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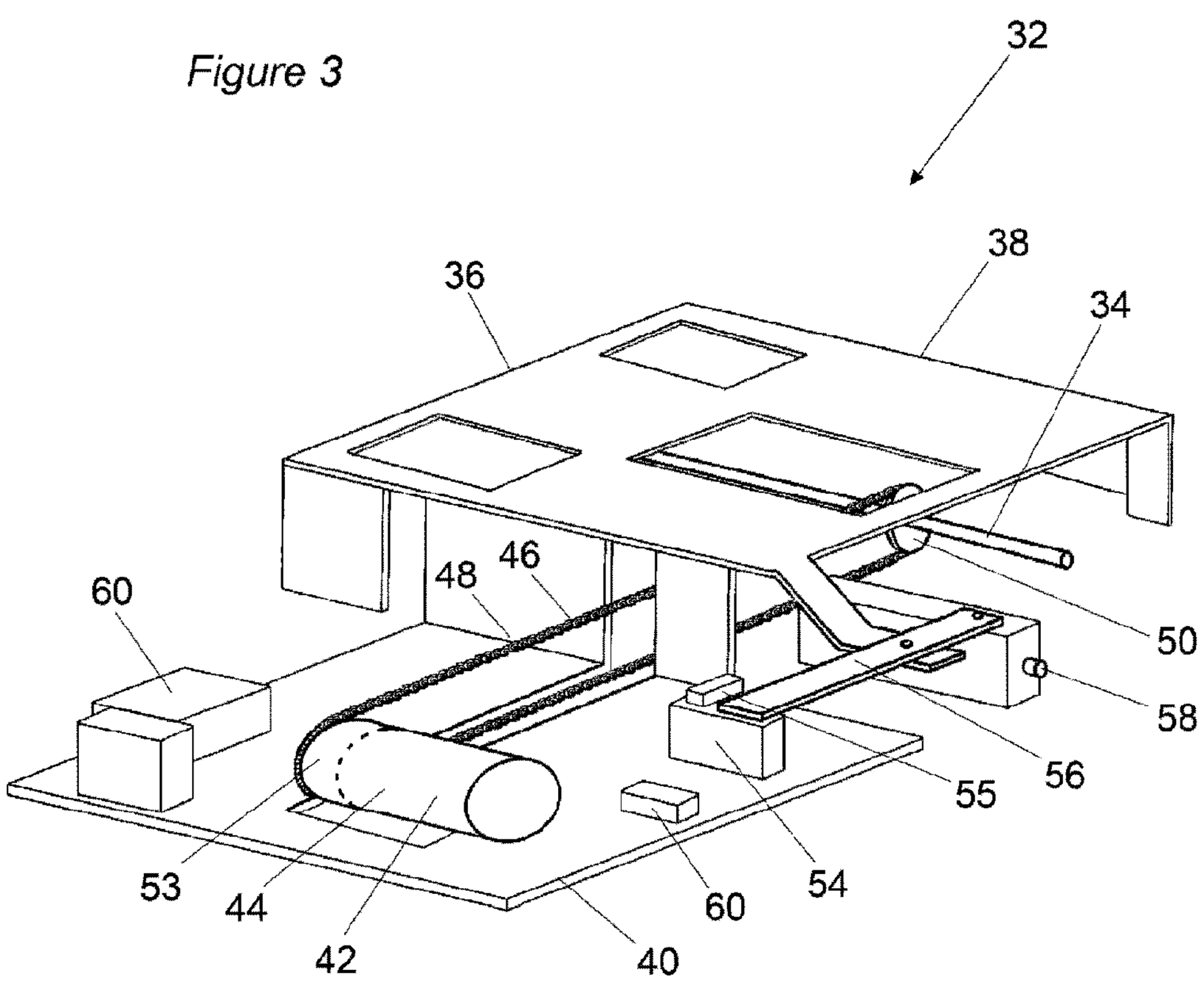
(54) Titre : SYSTEME DE SUPPORT DE DISJONCTEUR
(54) Title: CIRCUIT BREAKER RACKING SYSTEM

Figure 3



(57) Abrégé/Abstract:
A racking system for a circuit breaker assembly, comprising an electric drive motor having a rotatable drive shaft, wherein the drive motor is configured to be attached onto a sub-chassis of the circuit breaker assembly. The racking system further comprises a drive belt configured to extend between the drive shaft and a winding shaft of the circuit breaker assembly. When the drive shaft rotates, the drive belt causes the winding shaft to rotate thereby causing a circuit breaker of the circuit breaker assembly to move relative to the sub-chassis.

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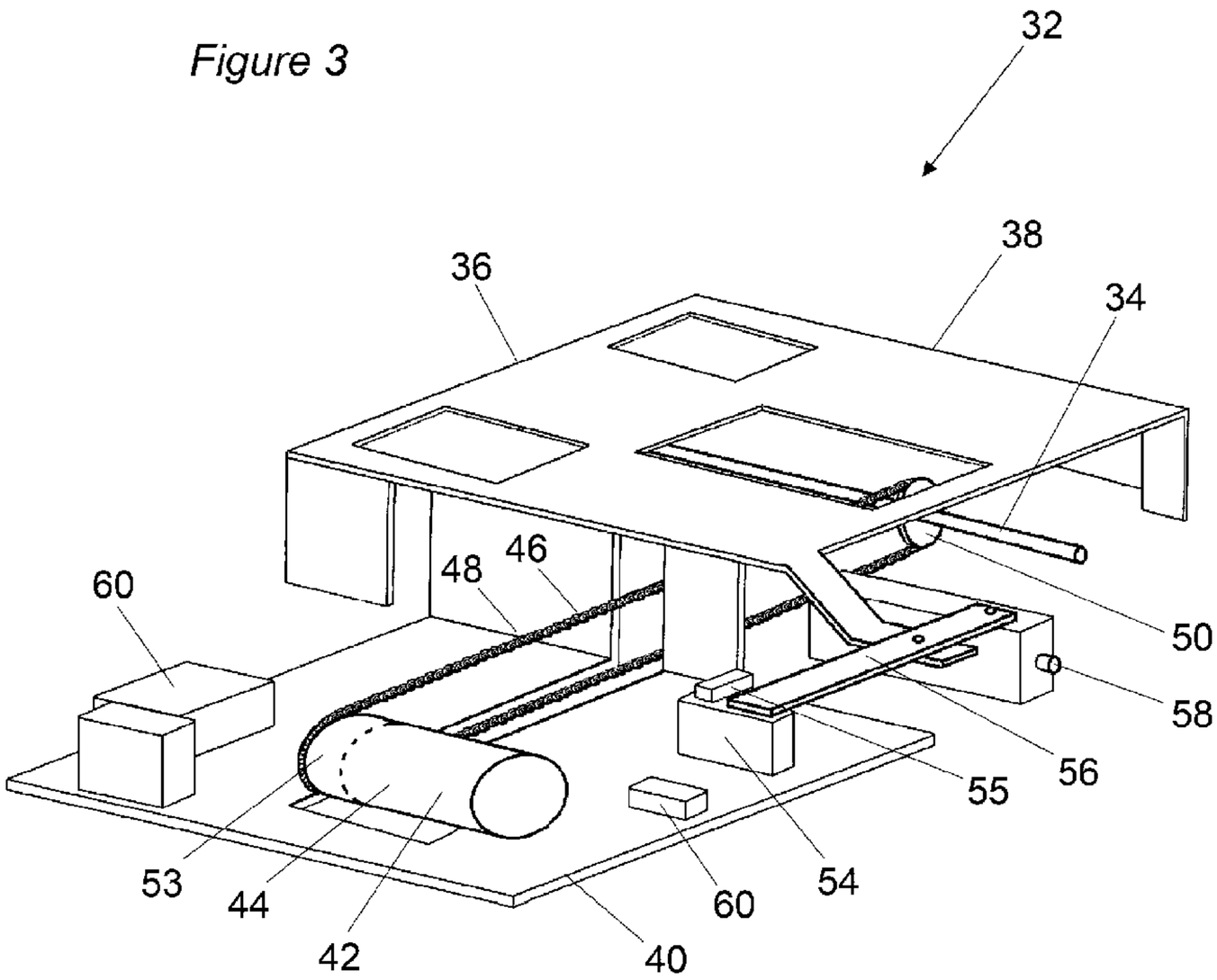
Figure 3



(57) Abstract: A racking system for a circuit breaker assembly, comprising an electric drive motor having a rotatable drive shaft, wherein the drive motor is configured to be attached onto a sub-chassis of the circuit breaker assembly. The racking system further comprises a drive belt configured to extend between the drive shaft and a winding shaft of the circuit breaker assembly. When the drive shaft rotates, the drive belt causes the winding shaft to rotate thereby causing a circuit breaker of the circuit breaker assembly to move relative to the sub-chassis.

TITLE

"CIRCUIT BREAKER RACKING SYSTEM"

FIELD OF INVENTION

[0001] The present invention relates to a circuit breaker racking system. In particular, the present invention relates to a circuit breaker racking system for withdrawable circuit breakers.

BACKGROUND ART

[0002] Circuit breakers are electrical switching devices that are used for controlling and protecting electrical circuits from damage caused by electrical overload or short circuit.

[0003] In particular, circuit breakers known as air circuit breakers (ACBs) are commonly used as principal circuit breakers for power distribution switchboards in buildings, factories and large industrial facilities. ACBs have several advantages over alternative types, such as oil circuit breakers. For example, air circuit breakers are non-inflammable and provide for rapid arc extinction.

[0004] Circuit breakers, including ACBs, are commonly incorporated into withdrawable circuit breaker assemblies. These assemblies consists of two main parts: (i) the circuit breaker itself, which contains one or more circuit breaker switches and associated control devices and (ii) a sub-chassis. The sub-chassis houses the circuit breaker and is connected to electrical conductors in the switchboard of the facility in which the circuit breaker assembly is installed. In use, the circuit breaker may be removed from its sub-chassis periodically for maintenance and testing.

[0005] Circuit breaker assemblies are typically configured such that the circuit breaker can be moved, and locked, into three fixed positions within the sub-chassis. In a first (connected) position, the circuit breaker is disposed fully inside the sub-chassis such

that power and control connectors on the circuit breaker are connected to corresponding power and control connectors on the sub-chassis. In a second (test) position, the circuit breaker is disposed partially inside the sub-chassis only, such that the circuit breaker's control connectors are connected to the corresponding sub-chassis control connectors but the respective circuit breaker and sub-chassis power connectors are unconnected. In a third (isolated) position, the circuit breaker is disposed in a position such that neither the power nor control connectors of the circuit breaker and sub-chassis are connected.

[0006] During installation, maintenance and testing operations, the circuit breaker may be moved, or racked, into and between each of the three fixed positions described above using a manually operated racking system. To operate the racking system, a racking or crank handle is inserted into an aperture that is located at the front of the circuit breaker or, in some models, at the front of the sub-chassis. The crank handle engages with a winding shaft disposed in the assembly. Winding the handle causes the winding shaft to rotate, thereby causing the circuit breaker to move progressively inwardly (or outwardly) relative to the sub-chassis. When the circuit breaker has reached one of its three fixed positions, a locking mechanism engages to lock the circuit breaker in position.

[0007] These manual racking mechanisms also include a locking release button which, when pressed, disengages the locking mechanism so that the circuit breaker can then be racked into a new position using the crank handle.

[0008] Racking a circuit breaker is a hazardous operation, particularly when it has been damaged or is malfunctioning. In these circumstances, large electrical currents can lead to thermal ionization of gas present inside the circuit breaker causing the gas to become electrically conductive. This presents a risk of explosion or electrical shock to maintenance personnel operating the crank handle and any associated testing equipment. For these reasons, maintenance personnel are increasingly required to wear arc proof protective clothing when handling circuit breakers on site.

[0009] In effort to further reduce these risks, it is also known to use a separate racking apparatus that is adapted to interface with a manually operated racking system to enable remote racking of the circuit breaker.

[0010] Racking apparatuses consist of a wheeled assembly that, in use, is moved next to, and attached to, the particular circuit breaker that needs to be tested or maintained. The racking apparatus comprises a motorized shaft that engages with the aperture that would normally receive the crank handle of the manual racking system so that it may turn the winding shaft. The racking apparatus also comprises a device that is adapted to press the locking release button that disengages the racking system's locking mechanism. The racking apparatus is operated remotely, using wired or wireless control means, which enables maintenance personnel to operate the circuit breaker's manual racking system from a safe distance.

[0011] Known racking apparatuses are large, expensive and cumbersome to operate. Typically, only one racking apparatus is used at a facility to service all circuit breakers installed at the facility. This apparatus must, therefore, be moved to, and be manipulated to engage with, each and every circuit breaker that needs to be tested. This is significantly time consuming and labour intensive.

[0012] The present invention attempts to overcome, at least in part, the aforementioned disadvantages of previous circuit breaker racking apparatuses and methods.

SUMMARY OF THE INVENTION

[0013] In accordance with one aspect of the present invention, there is provided a racking system for a circuit breaker assembly, the racking system comprising:

an electric drive motor having a rotatable drive shaft, wherein the drive motor is configured to be attached onto a sub-chassis of the circuit breaker assembly; and

a drive belt configured to extend between the drive shaft and a winding shaft of the circuit breaker assembly,

wherein when the drive shaft rotates, the drive belt causes the winding shaft to rotate thereby causing a circuit breaker of the circuit breaker assembly to move relative to the sub-chassis.

[0014] The drive belt may be a roller chain extending between and around the drive shaft and a sprocket affixed to the winding shaft.

[0015] The sprocket may consist of first and second complementary sprocket segments configured to be press-fitted together, thereby allowing the sprocket to be affixed releasably to the winding shaft.

[0016] The first sprocket segment may comprise a male section and a female section configured to engage releasably with a respective female and male section of the second sprocket segment.

[0017] The racking system may further comprise a tray attachable to the sub-chassis, wherein the tray consists of a first tray section and a second tray section and the drive motor is attachable to the second tray section.

[0018] The second tray section may comprise an adjustable attachment mechanism for attaching the drive motor to the second tray section, the adjustable attachment mechanism being configured to allow a position of the drive motor relative to the winding shaft to be moved for adjusting a tension of the drive belt.

[0019] The racking system may further comprise a servo motor and pivotable lever, wherein the servo and lever are adapted to press and depress a locking release button of the circuit breaker assembly.

[0020] The racking system may further comprise an internal control unit comprising combinational logic circuitry for controlling the drive and servo motors.

[0021] The control unit may comprise a microprocessor.

[0022] The control unit may comprise a programmable logic array.

[0023] The racking system may further comprise an external control means that enables the drive and servo motors to be operated remotely by a human operator.

[0024] The external control means may comprise a control pad connected to the racking system by wire.

[0025] The racking system may further comprise sensing means adapted to detect and control the position of the circuit breaker relative to the sub-chassis.

[0026] The drive motor and drive belt may be configured such that a racking handle may be used to turn the winding shaft manually.

[0027] The drive motor may comprise a gear transmission mechanism.

[0028] The drive motor may be a brushless electric motor.

[0029] The circuit breaker may be an air circuit breaker.

BRIEF DESCRIPTION OF DRAWINGS

[0030] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

[0031] Figure 1 shows a schematic representation of a conventional withdrawable circuit breaker assembly, as known in the art;

[0032] Figure 2 shows the withdrawable circuit breaker assembly of Figure 1 with a manually operated racking system installed therein, as known in the art;

[0033] Figure 3 shows a perspective view of a racking system according to a preferred embodiment of the present invention;

[0034] Figures 4(a) and 4(b) show a sprocket used in the racking system of Figure 3;

[0035] Figure 5 shows the racking system of Figure 3 with an external control pad attached thereto; and

[0036] Figure 6 shows the racking system of Figure 3 installed into a conventional withdrawable circuit breaker assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

[0037] Referring to Figure 1, there is shown a schematic representation of a withdrawable circuit breaker assembly 10, as known in the art.

[0038] The assembly 10 comprises a circuit breaker 12 and a sub-chassis 14. The circuit breaker 12 is smaller than, and adapted to fit inside, the sub-chassis 14 and may be moved (racked) into and out of the sub-chassis 14. In use, the sub-chassis 14 is connected to electrical conductors (not shown) in a switchboard of a facility in which the assembly 10 is installed.

[0039] The circuit breaker 12 and sub-chassis 14 each have one or more complementary power connectors (not shown) which can engage with, and connect to, one another when the circuit breaker 12 is moved into a first (connected) position inside the sub-chassis 14. The power connectors enable electrical power to be supplied from the local grid to the switchboard via the circuit breaker 12 and sub-chassis 14.

[0040] The power connectors are positioned such that they connect with one another at a back section 16 of the assembly 10 when the circuit breaker 12 has been moved fully inside the sub-chassis 14.

[0041] The circuit breaker 12 and sub-chassis 14 each also have one or more complementary control connectors (not shown) which can engage with, and connect to, one another and permit external or remote control of switches disposed inside the circuit breaker 12. The control connectors are commonly positioned such that they connect to one another at first and second side sections 18,20 of the assembly 10.

[0042] The control connectors are arranged such that they connected to one another when the circuit breaker 12 is positioned its first (connected) position. When the circuit breaker 12 is moved partially outside of its sub-chassis 12 into a second (test) position, the control connectors are connected to one another but the power connectors are unconnected.

[0043] When the circuit breaker 10 is moved further out of its sub-chassis 12 into a third (isolated) position, neither the power nor control connectors of the circuit breaker 12 and sub-chassis 14 are connected.

[0044] Referring to Figure 2, there is shown a conventional manually operated racking system 22 installed into the withdrawable circuit breaker assembly 10 shown in Figure 1, as known in the art.

[0045] The racking system 22 comprises a fixing plate 24 that is secured to a base end 25 of the sub-chassis 14 using a plurality of fixing screws. An elongated winding shaft 26 passes substantially through the fixing plate 24 which, when rotated, causes the circuit breaker 12 to move progressively into or out from the sub-chassis 14.

[0046] To operate the racking system 22, a crank handle 28 is inserted into an aperture located in the front of the circuit breaker 12 so that the crank handle 28 engages with the winding shaft 26. A human operator turns the crank handle 28 to rack the circuit breaker 12 into, and between, the three set positions within the sub-chassis 14.

[0047] When the circuit breaker 12 reaches one of the set positions, a locking mechanism (not shown) within the racking system 22 engages and locks the circuit breaker 12 into the position. The racking system 22 also comprises a push button 30 which, when pressed, disengages the locking mechanism so that the circuit breaker 12 may be racked into a new position.

[0048] Referring to Figure 3, there is shown a racking system 32 for a circuit breaker assembly according to a preferred embodiment of the present invention. The racking system 32 is adapted such that it may be conveniently installed into a conventional

withdrawable circuit breaker assembly that already has an existing manually operated racking mechanism installed therein. As shown in the Figure, the racking system 32 attaches to a winding shaft 34 of the existing manually operated racking mechanism.

[0049] The racking system 32 comprises an electric drive motor 42 having a rotatable drive shaft, wherein the drive motor 42 is configured to be attached onto a sub-chassis of a circuit breaker assembly. The racking system 32 also comprises a drive belt 46 configured to extend between the drive shaft and the winding shaft 34 of the circuit breaker assembly. When the drive shaft of the drive motor 42 rotates, the drive belt 46 causes the winding shaft 34 to rotate thereby causing a circuit breaker of the circuit breaker assembly to move relative to the sub-chassis.

[0050] More particularly, the racking system 32 comprises a tray 36 consisting of a first tray section 38 and a second tray section 40. The drive motor 42 attaches to the second tray section 40. The tray 36 is made from a hard, resilient material and, preferably, a metallic material and is attachable to the sub-chassis.

[0051] The second tray section 40 may also comprise an adjustable attachment mechanism (not shown) for attaching the drive motor 42 onto the second tray section 40. The adjustable attachment mechanism is configured to allow a position of the drive motor 42 relative to the winding shaft 34 to be moved for adjusting a tension of the drive belt 46.

[0052] The drive motor 42 comprises any type of conventional electric motor having sufficient torque and power consumption characteristics and may be, for example, a brushless electric motor 44.

[0053] The drive belt 46, preferably, consists of a roller chain 48 that extends between, and connects, the drive shaft of the drive motor 42 to a sprocket 50 that is affixed around and to the winding shaft 34. The roller chain 48 and sprocket 50 enable the drive motor 42 to turn the winding shaft 34 in both clockwise and anti-clockwise rotational directions.

[0054] As shown in Figures 4(a) and 4(b), the sprocket 50, preferably, comprises first and second 51,52 complementary sprocket segments that may be press-fitted together to form the complete sprocket 50. The first sprocket segment 51 comprises a male section 81 and a female section 82 configured to engage releasably with a respective female 83 and male 84 section of the second sprocket segment 52. The sprocket 50 may, therefore, be releasably affixed around and to the winding shaft 34 during installation of the racking system 32 without disassembling the winding shaft 34 or any other components of the withdrawable circuit breaker assembly which the racking system 32 is installed into.

[0055] As shown schematically in Figure 3, the drive motor 42, preferably, has a section having a gear transmission mechanism 53 incorporated therein for modifying a gear ratio between the rotational motion generated by the drive motor 42 and the resultant rotational motion transmitted to its drive shaft.

[0056] The racking system 32 further comprises a servo 54 attached to the second tray section 40 that has a movable actuator arm 55. The actuator arm 55 is adapted to move a contact end of a pivotable lever 56 that straddles the first and second tray sections 38,40 and engages with a locking release button 58 comprised in the withdrawable circuit breaker assembly that the racking system 32 is installed into. The servo 54 and lever 56 are, together, adapted such that the locking release button 58 may be pressed and de-pressed selectively.

[0057] The racking system 32 further comprises a control unit 60 comprising a microprocessor, programmable logic array (PLA) or similar combinational logic circuit.

[0058] The racking system 32 further comprises an external control means that enables the racking system 32 to be controlled remotely by a human operator. Referring to Figure 5, there is shown an exemplary arrangement in which the control means comprises a control pad 62. The control pad 62 is connected to the racking system 32 by wire 64 and comprises a plurality of push buttons 66.

[0059] In use, a human operator presses each of the push buttons 66 to operate the drive motor 42 and servo 54 remotely and, in turn, the winding shaft 34 and locking release button 58 of the withdrawable circuit breaker assembly that the racking system 32 is installed into.

[0060] It will be appreciated that alternative control means may be used in conjunction with the present invention. For example, a wireless control mechanism may be used that enables the racking system 32 to be operated remotely from a substantial distance. Further, the racking system 32 may be attached to, and be communicable with, a computer network system operating at the facility at which the withdrawable circuit breaker assembly and racking system 32 are installed.

[0061] Figure 6 illustrates how the racking system 32 may be installed into a conventional withdrawable circuit breaker assembly 68 consisting of a circuit breaker 70 and sub-chassis 72.

[0062] The racking system 32 is affixed directly onto a base end 73 of the sub-chassis 72 of the assembly 68, preferably using an arrangement of fixing screws. The racking system 32 serves as a direct replacement for the fixing plate 24 of the conventional manually operated racking system that is shown in Figure 2.

[0063] As shown in Figure 6, once the racking system 32 has been installed, a conventional crank handle 74 may continue to be used to operate the racking system manually. The present invention, therefore, serves to complement existing manual racking systems. The racking system 32 can, therefore, advantageously be retrofitted into circuit breaker assemblies that already have existing manual racking systems installed with minimal mechanical intervention and labour and without any modifications having to be made to the circuit breaker or sub-chassis.

[0064] The first tray section 38 also preferably comprises sensing means (not shown) which, in conjunction with the control unit 60, are adapted to detect and control the position of the circuit breaker 70 as and when the racking system 32 is used by a human

operator to move the circuit breaker 70 between each of its three set positions (connected, test, isolated) within the sub-chassis 68.

[0065] The sensing means and control unit 60 additionally cause the rotational velocity of the drive motor 42 (and, by extension, the winding shaft 34) to slow down incrementally when the circuit breaker 70 approaches a set position. This ensures that there is a smooth transition of the circuit breaker 70 between set positions and avoids sudden or jamming motions that might lead to damage or undue wear and tear of the racking system 32. The control unit 60 also preferably includes a timing circuit that prevents operation of the drive motor 42 when a system malfunction has occurred, for example when welding of isolated contacts has taken place.

[0066] The sensing means and control unit 60 additionally enable the position of the circuit breaker 70 (and status information relating to the racking system 32 generally) to be reported to its human operator via wired or wireless communication means.

[0067] The control unit 60 further comprises logic circuitry adapted to detect and protect the drive motor 42 from over-current and overheating. The control unit 60 is also preferably configured to detect when a conventional crank handle 74 is connected to the winding shaft 34 for manual operation and to disconnect the power supply to the drive motor 42 in such circumstances.

[0068] Conventional withdrawable circuit breaker assemblies often include a safety lever that may be pivoted across the aperature in the front end of the assembly that receives the crank handle 74 and locked in place using a padlock. The lever covers the aperture and stops the crank handle 74 from being inserted therein for safety reasons. For situations where the present racking system 32 has been installed into this type of circuit breaker assembly, the control unit 60 is also configured to detect when the safety lever has been pivoted away from the aperture to enable manual cranking and to disconnect the power supply to the drive motor 42 accordingly.

[0069] In further alternative embodiments, the racking system 32 further comprises an external interface module comprising a power supply, operations counter and further electrical protection devices.

[0070] Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

[0071] In the claims that follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" are used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

CLAIMS

1. A racking system for a circuit breaker assembly, the racking system comprising:

an electric drive motor having a rotatable drive shaft, wherein the drive motor is configured to be attached onto a sub-chassis of the circuit breaker assembly; and

a drive belt configured to extend between the drive shaft and a winding shaft of the circuit breaker assembly,

wherein when the drive shaft rotates, the drive belt causes the winding shaft to rotate thereby causing a circuit breaker of the circuit breaker assembly to move relative to the sub-chassis.

2. The racking system according to claim 1, wherein the drive belt consists of a roller chain extending between and around the drive shaft and a sprocket affixed to the winding shaft.

3. The racking system according to claim 2, wherein the sprocket consists of first and second complementary sprocket segments configured to be press-fitted together, thereby allowing the sprocket to be affixed releasably to the winding shaft.

4. The racking system according to claim 3, wherein the first sprocket segment comprises a male section and a female section, the male and female sections being configured to engage releasably with respective female and male sections of the second sprocket segment.

5. The racking system according to any one of the preceding claims, wherein the racking system further comprise a tray attachable to the sub-chassis, wherein the tray consists of a first tray section and a second tray section and the drive motor is attachable to the second tray section.

6. The racking system according to claim 5, wherein the second tray section comprises an adjustable attachment mechanism for attaching the drive motor to the second tray section, the adjustable attachment mechanism being configured to allow a position of the drive motor relative to the winding shaft to be moved for adjusting a tension of the drive belt.

7. The racking system according to any one of the preceding claims, wherein the racking system further comprises a servo motor and pivotable lever, wherein the servo and lever are adapted to press and depress a locking release button of the circuit breaker assembly.

8. The racking system according to any one of the preceding claims, wherein the racking system further comprises an internal control unit comprising combinational logic circuitry for controlling the drive and servo motors.

9. The racking system according to claim 8, wherein the control unit comprises a microprocessor.

10. The racking system according to claim 8, wherein the control unit comprises a programmable logic array.

11. The racking system according to any one of the preceding claims, wherein the racking system further comprises an external control means that enables the drive and servo motors to be operated remotely by a human operator.

12. The racking system according to claim 11, wherein the external control means comprises a control pad connected to the racking system by wire.

13. The racking system according to any one of the preceding claims, wherein the racking system further comprises sensing means adapted to detect and control the position of the circuit breaker relative to the sub-chassis.

14. The racking system according to any one of the preceding claims, wherein the drive motor and drive belt are each configured such that a racking handle may be used to turn the winding shaft manually.

15. The racking system according to any one of the preceding claims, wherein the drive motor comprises a gear transmission mechanism.

16. The racking system according to any one of the preceding claims, wherein the drive motor is a brushless electric motor.

17. The racking system according to any one of the preceding claims, wherein the circuit breaker is an air circuit breaker.

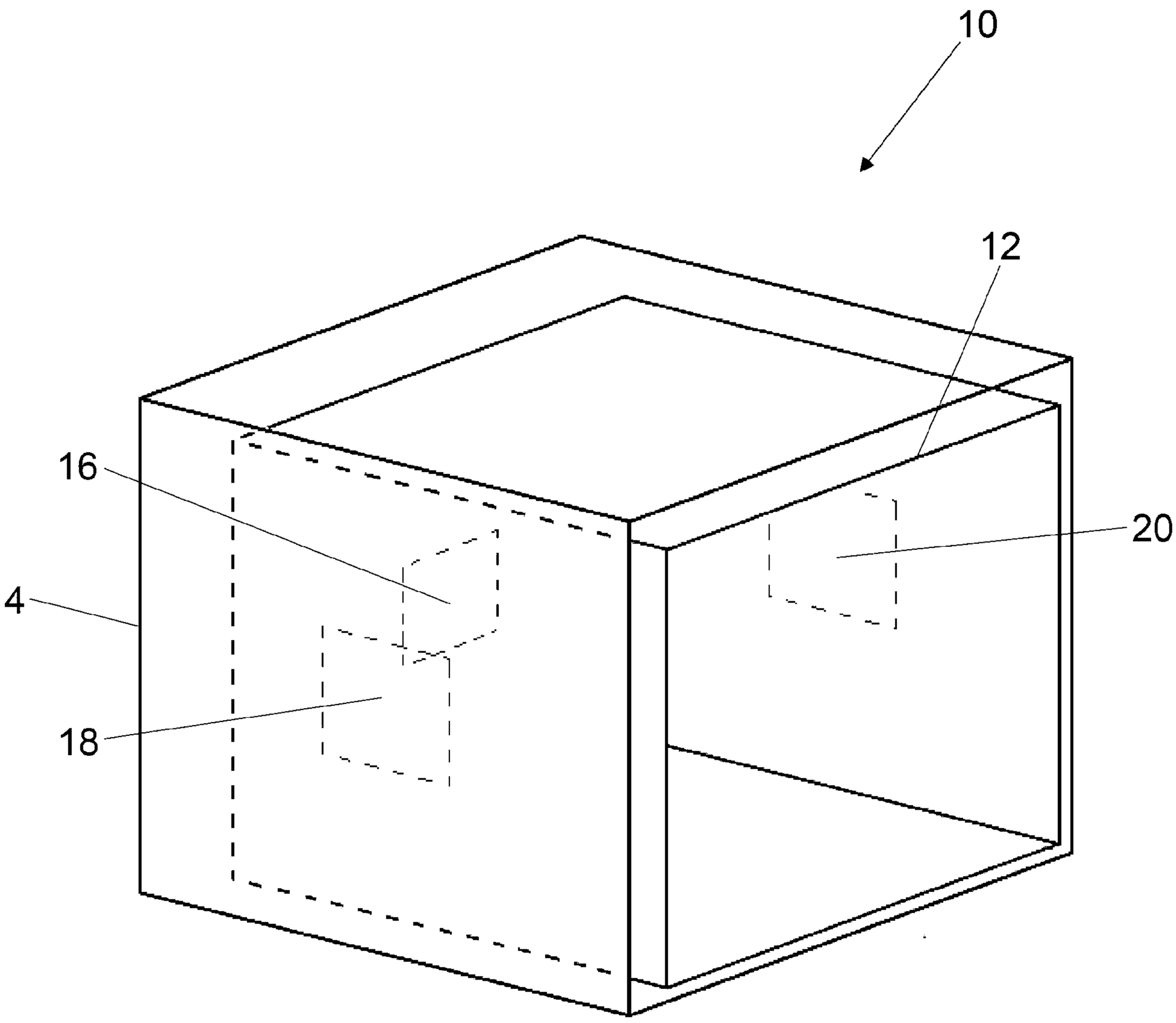


Figure 1 (prior art)

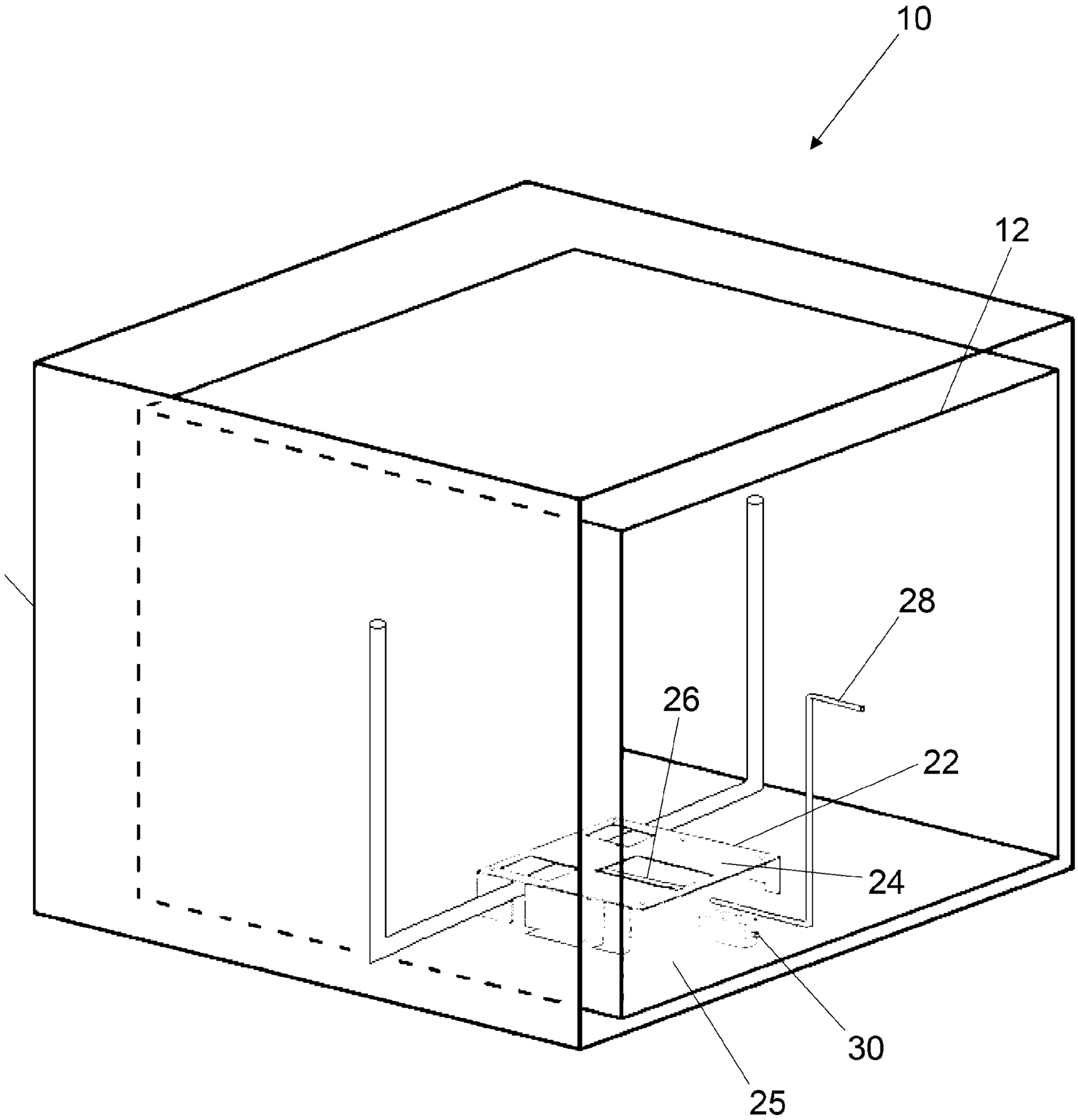


Figure 2 (prior art)

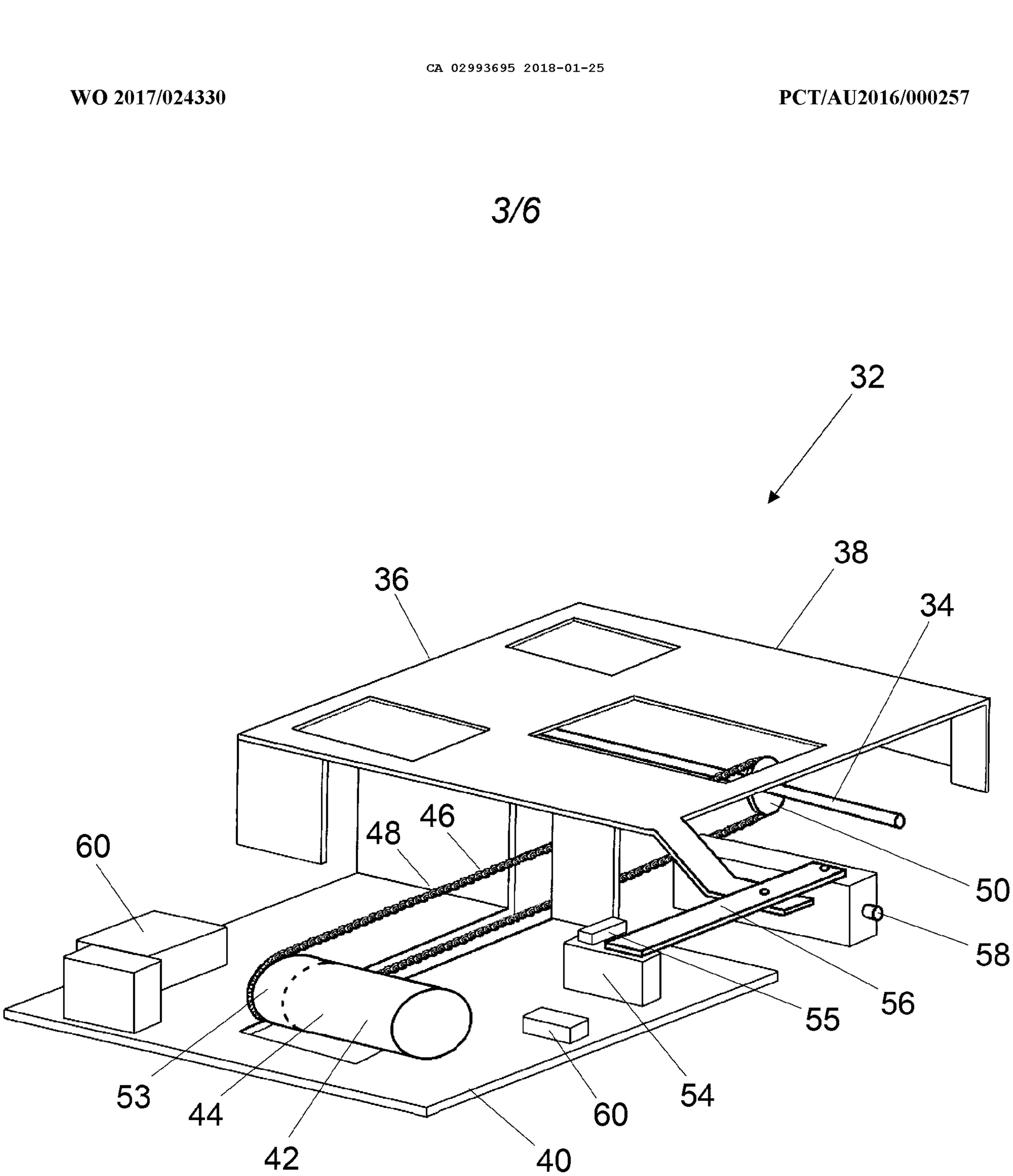


Figure 3

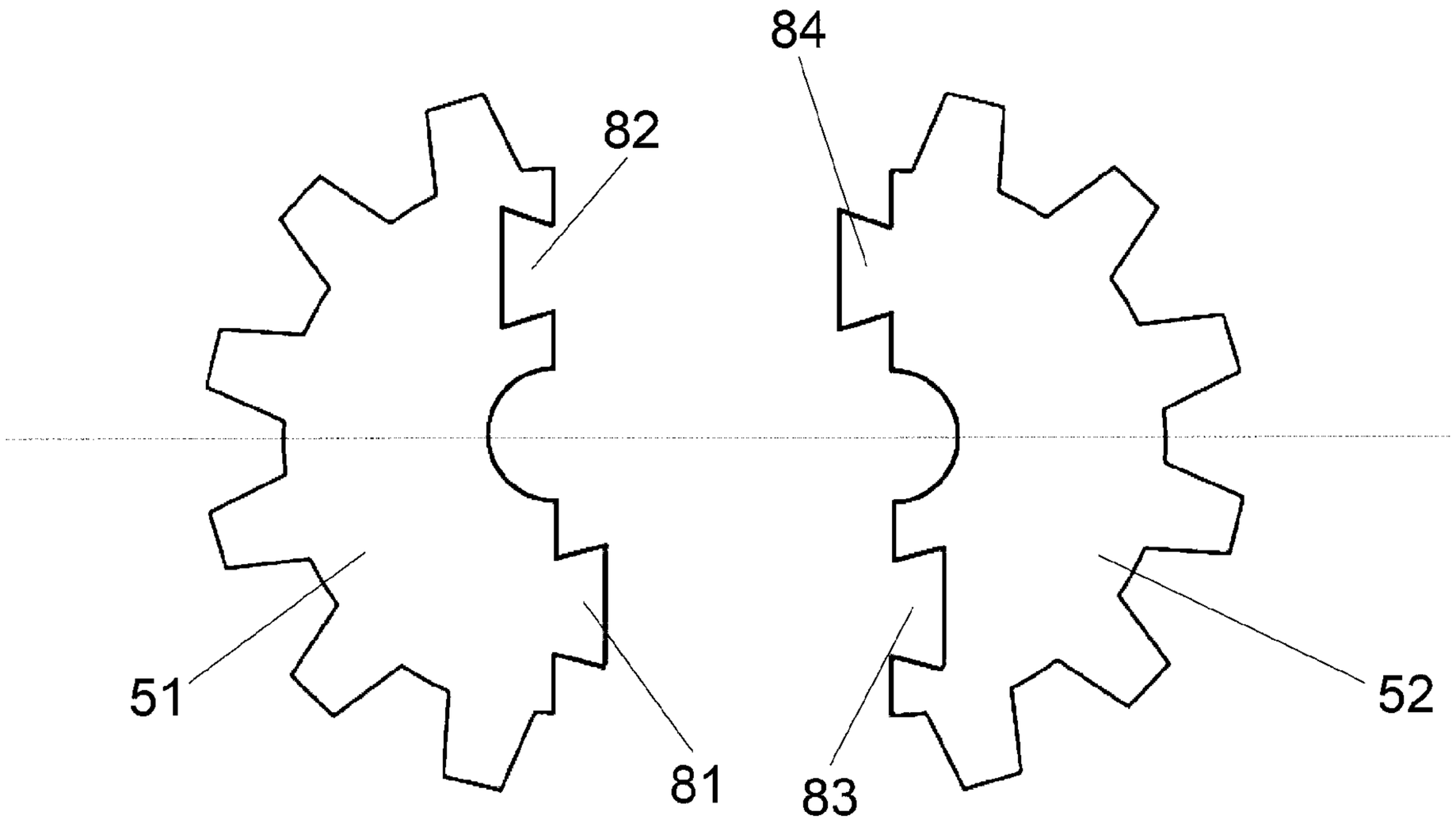


Figure 4(a)

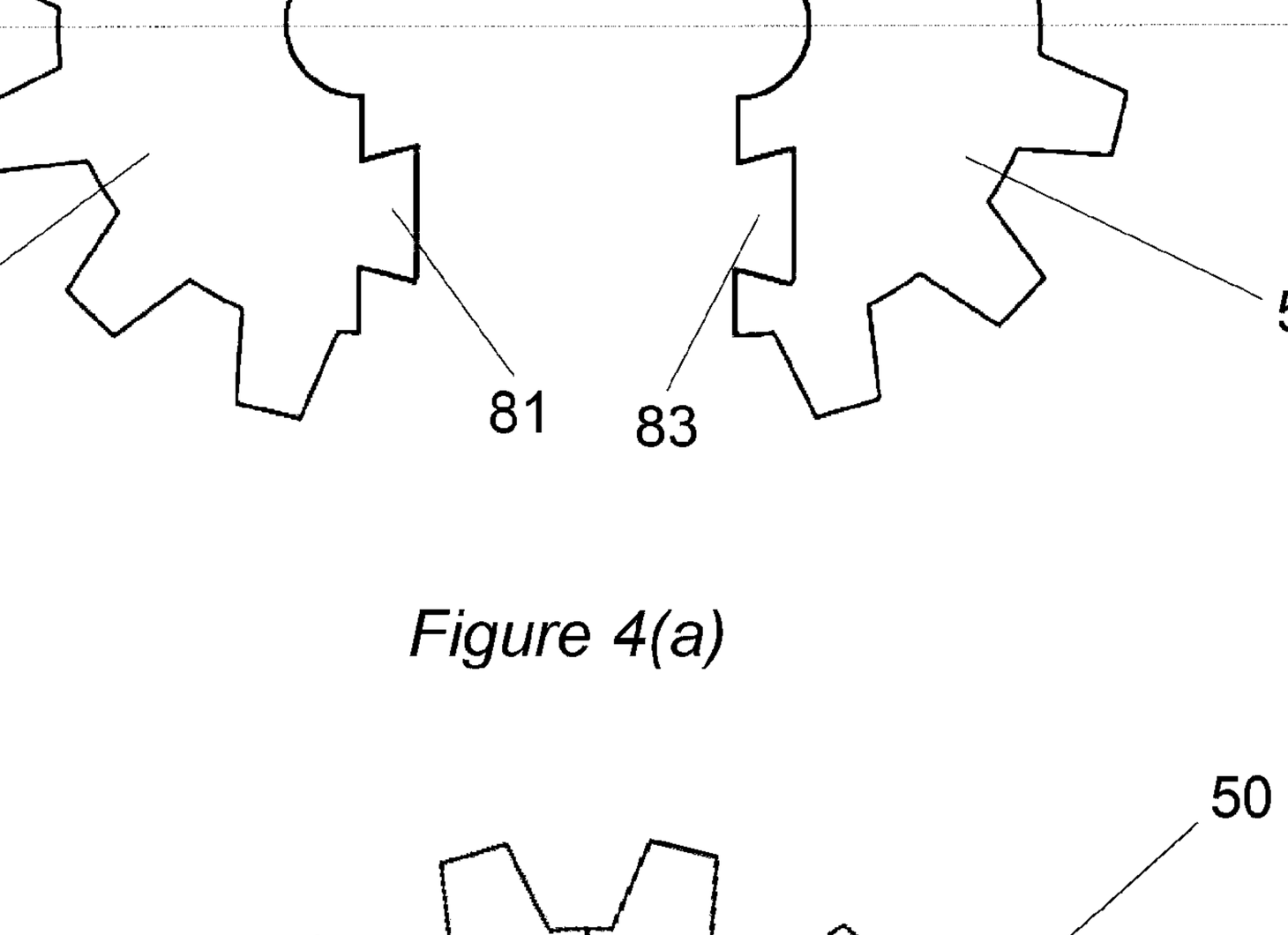


Figure 4(b)

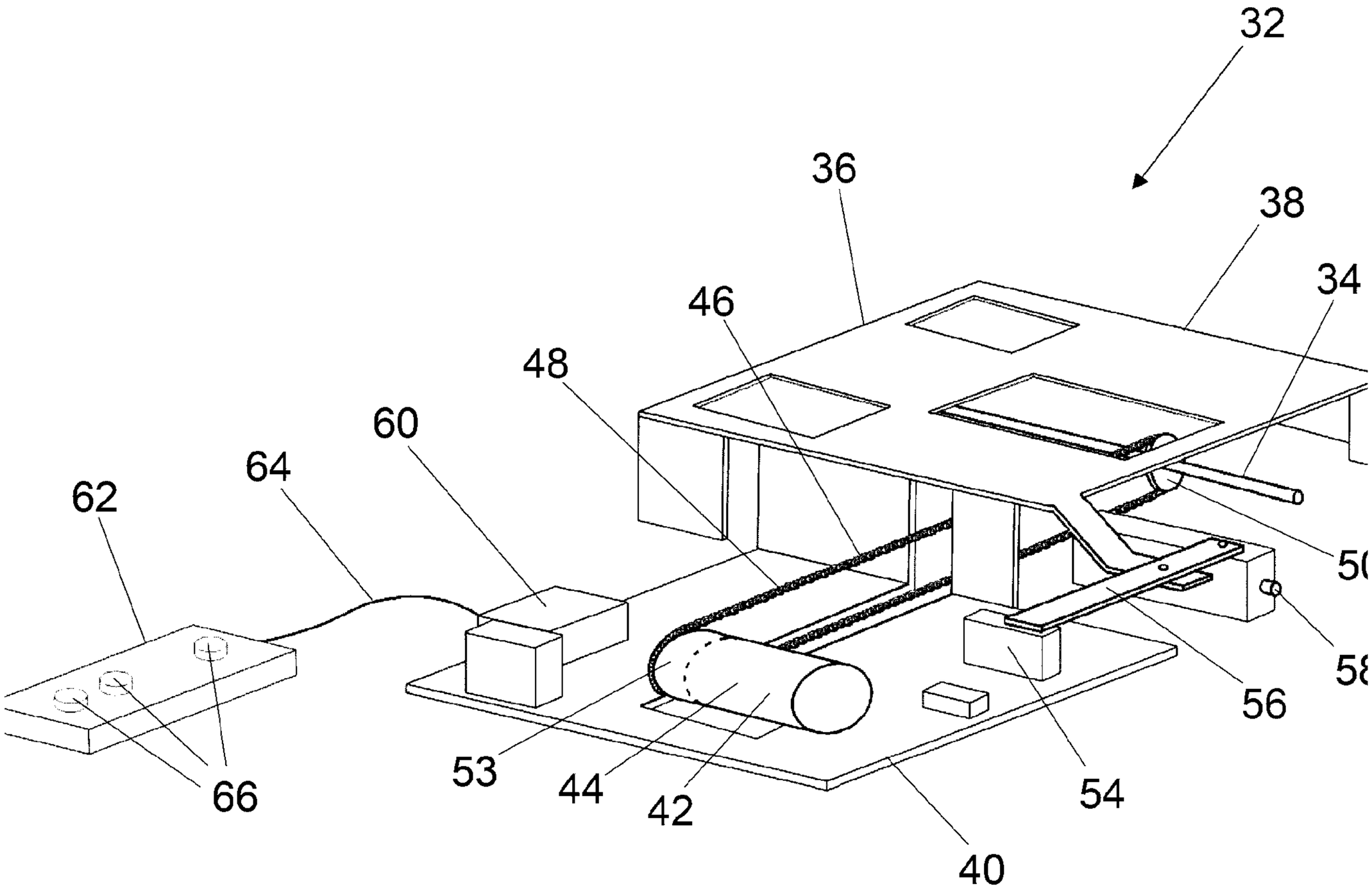


Figure 5

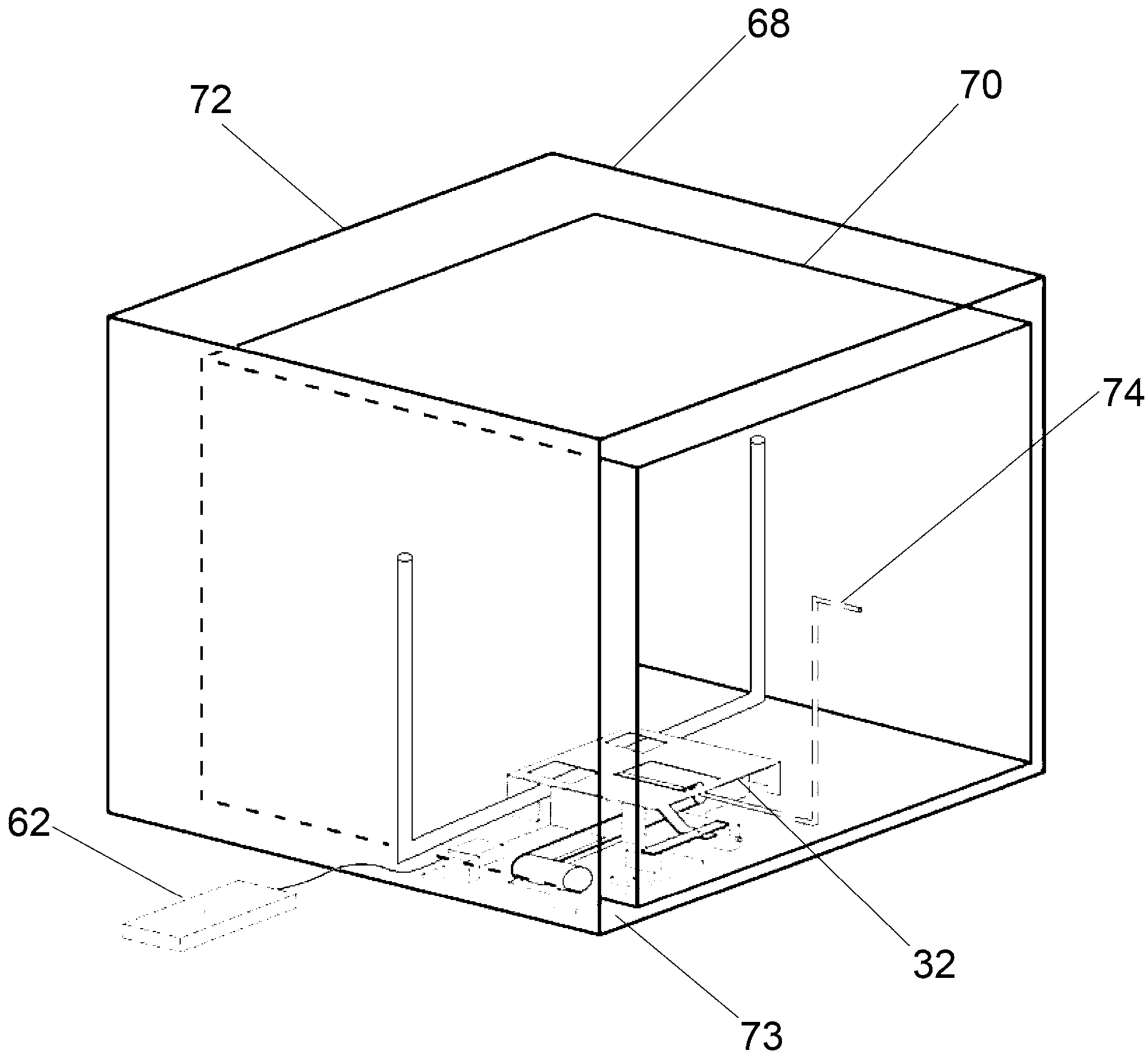


Figure 6

Figure 3