] It can be understood that when the second locking mechanism is released, the second double-piston actuator can also drive the rock splitter 52 to move linearly, so as to regulate the working position of the rock splitter 52 and realize the splitting operation on different positions of the tunnel face.

[0110] Accordingly, the second lateral frame is provided with a second limit slide hole in the direction far away from the splitting frame 511, the rock splitter 52 penetrates through the second limit slide hole, and the rock splitter 52 can be driven by the second double-piston actuator 515 to slide along the second limit slide hole. The arrangement of the second limit slide hole can guide and limit the movement of the rock splitter 52 and improve movement stability and accuracy of the rock splitter 52.

[0111] The second limit slide hole is also set as a long hole, and a splitting rod of the rock splitter 52 penetrates through the long hole in a sliding way. When the first double-piston actuator 515 drives the rock splitter 52 to move linearly, the splitting rod of the rock splitter slides along the long hole.

[0112] This embodiment further includes a control system, wherein corresponding programs are built in the control system. Parameters such as size, lithology and single-cycle footage of the tunnel face to be excavated are input into the programs of the control system, and the parameters such as distribution, aperture and depth of the drilled hole to be split are reasonably designed after

program calculation, so that the drilling machine 51 and the rock splitter 52 can perform corresponding drilling and splitting operations according to the set parameters, with high control precision and high degree of automation. As the parameter acquisition and calculation of the control system belong to prior art in the field, the details will not be repeated in some embodiments.

[0113] Meanwhile, a camera may further be arranged, wherein the camera is arranged towards the tunnel face to monitor a construction situation of the tunnel face and position an actual opening position of the drilled hole.

[0114] After drilling, the splitting operation can be carried out. According to the distribution of the drilled holes designed by the control system, the preorder drilling machine 51 has completed the drilling work. The rock splitter 52 should realize rapid positioning of the drilled hole. On one hand, positioning is carried out through the preset parameters of the control system. On the other hand, through an identification function of the arranged camera and in combination with program control, hole finding and positioning of the rock splitter 52 are automatically carried, and the control accuracy is high.

[0115] After finding the drilled hole accurately, the splitting operation is carried out from an outer ring to an inner ring in general. Before the splitting operation, the grooving cutter 42 should be retracted into the grooving cutter hole 311 to avoid interference between the grooving cutter 42 and the rock splitter 52 and other devices.

[0116] After the splitting of each drilled hole is completed, a lot of fractured rock blocks fall off, and some rock blocks that have not fallen off are stuck on the tunnel face. Based on this, the hazard removal device 50 in some embodiments is abutted against the tunnel face, and the remaining rock blocks can be ensured to fall off by a vibration force of the hazard removal device 50, and subsequent new cycle excavation work can be carried out after all the rock blocks fall off.

[0117] In some embodiments, the hazard removal device 50 is preferably a multi-section short arm structure arranged at a front end of the vehicle-mounted platform 11, so that the multi-section short arm can achieve effective extension working length and height after being fully unfolded on one hand, and on the other hand, the multi-section short arm can be fully folded to reduce the occupation of space and avoid affecting the use of other devices. Specifically, the hazard removal device 50 includes: a hazard removal bucket 501, a driving cylinder 502 and a folding arm 503. The hazard removal bucket 501 is suitable for being matched with the tunnel face. The driving cylinder 502 is hinged to the vehicle-mounted platform 11, and the driving cylinder 502 is hinged with the hazard removal bucket 501 to drive the hazard removal bucket 501 to swing. The folding arm 503 is hinged to the vehicle-mounted platform 11, the folding arm 503 is hinged with both the driving cylinder 502 and the hazard removal bucket 501, and the driving cylinder 502 can drive the folding arm 503 to be folded or unfolded to drive the hazard removal bucket 501 to be accommodated or

extended. The hazard removal bucket 501 may be a bucket similar to a backacting shovel, or a finger grab similar to a hand with a gap at fingertips. After completing the drilling operation of the working disc 3 is completed, the working disc 3 is brought as close as possible to the vehicle-mounted platform 11 through the contraction of the longitudinal arm 91 and the transverse arm 92, so as to regulate position after rotation. Then, the working disc 3 is transformed from a vertical state facing the tunnel face to a horizontal state toward the top through the extension of the amplitude-variable cylinder, and then the regulating turntable 96 is driven to rotate by about 90 degrees, so that the entire working disc 3 is toward a side surface, making sufficient working space for the hazard removal device 50. The hazard removal bucket 501 is operated to scrape off the rocks from the tunnel face, so that the rocks fall from the tunnel face. Meanwhile, a hazard removal operation is carried out on the tunnel face to prevent the rocks from falling and injuring people in the subsequent work. After the large rocks falling on the ground are partially crushed by the pressing of the hazard removal bucket 501, the rocks are scraped onto the hopper 71 and the mucking machine 72, and conveyed to the cart by the belt conveyor 73.

[0118] The driving cylinder 502 includes a main cylinder, an secondary cylinder and a hopper cylinder. The folding arm 503 includes a main hopper arm and an secondary hopper arm. One end of the main cylinder is hinged to the vehicle-mounted platform 11, and the other end of the main cylinder is hinged to a middle of the main hopper arm. One end of the secondary cylinder is hinged to the middle of the main hopper arm, and the other end of the secondary cylinder is hinged to the secondary hopper arm. The bottom of the main hopper arm is hinged to the vehicle-mounted platform 11, and a top of the main hopper arm is hinged to a middle of the secondary hopper arm. One end of the hopper cylinder is hinged with one end of the secondary hopper arm close to the main hopper arm, and the other end of the hopper cylinder is hinged with both one end of the secondary hopper arm far away from the main hopper arm and the hazard removal bucket 501. One end of the secondary hopper arm far away from the hopper cylinder is hinged with the hazard removal bucket 501.

[0119] The hazard removal device 50 further includes a rotating hopper 504 rotatably arranged on the vehicle-mounted platform 11, wherein a bottom of the main hopper arm is hinged to the rotating hopper 504, a bottom of the main cylinder is connected to the vehicle-mounted platform 11 by ball hinge and/or a top of the main cylinder is connected to the main hopper arm by ball hinge, and the rotating hopper 504 drives the main hopper arm and a structure thereon to rotate together so as to regulate a working position of the hazard removal bucket 501.

[0120] The non-blasting tunnel boring machine further includes a camera device and a control center, wherein the camera device is suitable for monitoring working conditions of the tunnel face and transmitting information

to the control center, and the control center controls the starting of the rotational driving device 2, the translation device 40, the foundation trench excavation device 4, the drilling and splitting device 5 and the hazard removal device 50 according to the information.

[0121] in some embodiments, the dust suppression device 6 may include a water tank 61, a water spray pipe 62 and an atomizing nozzle 63, wherein the water tank 61 is arranged on the vehicle-mounted device 1, the water spray pipe 62 is connected with the water tank 61, the atomizing nozzle 63 is connected with the water spray pipe 62, and the atomizing nozzle 63 is arranged towards the tunnel face. The water in the water tank 61 flows to the atomizing nozzle 63 through the water spray pipe 62, and is atomized and sprayed by the atomizing nozzle 63, so that the dust generated by excavation is suppressed and the safety of construction workers and devices are prevented from being affected after the dust diffuses in a tunnel or closed space. The water spray pipe 62 preferably adopts an elastic semi-hose structure, which means that, when other devices or structures need to temporarily occupy the position of the water spray pipe 62 due to limited space, the water spray pipe 62 can be temporarily pushed and deformed to make room for work. When the structure occupying the position of the water spray pipe is withdrawn, the water spray pipe 62 can be restored to the original position thereof because of the elasticity thereof so as to facilitate spraying and dust suppression thereof.

[0122] Specifically, the water tank 61 is arranged on the vehicle-mounted platform 11, and a water pump is arranged in the water tank 61. The water is pumped into the water spray pipe 62 by the water pump at a certain water pressure, and then atomized and sprayed by the atomizing nozzle 63.

[0123] There are a plurality of atomizing nozzles 63 arranged annularly along the working disc 3 to spray water around the tunnel face to suppress the dust. Because the atomizing nozzle 63 rotates with the working disc 3, correspondingly, the water spray pipe 62 of this embodiment is preferably a hose to adapt to the rotation of the atomizing nozzle 63.

[0124] Further, in order to facilitate detection of a dust index, this embodiment further includes a dust detection device 64, and the dust detection device 64 is suitable for detecting the dust index to turn on the dust suppression device 6 when the dust index reaches a preset value. Therefore, the dust index is detected by the dust detection device 64, and the dust suppression device 6 is turned on only when the dust index reaches the preset value to realize dust suppression, while the dust suppression device 6 is kept off when the dust index does not reach the preset value, which means that, when the dust does not pose a safety threat, thus playing an energy-saving role.

[0125] Since the structure and the principle of the dust detection device 64 belong to the prior art, they will not be described in some embodiments. It can be understood that the preset value of the dust index here may be set as

needed, which is not specifically limited in some embodiments.

[0126] Materials such as rocks and sandy soil that fall after splitting are loaded to a transport vehicle through the material feeding device 7, and then transported away for reuse or abandoned, so as to avoid material accumulation and realize continuous construction operation.

[0127] in some embodiments, the material feeding device 7 includes the hopper 71, the mucking machine 72 and the belt conveyor 73, wherein the hopper 71 is arranged below the working disc 3, the mucking machine 72 is arranged in the hopper 71 to drive the materials to be conveyed in the hopper 71, the belt conveyor 73 is arranged on the vehicle-mounted device 1 and the belt conveyor 73 is connected with the hopper 71. The materials generated by excavation fall into the hopper 71, and the mucking machine 72 drives the materials to be transported along the hopper 71 to the belt conveyor 73, and then the materials are transported out by the belt conveyor 73, so as to avoid material accumulation.

[0128] The hopper 71 is a conical hopper, a big end of which is convenient for receiving materials, and a small end of which is connected with the belt conveyor 73.

[0129] The mucking machine 72 includes at least two material scraping gears arranged at intervals, the material scraping gear is rotatably arranged in the hopper 71, and a grinding gap is formed between the adjacent material scraping gears to crush the material. The rotation of the material scraping gear drives the material to be transported in the hopper 71, and meanwhile, the adjacent material scraping gears can squeeze and crush the material entering the grinding gap, and further crush the larger rocks and other materials, which is convenient for the transportation of the material with small particles and does not occupy the transportation space.

[0130] The belt conveyor 73 includes structures such as a belt conveyor and belt pulleys at two sides, so as to drive the belt conveyor to move through the rotation of the belt pulleys, and further drive the material to move and transport along the belt conveyor. Since the specific structure and the principle of the belt conveyor 73 both belong to the prior art, they will not be described here.

[0131] Specifically, a tail transmission end of the belt conveyor 73 is butted with the transport cart, so that the material is transported to the transport cart and transported to a stockyard by the transport cart.

in some embodiments, the material feeding device 7 further includes a rear luffing driving cylinder 74. The rear luffing driving cylinder 74 is arranged on the vehicle-mounted device 1. One end of the belt conveyor 73 close to the mucking machine 72 is connected with the vehicle-mounted device 1 through a front amplitude-variable cylinder. Before the vehicle-mounted device 1 is transported in transit, the mucking machine 72 is extended out through the front amplitude-variable cylinder to lift the mucking machine 72 off the ground, so as to avoid scratching damage with the ground due to bumps during transportation. The rear luffing driving cylinder 74

is hinged with one end of the belt conveyor 73 far away from the mucking machine 72 to drive one end of the belt conveyor 73 far away from the mucking machine 72 to ascend and descend. By setting the rear luffing driving cylinder 74, the rear luffing driving cylinder 74 can drive one end of the belt conveyor 73 far away from the mucking machine 72 to ascend or descend, so as to adapt to the use of transport carts with different heights and enhance the applicability of the belt conveyor 73.

[0132] In addition to the above arrangement, the non-blasting tunnel boring machine of this embodiment further includes a support boom 9. The support boom 9 includes a longitudinal arm 91 and a transverse arm 92, wherein the longitudinal arm 91 is vertically arranged on the vehicle-mounted device 1, the transverse arm 92 is transversely arranged and hinged with the longitudinal arm 91 through a hinge point, and the working disc 3 is connected with the transverse arm 92 through the rotational driving device 2. The support boom 9 is suitable for supporting the working disc 3, and the support boom 9 is arranged in a form of a connection of the longitudinal arm 91 and the transverse arm 92, wherein the longitudinal arm 91 facilitates a vertical distance between the working disc 3 and the vehicle-mounted device 1, and the transverse arm 92 facilitates a transverse distance between the working disc 3 and the vehicle-mounted device 1, so as to set the working disc 3 in a proper position.

[0133] Further, the support boom 9 further includes a longitudinal arm telescopic cylinder 93. The longitudinal arm telescopic cylinder 93 is vertically arranged inside the longitudinal arm 91 and connected with an internal supporting structure of the longitudinal arm 91 to drive the longitudinal arm 91 to move vertically. An outside of the longitudinal arm 91 adopts a sleeved steel structure. When the longitudinal arm telescopic cylinder 93 is telescopic, the steel structure sleeved outside the longitudinal arm 91 is also telescopic synchronously. Through the expansion and contraction of the longitudinal arm telescopic cylinder 93, the longitudinal arm 91 is driven to move vertically, so as to regulate a height of the working disc 3 and meet the construction requirements of different heights.

[0134] Further, the support boom 9 of this embodiment further includes a transverse arm telescopic cylinder 94. The transverse arm telescopic cylinder 94 is arranged inside the transverse arm 92 and connected with an internal supporting structure of the transverse arm 92 to drive the transverse arm 92 to move transversely. An outside of the transverse arm 92 adopts a sleeved steel structure. When the transverse arm telescopic cylinder 94 is telescopic, the steel structure sleeved outside the transverse arm 92 is also telescopic synchronously. The telescoping of the transverse arm telescopic cylinder 94 drives the transverse arm 92 to move transversely, thus driving the working disc 3 to realize transverse position regulating to satisfy different use scenario requirements.

[0135] The transverse arm telescopic cylinder 94 is hinged with the longitudinal arm 91 through a main

arm hinge point. The support boom 9 further includes a boom luffing cylinder 95, one end of the boom luffing cylinder 95 is hinged with an outer wall of the longitudinal arm telescopic cylinder 93, the other end of the boom luffing cylinder 95 is hinged with an outer wall of the transverse arm telescopic cylinder 94, and the boom luffing cylinder 95 drives the transverse arm telescopic cylinder 94 and the transverse arm 92 to entirely rotate up and down around a hinge point relative to the longitudinal arm 91. With the arrangement of the boom luffing cylinder 95, the extension of a piston rod of the boom luffing cylinder 95 can push the transverse arm telescopic cylinder 94 and the transverse arm 92 to entirely rotate upward relative to the longitudinal arm 91 around the hinge point, thus driving the whole working disc 3 to swing upward. With the shortening of the piston rod of the boom luffing cylinder 95, the transverse arm telescopic cylinder 94 and the transverse arm 92 can be entirely pulled downward relative to the longitudinal arm 91 around the hinge point, thus driving the whole working disc 3 to swing downward, thus realizing the regulating of the up-and-down inclination angle of the working disc 3, and improving parallelism of matching between the working disc 3 and the tunnel face.

[0136] The support boom 9 further includes a regulating turntable 96. The regulating turntable 96 is rotatably arranged on the vehicle-mounted device 1 and is connected with the vehicle-mounted platform 11 through a bearing. The regulating turntable 96 is connected with an inner ring of the bearing, and an outer ring of the bearing is fixedly connected with the vehicle-mounted platform 11, so that the regulating turntable 96 can rotate around the vehicle-mounted platform 11. The inner ring of the bearing is provided with a large gear ring arranged annularly along the inner ring, and the outer ring of the bearing or the vehicle-mounted platform 11 is provided with a star gear driven by a star gear motor through a bracket, and the star gear is engaged with the large gear ring to drive the large gear ring to drive the regulating turntable 96 to rotate.

[0137] The translation device 40 includes a translation mount 401, translation rails 402 and a translation driving unit 403. The translation mount 401 is arranged at a bottom of the support boom 9. The translation rails 402 are arranged on the regulating turntable 96 along a length direction of the vehicle-mounted platform 11, and the translation mount 401 is movably connected to the translation rails 402. The translation driving unit 403 is in transmission connection with the translation mount 401 to drive the translation mount 401 to move along the translation rails 402. The translation driving unit 403 drives the translation mount 401 to move along the translation rails 402, and then drives the support boom 9 and the components thereon to move along the translation rails 402.

[0138] Two translation rails 402 are arranged at intervals in parallel, a bottom of the translation mount 401 is provided with two rows of traveling wheels 4011 at inter-

vals, the two rows of traveling wheels 4011 are respectively matched on the two translation rails 402, and the traveling wheel 4011 is in transmission connection with the translation driving unit 403. The traveling wheel 4011 supports the translation mount 401 while reducing a moving friction.

[0139] The translation device 40 further includes an anti-roll rod 404, and the anti-roll rod is connected between the two rows of traveling wheels 4011 to improve movement synchronization of the two rows of traveling wheels 4011 and prevent the translation mount 401 from turning out of the translation rails 402.

[0140] Specifically, the traveling wheels 4011 drive the longitudinal arm 91 to reciprocate linearly on the translation rails 402, and a traveling motor of the translation driving unit 403 drives a traveling star gear of the translation driving unit 403 to engage with gears of the traveling wheels 4011 arranged on the traveling wheels 4011 for movement. The anti-roll rod 404 is lower than a height of the translation rail 402. When the working disc 3, the longitudinal arm 91 and the transverse arm 92 are likely to overturn, the anti-roll rod 404 can be stuck in inner edges of the translation rails 402 to avoid danger. Two ends of the translation rails 402 are also provided with terminal limit stops to prevent the translation mount 401 from running out of the rails.

[0141] The rotation of the regulating turntable 96 can drive the longitudinal arm telescopic cylinder 93 and the longitudinal arm 91, the transverse arm 92, the working disc 3 and other structures connected thereon to rotate as a whole, thereby further regulating the left-and-right inclination angle of the working disc 3 and improving the parallelism of matching between the working disc 3 and the tunnel face. Similarly, the translation mount 401 can move left and right along the translation rails 402, which can drive the longitudinal arm telescopic cylinder 93 and the longitudinal arm 91, the transverse arm 92, the working disc 3 and other structures connected thereon to move transversely as a whole, so that the working disc 3 can be aligned left and right with the tunnel face.

[0142] An end part of the central shaft in disk 321 is a steel cylinder cavity structure, and a sweeping structure, a laser generator, a camera and other devices are installed on an end cover and in the cavity. A camera lens of the camera device, a laser hole of the laser generator and the sweeping structure are respectively extended from three holes on a end cover surface. The laser generator is suitable for emitting a laser beam to the tunnel face, and the laser beam is aligned with a pre-calibrated point on the tunnel face through the camera to position the working disc 3. The sweeping structure includes an oscillating brush motor and a dust brush. An oscillating hinge of the oscillating brush motor is connected with the dust brush to drive the dust brush to oscillate and sweep the camera and the laser generator, so as to sweep the dust and moisture on the laser hole and the camera lens. A center point is calibrated in advance on the excavated tunnel face, and the working disc 3 is aligned before working.

The laser generator emits a laser beam from the laser hole, and the center point calibrated in advance on the tunnel face is subjected to point alignment and position alignment by the camera lens. The point alignment and position alignment can be completed manually by an operator, and can also be automatically corrected, or the point alignment and position alignment can be carried out under program control. If it is found that the working disc 3 is not accurately aligned, it can be accurately aligned and aligned after three-dimensional regulation by the above method.

[0143] Therefore, in the non-blasting tunnel tunneling machine of this embodiment, the up-and-down inclination angle of the working disc 3 is regulated by the boom luffing cylinder 95, the left-and-right inclination angle of the working disc 3 is regulated by the regulating turntable 96, and the horizontal alignment of the working disc 3 is regulated by the transverse movement of the trolley on the rails, so that the working disc 3 can be kept parallel to the tunnel face, and then the working disc 3 can be driven to move transversely toward the tunnel face by an expansion rod of the transverse arm 92, so that the working disc 3 can be in parallel contact with the tunnel face, which is convenient for construction.

[0144] It should be noted that the up-and-down inclination angle of the working disc 3 may be understood as an angle formed by the upward or downward rotation of the working disc 3 around the central shaft in disk 321 in FIG. 3, and the left-and-right inclination angle of the working disc 3 may be understood as an angle formed by the left or right rotation of the working disc 3 around the regulating turntable 96 in FIG. 4.

[0145] Further, the vehicle-mounted device 1 is further provided with a boom support 30, and the boom support 30 is suitable for supporting the transverse arm 92. When the construction is completed, the regulating turntable 96 drives the longitudinal arm telescopic cylinder 93 to rotate, which drives the transverse arm 92 and the working disc 3 thereon to rotate integrally until the transverse arm 92 rotates above the boom support 30, and then the longitudinal arm telescopic cylinder 93 drives the transverse arm 92 to descend integrally until the transverse arm 92 abuts against the boom support 30, thus completing the storage of the whole non-blasting tunnel boring machine and reducing the occupied space.

[0146] Specifically, the boom support 30 may be set as an arc-shaped base, and a radian of the arc-shaped base is matched with a radian of the cylindrical transverse arm 92, so that the transverse arm 92 can be clamped in the arc-shaped base to realize stable support.

[0147] This embodiment further includes a main cab 10 and an secondary cab 20 oppositely arranged at two ends of the vehicle-mounted device 1 respectively, and the boom support 30 is arranged at a top of the secondary cab 20 and a side edge of the vehicle-mounted device 1, so as to support the transverse arm 92 in various directions. The arrangement of the main cab 10 and the secondary cab 20 can ensure that the vehicle-mounted

device 1 can run in two directions without turning around, thus improving working flexibility.

[0148] In addition to the above arrangement, the vehicle-mounted device 1 of this embodiment is further provided with a counterweight. The counterweight and the regulating turntable 96 are respectively arranged at two ends of the vehicle-mounted device 1, and the counterweight is used for balancing a stress of the vehicle-mounted device 1 when the working disc 3 is in a working state, so as to avoid rollover of the vehicle-mounted device 1 caused by unbalanced stress.

[0149] The present disclosure is provided with a multi-system control device, which can undertake the functions of local control or remote control. The local control mainly includes a local electric cabinet, and the remote control device mainly includes a remote control system. The electric cabinet is used for electrical and signal transmission and control of the whole machine. A power device and a power control box are used for providing power for the whole machine and controlling the power.

[0150] This embodiment further provides a tunneling method using the non-blasting tunnel boring machine according to this embodiment, including the following steps.

[0151] Both a longitudinal arm 91 and a transverse arm 92 of a working disc 3 are contracted to a shortest state, and the working disc 3 needs to be oriented to one side of a vehicle-mounted device 1 by the rotation of a regulating turntable 96, so as to facilitate transportation in transit and avoid interference with a structure in a hole to a greatest extent.

[0152] A vehicle-mounted device 1 drives a rotational driving device 2 and a working disc 3 to move to a tunnel face. Specifically, a structure of the vehicle-mounted device 1 is described above. A vehicle-mounted platform 11 is driven to move by the rotation of wheels 12, and then a support boom 9 on the vehicle-mounted platform 11, the rotational driving device 2 on the vehicle-mounted platform and the working disc 3 are driven to move together until the whole non-blasting tunnel tunneling machine moves to the tunnel face to be excavated. Then, the regulating turntable 96 is rotated to rotate the transverse arm 92 on the boom support 30 and the working disc 3 towards the tunnel face until the working disc 3 corresponds to the tunnel face.

[0153] The vehicle-mounted device 1 should try to dock with a central axis of the tunnel face, so as to realize initial alignment. Then, the regulating turntable 96 is rotated to turn the working disc 3 towards the tunnel face to perform further accurate positioning. First, laser emitted by an laser generator at an end part of a central shaft in disk 321 is aligned with a positioning point on the tunnel face, and observed by a camera lens. If there is any deviation, accurate regulating is carried out, wherein the accurate regulating method includes: rotating the regulating turntable 96, driving a trolley of a base of the longitudinal arm 91 to move transversely on rails, extending and retracting the longitudinal arm 91 or the

transverse arm 92, regulating an angle of a main arm hinge point, driving a certain traveling wheel 4011 independently, or the like, so that preparation work before excavation can be completed.

[0154] The rotational driving device 2 drives the working disc 3 to rotate around a center of the working disc to further drive a foundation trench excavation device 4 on the working disc 3 to rotate and enable the foundation trench excavation device 4 to excavate an annular crack arrest groove on the tunnel face.

[0155] Specifically, a reversible motor rotates forward, driving a screw gear 411 to rotate forward, thus driving a cutterhead screw 412 to rotate forward, so that the cutterhead screw 412 rotates forward and moves along an axial direction of a threaded sleeve 413, and finally drives a grooving cutter 42 to rotate out of a grooving cutter hole 311 and match with the tunnel face. The rotational driving device 2 drives the working disc 3 to rotate around the center of the working disc, and then drives the grooving cutter 42 to rotate circularly on the tunnel face, thus opening an annular crack arrest groove. The grooving cutter 42 installed on the working disc 3 may be of various styles, such as deep slotting, sweeping away rocks protruding from a periphery of the tunnel face, properly expanding a width of the periphery of the tunnel face, or the like. A depth of the annular crack arrest groove can be controlled by controlling a length of the grooving cutter 42 extending out of the grooving cutter hole 311 through the cutterhead assembly 41. When the annular crack arrest groove is opened, the reversible motor rotates backward, driving the screw gear 411 to rotate backward, and driving the cutterhead screw 412 to rotate backward. Meanwhile, the cutterhead screw 412 moves along the axial direction of the threaded sleeve 413, driving the grooving cutter 42 on the cutterhead screw 412 to retract into the grooving cutter hole 311 and separate from the tunnel face.

[0156] When the working disc 3 is in the process of excavating the annular crack arrest groove, a drilling and splitting device 5 on a splitting frame 511 retracts a drilling rod and a splitting rod through the movement of a sliding cylinder and a turbine, which means that, end parts of the drilling rod and the splitting rod do not exceed a front end surface of the working disc 3.

[0157] Corresponding programs are built into a control system of the machine. Parameters such as size, lithology and single-cycle footage of the tunnel face to be excavated are input into the programs of the control system, and the parameters such as distribution, aperture and depth of the drilled holes to be split are reasonably designed after program calculation, so that corresponding drilling and splitting operations may be performed automatically or manually according to the settings.

[0158] Interference self-avoidance system of the splitting frame 511 is also provided: a guide rail of each splitting frame 511 is mounted with one or more drilling and splitting devices 5. In order to avoid interference

between the drilling and splitting devices 5, an avoidance system in the control program is designed. Each drilling and splitting device 5 on the guide rail can be positioned in real time through an attached position encoder. When the drilling and splitting devices 5 on two adjacent guide rails can be automatically controlled by the program in advance according to trajectory prediction analysis and an avoidance principle set in advance, it can enable one or several drilling and splitting devices 5 to fold one side or two side of the first lateral frames.

[0159] A drilling machine 51 on the working disc 3 is started to drill a hole on the tunnel face in the annular crack arrest groove.

[0160] Specifically, the drilling machine 51 rotates with the working disc 3 to drill a plurality of holes in a circumferential direction of the tunnel face, and meanwhile, a shifting device 8 drives the drilling machine 51 to move along a length direction of a connecting rod 33, so that the drilling machine 51 also drills a plurality of holes in a radial direction of the tunnel face, and further, through the matching of the rotation of the working disc 3 and the linear drive of the shifting device 8, the drilling machine 51 drills a plurality of holes in the circumferential direction and the radial direction of the tunnel face, which means that, drills a plurality of holes which are evenly distributed on the tunnel face.

[0161] A rock splitter is matched with the drilled hole to split the tunnel face.

[0162] Specifically, in principle, the first lateral frames 512 on left and right sides of each drilling and splitting device 5 should be provided with a drilling machine 51 on one side and a rock splitter 52 on the other side, and the same setting principle should be maintained on the whole working disc 3, which means that, if the drilling and splitting device 5 is provided with a drilling machine 51 on the left and a rock splitter 52 on the right, it should be set on the whole working disc 3 according to this principle. Certainly, the drilling machine 51 and the rock splitter 52 may also be exchanged, but it is still necessary to keep the same position on the working disc 3 without confusion. The same drilling machine 51 or rock splitter 52 cannot be arranged on two sides of the drilling and splitting device 5, which can improve drilling and blasting efficiency on the premise of minimizing the movement of the working disc 3. More specifically, in a fan-shaped working area surrounded by the guide rails of two adjacent splitting frames 511, if the rock splitter 52 on the right side of the drilling and splitting device 5 on the left guide rail falls into this fan-shaped working area, then the left drilling machine 51 on the right guide rail falls into this fan-shaped working area, so that one or more left drilling machines 51 on the right guide rail can drill holes in this fan-shaped working area first, and then the rock splitter 52 on the right side of one or more drilling and splitting devices on the left guide rail performs the splitting operation in this fan-shaped working area without rotating the working disc 3, so that the working efficiency can be greatly improved.

[0163] Specifically, the rock splitter 52 splits the drilled hole along a position of each drilled hole. The rock splitter 52 rotates along with the working disc 3 to split the drilled holes in the circumferential direction of the tunnel face, and meanwhile, a second movement driving unit drives the rock splitter 52 to move along the length direction of the connecting rod 33, so that the rock splitter 52 splits the drilled holes in the radial direction of the tunnel face, thereby realizing the splitting operation of a plurality of drilled holes in the tunnel face.

[0164] The hazard removal device 50 peels off the split rocks on the tunnel face to the ground after the working disc 3 rotates to keep clear the working position, cleans up the rocks that may fall off at the same time, and then crushes the big rocks that fall to the ground and gathers the rocks in front of the hopper 71 and the mucking machine 72, from which the rocks are delivered to the belt conveyor 73. A material feeding device 7 receives and conveys materials dropped during excavation. Specifically, the materials generated by excavation fall into the hopper 71 of the material feeding device 7, and the mucking machine 72 of the material feeding device 7 drives the materials to be transported along the hopper 71 to the belt conveyor 73 of the material feeding device 7, and then the materials are transported out by the belt conveyor 73, so as to avoid material accumulation.

[0165] The above steps are repeated in this way, and continuous excavation operations such as tunnel and open cut can be realized.

[0166] It should be noted that before the construction, construction preparations should be made: according to a size of a tunnel section (tunnel face) to be excavated, a working disc 3 with an appropriate diameter is selected first, and then corresponding accessories are assembled. The working disc 3, the transverse arm 92 and the longitudinal arm 91 are assembled into a whole, and then a rotational driving device 2 with an appropriate power is matched.

[0167] A dust suppression device 6 is started to suppress dust generated by excavation.

[0168] Specifically, the dust suppression device 6 includes a water tank 61, a water spray pipe 62 and an atomizing nozzle 63. The water in the water tank 61 flows to the atomizing nozzle 63 through the water spray pipe 62, and is atomized and sprayed by the atomizing nozzle 63, so that the dust generated by excavation is suppressed and the safety of construction workers and devices are prevented from being affected after the dust diffuses in a tunnel or closed space.

[0169] The method of this embodiment realizes the drilling and splitting construction of the tunnel face through the matching of the foundation trench excavation device 4, the drilling machine 52, the rock splitter 52 and the hazard removal device 50, so as to realize the non-blasting tunnel boring construction, which requires no bursting during the whole construction process, has low noise, and will not generate vibration influence on buildings (structures) around the tunnel. Moreover, the mate-

rial feeding device 7 can convey the materials generated by excavation in time, so that material accumulation is reduced, construction continuity and efficiency are improved, and the dust suppression device 6 can suppress the generated dust, improve a construction environment and reduce environmental pollution.

[0170] Further, before the rotational driving device 2 drives the working disc 3 to rotate around the center of the working disc, the method further includes the following steps.

[0171] A longitudinal arm telescopic cylinder 93 is used to regulate a height of the working disc 3.

[0172] Specifically, when the longitudinal arm telescopic cylinder 93 is extended, the longitudinal arm 91 can be driven to move upward to increase a working height of the working disc 3. When the longitudinal arm telescopic cylinder 93 is shortened, the longitudinal arm 91 can be driven to move downward to reduce the working height of the working disc 3, so that the working height of the working disc 3 is convenient to regulate and the working disc has strong usability.

[0173] A transverse arm telescopic cylinder 94 is used to regulate a distance between the working disc 3 and the tunnel face to keep the working disc 3 in contact with the tunnel face.

[0174] When the transverse arm telescopic cylinder 94 is extended, the transverse arm 92 and the working disc 3 thereon can be driven to move towards the tunnel face, thus reducing the distance between the working disc 3 and the tunnel face, and keeping the working disc 3 in contact with the tunnel face. When the transverse arm telescopic cylinder 94 is shortened, the transverse arm telescopic cylinder 94 and the working disc 3 thereon can be driven to move far away from the tunnel face, thereby increasing the distance between the working disc 3 and the tunnel face and separating the working disc 3 from the tunnel face.

[0175] In addition, the tunneling method of this embodiment further includes the following steps.

[0176] A boom luffing cylinder 95 is used to regulate an up-and-down inclination angle of the working disc 3. A regulation angle of the working disc 3 from two sides of a vertical plane exceeds 90 degrees in principle. In this way, not only the drilling and splitting construction of the vertical tunnel face can be realized, but also the drilling and splitting construction of a top arch and the ground can be realized, so that the application scope of the device according to the present disclosure is further improved.

[0177] Specifically, the extension of a piston rod of the boom luffing cylinder 95 can push the transverse arm telescopic cylinder 94 and the transverse arm 92 to entirely rotate upward relative to the longitudinal arm 91 around the hinge point, thus driving the whole working disc 3 to swing upward. With the shortening of the piston rod of the boom luffing cylinder 95, the transverse arm telescopic cylinder 94 and the transverse arm 92 can be entirely pulled downward relative to the longitudinal arm 91 around the hinge point, thus driving the whole working

disc 3 to swing downward, thus realizing the regulating of the up-and-down inclination angle of the working disc 3, and improving parallelism of matching between the working disc 3 and the tunnel face.

[0178] A regulating turntable 96 is used to regulate a left-and-right inclination angle of the working disc 3 to keep the working disc 3 parallel to the tunnel face.

[0179] Specifically, the rotation of the regulating turntable 96 can drive the longitudinal arm telescopic cylinder 93 and the longitudinal arm 91, the transverse arm 92, the working disc 3 and other structures connected thereon to rotate as a whole, thereby further regulating the left-and-right inclination angle of the working disc 3 and improving the parallelism of matching between the working disc 3 and the tunnel face.

[0180] Therefore, the up-and-down inclination angle of the working disc 3 is regulated by the boom luffing cylinder 95, and the left-and-right inclination angle of the working disc 3 is regulated by the regulating turntable 96 and the translation device 40 together, so that the working disc 3 can be kept parallel to the tunnel face, and then the working disc 3 can be driven to move transversely toward the tunnel face by an expansion rod of the transverse arm 92, so that the working disc 3 can be in parallel contact with the tunnel face, which is convenient for construction.

[0181] Certainly, the above description is only the optimal technical solution of this embodiment. In addition:

[0182] In some embodiments, a structure of the shifting device 8 may also be set in a form of a linear driving cylinder or a motor matched with a lead screw, which can also drive the drilling machine 51 or the rock splitter 52 to move along the length direction of the connecting rod 33. Since the structure of the linear driving cylinder or the motor matched with the lead screw belongs to the prior art, the details are not repeated here.

[0183] In some embodiments, the cutterhead assembly 41 may also be set as a tool feed cylinder or other linear driving structure, and the grooving cutter 42 can also be driven to extend out of or retract into the grooving cutter hole 311.

[0184] In some embodiments, the dust suppression device 6 may also be set as a dust absorption structure, which absorbs the dust generated by excavation via negative pressure, and also plays a role in dust suppression.

[0185] The present disclosure has the advantages that:

(I) The working method is novel and efficient. The present disclosure adopts the method of slotting at the edge while drilling and splitting in the middle without using explosives, so that the impact on a surrounding environment is small, the requirements on construction conditions are low, the working method is simple and feasible, and the working efficiency is high.

(II) The application range is wide. The present dis-

closure can be used in various occasions requiring rock excavation, both in open cut and in tunnel excavation, has good applicability and low requirements on the conditions required for a use place, and can be quickly popularized.

(III) Integrated construction is realized. The present disclosure carries out integrated research on excavation and shipment, can realize full-flow operation, has high device integration degree, does not need more devices for matching, and well embodies an effect of integral integrated construction.

[0186] Obviously, the above-mentioned embodiments are merely examples for clarity of illustration and are not intended to limit the modes of execution. For those of ordinary skills in the art, other different forms of changes or variations can be made on the basis of the above description. It is not necessary or possible to exhaust all the implementations here. Obvious changes or variations derived therefrom are still within the scope of protection of the present disclosure.

Claims

1. A non-blasting tunnel boring machine, **characterized in that**, comprising:

a vehicle-mounted device (1);
a rotational driving device (2) arranged on the vehicle-mounted device (1);
a translation device (40) arranged on the vehicle-mounted device (1) and connected to the rotational driving device (2), wherein the translation device (40) drives the rotational driving device (2) to move away from or towards a tunnel face;
a working disc (3) in transmission connection with the rotational driving device (2), wherein the rotational driving device (2) drives the working disc (3) to rotate around a center of the working disc (3);
a foundation trench excavation device (4) arranged on the working disc (3), wherein the foundation trench excavation device (4) is suitable for coordinating with the tunnel face, and the working disc (3) drives the foundation trench excavation device (4) to rotate to excavate an annular crack arrest groove in the tunnel face;
a drilling and splitting device (5) comprising a drilling machine (51) and a rock splitter (52) both arranged on the working disc (3), wherein the drilling machine (51) is suitable for drilling a hole in the tunnel face in the annular crack arrest groove, and the rock splitter (52) is suitable for coordinating with the drilled hole to split the tunnel face;
a hazard removal device (50) arranged on the

vehicle-mounted device (1) and suitable for spalling crushed stones split on the tunnel face; a dust suppression device (6) arranged on the vehicle-mounted device (1) and suitable for suppressing generated dust; and

a material feeding device (7) arranged on the vehicle-mounted device (1), wherein the material feeding device (7) is located below the working disc (3) and used for receiving and conveying materials dropped during excavation.

2. The non-blasting tunnel boring machine according to claim 1, **characterized in that**, a plurality of foundation trench excavation devices (4) are provided at intervals along a circumferential direction of the working disc (3), wherein the foundation trench excavation device (4) comprises:

grooving cutter hole (311) arranged on the working disc (3);

a cutterhead assembly (41) connected with the working disc (3), wherein the cutterhead assembly (41) comprises:

a reversible motor fixedly arranged on the working disc (3);

a screw gear (411) connected with the reversible motor;

a cutterhead screw (412) arranged in the grooving cutter hole (311) and connected with a grooving cutter (42), wherein the cutterhead screw (412) is engaged with the screw gear (411); and

a threaded sleeve (413) fixedly arranged in the grooving cutter hole (311), wherein the cutterhead screw (412) is in threadly fit in the threaded sleeve (413); and

the grooving cutter (42) suitable for coordinating with the tunnel face, wherein the cutterhead assembly (41) is in transmission connection with the grooving cutter (42) to drive the grooving cutter (42) to extend out of or retract into the grooving cutter hole (311), wherein the grooving cutter (42) is set as an arc-shaped tool, and a convex arc surface of the arc-shaped tool is arranged deviating from the center of the working disc (3).

3. The non-blasting tunnel boring machine according to any one of claims 1 to 2, **characterized in that**, the working disc (3) comprises:

a front plate (31), an edge of which is provided with the foundation trench excavation device (4);

a rear plate (32) located behind the front plate (31), wherein the drilling and splitting device (5)

is arranged on the rear plate (32), and the drilling and splitting device (5) extends to the front of the front plate (31) to coordinate the tunnel face, wherein the rear plate (32) comprises:

an annular sleeve (322) sleeved on an outer circumference of a central shaft in disk (321);

connecting rods (33) connected to both the central shaft in disk (321) and the annular sleeve (322), wherein a plurality of connecting rods (33) are provided and are arranged at intervals along a circumferential direction of the central shaft in disk (321), and the drilling and splitting device (5) is arranged on the connecting rod (33), wherein the drilling and splitting device (5) further comprises a splitting frame (511), one side of the splitting frame (511) is provided with the drilling machine (51), the other side of the splitting frame is provided with the rock splitter (52), and the splitting frame (511) is movably arranged on the connecting rod (33);

the central shaft in disk (321), one end of which is connected to both a center of the front plate (31) and a center of the rear plate (32), and the other end of which is in transmission connection with the rotational driving device (2); and

a support boom (9), one end of which is connected to the translation device (40) and the other end of which is connected to the rotational driving device (2).

4. The non-blasting tunnel boring machine according to claim 3, **characterized in that**, further comprising: a shifting device (8) connected with the splitting frame (511) to drive the splitting frame (511) to move along a length direction of the connecting rod (33), wherein the shifting device (8) comprises:

a rack (331) arranged along the length direction of the connecting rod (33);

a travel motor (81) arranged on the splitting frame (511);

a traveling gear mechanism (82) in transmission connection with the travel motor (81), wherein the traveling gear mechanism (82) is engaged with the rack (331), and the travel motor (81) drives the traveling gear mechanism (82) to rotate to drive the splitting frame (511) to move along the length direction of the connecting rod (33);

and/or

a sliding mechanism arranged on the splitting frame (511), wherein the sliding mechanism is connected with the drilling machine (51) and/or

the rock splitter (52) to drive the drilling machine (51) and/or the rock splitter (52) to slide along the splitting frame (511).

5. The non-blasting tunnel boring machine according to claim 4, **characterized in that**, the connecting rod (33) comprises two I-shaped plates relatively arranged at intervals, both a front surface and a back surface of the I-shaped plate are provided with the rack (331), and the traveling gear mechanism (82) comprises:

a synchronous driving shaft (821) arranged between the two I-shaped plates relatively arranged at intervals, wherein the synchronous driving shaft (821) is connected with the travel motor (81), and the synchronous driving shaft (821) is provided with a first synchronizing gear (8211) and a second synchronizing gear (8212) arranged at intervals;

traveling screws, comprising an inner traveling screw (822) arranged on the back surface of the I-shaped plate and an outer traveling screw (823) arranged on the front surface of the I-shaped plate, wherein the inner traveling screw (822) is engaged with the first synchronizing gear (8211) and the outer traveling screw (823) is engaged with the second synchronizing gear (8212);

the inner traveling screw (822) is rotatably arranged on the splitting frame (511), two ends of the inner traveling screw (822) are provided with inner traverse gears (8221), the inner traverse gears (8221) are engaged with the racks (331) on the back surfaces of the two I-shaped plates, two ends of the outer traveling screw (823) are provided with outer traverse gears (8231), and the outer traverse gears (8231) are engaged with the racks (331) on the front surfaces of the two I-shaped plates; and/or

the traveling gear mechanism (82) further comprises:

a synchronous bushing matched with an outer circumference of the synchronous driving shaft (821), wherein the synchronous bushing is located between the first synchronizing gear (8211) and the second synchronizing gear (8212); and

a guide support beam (83) fixedly connected with the synchronous bushing at an included angle, wherein two ends of the guide support beam (83) are both provided with a guide support wheel (831), the guide support wheel (831) at one end is in rolling contact with a vertical plate of one I-shaped plate, and the guide support wheel (831) at the other end is in rolling contact

with a vertical plate of the other I-shaped plate.

6. The non-blasting tunnel boring machine according to claim 4, **characterized in that**, the drilling and splitting device (5) further comprises a first lateral frame (512) and a second lateral frame, wherein:

the first lateral frame (512) and the second lateral frame are respectively connected to two sides of the splitting frame (511), the drilling machine (51) is movably arranged on the first lateral frame (512), the rock splitter (52) is movably arranged on the second lateral frame, and the sliding mechanism is connected with both the drilling machine (51) and the rock splitter (52) to drive the drilling machine (51) to slide along the first lateral frame (512) and drive the rock splitter (52) to slide along the second lateral frame; and/or

both the first lateral frame (512) and the second lateral frame are hinged with the splitting frame (511), and one sides of the first lateral frame (512), the second lateral frame and the splitting frame (511) far away from the central shaft in disk (321) are all provided with an opening, the sliding mechanism comprises a first double-piston actuator (515) arranged at the opening of the splitting frame (511), one piston rod of the first double-piston actuator (515) penetrates through the opening of the first lateral frame (512) and is hinged with the drilling machine (51), and the other piston rod of the first double-piston actuator penetrates through the opening of the second lateral frame and is hinged with the rock splitter (52);

the first lateral frame (512) is provided with a first limit slide hole (5121) in a direction far away from the splitting frame (511), a drill bit of the drilling machine (51) passes through the first limit slide hole (5121), and the drilling machine (51) is driven by the first double-piston actuator (515) to slide along the first limit slide hole (5121); and/or

the second lateral frame is provided with a second limit slide hole in the direction far away from the splitting frame (511), a splitting head of the rock splitter (52) passes through the second limit slide hole, and the rock splitter (52) is driven by the second double-piston actuator to slide along the second limit slide hole; and

the drilling and splitting device (5) further comprises a first locking mechanism (514) and a second locking mechanism, the first locking mechanism (514) is suitable for locking the first lateral frame (512) and the drilling machine (51), and the second locking mechanism is suitable for locking the second lateral frame and the rock

splitter (52), the first double-piston actuator (515) drives both the first lateral frame (512) and the second lateral frame to rotate relative to the splitting frame (511) around a hinge point away from the center of the working disc (3) to achieve folding of the drilling and splitting device (5), wherein the first locking mechanism (514) and the second locking mechanism are both arranged in an electromagnetic attraction type locking structure.

7. The non-blasting tunnel boring machine according to any one of claims 1 to 2, **characterized in that**, the dust suppression device (6) comprises:

a water tank (61) arranged on the vehicle-mounted device (1);
 a water spray pipe (62) connected with the water tank (61); and
 an atomizing nozzle (63) connected with the water spray pipe (62), wherein the atomizing nozzle (63) is arranged towards the tunnel face; and/or
 the dust suppression device (6) further comprises a dust detection device (64), and the dust detection device (64) is suitable for detecting a dust index to turn on the dust suppression device (6) when the dust index reaches a preset value.

8. The non-blasting tunnel boring machine according to any one of claims 1 to 2, **characterized in that**, the material feeding device (7) comprises:

a hopper (71) arranged below the working disc (3);
 a mucking machine (72) arranged in the hopper (71) to drive a material to be transmitted in the hopper (71), wherein the mucking machine (72) comprises at least two material scraping gears arranged at intervals, the material scraping gear is rotatably arranged in the hopper (71), and a grinding gap is formed between the adjacent material scraping gears to crush the material;
 a belt conveyor (73) arranged on the vehicle-mounted device (1), wherein the belt conveyor (73) is connected with the hopper (71); and
 an luffing driving cylinder (74), wherein the luffing driving cylinder (74) is arranged on the vehicle-mounted device (1), one end of the belt conveyor (73) close to the mucking machine (72) is rotatably connected with the vehicle-mounted device (1), and the luffing driving cylinder (74) is hinged with one end of the belt conveyor (73) far away from the mucking machine (72) to drive one end of the belt conveyor (73) far away from the mucking machine (72) to ascend and descend.

9. The non-blasting tunnel boring machine according to claim 3, **characterized in that**, the support boom (9) comprises:

a longitudinal arm (91) vertically arranged on the translation device (40);
 a transverse arm (92) arranged transversely, wherein one end of the transverse arm (92) is connected with the longitudinal arm (91), and the other end of the transverse arm is connected with the rotational driving device (2);
 a longitudinal arm telescopic cylinder (93) vertically arranged on the translation device (40), wherein the longitudinal arm telescopic cylinder (93) is connected with the longitudinal arm (91) to drive the longitudinal arm (91) to move vertically; and/or
 a transverse arm telescopic cylinder (94) arranged between the transverse arm (92) and the longitudinal arm (91) to drive the transverse arm (92) to move transversely;
 wherein, the transverse arm telescopic cylinder (94) is hinged with the longitudinal arm (91), the support boom (9) further comprises a boom luffing cylinder (95), one end of the boom luffing cylinder (95) is hinged with an outer wall of the longitudinal arm telescopic cylinder (93), the other end of the boom luffing cylinder (95) is hinged with an outer wall of the transverse arm telescopic cylinder (94), and the boom luffing cylinder (95) drives the transverse arm telescopic cylinder (94) and the transverse arm (92) to entirely rotate up and down around a hinge point relative to the longitudinal arm (91);
 and/or
 the support boom (9) further comprises a regulating turntable (96), the regulating turntable (96) is rotatably arranged on the vehicle-mounted device (1), the translation device (40) is arranged on the regulating turntable (96), and the regulating turntable (96) drives the translation device (40) to rotate around a center of the translation device.

10. The non-blasting tunnel boring machine according to claim 9, **characterized in that**, the vehicle-mounted device (1) is further provided with a boom support (30), a main cab (10) and an secondary cab (20), wherein the boom support (30) is suitable for supporting the transverse arm (92), the main cab (10) and the secondary cab (20) are oppositely arranged at two ends of the vehicle-mounted device (1) respectively, and the boom support (30) is arranged at a top of the secondary cab (20) and a side edge of the vehicle-mounted device (1).

11. The non-blasting tunnel boring machine according to claim 8, **characterized in that**, the vehicle-mounted

device (1) comprises:

a vehicle-mounted platform (11), wherein the vehicle-mounted platform (11) is provided with a support boom (9) and the material feeding device (7);
wheels (12) arranged at a bottom of the vehicle-mounted platform (11); and
storable support legs (13), wherein the support legs (13) are arranged at the bottom of the vehicle-mounted platform (11) and suitable for supporting the vehicle-mounted platform (11).

12. The non-blasting tunnel boring machine according to claim 9, wherein the translation device (40) comprises:

a translation mount (401) arranged at a bottom of the support boom (9);
translation rails (402) arranged on the regulating turntable (96) along a length direction of the vehicle-mounted platform (11), wherein the translation mount (401) is movably connected to the translation rails (402), wherein two translation rails (402) are arranged at intervals in parallel, a bottom of the translation mount (401) is provided with two rows of traveling wheels (4011) at intervals, and the two rows of traveling wheels (4011) are respectively matched on the two translation rails (402);
a translation driving unit (403) in transmission connection with the translation mount (401) to drive the translation mount (401) to move along the translation rail (402) and in transmission connection with the traveling wheel (4011); and
an anti-roll rod (404), wherein the anti-roll rod (404) is connected between the two rows of traveling wheels (4011).

13. The non-blasting tunnel boring machine according to any one of claims 1 to 2, wherein the hazard removal device (50) comprises:

a hazard removal bucket (501) suitable for coordinating with the tunnel face;
a driving cylinder (502) hinged to the vehicle-mounted platform (11), wherein the driving cylinder (502) is hinged with the hazard removal bucket (501) to drive the hazard removal bucket (501) to swing, wherein the driving cylinder (502) comprises a main cylinder, an secondary cylinder and a hopper cylinder;
a folding arm (503) hinged to the vehicle-mounted platform (11), wherein the folding arm (503) is hinged with both the driving cylinder (502) and the hazard removal bucket (501), and the driving cylinder (502) drives the folding arm (503) to be folded or unfolded to drive the hazard

removal bucket (501) to be accommodated or extended, wherein the folding arm (503) comprises a main hopper arm and an secondary hopper arm; and

a rotating hopper (504) rotatably arranged on the vehicle-mounted platform (11), wherein a bottom of the main hopper arm is hinged to the rotating hopper (504), a bottom of the main cylinder is connected to the vehicle-mounted platform (11) by ball hinge and/or a top of the main cylinder is connected to the main hopper arm by ball hinge, and the rotating hopper (504) drives the main hopper arm and a structure thereon to rotate together;

wherein, one end of the main cylinder is hinged to the vehicle-mounted platform (11), the other end of the main cylinder is hinged to a middle of the main hopper arm, one end of the secondary cylinder is hinged to the middle of the main hopper arm, the other end of the secondary cylinder is hinged to the secondary hopper arm, the bottom of the main hopper arm is hinged to the vehicle-mounted platform (11), a top of the main hopper arm is hinged to a middle of the secondary hopper arm, one end of the hopper cylinder is hinged with one end of the secondary hopper arm close to the main hopper arm, the other end of the hopper cylinder is hinged with both one end of the secondary hopper arm far away from the main hopper arm and the hazard removal bucket (501), and one end of the secondary hopper arm far away from the hopper cylinder is hinged with the hazard removal bucket (501).

14. The non-blasting tunnel boring machine according to any one of claims 1 to 2, further comprising a camera, a laser generator and a sweeping structure which are all arranged on the working disc (3), wherein the laser generator is suitable for emitting a laser beam to the tunnel face, and the laser beam is aligned with a pre-calibrated point on the tunnel face through the camera to position the working disc (3), the sweeping structure comprises an oscillating brush motor and a dust brush, and an oscillating hinge of the oscillating brush motor is connected with the dust brush to drive the dust brush to oscillate and sweep the camera and the laser generator.

15. A tunneling method using the non-blasting tunnel boring machine according to any one of claims 1 to 14, comprising:

using a vehicle-mounted device (1) to drive a rotational driving device (2), a translation device (40) and a working disc (3) to move to a tunnel face;
using the translation device (40) to drive the

rotational driving device (2) and the working disc
 (3) to synchronously move to regulate a distance
 between the working disc (3) and the tunnel
 face;
 using a longitudinal arm telescopic cylinder (93) 5
 to regulate a height of the working disc (3);
 using a transverse arm telescopic cylinder (94)
 to regulate a distance between the working disc
 (3) and the tunnel face to keep the working disc
 (3) in contact with the tunnel face; 10
 using a boom luffing cylinder (95) to regulate an
 up-and-down inclination angle of the working
 disc (3);
 using a regulating turntable (96) and the transla-
 tion device (40) to together regulate a left-and- 15
 right inclination angle of the working disc (3) to
 keep the working disc (3) parallel to the tunnel
 face;
 using the rotational driving device (2) to drive the
 working disc (3) to rotate around a center of the 20
 working disc to further drive a foundation trench
 excavation device (4) on the working disc (3) to
 rotate and enable the foundation trench excava-
 tion device (4) to excavate an annular crack
 arrest groove on the tunnel face; 25
 starting a drilling machine (51) on the working
 disc (3) to drill a hole on the tunnel face in the
 annular crack arrest groove;
 using a rock splitter (52) to be matched with the
 drilled hole to split the tunnel face; 30
 using a hazard removal device (50) matched
 with the tunnel face to peel off crushed stones
 split on the tunnel face;
 using a material feeding device (7) to receive
 and convey materials dropped during excava- 35
 tion; and
 starting a dust suppression device (6) to sup-
 press dust generated by excavation.

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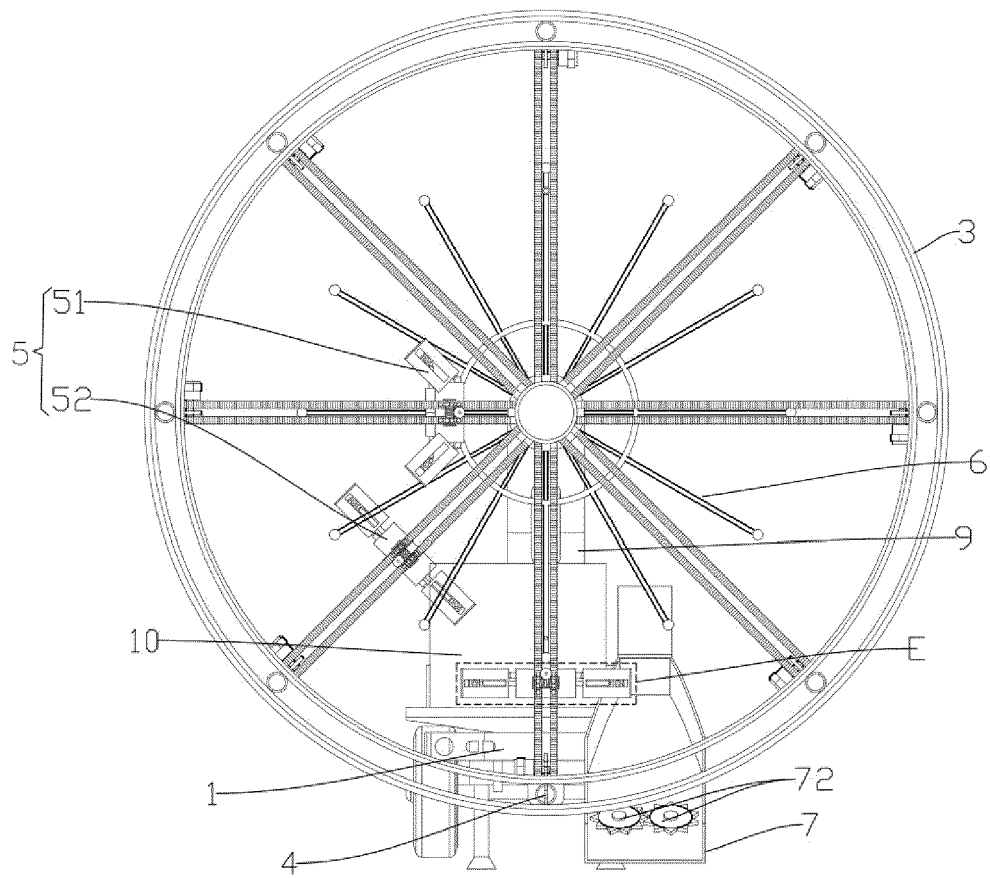


FIG. 1

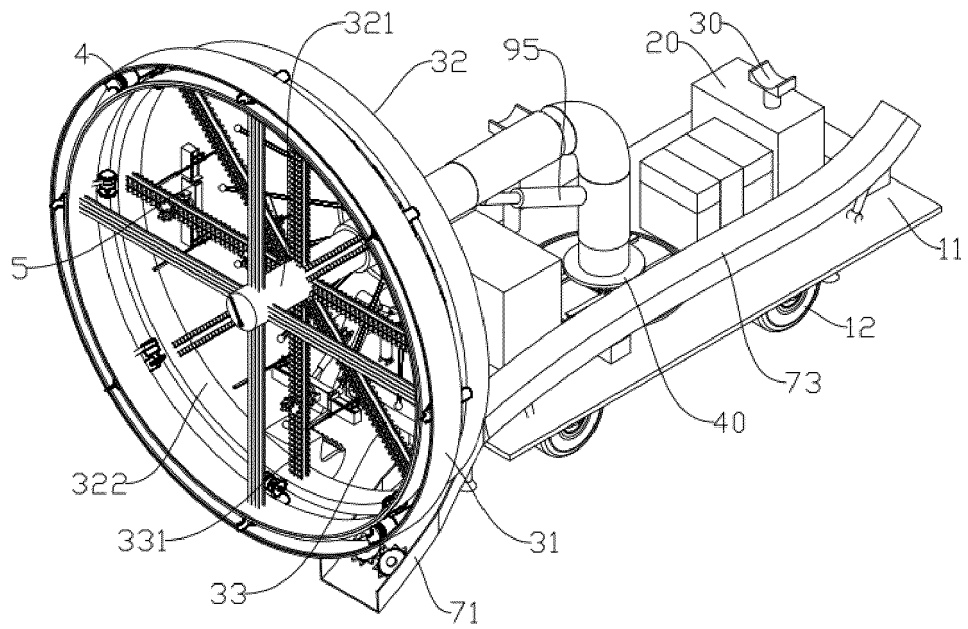


FIG. 2

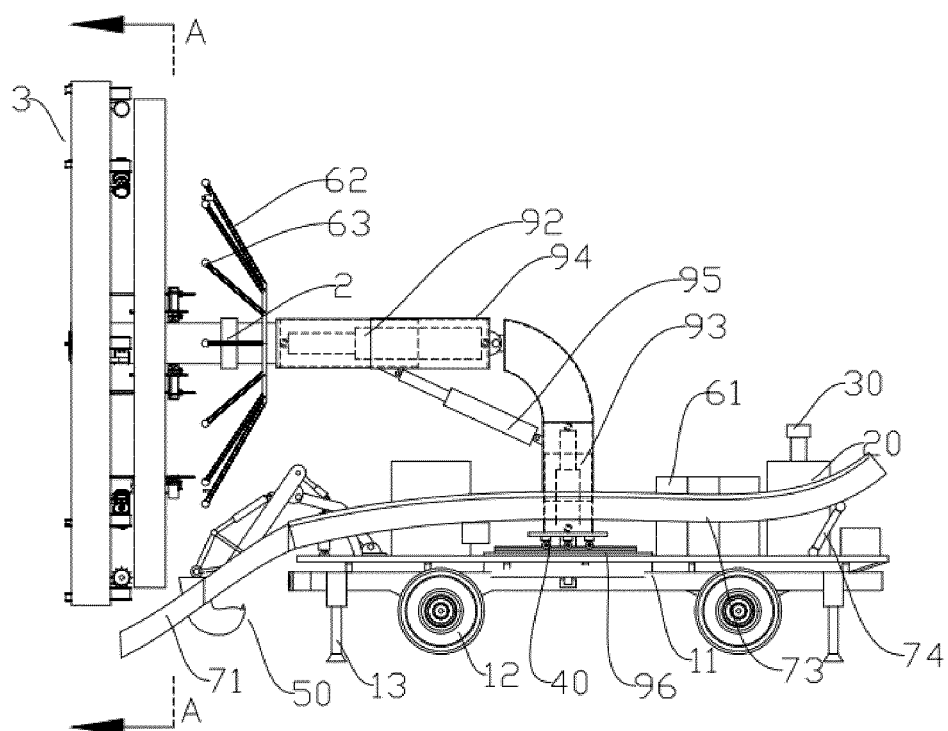


FIG 3

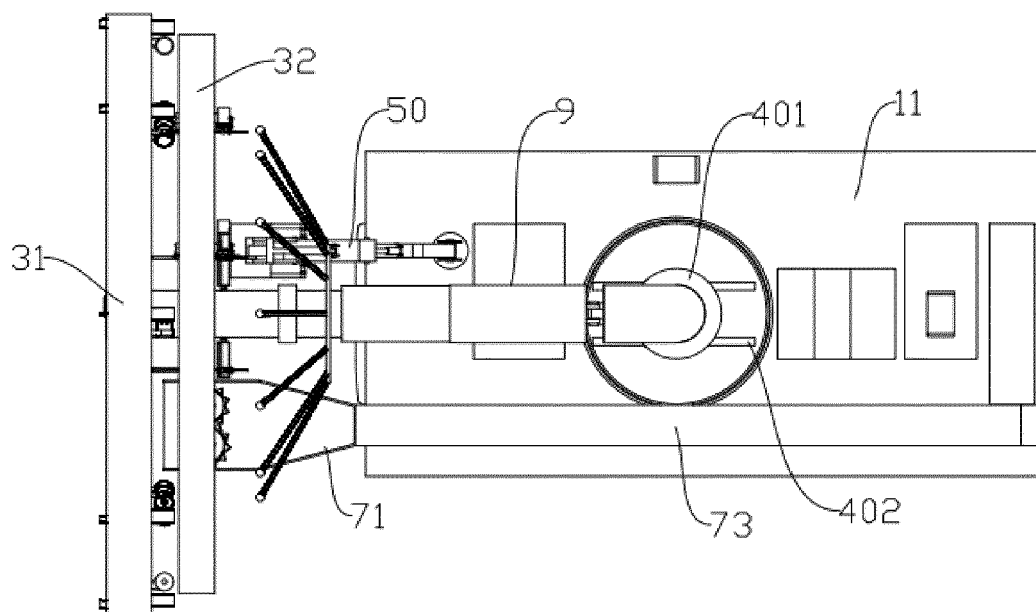


FIG 4

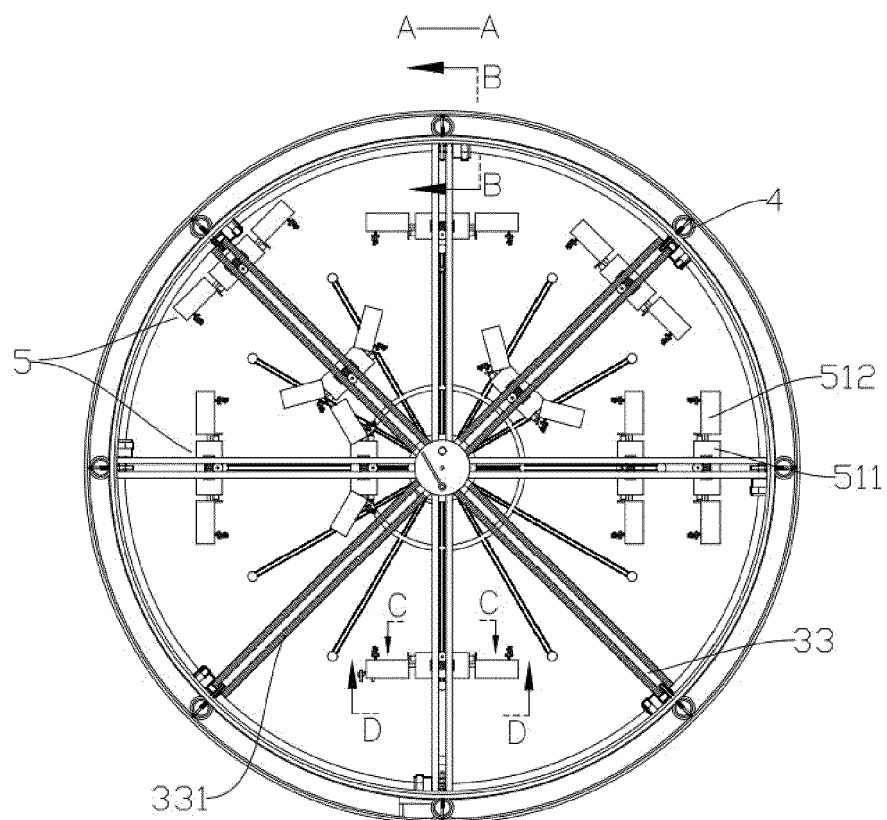


FIG. 5

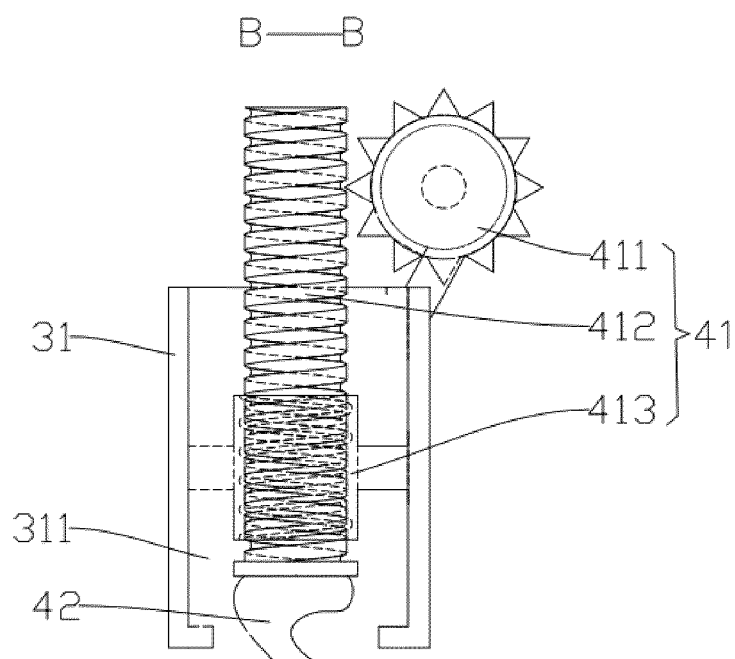


FIG. 6

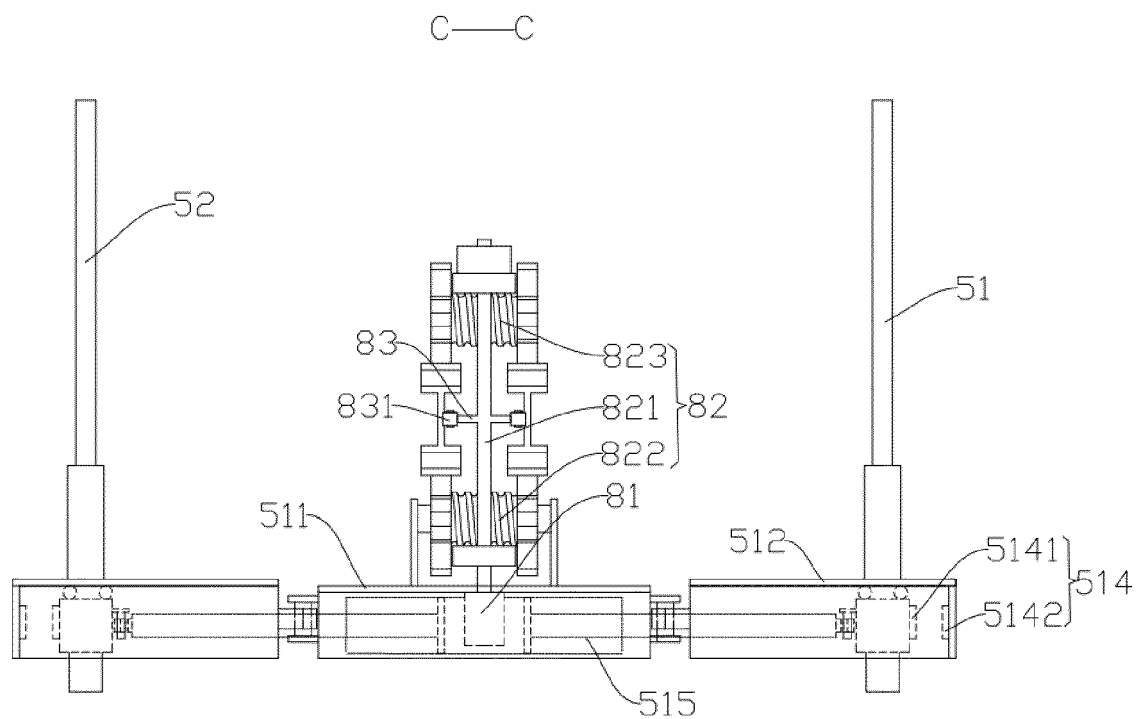


FIG. 7

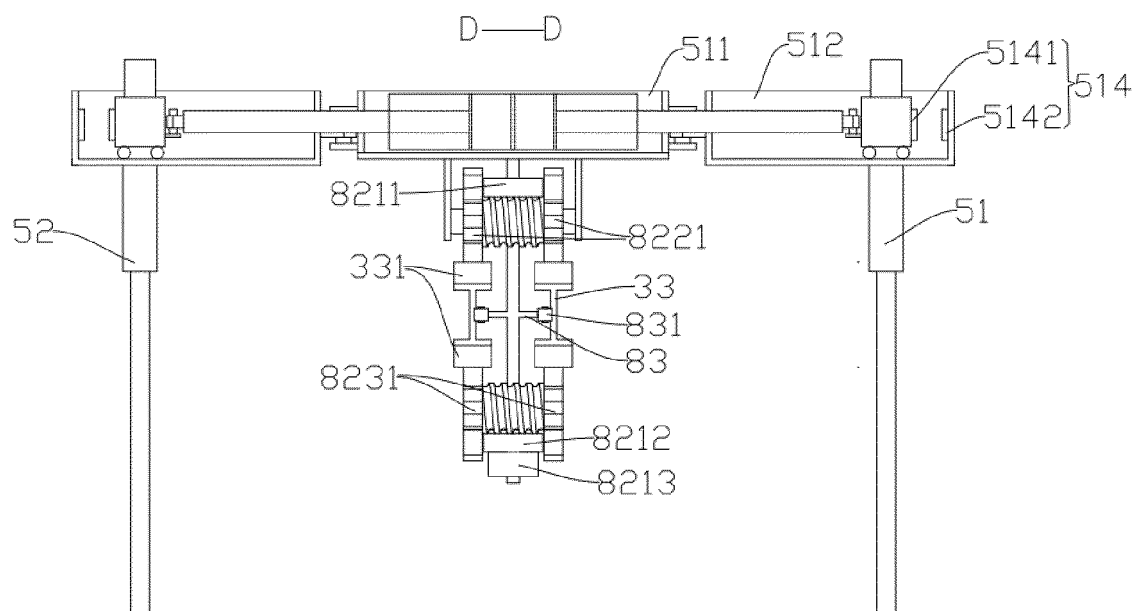


FIG. 8

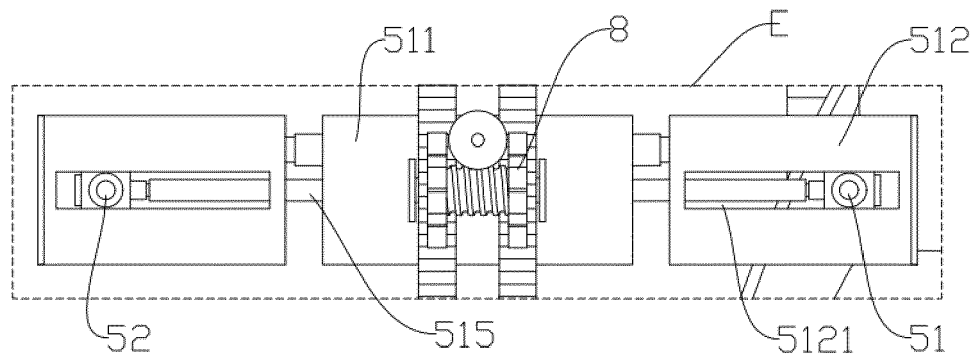


FIG. 9

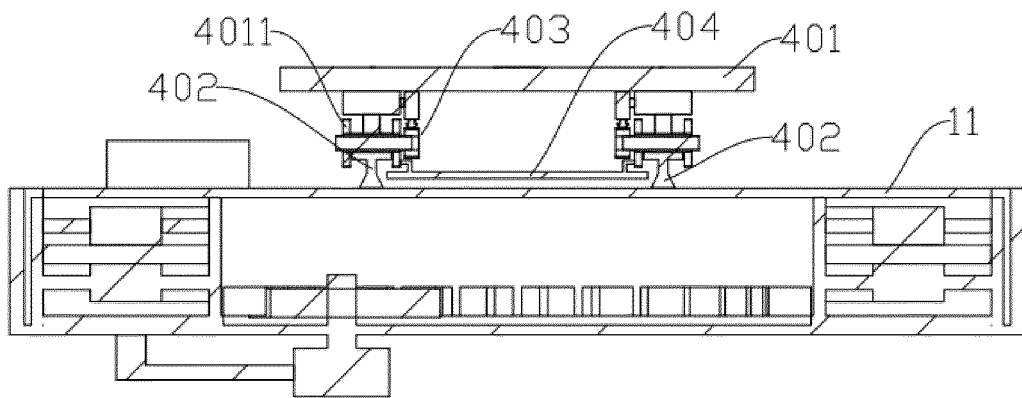


FIG. 10

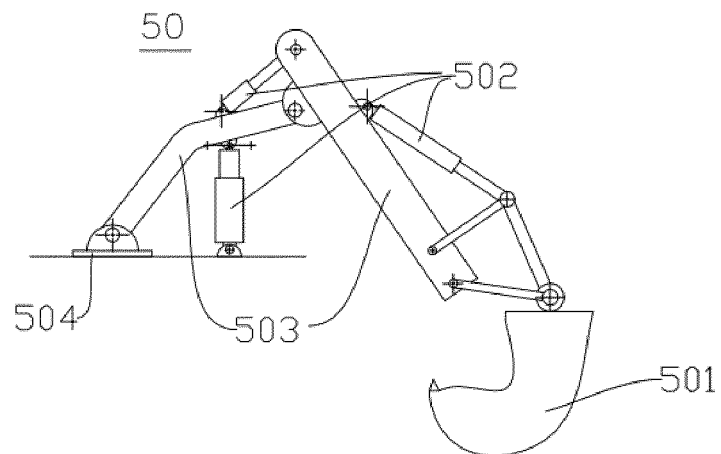


FIG. 11



EUROPEAN SEARCH REPORT

Application Number

EP 24 17 5180

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A	CN 111 485 900 A (OU YUJIN) 4 August 2020 (2020-08-04) * figures 1-3 * * claim 2; figures 4,5 * * the whole document * -----	1	
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			E21D E02F E21F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		3 October 2024	van Berlo, André
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