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(54) Title: POWER TOOL WITH INTERLOCK SYSTEM

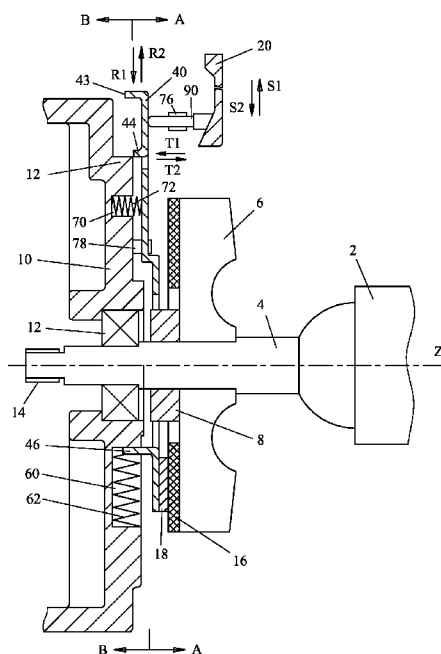


Figure 1

(57) Abstract: A power tool comprises a housing, a motor (2) mounted in the housing and having a rotary spindle (4), a trigger (20) configured for switching on/off the motor (2), a support member (10) fixed to the housing, and a spindle lock (40) configured to be actuated to move in a first radial direction (R1) to lock the spindle (4) and a second opposite radial direction (R2) to release the spindle (4). When the trigger (20) is switched on, it moves the spindle lock (40) in a first axial direction (T1), and when the trigger (20) is switched off, the spindle lock (40) is allowed to move in a second opposite axial direction (T2). The spindle lock (40) has a positioning member (44) which cooperates with a stop portion (12) of the support member (10) to prevent the power tool from being switched on and being locked at the same time.

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GW, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

Power Tool with Interlock System

Technical Field

The invention relates to a power tool having an interlock system for preventing the power tool from being switched on and being locked at the same time.

Background Art

Power tools, such as portable power tools, are widely used. A typical power tool has an electrical motor and a tool bit driven by the rotational spindle of the motor via a transmission mechanism which converts the rotational movement of the spindle to the movement required by the tool bit. The motor is switched on/off by an operator by means of a switch trigger.

Sometimes, after the operation of the power tool, the spindle of the motor should be locked from rotation for the purpose of, for example, exchanging the tool bit, or the like. For this end, some conventional power tools are equipped spindle locks for locking their spindles in place from rotation.

However, in a power tool having such a spindle lock, there is a problem that dangers related with the spindle lock may happen. For example, when the power tool is switched on, the spindle lock is still able to be pressed to lock the spindle of the motor; or, when the spindle lock has been activated to stop the spindle, the tool is still able to be switched on. In both conditions, the operations are very dangerous for the operators and the tools.

For this reason, it is desired to provide a safety system for such power tools to offer a safer working condition for operators by avoiding the above dangerous operations. However, some portable power tools with spindle locks don't have such a safety system. Some plunge type power tools on market, such as Festool TS55 EBQ, have a safety function setting for this purpose, but such tools have complicated spindle locks and safety systems.

As the safety system, an interlock system for preventing its spindle lock and switch trigger from being operated at the same time is believed to be a good option.

Summary of the Invention

In view of the problems existed in the prior art, an object of the invention is to provide a power tool having a simple and reliable interlock system for protecting the power tool from being switched on and being locked at the same time.

For achieving this object, in one aspect, the present invention provides a power tool

comprising:

a housing;

a motor mounted in the housing and having a rotary spindle;

a trigger configured for switching on/off the motor;

a support member fixed to the housing; and

a spindle lock configured to be actuated to move in a first radial direction to lock the spindle and a second opposite radial direction to release the spindle;

wherein when the trigger is being switched on, it moves the spindle lock in a first axial direction, and when the trigger is switched off, the spindle lock is allowed to move in a second opposite axial direction; and

wherein the spindle lock has a positioning member which cooperates with a stop portion of the support member so that:

when the spindle lock has been moved in the first radial direction to lock the spindle, the positioning member is blocked by the stop portion to prevent the spindle lock from being moved in the first axial direction and thus prevent the trigger from being switched on, and

when the trigger has been switched on and thus has moved the spindle lock in the first axial direction, the positioning member is blocked by the stop portion to prevent the spindle lock from being moved in the first radial direction to lock the spindle.

In accordance with a preferred embodiment of the invention, the power tool further comprises a nut fixed to the spindle, wherein when the spindle lock moves in the first radial direction, it comes into contact with the nut and thus locks the spindle.

In accordance with another preferred embodiment of the invention, the power tool further comprises a fan fixed to the spindle by the nut.

In accordance with another preferred embodiment of the invention, the power tool further comprises a brake pad fixed to the spindle, such as by being attached to the fan, and a frictional material attached to the spindle lock;

wherein when the spindle lock moves in the second axial direction, the frictional material comes into contact with the brake pad to perform brake to the spindle, and when the spindle lock moves in the first axial direction, the frictional material moves away from the brake pad.

In accordance with another preferred embodiment of the invention, the power tool further comprises a first returning member, such as a spring, biasing the spindle lock in the second radial direction and a second returning member, such as a spring, biasing the

spindle lock in the second axial direction.

In accordance with another preferred embodiment of the invention, the power tool further comprises a pushing rod arranged between the trigger and the spindle lock;

wherein the pushing rod and the trigger each have a cam surface, and

when the trigger is switched on, the pushing rod is moved by means of the camming action between the cam surfaces of the pushing rod and the trigger and thus pushes the spindle lock to move in the first axial direction.

In accordance with another preferred embodiment of the invention, the positioning member of the spindle lock has a radial positioning surface and an axial positioning surface, and the stop portion of the support member has a radial stop surface and an axial stop surface;

wherein when the spindle lock has been moved in the first radial direction to lock the spindle, the radial positioning surface faces directly to and is blocked by the radial stop surface to prevent the spindle lock from being moved in the first axial direction, and

when the spindle lock has been moved in the first axial direction by switching on the trigger, the axial positioning surface faces directly to and is blocked by the axial stop surface to prevent the spindle lock from being moved in the first radial direction.

In accordance with another preferred embodiment of the invention, the support member is a guard of the power tool.

This interlocking concept of the invention can be used on circular saws, angle grinders, marble cutters, and other rotary or linear power tools. The power tool of the invention is preferably a portable power tool.

The invention provides a power tool having a new safety system, i.e., an interlock system between its spindle lock and switch trigger. The interlock system has a simple structure to avoid locking the spindle when tool is operating and avoid switching on the tool when the spindle is locked, and thus improves safety condition for both the power tool and its operators.

Brief Description of the Drawings

The invention will be further understood by reading the following detailed description with reference to the drawings in which:

Figure 1 is a schematic cross-sectional view of a power tool according to an embodiment of the invention, showing a stand-by state of the power tool;

Figure 2 is a schematic cross-sectional view of the power tool of Figure 1, showing a state that the power tool is turned on and the spindle lock cannot be activated;

Figure 3 is a schematic cross-sectional view of the power tool of Figure 1, showing a state that the spindle lock is activated and the power tool cannot be turned on;

Figure 4 is a cross-sectional side view of the spindle lock of the power tool of Figure 1;

Figure 5 is a schematic view showing the relation of the spindle lock and the lock nut of the power tool taken in an A-A direction in Figure 1;

Figure 6 is a schematic view showing the relation of the spindle lock and the stationary support member of the power tool taken in a B-B direction in Figure 1;

Figure 7 to 9 are enlarged schematic views showing the positional relations of the pushing rod, the spindle lock and the support member of the power tool corresponding to the states of Figures 1 to 3 respectively; and

Figures 10 and 11 are partly sectional views showing variations of the spindle lock.

Detailed Description of Preferred Embodiments

Now, a power tool according to a preferred embodiment of the invention will be described with reference to the drawings.

As shown in Figure 1, the power tool mainly comprises a housing (not shown), a motor 2 fixedly mounted in the housing and having a rotary spindle 4 which defines a rotational axis Z, a fan 6 fixedly mounted around the rotary spindle 4 by a nut 8 so as to be rotated by the spindle for cooling the motor, a stationary support member (for example, a guard) 10 fixed to or integrally formed with the housing, for carrying a bearing 12 which rotatably supports the spindle 4 near the tip end of the spindle 4; a pinion 14 formed on or mounted to the tip end of the spindle, as a member of a transmission mechanism for converting the rotational movement of the spindle 4 to a rotational, linear or other movement required by a tool bit (not shown, such as a saw blade, a grinding wheel, a drill bit, or the like); a trigger 20 configured to be operated by an operator for switching on/off the motor 2; and a spindle lock 40 for locking the spindle 4 from rotation.

The spindle lock 40 is moveable in radial directions R1 and R2, which are opposite to each other, in Figure 1 to lock and release the spindle 4 respectively. Further, the spindle lock 40 is also moveable in axial directions T1 and T2, which are opposite to each other, to block and allow the spindle lock 40 moving in the radial direction R1 respectively, as described below.

Specifically, with further reference to Figures 4 to 6, the spindle lock 40 according to a preferred embodiment of the invention is a single piece member formed of a sheet metal by punching and bending. The spindle lock 40 has a central ring portion 41 mounted in normal state around the nut 8 between the fan 6 and the support member 10. The central

ring portion 41 may have any shape, such as the circular shape in the illustrated example, a rectangular shape, an elliptical shape, or the like.

An elongated actuation portion 42 extends radially from the outer periphery of the central ring portion 41 in the radial direction R2 and terminates with a bent actuation end 43 which can be pushed by an operator.

A protrusion (positioning member) 44 is protruded from actuation portion 42 at a position between the actuation end 43 and the outer periphery of the central ring portion 41 towards the support member 10 so as to be restrained by a stop portion 12 of the support member 10.

In the illustrated example, the protrusion 44 is formed by punching out a part of the actuation portion 42. However, the protrusion 44 can be formed by any manner. For example, it may be a separate member and is fixed to the actuation portion 42 by welding, screw fastening, or the like. Meanwhile, the protrusion 44 may be a straight flap extending parallel to the axis Z, like that shown in Figures 1 to 6. However, the protrusion 44 may have varied shapes, such as that shown in Figures 10 and 11, only if it protrudes towards the stop portion 12 of the support member 10 and provides two positioning surfaces to be restrained by corresponding stopping surfaces of the stop portion 12, i.e., a first (radial) positioning surface 44a extending in a plane perpendicular to the axis Z and facing towards the support member 10 so as to be restrained by a first (radial) stopping surface 12a of the stop portion 12 which extends also in a plane perpendicular to the axis Z and faces towards the spindle lock 40, and a second (axial) positioning surface 44b extending in an inwardly facing plane parallel to the axis Z so as to be restrained by a second (axial) stopping surface 12b of the stop portion 12 which extends in an outwardly facing plane parallel to the axis Z. Please refer to Figure 7 (corresponding to the state shown in Figure 1) for details.

The spindle lock 40 further has a locking portion 45 formed on the inner periphery of the ring portion 41 at a position corresponding to the actuation portion 42 and protruded in a radial direction opposite to the actuation portion 42 towards the nut 8. By engaging the locking portion 45 with a flat surface portion of the nut 8, the spindle 4 will be locked from rotating.

The spindle lock 40 further has a biased portion 46 which is also protruded towards the support member 10 as the protrusion 44 but much longer than the protrusion 44. In the illustrated example, the biased portion 46 is formed from a position on the inner periphery of the ring portion 41 diametrically opposed to the locking portion 45. However, the biased portion 46 may be formed at any suitable position along the extension line of the actuation portion 42 or even form on the actuation portion 42.

The biased portion 46 inserts into a recess 60 formed in the support member 10 and is biased by a spring (first returning member) 62 mounted in the recess 60 in the radial direction R2.

In the normal state of the spindle lock 40, the biased portion 46 is biased by the spring 62 against an inner wall portion of the recess 60. When an operator pushes the actuation end 43 of the spindle lock 40, the spindle lock 40 will move in the radial direction R1 against the spring 62, so that the locking portion 45 engages the nut 8 to lock the spindle 4. After the operator releases the actuation end 43 of the spindle lock 40, the spring 62 will force the spindle lock 40 back in the radial direction R2 so that the locking portion 45 leaves the nut 8 to unlock the spindle 4.

In this way, the spindle lock 40 locks the spindle 4 according to the operator's actuation to it and automatically unlocks the spindle 4 when the operator's actuation releases.

As an optional feature of the spindle lock 40, the spindle lock 40 is combined with a brake assembly. Specifically, as shown in Figures 1 to 3, the brake assembly comprises a circular brake pad 16 attached to the back surface of the fan 6 (the surface facing away from the main body of the motor 2) and a frictional material 18 attached to a brake portion 48 of the spindle lock 40. The brake portion 48 may be formed at any position around the outer periphery of the ring portion 41, and may be formed at more than one position.

When the spindle lock 40 moves in the axial direction T1, the frictional material 18 is away from the brake pad 16, and no brake action is applied to the spindle 4. When the spindle lock 40 moves in the axial direction T2, the frictional material 18 pushes against the brake pad 16, and brake action is applied to the spindle 4 to quickly stop the rotating spindle 4.

The movement of the spindle lock 40 moves in the directions T1 and T2 are achieved by the trigger 20 and a spring (second returning member) 72 respectively.

The trigger 20 moves the spindle lock 40 in the axial direction T1 by means of a pushing rod 90 which is arranged at a side of the spindle lock 40 which is opposite to the support member 10.

As more clearly shown in Figure 7, the trigger 20 has a cam surface 22. The pushing rod 90 has a front end 90a which biases against the actuation portion 42 (or one or more of other portions of the spindle lock 40), a middle portion 90b guided by a guiding portion 76 formed on the housing, and a back end 90c having a cam surface 90d cooperative with the cam surface 22 of the trigger 20 so that, when the trigger 20 moves in direction S1, the camming action created by the cam surfaces 22 and 90d results in that the pushing rod 90 moves in the axial direction T1, and thus the spindle lock 40 is driven by

the front end 90a of the pushing rod 90 to move in the axial direction T1.

The spring 72 is mounted in the recess 70 formed in the support member 10 at a position facing the spindle lock 40 (in the illustrated example, at a position facing the actuation portion 42; however, the recess 70 can be formed at one or more positions facing other portions of the spindle lock 40). When the trigger 20 moves in direction S2 which is opposite to the direction S1, the spring 72 pushes the spindle lock 40 in the axial direction T2 back to its original position.

The moving directions S1 and S2 may be any directions that perpendicular to the axis Z. The trigger 20 can be moved in the direction S1 by an operator to switch on the power tool. When the operator wants to end the operation of the power tool, he may release the trigger 20 to allow it to move in the direction S2. The trigger 20 may move in the direction S2 by the camming action between the cam surfaces 22 and 90d. However, to improve reliability, a returning member (such as a spring, not shown) may be provided for the trigger 20 to move it in the direction S2.

For limiting the movement distance of the spindle lock 40 in the axial direction T1, the back end 90c of the pushing rod 90 may have a larger diameter than the middle portion 90b, so that when the back end 90c contacts and is blocked by the guiding portion 76, the pushing rod 90 and thus the spindle lock 40 cannot be moved in the axial direction T1 anymore.

For guiding the movements of the spindle lock 40 in the directions R1, R2, T1 and T2, a guiding structure 78 may be formed or mounted at one or more positions of the support member 10.

In the normal or stand-by state of the power tool as shown in Figure 1, both the trigger 20 and the spindle lock 40 are released.

In this state, the spindle lock 40 is biased by springs 62 and 72 so as to be located in its radial and axial home positions. Now the spindle lock 40 is able to be moved both in the radial direction R1 by an operator pushing on the actuation end 43 and in the axial direction T1 by the operator switching on the trigger 20 in the direction S1.

In this state, as clearly shown in Figure 7, the protrusion 44 of the spindle lock 40 is positioned with respect to the stop portion 12 of the support member 10 in a condition that its first and second positioning surfaces 44a and 44b near but unaligned with the first and second stopping surfaces 12a and 12b of the stop portion 12 respectively.

In this state, although the spindle lock 40 is able to be moved in both radial and axial directions, its movability in one direction is blocked once it has been moved in the other direction. That is to say, once the spindle lock 40 has been moved in the radial direction R1, it is blocked by the stop portion 12 from moving in the axial direction T1; on the

other hand, once the spindle lock 40 has been moved in the axial direction T1, it is blocked by the stop portion 12 from moving in the radial direction R1. This function will be described in more details below.

Specifically, as shown in Figures 2 and 8, the power tool is turned on by an operator moving the trigger 20 in the direction S1. As the trigger 20 is moving in the direction S1, the camming action created by the cam surfaces 22 and 90d results in that the pushing rod 90 moves in the axial direction T1, and thus the spindle lock 40 is driven by the pushing rod 90 to move in the axial direction T1. As a result, the second positioning surface 44b of the protrusion 44 of the spindle lock 40 is aligned to or directly faces to the second stopping surface 12b of the stop portion 12. In this state, the protrusion 44 of the spindle lock 40 is blocked by the stop portion 12 from moving in the radial direction R1, and thus the spindle lock 40 cannot be pushed down in the radial direction R1. This will prevent the rotating spindle 4 from being locked by the spindle lock 40.

As also can be seen in Figure 2, as the spindle lock 40 moves in the axial direction T1, the frictional material 18 attached to the spindle lock 40 leaves the brake pad 16 to allow the spindle 4 to rotate.

During the operation of the power tool, the operator keeps the switching on state of the trigger 20, as is understood by those skilled in the art.

In the operation state of the power tool as shown in Figures 2 and 8, when the operator release the trigger 20, the trigger 20 moves in the direction S2, and then the spindle lock 40 moves in the axial direction T2 under the returning force of the spring 72 so that the frictional material 18 moves to and contacts the brake pad 16 to stop the rotation of the spindle 4. Meanwhile, the protrusion 44 of the spindle lock 40 leaves the stop portion 12 and the blocking to the movability of the spindle lock 40 in the radial direction R1 is removed. Then, the spindle lock 40 can be pushed down in the radial direction R1 to lock the spindle 4.

On the other hand, as shown in Figures 3 and 9, in the turned off state of the power tool, the spindle lock 40 is pushed down in the radial direction R1. By this action, the locking portion 45 of the spindle lock 40 moves to and contacts the nut 8, thus locking the spindle 4 from rotating. Meanwhile, the first positioning surface 44a of the protrusion 44 of the spindle lock 40 being aligned to or directly facing to the first stopping surface 12a of the stop portion 12. In this state, the protrusion 44 of the spindle lock 40 is blocked by the stop portion 12 from moving in the axial direction T1, and thus the spindle lock 40 and the pushing rod 90 cannot be moved in the axial direction T1. This means that the trigger 20 cannot be switched on in the direction S1, and thus the power tool is prevent from being switched on when the spindle 4 is locked by the spindle lock 40.

The operator keeps pushing down the spindle lock 40 until he wants to remove the locking to the spindle 4.

When the operator release the spindle lock 40, the spindle lock 40 moves in the axial direction R2 under the returning force of the spring 62. Then, the whole power tool goes back to its stand-by state shown in Figure 1.

It can be seen that the trigger 20, the spindle lock 40 and the support member 10 form an interlock system to prevent the spindle lock 40 from being moved in both radial and axial directions at the same time. Thus, the power tool according to the invention is equipped with a simple and reliable interlock system for protecting the power tool from being switched on and being locked at the same time.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. The attached claims and their equivalents are intended to cover all the modifications, substitutions and changes as would fall within the scope and spirit of the invention.

CLAIMS

1. A power tool comprising:

a housing;

a motor mounted in the housing and having a rotary spindle;

a trigger configured for switching on/off the motor;

a support member fixed to the housing; and

a spindle lock configured to be actuated to move in a first radial direction to lock the spindle and a second opposite radial direction to release the spindle;

wherein when the trigger is being switched on, it moves the spindle lock in a first axial direction, and when the trigger is switched off, the spindle lock is allowed to move in a second opposite axial direction; and

wherein the spindle lock has a positioning member which cooperates with a stop portion of the support member so that:

when the spindle lock has been moved in the first radial direction to lock the spindle, the positioning member is blocked by the stop portion to prevent the spindle lock from being moved in the first axial direction and thus prevent the trigger from being switched on, and

when the trigger has been switched on and thus has moved the spindle lock in the first axial direction, the positioning member is blocked by the stop portion to prevent the spindle lock from being moved in the first radial direction to lock the spindle.

2. The power tool of claim 1, further comprising a nut fixed to the spindle, wherein when the spindle lock moves in the first radial direction, it comes into contact with the nut and thus locks the spindle.

3. The power tool of claim 2, further comprising a fan fixed to the spindle by the nut.

4. The power tool of claim 3, further comprising a brake pad fixed to the spindle, such as by being attached to the fan, and a frictional material attached to the spindle lock;

wherein when the spindle lock moves in the second axial direction, the frictional material comes into contact with the brake pad to perform brake to the spindle, and when the spindle lock moves in the first axial direction, the frictional material moves

away from the brake pad.

5. The power tool of any one of claims 1 to 4, further comprising a first returning member, such as a spring, biasing the spindle lock in the second radial direction and a second returning member, such as a spring, biasing the spindle lock in the second axial direction.

6. The power tool of any one of claims 1 to 5, further comprising a pushing rod arranged between the trigger and the spindle lock;

wherein the pushing rod and the trigger each have a cam surface, and

when the trigger is switched on, the pushing rod is moved by means of the camming action between the cam surfaces of the pushing rod and the trigger and thus pushes the spindle lock to move in the first axial direction.

7. The power tool of any one of claims 1 to 6, wherein the positioning member of the spindle lock has a radial positioning surface and an axial positioning surface, and the stop portion of the support member has a radial stop surface and an axial stop surface;

wherein when the spindle lock has been moved in the first radial direction to lock the spindle, the radial positioning surface faces directly to and is blocked by the radial stop surface to prevent the spindle lock from being moved in the first axial direction, and

when the spindle lock has been moved in the first axial direction by switching on the trigger, the axial positioning surface faces directly to and is blocked by the axial stop surface to prevent the spindle lock from being moved in the first radial direction.

8. The power tool of any one of claims 1 to 7, wherein the support member is a guard of the power tool.

9. The power tool of any one of claims 1 to 8, wherein the power tool is a circular saw, an angle grinder, or a marble cutter.

10. The power tool of any one of claims 1 to 9, wherein the power tool is a portable power tool.

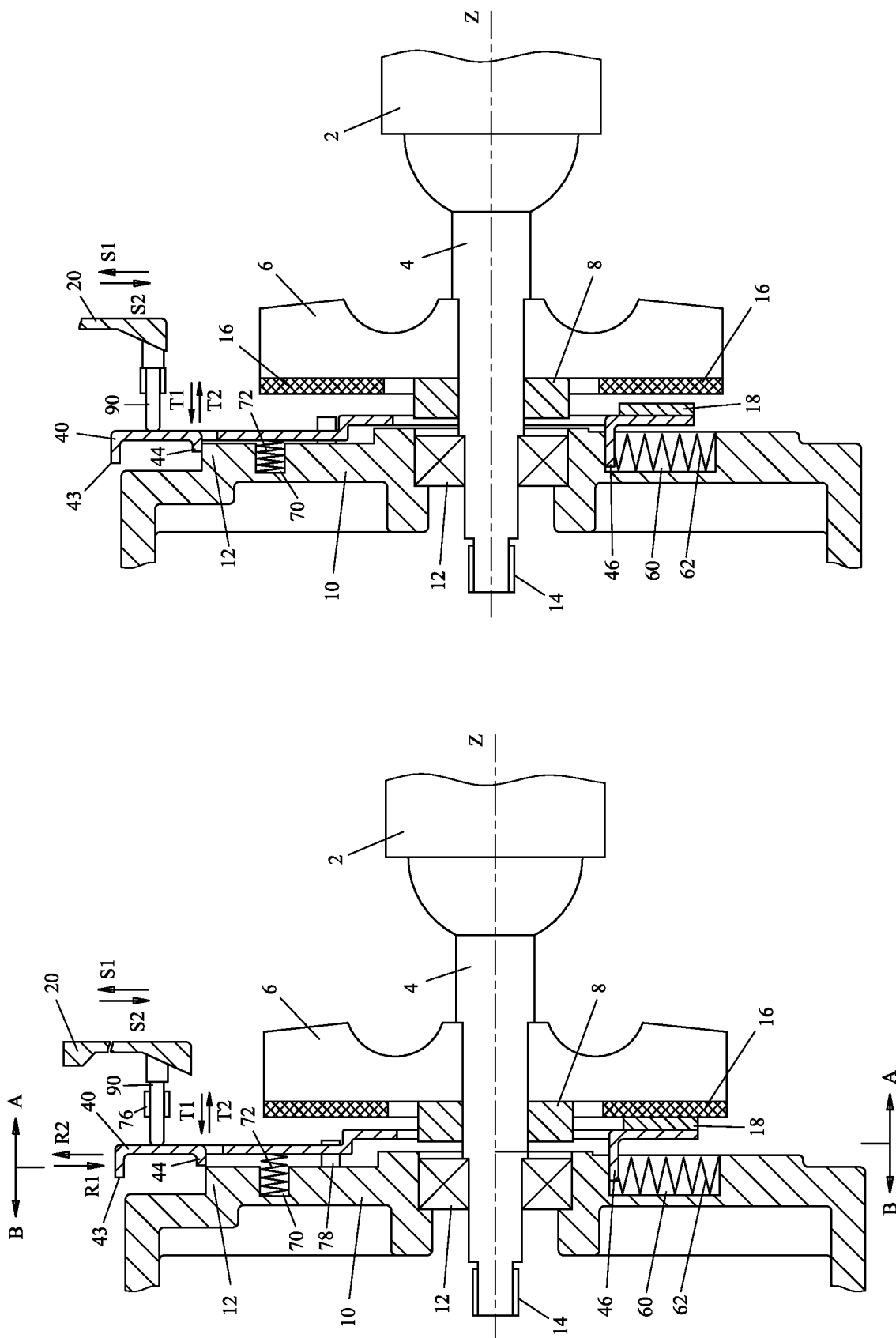


Figure 2

Figure 1

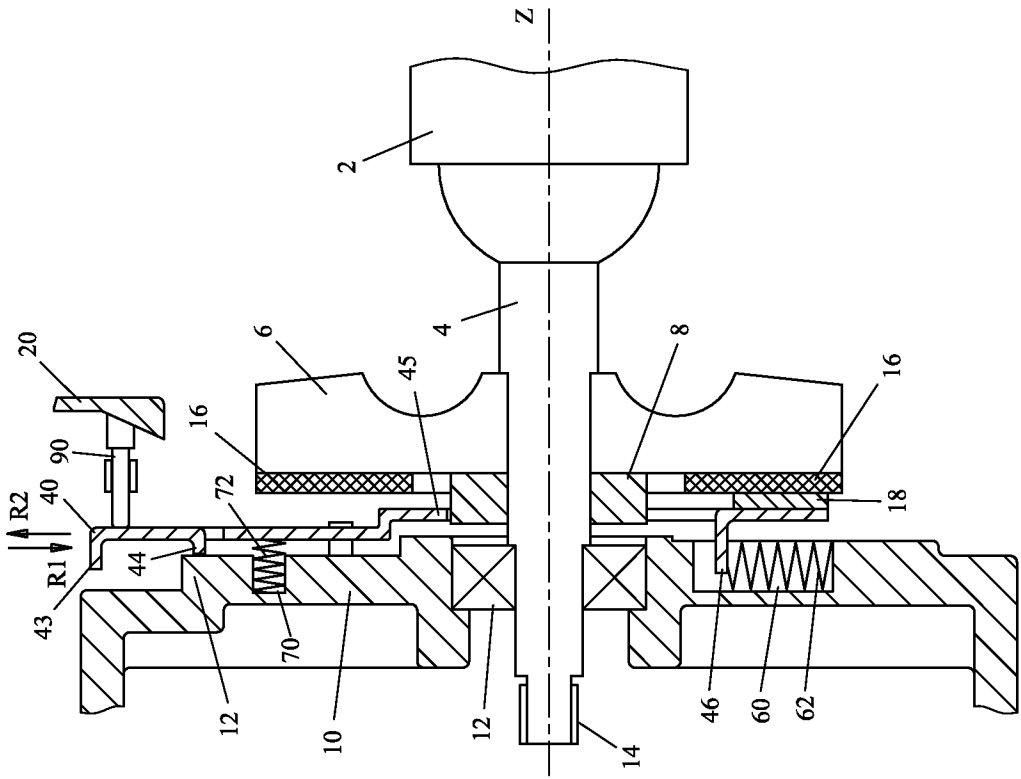


Figure 3

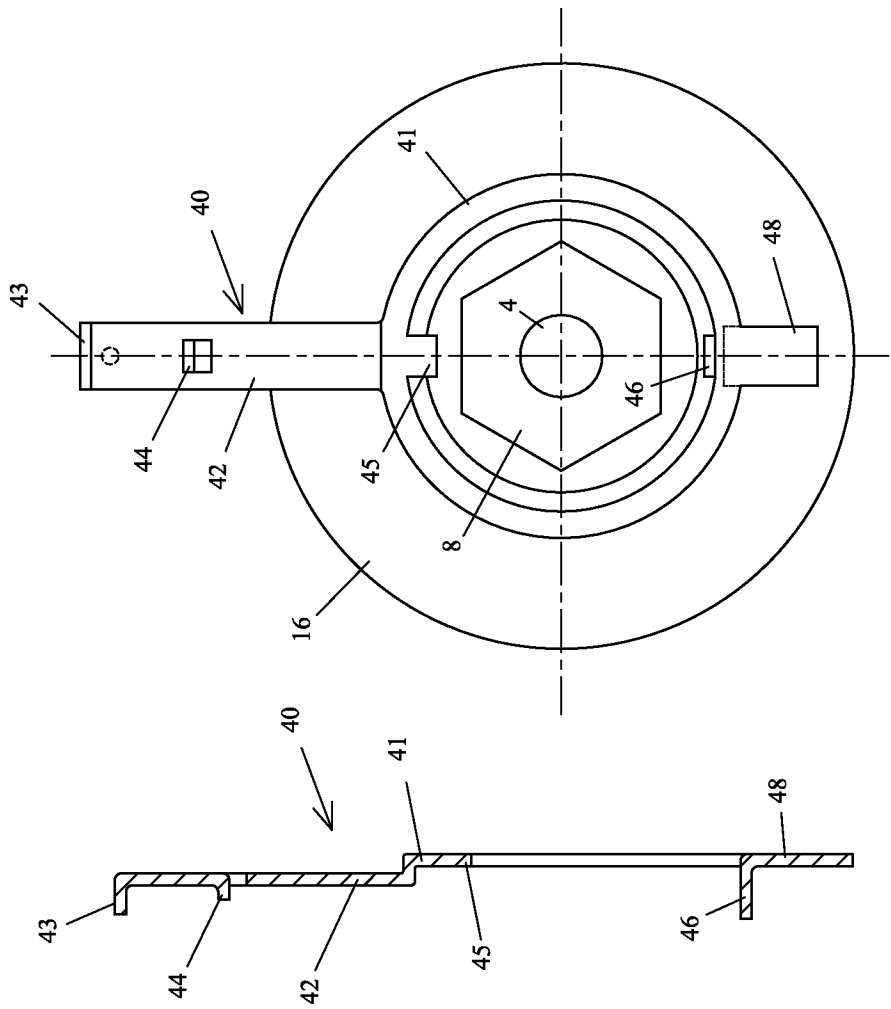


Figure 4

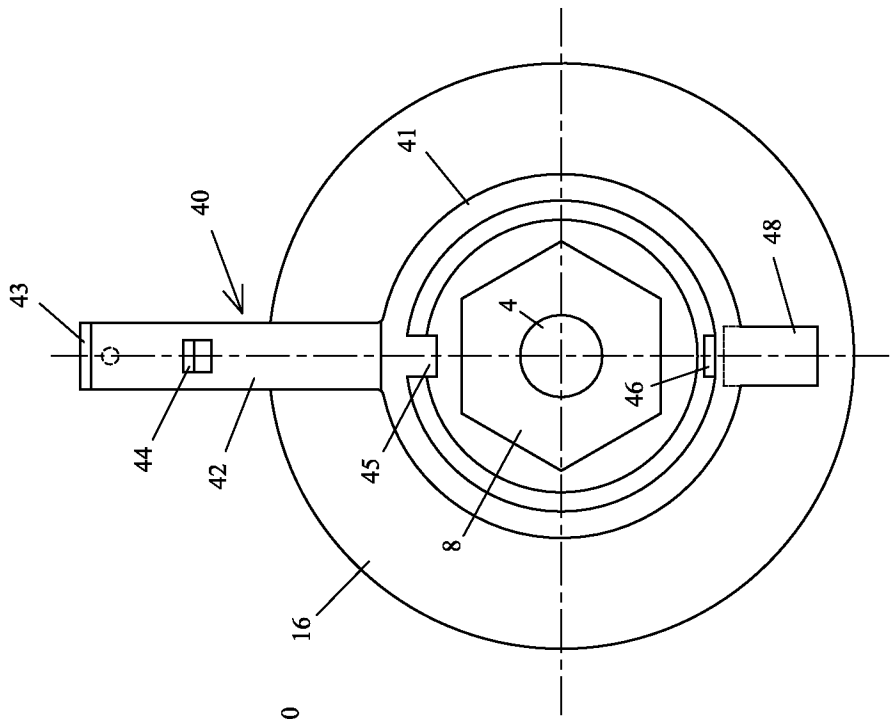


Figure 5

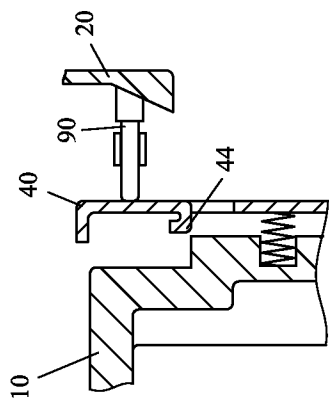


Figure 10

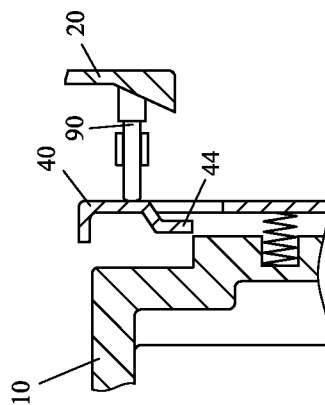


Figure 11

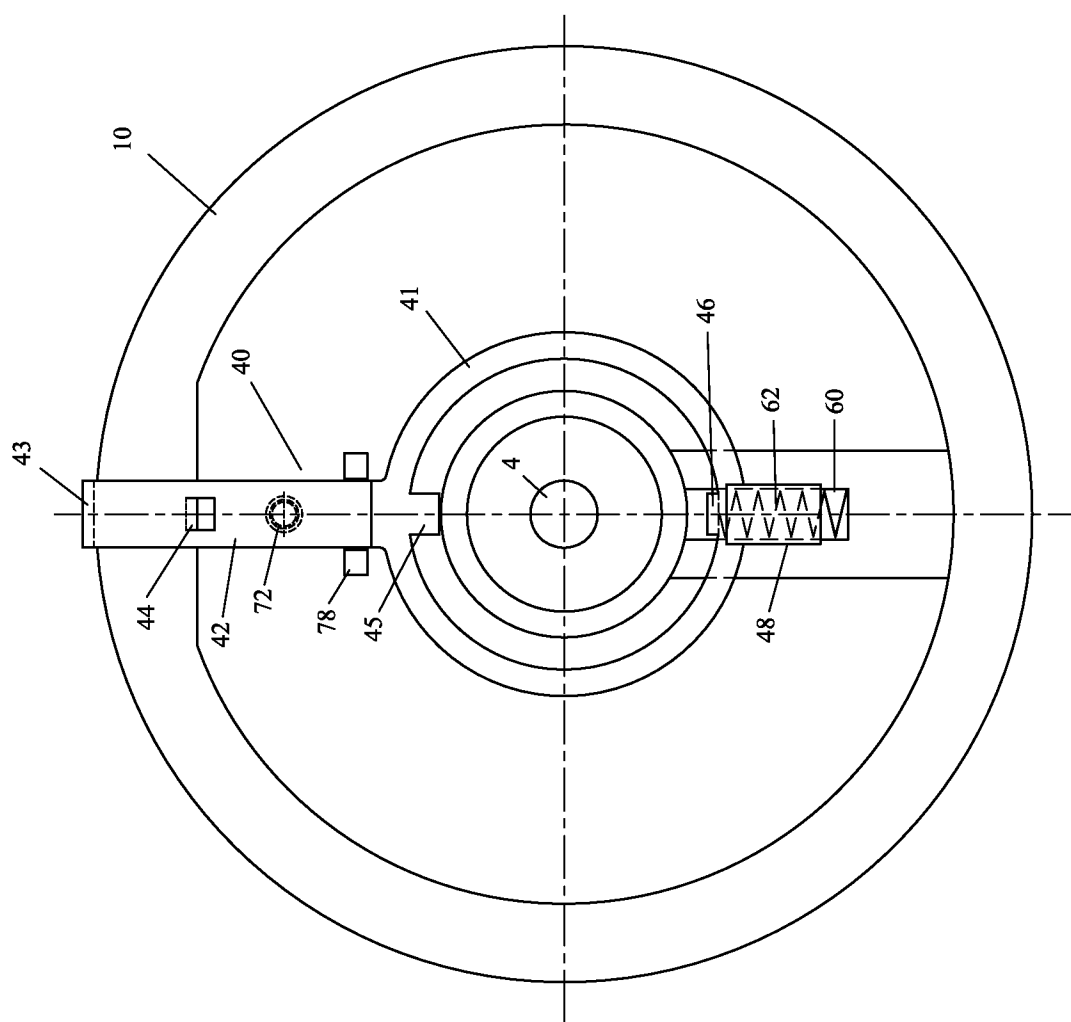


Figure 6

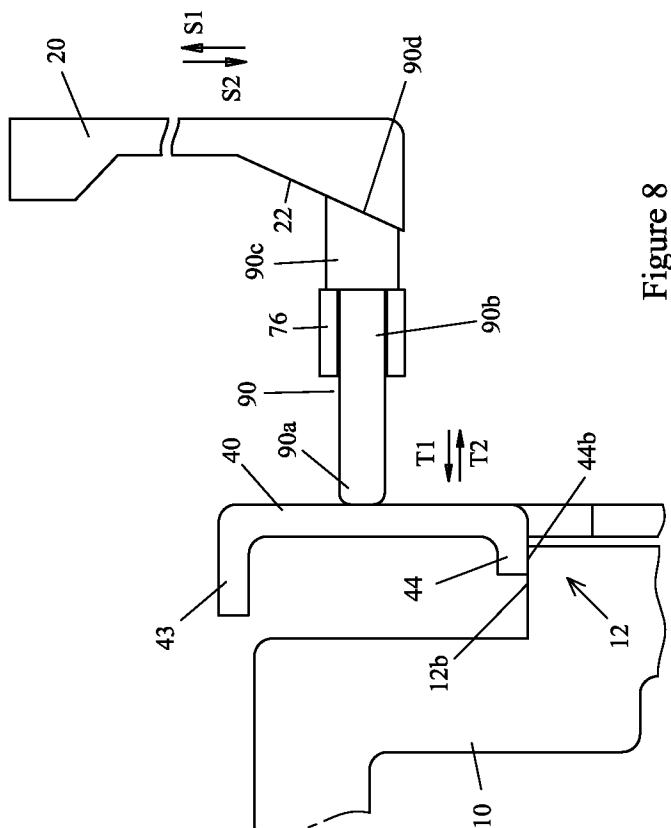


Figure 8

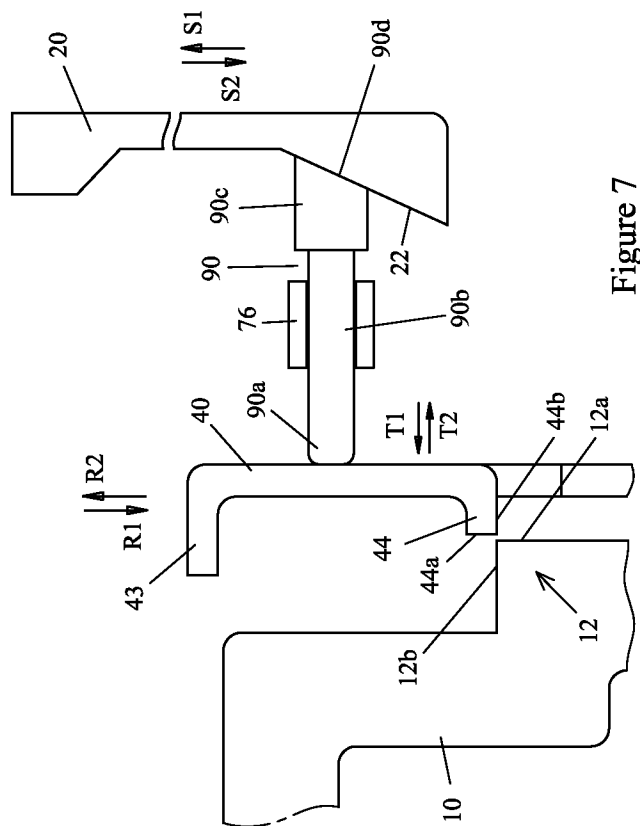


Figure 7

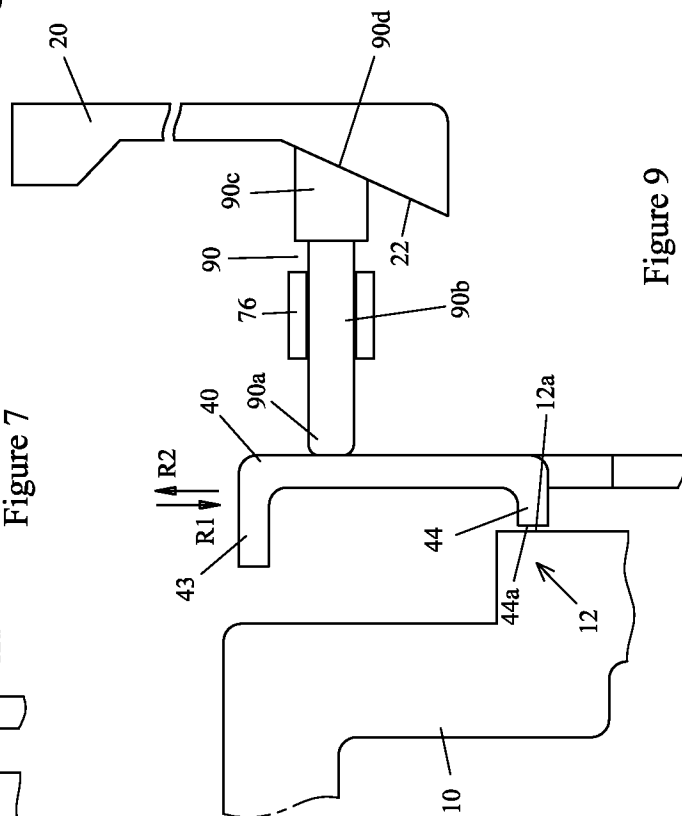


Figure 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/077356

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B25F/-, B24B/-

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

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

WPI, CNPAT, CNKI, EPODOC: power, tool, spindle?, shaft?, switch+, axial, radial, position+,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1071176C(BLACK & DECKER INC.)19 Sep. 2001(19.09.2001) page 3, lines 5-25, figs. 1-4	1-10
A	CN1910017B(BOSCH GMBH. ROBERT)05 May 2010(05.05.2010) the whole document	1-10
A	CN1095327A(KRESS ELEKTRIK GMBH. & CO.)23 Nov. 1994(23.11.1994) the whole document	1-10
A	CN1332066A(BLACK & DECKER INC.)23 Jan. 2002(23.01.2002) the whole document	1-10
A	DE102005037530A1(GISON MACHINERY CO., LTD.)15 Feb. 2007(15.02.2007) the whole document	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer FANG, Yong Telephone No. (86-10)62412889

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Information on patent family members

International application No.
PCT/CN2010/077356

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Continuation of : A. CLASSIFICATION OF SUBJECT MATTER:

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B24B 23/02 (2006.01)i