USER'S MANUAL

PHB-3000E General Type
PHB-3000EA Chain Type

Automatic Portable Brinell Hardness Tester

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⚠ Safety Tips:

Before using, please read and understand the following safety instructions carefully. Otherwise, the operator's safety or the instrument's safety may be endangered.

1. Safe use of lithium batteries

The lithium battery pack is equipped with a power management circuit to prevent the lithium battery pack from short circuit, overcharge, over discharge, and overheating. However, there are still the following points need to note:

a. The replaced old lithium battery pack should be properly disposed of and not put into fire, otherwise explosion will occur.

b. Do not remove the replaced lithium battery pack at will. Short circuit of the battery may cause fire.

c. The instrument should not be stored near the heating element, exposed to the hot sun, and kept away from fire. Otherwise, the plastic shell of the electric control device may be deformed, and in serious cases, the lithium battery pack may be harmed.

2. Chain injury people of chain hardness tester

The diameter measuring range of chain hardness tester has been determined by the configuration of the instrument when leaving the factory. It is strictly prohibited to use beyond the scope. In particular, the use of 29420 N (3000 kgf) test force, when testing large diameter material beyond the range, it will cause hook deformation and chain decoupling, the chain will be taut off instantly, leading to serious personal injury. Therefore, the following safety regulations should be strictly observed:

a. When ordering, order a suitable instrument according to the test force and the diameter range of the workpiece, and the diameter of the measured workpiece shall not exceed the allowable range.

b. When measuring, the operator should avoid the direction in which the chain may break.

3. The hook rod clamps hand.

When using chain hardness tester, please do not hold the hook bar. If the chain adapter falls over after hanging one side of the hook, the hook rod and chain adapter will pinch the finger.

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1. Overview

PHB-3000E Automatic portable Brinell hardness tester is an improvement of PHB-3000 portable Brinell hardness tester.

PHB-3000 portable Brinell hardness tester is a manual Brinell hardness tester in accordance with ASTM E110 standard. The instrument is recognized as the mainstream product of portable Brinell hardness tester, similar products have been widely used in the world for more than 80 years, which is the only choice of using portable hardness tester with large test force testing on-site, widely welcomed by users. The disadvantage of the instrument is that the test force cannot be maintained, and the test force fluctuates greatly during the force loading process (showing the large fluctuation of the pointer of the gauge), these do not meet the requirements of ASTM E10 on the test cycle time and test force accuracy, and cannot pass the direct test of the Brinell hardness tester. In addition, the PHB-3000 instrument also has the problem of applying test force manually, complex operation, high labor intensity, low inspection efficiency, high failure rate. And the measurement accuracy is affected by the user's experience and operation techniques.

PHB-3000E general type with lithium battery power supply, the use of motor drive hydraulic pump to apply the force loading automatically, the use of microprocessor automatic control force loading process, cancel the manual pump and force loading bar in PHB-3000, the test force is accurate, the test force can be maintained, the main technical parameters comply with ASTM E10. It can be directly tested by Brinell hardness tester. This PHB-3000E instrument does not belong to ASTM E110 portable Brinell hardness tester, this is a compliant, accurate, true Brinell hardness tester, and its performance index is the same as the bench type Brinell hardness tester.

This PHB-3000E can measure castings, forgings, steel, non-ferrous metals and other large and medium-sized heat-treated parts, as long as it can be placed in the opening of the instrument, and can make the measuring surface perpendicular to the indenter axis, any part can be measured. The instrument is used to test materials that cannot be tested using a traditional bench type hardness tester due to conditions such as size, position or test point.

This instrument can be used in production site, construction site and material warehouse, can be used vertically, horizontally, can also be used upside down.

PHB-3000EA chain type automatic portable Brinell hardness tester is an extension of general type PHB-3000E to test cylindrical workpiece, which can be used to measure steel pipes, gas cylinders, shafts and other cylindrical heat-treated parts.

2. Characteristics

- **The test force can be maintained.** The test principle is in full compliance with ASTM E10.
- **The test force is accurate.** The test force accuracy conforms to ASTM E10.
- **Hardness measurement is accurate.** The main technical parameters can be directly tested and indirectly tested by Brinell hardness tester, indicating value error and repeatability in accordance with ASTM E10.
- **One button automatic force loading.** Motor driven hydraulic pump to load testing force automatically, instead of manual force loading, simple operation, easy to use, reduce the labor intensity, eliminate the influence of human factors on the measurement results.
- **Failure rate.** The manual pump is cancelled, the control valve design is improved, the air leakage, oil leakage is greatly reduced, there is not the case that contamination of hydraulic oil due to wear of rack of pump gear, eliminate the main source of failure, oil change cycle is prolonged, and the failure rate is greatly reduced.
- **Long battery life.** The battery can be used about 400 times on a single charge, which can meet the needs of frequent measurements throughout the day.
- **Lightweight design.** After adding the motor, electric hydraulic pump, lithium battery pack, control system, the weight of the PHB-3000E is the same as PHB-3000

3. MainTechnical Parameters

3.1 PHB-3000E Automatic Portable Brinell Hardness Tester

Execution Standard: ASTM E10;
Test Force: 29420 N (3000 kgf), 9807 N (1000 kgf), 7355 N (750 kgf), 4903 N (500 kgf) optional;
Indenter: 10 mm carbide alloy ball (5 mm ball is optional);
Measurement Range: 100 HBW ~ 650 HBW (16 HBW ~ 650 HBW optional);
Value Error: in accordance with ASTM E10;
Repeatability: in accordance with ASTM E10;
Test Force Accuracy: ± 1%, in line with ASTM E10;
Loading Mode: automatic;
Test Time: about 15 s (including test force holding time of 10 s);
Opening Size: 350 mm (height) × 100 mm (throat depth);
Dimensions: 570 mm (H) × 230 mm (W) × 280 mm (D);
Machine Weight: 13.8 kg;
Power Supply: lithium battery pack (3000 mAh, 24 V);
Battery Life: about 400 measurements

3.2 PHB-3000EA Chain Automatic Portable Brinell Hardness Tester

Execution Standard: ASTM E10
Test Force: 29420 N (3000 kgf), 7355 N (750 kgf) optional
Indenter: 10 mm carbide alloy ball (5 mm ball is optional)
Measurement Range: 100 HBW ~ 650 HBW
Value Error: in accordance with ASTM E10
Repeatability: in accordance with ASTM E10
Test Force Accuracy: ± 1%, in line with ASTM E10;
Loading Mode: automatic;

Test Time: about 15s (including test force holding time of 10s);
Measurement Diameter Range:150 mm ~ 550 mm (maximum 1200 mm optional);
Dimensions: 420 mm (H) × 150 mm (W) × 160 mm (D)
Weight of Machine: 11.0 kg (measuring bracket + measuring head)
Standard Chain: 1500 mm/ 4.0 kg
Power Supply: Lithium battery pack (3000 mAh, 24 V)
Battery Life: about 400 measurements

4.Principle and Structure

The PHB-3000E is composed of a measuring head and a lifting support. The measuring head is mounted on the front of the lifting support, and a crank controls the moving of the measuring head up and down. The instrument structure is shown in Figure 1.

Chain type PHB-3000EA is composed of a measuring head, a measuring bracket and a chain. The measuring head is installed in the front of the measuring bracket, and there is a hook on both sides of the measuring bracket. When measuring, the chain is hung on the hook around the cylinder being measured, and rotating the hand wheel at the top of the measuring bracket can tighten the chain and press the measuring head on the workpiece surface. The structure of the chain type PHB-3000EA is shown in Figure 2.

As shown in Figure 3, the measuring head is composed of a hydraulic assembly block and an electronic control device. The hydraulic assembly block is a small hydraulic system with a miniature hydraulic pump inside, a high pressure area and a low pressure area. The electronic control device is composed of a microprocessor control system, a driving motor and a lithium battery pack. The electric control device is powered by a lithium battery pack and controls the motor to drive the micro hydraulic pump to automatically apply force, while the microprocessor automatically controls the process of applying and retaining force.

The lower part of the high pressure area in the hydraulic integrated block is the indenter body, and the lower end of the indenter body is the ball indenter. The ball indenter will move down under the action of liquid pressure and press the ball indenter into the surface of the sample. The upper part of the hydraulic assembly block has a control valve, which is located between the high pressure area and the low pressure area. The control valve realizes the control of the test force on indenter by controlling the highest pressure in the high pressure area. The control valve has been accurately calibrated to 29420 N (3000 kgf) before leaving the factory. When the test force on the ball indenter reaches 29420 N (3000 kgf), the control valve opens, the liquid in the high pressure zone flows into the low pressure zone, the pressure no longer rises, because of the continuous oil supply of the hydraulic pump, during the test force maintenance, the control valve has been kept open. The test force remained unchanged at 29420 N (3000 kgf).

Press the "test force key" of the instrument to automatically complete the loading and maintaining process of the test force, press out the accurate Brinell hardness indentation, with Brinell hardness indentation measuring system, you can quickly finish a Brinell hardness test.

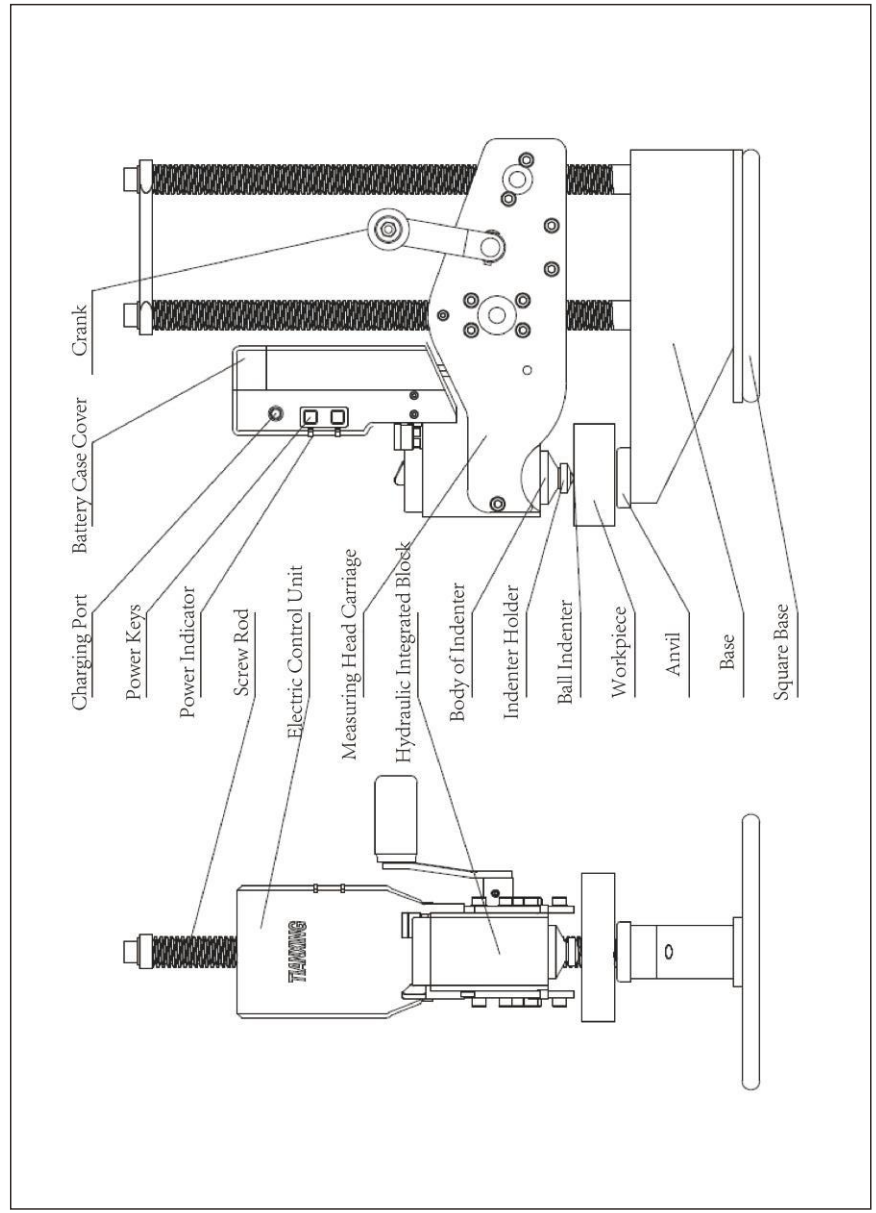

Figure 1. Structure of PHB-3000E Hardness Tester

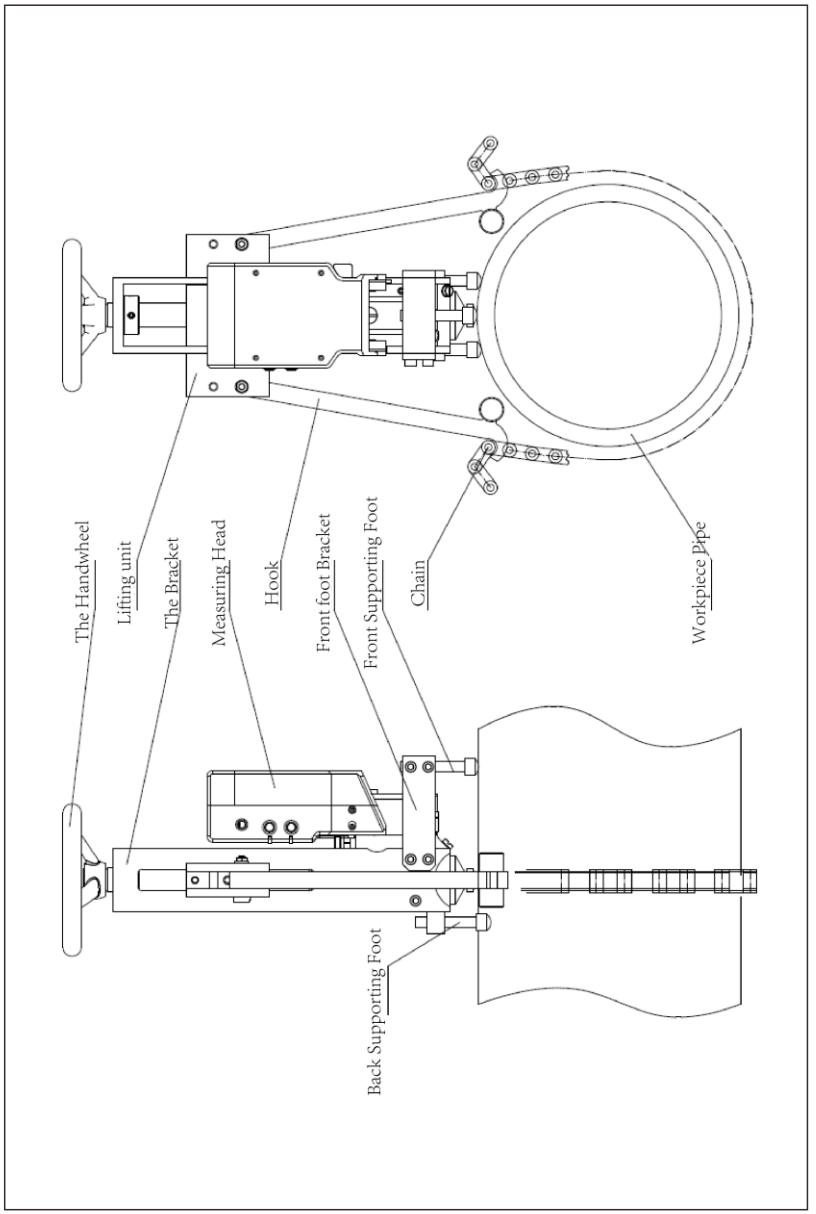

Figure 2. Structure of PHB-3000EA Chain Hardness Tester

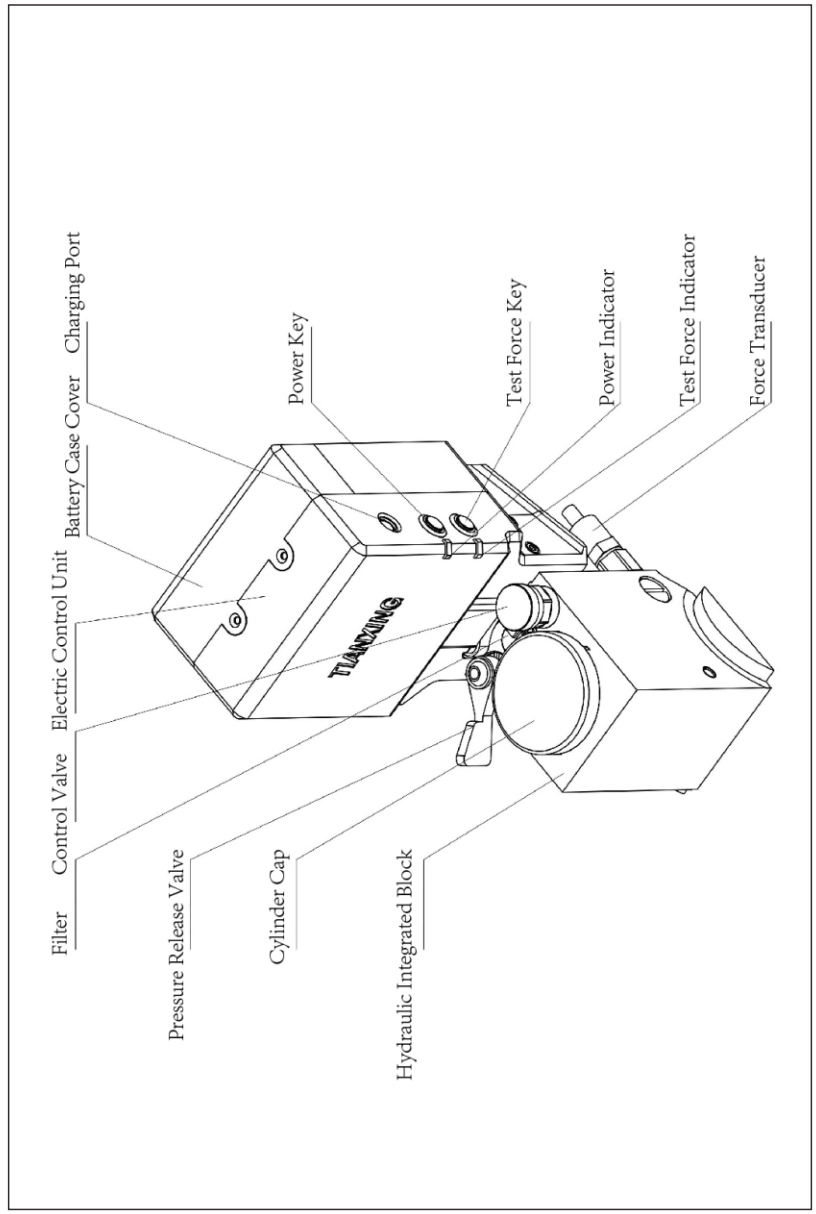

Figure 3. Structure of Measuring Head

5. Description of Main Components

5.1 Lifting Support

PHB-3000E uses lifting support, as shown in Figure 1. The lifting support is composed of a base, a square base, a lifting screw rod, a lifting gear group and a measuring head carriage. The shape of base is pointed forward, which makes it easy to test the edge of the workpiece or the steel pipe. The PHB-3000E can test most of the workpiece, as long as a part of the workpiece can be stably clamped between the indenter and the anvil, and can make the testing surface of the workpiece perpendicular to the axis of the indenter body, any workpiece can be tested.

The standard configuration of the PHB-3000E is square base; when you need to measure the large diameter steel pipe can choose a more convenient triangle base.

5.2 Chain Measuring Bracket

Chain type PHB-3000EA uses chain measuring brackets, as shown in Figure 2. The chain measuring bracket is composed of a frame body, a hand wheel, a lifting unit, three supporting feet and two hooks. The measuring head is installed in the front of the measuring support, and the height of the three supporting feet can be adjusted to ensure that the indenter is perpendicular to the bus bar of the cylinder.

Please note that the measuring head is reverse-mounted compared to the PHB-3000E, and the keys and indicator light are located on the left side of the PHB-3000EA.

The standard chain measuring bracket and the standard chain are only applicable to the specified test force and the specified range of workpiece diameter. When it is necessary to use large diameter pipe with large test force to measure out of range, the measuring bracket and strengthened chain with strengthened hook should be ordered.

5.3 Cylinder Assembly

The cylinder assembly is composed of the indenter body, the cylinder cap, the oil cylinder, the oil sac and the oil sac nut. When the indenter body extends or retracts, the oil quantity in the oil cylinder will change. This oil quantity change is adjusted by the contraction or expansion of the oil sac to ensure that there will be no cavity or negative pressure in the oil cylinder, and the hydraulic oil will not overflow.

During the use of the instrument, there will be a trace leakage of hydraulic oil, after the long-term use of the instrument, the oil in the oil cylinder is reduced, when the test force is applied, the displacement of the indenter is not enough to press the Brinell indentation on the workpiece, the specific performance is that the hydraulic system cannot make the test force to reach 29420 N (3000 kgf), at this time, the instrument will issue a fault warning. When the above situation occurs, the hydraulic oil should be replaced.

5.4 Indenter

The indenter is composed of an indenter body, a ball and an indenter holder.

Indenter body is a large piston in the hydraulic system, through its own large cross-sectional area to obtain a huge test force from the hydraulic system. Under the test force, the indenter body can be extended from the lower part of the hydraulic integrated block, so that the ball indenter will press an indentation on the workpiece. The indenter body will not automatically retract. Before pressing the "Test Force Key", the indenter body should be pushed back to the retracted position under the condition that the pressure release valve is opened. The indenter holder is used to secure the ball indenter. Make sure the indenter holder is tight before each test.

5.5 Electric Hydraulic Pump

The electric hydraulic pump is the core part of the hydraulic system. It is powered by the motor and pumps the hydraulic oil from the low pressure area to the high pressure area to provide the test force for the indenter. Installation and disassembly of hydraulic pump need professional skills, do not disassemble without authorization, otherwise, it will damage the instrument.

5.6 Pressure Release Valve

The pressure release valve is the pressure release switch of the hydraulic system, which connect the high pressure area and the low pressure area of the system. Open the pressure release valve, the hydraulic oil in the high pressure area will flow into the low pressure area, and the pressure in the high pressure area will leak out. On the contrary, close the pressure release valve, the high pressure area and the low pressure area are separated, and the hydraulic oil input by the hydraulic pump will increase the pressure in the high pressure area.

The use of pressure release valve should pay attention to the following points:

a. When the instrument is not in use, the pressure release valve should be placed in the normally open state.

b. The pressure release valve should be closed only when the indenter is pressed to the workpiece and the test force is applied immediately by pressing the "Test Force Key".

c. Immediately open the pressure release valve, raise the measuring head, and remove the instrument after the measurement is finished.

5.7 Control Valve

The control valve is the automatic control switch of the hydraulic system. Before the instrument leaves the factory, the operating point of the control valve is accurately calibrated to 29420 N (3000 kgf), the error is not more than ± 1%. When the test force on the indenter reaches 29420 N (3000 kgf), the control valve will automatically open and begin to drain oil, so that the pressure on the indenter will not rise. Due to the continuous oil supply of the hydraulic pump, the control valve will remain open during the test force maintenance period, and the test force will remain unchanged at 29420 N (3000 kgf).

The control valve has been accurately calibrated before the instrument leaves the factory. The operator is not allowed to turn the screw of the control valve at will; otherwise, the instrument will be out of alignment.

The design of the control valve of the instrument makes the calibration nut no longer sink into the oil, which will greatly reduce the loss of hydraulic oil when calibrating the test force. Extend the oil change cycle.

5.8 Filters

In the process of using the hydraulic system, some impurities such as iron filings will fall from the inner wall of the pipeline, which will damage the hydraulic pump, or make the control valve and pressure release valve close loosely. The function of the filter is to filter out these impurities and protect the safety of the hydraulic pump and other components.

5.9 Control System

The control system is a circuit board with a microprocessor at its core. It also includes other hardware and control software. The function of the control system is to control the motor to drive the hydraulic pump to complete the loading and maintenance of the test force. Other functions of the control system including to control the operation of the instrument, the detection and indication of the instrument state.

5.10 Force Transducer

The force transducer is installed in the high pressure area, which can measure the liquid pressure corresponding to the test force in real time and transmit the signal to the controller. When the test force reaches 29420N (3000kgf), the controller adjusts the motor speed according to the measured liquid pressure value, so that the test force is accurately maintained at 29420N (3000kgf) unchanged. At the same time, the test force retention time is timed.

5.11 Battery Pack

The power supply is a lithium battery pack with 3000 mAh and 24V parameters. There is a power management circuit in the lithium battery pack, which is used to control and protect the battery charging process to avoid the occurrence of battery faults such as short circuit, overcharge, overdischarge and heating. The battery supports about 400 measurements on a full charge and takes less than 4 hours to charge. Use the charger that comes with the package to charge the battery pack. The charger and spare battery pack can be purchased from manufacturer.

5.12 Charger

The instrument charger plug specification is 25.2V, DC5.5 ~ 2.1, using 220V AC power supply. If 110V or other AC power is used, please use an appropriate power converter.

6. Restription of External Electrical Components

External electrical components of the instrument include charging ports, buttons and indicators, as shown in Figure 3. Its functions are as follows:

6.1 Power Supply

6.1.1 Charging port: The battery can be charged by inserting the charger, and the instrument can still be used during charging.
6.1.2 Power button: Used to switch the power supply of the instrument.
6.1.3 Power indicator: It is used to indicate the startup, shutdown and power state of the instrument.
No power indicator light means power off.
Steady green light means power on or fully charged, waiting for measurement.
Green blinking means the battery is underpowered and needs to be charged (it can still be used for 20 minutes).
Steady red light means the battery is about to run out or idle for more than 5 minutes. Blink for 10 seconds and then power off.
Red blinking means charging.

6.2 Test Force Part

6.2.1 Test Force Key: used to start or interrupt the force, and used to cancel the alarm in case of alarm.

6.2.2 Test Force Indicator: used to indicate the loading process of test force and alarm failure. In startup state:
No light –– wait for measurement.
Steady blue light – test force loading.
Blinking blue light – test force maintained.
Steady green light –– The test force holding over, waiting for unloading.
Blinking red light: A fault alarm.

6.3 Fault Alarm

When the instrument cannot carry out the loading and holding procedures of the test force normally, the "test force indicator" will turn red and blink, indicating that a fault has occurred.
Common faults are as follows:
a. The pressure release valve is not closed.
b. The indenter is suspended.
c. Press the indenter to a soft material, such as human hands.
d. Applying test force time exceeds 8s.
Press the "test force key" button to cancel the alarm.

7. Prepare for the test

7.1 Grinding Workpiece

The testing position of the workpiece should be determined before measurement. The selection of testing position should first make the instrument clamp the workpiece, and then make the surface of the workpiece perpendicular to the axis of the indenter. The workpiece surface should be properly polished, remove oxide skin, decarbonized layer and other debris, until exposed can represent the workpiece body hardness of the part so far. The workpiece surface should be polished smooth, grinding area is usually not less than 20mm × 20mm. When sanding the workpiece, pay attention to the overheating of the workpiece may cause the surface hardness to change.

7.2 Inspect the Hardness Tester

In order to ensure accurate measurement of the instrument, the hardness tester shall be routinely inspected in accordance with 9.4 prior to daily use.

7.3 Check the Reading Microscope

7.3.1 Checking the Zero Point

Observe the eyepiece, rotate the calibration wheel, and align the moving mark in the field of view with the zero scale line. At this time, the zero scale line on the calibration wheel should be aligned with the reading line on the left, as shown in Figure 4.

7.3.2 Checking Integer Marks

Observe the eyepiece, rotate the calibration wheel, and align the moving marks in the line of sight with each integer scale line in turn. At this time, the zero scale line on the calibration wheel should be aligned with the reading line on the left, as shown in Figure 4.

7.3.3. Zero Adjustment

When checking the zero point of the reading microscope, if it is found that when the moving mark in the eyepiece is aligned with the zero scale line, the zero scale line on the drum wheel is not aligned with the reading line on the left side, it indicates that the zero point of the microscope has shifted, and the zero point of the reading microscope should be adjusted as follows:

a. Observe the eyepiece and align the moving mark with the zero scale mark.
b. Loosen the three screws on the drum wheel.
c. Align the zero scale line on the drum wheel with the reading line on the left.
d. Tighten the three screws.
e. Check the zero point again.

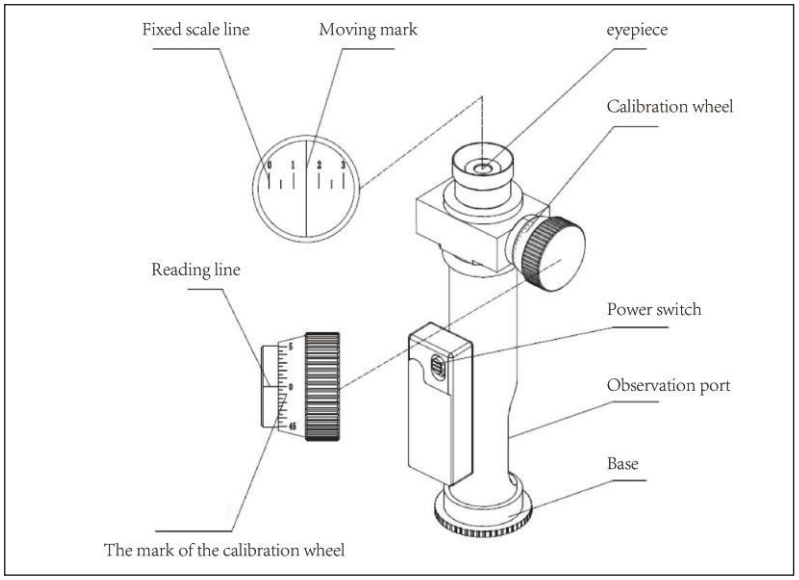

Figure 4. Schematic Diagram of a Reading Microscope

7.4 Select and Install the Anvil

When using the PHB-3000E Automatic portable Brinell hardness tester, the appropriate anvil should be selected according to the shape of the workpiece. There are three anvils in the instrument configuration. Flat anvil for workpieces with two parallel surfaces and standard hardness blocks, and V-anvil for round rods or small-diameter thick-walled tubing. Dome anvil is used to test workpiece with concave support surface or large

diameter pipe. Install the selected anvil into the anvil block hole and tighten the top wire.

7.5 Check the Indenter Holder

Make sure the indenter holder is tight before testing.

7.6 Checking the Battery Level

Before using the instrument, check the battery power to ensure that the instrument is fully charged.

7.7 Battery Charging

Connect the charger to the AC power supply, insert the charger plug into the "charging port" of the instrument, the "power indicator light" turns red and flashes, and start charging. It takes about four hours to fully charge. When fully charged, the "power indicator" turns green.

8. Measurement Operation

8.1 Measuring operation of Generaltype PHB–3000E Brinell hardness tester

8.1.1 Verify that the pressure release valve is opened

The pressure release valve handle should be in the open position counterclockwise.

8.1.2 Clamp the Workpiece

Place the workpiece in the instrument opening, align the indenter with the grinding plane on the workpiece, shake the lifting crank, clamp the workpiece between the ball indenter and the anvil, and ensure that the axis of the indenter body is perpendicular to the surface of the workpiece.

8.1.3 Press Back the Indenter Body

Continue to use greater force to shake the lifting crank, so that the indenter body back to the full retraction position.

8.1.4 Close the Pressure Release Valve

Turn the pressure release valve handle clockwise to close the pressure release valve.

8.1.5 Power On

Press the Power key. The Power indicator is steady green.

8.1.6 Loading Test Force

Press the “test force key", the "test force indicator" is steady blue, and the instrument begins to apply force (press the "test force key" again during the applying force process to interrupt the force applying). When the test force reaches 29420N (3000kgf), the "test force indicator" will turn blue and blink, and the instrument will automatically keep the 29420N (3000kgf) test force for 10s. After that, the “test force indicator” turns green and waits for unloading.

8.1.7 Remove the Test Force

Turn the handle of the pressure release valve counterclockwise, open the pressure release valve, and remove the test force. The "test force indicator” is off, and the force

applying is finished.

8.1.8 Remove Instrument (or workpiece)
When the measuring head is raised and the instrument (or workpiece) is removed, a Brinell indentation will be made on the workpiece surface.

8.1.9 Measuring Indentations
Measure the two diameters perpendicular to each other on the indentation with a reading microscope. Take their average values and refer to Table 1 to obtain the Brinell hardness values (see 8.3 for the method of using a reading microscope). Brinell hardness values can also be directly measured by the Brinell indentation measurement system.

8.1.10 Continuing the Measurement
Repeat 8.1.1 to 8.1.9 to complete the next measurement.

8.1.11 Power Off
If you do not measure any more, press the "Power key" to turn off the power supply, and the "Power indicator" is off.

8.2 Measurement Operation of Chaintype PHB-3000EA Brinell hardness tester
The operation of the chain hardness tester usually requires the cooperation of two people, and should be careful to avoid slipping during the operation.
Particular attention should be paid to:
Do not hold the hook rod with your hand during the whole operation, so as not to hurt your hand when the measuring support slips after hanging the chain.

8.2.1 Confirm that the lifting unit is adjusted to the bottom
Make sure that the lifting unit is adjusted to the bottom. Otherwise, rotate the handwheel counterclockwise to adjust the lifting unit to the bottom.

8.2.2 Verify that the pressure release valve is opened
The pressure release valve handle should be in the open position counterclockwise.

8.2.3 Placing a Measurement Support
The first operator placed the measuring support vertically above the cylindrical workpiece, and held the handwheel steady, and kept holding the handwheel steady during the steps of 8.2.3 ~ 8.2.5 to avoid the measuring support slipping.

8.2.4 Adjusting the Supporting Feet
The second operator observes and adjusts the supporting feet from the front and side directions.
Observe and adjust the front and rear support feet from the front (side with electric control unit), so that the three support feet and the indenter are in contact with the workpiece, and the two sides of the support are vertical, after adjustment, the height of the top of the two rear support feet should be the same.
Continue to observe and adjust the three support feet from the left side (the side with the keys and the indicator light), so that the front and rear sides of the support are vertical, or

the lower side of the front support foot is parallel to the cylinder bus. After adjustment, the three support feet and indenter should contact the workpiece, and the upper exposed height of the two rear legs is the same.

8.2.5 Hanging the Chain
The first operator holds the handwheel firmly with both hands and is not allowed to contact the hook rod.
The second operator hangs one end of the chain to a hook and the other end of the chain around the cylinder to another hook.

8.2.6 Gathering the Chain
The first operator holds the frame part of the measuring bracket with one hand and rotates the handwheel clockwise with the other hand to gather the chain (taking care to avoid the measuring bracket tilting or falling).

8.2.7 Confirm and fine adjustment
Verify that the chain is not crooked, that the three support feet and indenter are in contact with the workpiece surface, and that the front and side of the measuring support are perpendicular to the workpiece. If it doesn't fit, fine-tune the chain or feet.

8.2.8 Push back the indenter body and tighten the chain
The first operator continues to rotate the handwheel clockwise with both hands to bring the indenter back to the retracted position (in most cases, the indenter had already returned to the retracted position in the previous operation) and tighten the chain.

8.2.9 Closing the pressure release valve
Turn the pressure release valve handle clockwise to close the pressure release valve.

8.2.10 Turning on the Power Supply
Press the "Power key" .The "Power indicator" is steady green.

8.2.11 Apply Test Force
Press the "test force key", "test force indicator" blue on, the instrument began to apply test force, three support feet gradually rise, when the test force reached 29420N (3000kgf), "test force indicator" turned blue flashing, the instrument automatically maintain 29420N (3000kgf) test force 10s, then, "test force indicator" turned green on.

8.2.12 Remove the Test Force
Turn the handle of the pressure release valve counterclockwise, open the pressure release valve, remove the test force, and the "test force indicator" is off, the applying test force is over.

8.2.13 Loosen the Chain
The first operator rotates the handwheel counterclockwise with both hands. Then, one hand holds the frame part of the measuring bracket, and the other hand continues to rotate the handwheel to release the chain until the lifting unit falls to the end.

8.2.14 Removing the Chain
The first operator holds the handwheel steady while the second operator removes the chain from the hook.

8.2.15 Remove the Measurement Support
Remove the measuring bracket. A Brinell indentation will be made on the grinding surface of the workpiece.

8.2.16 Measuring Indentations
Measure the two diameters perpendicular to each other on the indentation with a reading microscope. Take their average values and refer to Table 1 to obtain the Brinell hardness values (see 8.3 for the method of using a reading microscope). Brinell hardness values can also be directly measured by the Brinell indentation measurement system.

8.2.17 Continuing Measurement
Repeat 8.2.1 to 8.2.16 to complete the next measurement.

8.2.18 Turning off the Power Supply
If you do not measure any more, press the "Power key" to turn off the power supply, and the "Power indicator" is off.

8.3 Method of using a Reading Microscope

8.3.1 Turning on the Lights
Flip the power switch and turn on the light.

8.3.2 Placing the reading microscope
Place the reading microscope over the indentation, observe the indentation through the observation port, and move the reading microscope so that the indentation is centered on the base of the reading microscope.

8.3.3 Fixing the Measurement Start Point
Holding the base of the reading microscope steady with your left hand, observe the indentation in the eyepiece and move the reading microscope slightly so that the zero scale line in the field of view is tangent to the left edge of the indentation.

8.3.4 Determining the Measurement End Point
Continue to hold the base of the reading microscope to ensure that it does not move. Observe the indentation in the eyepiece. Turn the calibration wheel with your right hand and move the moving mark to the position tangent to the right edge of the indentation.

8.3.5 Reading Indentation Diameters
Pick up the reading microscope, read the integer scale part of the measurement result to the left of the moving mark from the eyepiece, and read the remaining decimal part of the measurement result on the calibration wheel. The sum of the two is the measured indentation diameter.

8.3.6 Turning off the Lighting
If the reading microscope is no longer in use, flip the power switch to turn off the light.

Hint:
a. When there are grinding marks along one direction on the workpiece measurement surface, the diameter direction selected should be 45° with the grinding marks.
b. In order to correctly master the technology of indentation measurement, before the formal measurement of indentation on the workpiece, practice the following correct circular cutting method: First measure the standard indentation on the standard hardness block with a reading microscope, the measurement results should be consistent with the standard indentation diameter value given next to the standard indentation. If not, the operator's operation is not accurate. At this point, the operator should adjust the tangent position repeatedly until the reading is consistent with the diameter value of the standard indentation. The operator should master the correct circle cutting method according to the above operation.

9.Hardness tester inspection and calibration

9.1 Inspection standard
The inspection standard of Brinell hardness tester shall be according to ASTM E10, which includes direct, indirect and daily inspections.

9.2 Direct inspection
Direct inspection shall be carried out by the instrument manufacturer or a qualified metrological institution.
Direct inspection is the process of testing the technical parameters of key components of a hardness tester using calibrated measuring instruments to determine their allowable range. Direct inspection items include: test force, indenter, test cycle time (including test force loading time and test force holding time) and Brinell indentation measuring device.
The instrument has been directly tested before leaving the factory, and generally no longer do direct inspection after leaving the factory. When necessary, it can be sent to a qualified metrological institution for direct inspection.

9.3 Indirect inspection
The indirect inspection shall be carried out by the instrument manufacturer or a qualified metrological institution.
Indirect inspection is the process of testing the comprehensive performance of the hardness tester by using standard hardness block, so as to periodically confirm that its measurement error is within the allowable range. Indirect inspection items include indication error and indication repeatability. The cycle of indirect inspection of hardness tester is 12 months. When the indirect inspection is not carried out for more than 14 months, hardness tester is not allowed to be used again. It is necessary to carry out direct inspection first, and then indirect inspection. Only when both of them are qualified can they continue to be used.
Indirect inspection of chaintype Brinell hardness tester requires lifting bracket.
The indirect inspection shall be carried out in accordance with the procedure specified in ASTM E10, and the indication error and repeatability of the hardness tester shall be within the allowable error range specified in the standard.

9.4 Daily inspection
Daily inspection is the process of using standard hardness block to verify that the

measurement error of hardness tester is within the allowable range before using the instrument every day. It is suggested that the daily inspection of hardness tester should be carried out at the use site of hardness tester.
Daily inspection shall be carried out in accordance with the procedures specified in ASTM E10, and the indication error and repeatability of the hardness tester shall be within the allowable error range specified in the standard.
This handness tester is a kind of precision instrument, which is easily damaged when it is moved from one test site to another. Therefore, it is suggested to carry out daily inspection many times in the daily use process to ensure the reliability of the measurement results.

9.4.1 Daily inspection of PHB–3000EA hardness tester
Measure at least one point on the standard hardness block according to the steps from 8.1.1 to 8.1.9, and the difference between the measured hardness (average) value and the marked value of the standard hardness block shall be within the allowable error range specified in ASTM E10.

9.4.2 Daily inspection of PHB–3000EA Chain Brinell hardness tester
The daily inspection of the chain hardness tester can be carried out in the following ways:
a. Use lifting bracket
During inspection, the measuring head is detached from the chain measuring bracket and installed on the lifting bracket (the installation direction of the measuring head on the lifting bracket is opposite to that of the chain measuring bracket, but it does not affect the performance and operation of the instrument). Carry out daily inspection of the measuring head according to the method in 9.4.1. After inspection, remove the measuring head and reinstall it on the chain measuring bracket.
b. No lifting bracket
When there is no lifting bracket available, a section of thick-walled steel pipe with appropriate diameter can be prepared at the use site of the instrument, and a plane with a length of 110mm and a depth of about 16mm can be machined on the pipe wall with a machine tool. The size and height of the plane should be able to put down the standard hardness block, and the placement of the steel pipe should be convenient for operation, and the machined plane should be in a horizontal state.

10. Standard configuration

10.1 Configuration of General type PHB–3000E
Electric test head (built-in lithium battery)
Lifting bracket/support
Brinell hardness test block (high value *1 and low value*1)
Anvil(Flat, V-type, Dome type)
20X Reading Microscope
10mm spare Carbide alloy ball (Another one is in test head)
Recharger
Allen wrench

10.2 Configuration of Chain type PHB–3000EA
Electric test head (built-in lithium battery)

Chain measuring bracket (with standard hook)
1500mm standard chain (measuring diameter :150mm ~ 550mm)
Brinell hardness test block (high value *1 and low value*1)
20X Reading Microscope
10mm spare Carbide alloy ball (Another one is in test head)
Recharger
Allen wrench

11. Optional accessories

Electric test head (test force can be customized)
Lifting bracket/support
Chain measuring bracket
Triangular base (for measuring large diameter steel pipes by using Brinell hardness tester)
Enhanced chain measuring bracket
1500mm standard chain
Enhanced chain (length can be customized)
Brinell indentation measurement system
Reading Microscope (20X, 40X)
Brinell hardness test block (high value, low value)
Carbide alloy ball (10mm,5mm)
Ball indenter holder(10mm,5mm)
5mm ball indenter lock nut
Spare lithium battery pack (3000mAh， 24V)
Recharger

12. Accessories and tools for maintenance

Hydraulic oil (twiceuse)
Syringe (for filling hydraulic oil)
Oil sac
Filter
Control valve O ring
Control valve copper gasket
Oil sac nut wrench
Control valve cover wrench
Pressure release valve wrench

13. Precautions for use

a. The anvil shall have a firm support for the workpiece,in the process of loading the test force,slide between the workpiece and the anvil can seriously affect the measurement results,therefore,should pay special attention to avoid this kind of slide.
b. The vertical degree between the indenter and the workpiece surface can obviously affect the measuring accuracy of the instrument.The operator should keep the axis of the indenter body perpendicular to the test surface as far as possible.Generally,the

instrument is only suitable for measuring the workpiece with two parallel or cylindrical surface,and cannot be used for measuring the workpiece with an inclined plane.

c. Donot try to measure the workpiece hardness of more than 60 HRC,otherwise it will affect the life of the ball indenter.

d. The instrument should be used in a clean environment as far as possible.It should avoid the abrasive iron filings,oxide skin and sand particles falling on the screw rod, which will be embedded in the thread of the screw rod and gear,so that the lifting of the measuring head is blocked and the measurement operation is affected.

e. During the use and movement of the instrument,collision should be avoided and do not fall,otherwise,the instrument will be damaged.

f. The instrument should be used at normal temperature, beyond the normal temperature environment,the measurement accuracy will be affected,whenthe use environment is lower than +10℃,the measurement result may be obviously out of tolerance.

g. Donot disassemble the instrument at will.Inappropriate disassembly will cause the instrument to be inaccurate,damaged or bear more maintenance costs.

h. When the instrument is not in use for a long time,the measuring head should be lowered so that the indenter contacts the anvil.

i. The instrument must not be drenched with water,otherwise it may cause damage to electrical parts and rust to mechanical parts.

j. If you encounter any difficulties or faults when using the instrument,please contact manufacturer immediately.

Appendix 1:

Warranty and Maintenance

1. Warranty

If the user follows the instructions to use the hardness tester correctly, the failure occurs due to the quality of parts or assembly of the hardness tester, and within the warranty period, manufacturer shall be responsible for free product repair or replacement of parts, the buyer does not bear the cost. Faulty instruments or parts should be shipped back to manufacturer or authorized agents. hardness tester warranty is 12 months after purchase, subject to invoice date.

2. Charge for maintenance

The following conditions are not covered by the warranty, the maintenance of the instrument needs to be charged.

a. Failure of the instrument caused by any use, storage, packaging or transportation in violation of the instructions.

b. Failure of the instrument caused by repair, maintenance, disassembly and other activities carried out by unauthorized buyer or third party.

c. Failure of the instrument caused by other improper acts.

d. Failure of the instrument after the warranty period.

e. Instrument damage caused by force majeure.

3. Apply for repair

Users should contact the maintenance department of the manufacturer or authorized agents immediately after they find that the instrument is faulty.

Appendix 2:

Maintenance Manual

Some parts of the hardness tester may wear after long time use, for example, seals leakage, difficulty in loading full scales force, inaccurate test result, and difficulty in retracting the indenter, deformed or worn indenter, loose support frame, extension of loading time, battery failure and other failures. If these problems occur, the hardness tester needs to be repaired.

Some of the maintenance tasks must to be done by the manufacturer. If the hardness tester is damaged or broken, send it back to the manufacturer.
Another part of the repair work can be done by the resellers. The manufacturer will have training for the technical team of main resellers to make them professional to calibrate the tester, change oil, exhaust or accomplish some of the maintenance work. The user can repair their hardness testers at the nearest retailer.

Other maintenance tasks can be accomplished by the user. Because of location or transportation limitation, some end users can not send the hardness tester back to manufacturer or distributor. The user who has professional technicist can do by himself to change oil, exhaust, calibrate tester and repair the seals according to the maintenance manual. If there is any difficulty during the repairing, contact the manufacturer for support. Parts and tools for changing oil can be bought from the manufacturer.

The instrument has some disposable parts, the maintenance of the disposable parts should be discarded, the old disposable parts used repeatedly will affect the performance of the instrument, such as: O ring, washer, filter and so on.

The repair, maintenance, oil change and force correction of the instrument are mainly for the measuring head. **The mechanical parts of the measuring head are shown in Figure 5.**

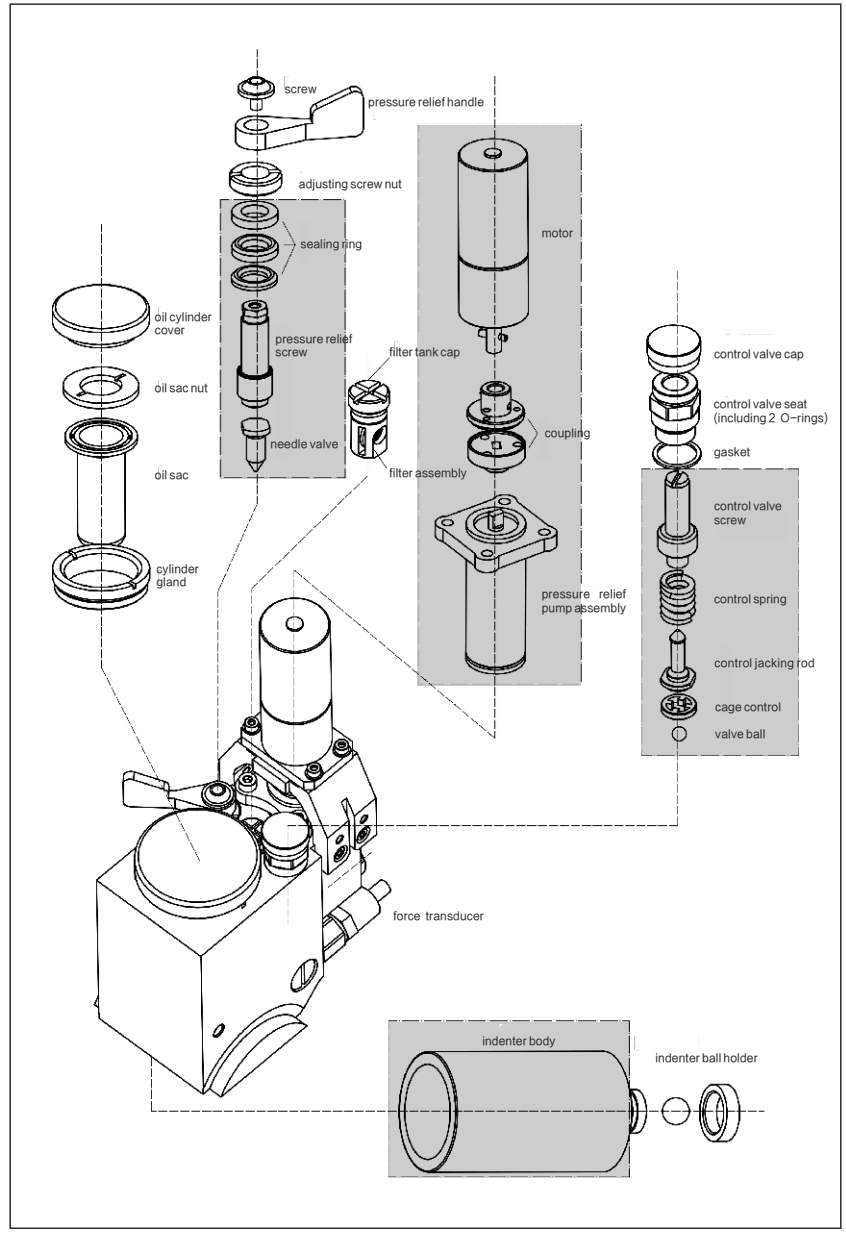

Figure 5. Assembly of measuring head mechanical parts

The common faults of the instrument and the treatment methods are as follows:

1. Abnormal loading the test force

If the instrument cannot be applied force to 29420N (3000kgf) or application time is significantly extended, possible reasons and treatment methods are as follows:

1.1 The indenter body is not reset

Before starting the measuring force application, the indenter body should be pushed back to the retracted position under the condition of opening the pressure release valve. If this operation is not performed, the indenter body may be extended too long in the subsequent loading test force process, and the displacement of the indenter is insufficient during loading the test force, and cannot be applied force to 29420N (3000kgf). At this time, the "test force indicator" flashes red and gives an alarm signal.

The solution is: open the pressure release valve, press the indenter against the workpiece or anvil, shake the lifting crank vigorously, and push the indenter body back to the retracted position.

1.2 The indenter is suspended

When the indenter is suspended, press the "test force key", the motor works, and the indenter moves down. At this time, the test force measured by the pressure sensor is 0, the controller will determine that the indenter does not contact the workpiece, the motor will stop working immediately, the " test force indicator" flashes red, and the alarm signal is issued.

The solution is: shake the lifting crank, lower the measuring head, so that the indenter against the workpiece, and then press the " test force key ".

1.3 The indenter is pressed into a softer object

When the indenter presses the soft object, the test force value measured by the pressure sensor is obviously lower than the normal value, the controller will determine the hardness of the object to be measured is abnormal (such as pressure to the hand), at this time, the motor immediately stops working, the indenter stops moving down, the "test force indicator" flashes red, and sends out an alarm signal.

The solution is: remove soft objects, measure again.

1.4 Hydraulic system inlet air

1.4.1 Phenomena and Causes

The air entering into the hydraulic system will make the force application process abnormal, which is manifested in the test force loading process. In the hydraulic manifold block, there is an obvious "bang bang" sound, and the instrument will shake slightly. The reason for this phenomenon is that in the process of maintaining the test force, the air bubbles in the hydraulic oil are compressed and suddenly burst, which causes the pressure in the high-pressure area of the hydraulic system to drop instantly, resulting in the short-term closing of the control valve, the short-term drop of the test force and the out-of-tolerance of the force value.

1.4.2 Ways of air intake in hydraulic system

a. The operator does not push the indenter body back to the retracted position after each measurement, so that the indenter body extends too long, negative pressure is generated in the hydraulic system, and the outside air enters the hydraulic system along the small gap with poor seal.

b. Oil change operation of careless oil contains air bubbles or make the air directly into the hydraulic system in the process of operation.

c. Careless or seal in the maintenance processes improper, make the air through hydraulic pump, relief valve, control valve into the hydraulic system.

1.4.3 Method of exhaust

The air in the system can be discharged through the oil change operation.
See "1.5.3" for operation.

1.5 Hydraulic oil shortage

There will be a slight loss of hydraulic oil during the use of the instrument. After the instrument is used for a long time, the remaining hydraulic oil is not enough to make the indenter produce enough displacement, and the force cannot be applied to 29420 N (3000 kgf). At this time, the hydraulic oil should be replaced. Procedures and methods for changing hydraulic oil are as follows:

1.5.1 Confirm insufficient oil

Remove the oil cylinder cover, and you can see the oil sac underneath. Open the pressure release valve, shake the lifting crank, and push the indenter body back to the retractable position. Observe the curling state of the oil sac. If the oil sac is tight and completely curled, it indicates that there is enough oil. Otherwise, if the oil sac is slightly soft and does not curl enough, the oil quantity is insufficient.

1.5.2 Replace hydraulic oil

After the long-term use of the instrument, the hydraulic oil will contain iron filings, mud and other dirt, which will damage the hydraulic pump and affect the reliable work of the control valve and pressure release valve. Therefore, when the oil is insufficient, all the hydraulic oil should be replaced.

The replacement of hydraulic oil should generally be completed at the instrument manufacturer, or can be sent to the dealer by the manufacturer trained technicians to complete. Conditional users may also attempt to complete the work themselves, but should contact the manufacturer for guidance. The operation of replacing hydraulic oil is complicated. If you make any mistake, the instrument must be returned to the factory for repair. Therefore, whether to change the oil by yourself should be treated with caution.

It is very important to use correct brand of hydraulic oil. Mobil SAE50 hydraulic oil can be purchased locally. Spare hydraulic oil and special tools for oil changes are available at instrument manufacturer.

The operation sequence of oil change is very important and complicated. Whether understood or not, the procedures specified in this maintenance manual should be strictly followed. Any careless operation may cause damage to some parts.

1.5.3 Oil change operation steps

Oil change operation steps are as follows:

a. Jacking back the indenter body
Open the pressure release valve.
Push the indenter back to the retracted position.

b. Find the oil sac
Unscrew the oil cylinder cover, and then you can see the completely curled oil sac in the oil cylinder.

c. Take out the oil sac
Close the pressure release valve.
The indenter is suspended.
Press the "test force key" continuously (every time you press the "test force key", the motor will work for one second, and then the "test force indicator " will flash with a red light, indicating that the indenter is suspended, so this fault prompt can be ignored), and slowly press the indenter body out. At this point, you can see that the oil sac slowly expands, and continue to press the "test force key" until the oil sac is fully expanded.
Remove the oil sac nut with a special wrench and take out the oil sac.

d. Remove the measuring head
Open the pressure release valve, shake the lifting crank, and push the indenter body back to the retracted position.
Remove the fixing screws on the clamp plate of the measuring head and remove the measuring head.

e. Pour out the old oil
Pour out the old oil in the oil cylinder.
Reinstall the measuring head to the bracket and tighten the fixing screw.
Wipe the dirt at the bottom of the oil cylinder with a sponge.

f. Inject new oil
Use a syringe to slowly extract a tube of hydraulic oil from the container, drain the air from the syringe and then slowly inject it into the hydraulic cylinder. Continue to inject hydraulic oil until it is full. Attention should be paid during operation to avoid bringing air into hydraulic oil as much as possible.

g. Clean the oil circuit and exhaust
Put a small iron block on the anvil, and let the indenter touch the small iron block.
Perform the operation of "closing the pressure release valve-pressing the "test force key "-opening the pressure release valve after the application of force. ", and the operator can see dirty oil gushing out from the oil hole at the upper part of the oil cylinder. Continue to repeat the above.
After 50 times of operation, a layer of black dirty oil will appear on the upper part of the oil cylinder. Slowly pump out about 1/3 of the oil in the upper part of the oil cylinder with a syringe, and drain the dirty oil. The remaining oil in the lower part should be relatively clean. Then slowly fill it with new oil with a syringe.

Repeat the above operation twice, and the oil cleaning is completed.
The air in the hydraulic system is also discharged in the process of cleaning the oil circuit.

h. Standing still
Standing still for more than 12 hours to eliminate the remaining bubbles in the hydraulic oil.

i. Put back the oil sac
Use a syringe to pump out about 18 ml of oil in the cylinder.
Put back the oil sac, about 1/3 of which is submerged in the oil.

j. Make the oil sac fall to the bottom
Close the pressure release valve.
The indenter is suspended.
Gently press the oil sac with your hand, and continuously press the "test force key" to press the indenter body out slowly. At this point, the oil sac will drop slowly. During the operation, attention should be paid to keep the oil level higher than the step in the oil cylinder until the oil sac drops to the bottom and is fully deployed.
During operation, hydraulic oil may spill into the oil sac, so wipe it off with a soft cloth.

k. Cover the oil cylinder cover
Install and tighten the oil sac nut quickly. Cover and tighten the oil cylinder cover.

l. Wipe the hardness tester
Wipe the hardness tester clean with a soft cloth and detergent.

m. Jacking back the indenter body
Open the pressure release valve.
Shake the lifting crank to push the indenter body back to the retracted position.
End of oil change and exhaust operation.

1.6 Replace the filter

Replace the filter according to the method in Article 5 below.

2. Instrument misalignment

Misalignment may occur after prolonged use of the instrument, as a result of testing standard Brinell hardness blocks with errors exceeding the allowable range specified in ASTM E10.
The reasons for the misalignment of the instrument and the solutions are as follows:

2.1 Abnormal loading the test force

Abnormal loading the test force in clause 1 of this appendix may lead to out-of-tolerance of the instrument, and the solution in clause 1 should be followed to eliminate the fault.

2.2 Hardness block expiration

Standard hardness blocks are calibrated before leaving the factory. The hardness value is engraved on the front or side of the block, and the date of inspection is written on the inspection report. The validity period of the hardness block is 1 year, and the hardness

value of the hardness block needs to be re-calibrated after 1 year. The hardness value of the hardness block exceeding the validity period may be out of tolerance. When testing the instrument with it, the normal instrument may be out of tolerance. New, high-quality, traceable hardness blocks can be purchased from manufacturer.

2.3 Ball indenter deformation or wear

The carbide ball indenter equipped with this instrument has extremely high dimensional accuracy, hardness and wear resistance, but it may still be deformed or worn after long-term use, misoperation or frequent testing of hard workpieces.

When the instrument is out of alignment, after the cause of the hardness block is eliminated, the ball indenter can be taken down, the ball indenter can be rotated once, the test surface of the ball can be changed to a new position, and then the ball indenter can be reinstalled on the indenter body, and the indenter ball holder can be tightened.

2.4 Test force misalignment

The other main cause of instrument misalignment is the inaccurate test force of 29420N (3000kgf). The test force of 24920 N (3000 kgf) has been accurately corrected before the instrument leaves the factory, and the error is less than ± 1%.

2.5 Direct calibration of test force

Standardized and accurate test force calibration requires traceable high-precision dynamometer, which is completed by professional technicians in the laboratory. Some measuring institutions that use units may have this condition. When conditions do not meet, you can ask the local measurement agency to solve, or send the instrument to the manufacturer.

Force calibration test method is as follows:

Place the force sensor of the dynamometer on the flat anvil, remove the ball and ball holder, lower the measuring head, make the ball seat of the indenter body press the center of the force sensor, close the pressure release valve, turn on the power supply, press the "test force key", and adjust the test force at the holding stage to 29420 N (3000 KGF) according to the following instructions: Take off the control valve cap, and you can see a correction screw with a "— " groove. Turn the correction screw lightly with a screwdriver. When the displayed force value is low, tighten the correction screw clockwise. On the contrary, loosen the correction screw anticlockwise. Here, it is required that the action must be small (just move), otherwise it will be difficult to find the correct calibration point. When the test force is too large and exceeds the safety limit, the instrument will be damaged. The correction screw of the control valve can only be slightly adjusted, but not greatly adjusted, and it can't be removed, otherwise the instrument must be returned to the manufacturer for repair.

After adjusting the screw, check the instrument on the hardness block. If there is any deviation, repeat the above operation for many times until it is aligned. Adjust and install the upper control valve cap.

If there are more out-of-tolerance instruments for other reasons, please contact the manufacturer.

2.6 Indirect calibration of test force

Hardness tester users usually don't have the conditions to standardize and correct the test force. An alternative method is to calibrate test force indirectly by calibrating hardness blocks.

Correction hardness block method similar to article 2.5.Use a hardness block with a hardness value close to the common range within the validity period. Operate the hardness tester carefully, press a Brinell indentation on the hardness block, measure the Brinell hardness value with the indentation measuring device, and compare the measured result with the hardness value marked on the hardness block. If the out-of-tolerance is serious, it means that the instrument has failed, and it should be sent back to the instrument manufacturer for repair. If the out-of-tolerance degree is not large, the instrument can be calibrated on the hardness block by the method of Article 2.5. If the hardness value is low, loosen the correction screw anticlockwise. If the hardness value is too high, tighten the correction screw clockwise.

3. Sealing ring wear

If the hydraulic oil is replaced in a short period of time, it is difficult to apply force due to insufficient oil. If it is difficult to apply force due to insufficient oil quantity in a short time after hydraulic oil replacement, at this time, it should be suspected that the X-shaped sealing ring on the measuring head body is worn, and the serious wear of the X-shaped sealing ring will cause rapid oil leakage.

The X-shaped sealing ring on the measuring head body cannot be replaced by the user. At this time, you should contact the manufacturer and send the instrument back to the manufacturer for repair.

4. Oil leakage of pressure release valve

There are three V-shaped rubber sealing rings in the pressure release valve. After long-term use of the instrument, the sealing ring may be worn, the sealing effect is weakened, and a small amount of hydraulic oil may leak out. In the use of the instrument, attention should be paid to the pressure release valve. When oil is found under the handle of the pressure release valve, the following treatment should be done:

Close the pressure release valve, press the "test force key" continuously, ignore the troubleshooting tips, and make the extension of the indenter body to the maximum. Remove the screw on the handle of the pressure release valve with the allen wrench, remove the handle, there will be a nut below, tighten the nut with the special wrench of the pressure release valve, and tighten it clockwise for 1/16 ~ 1/8 turns. Reinstall the pressure release valve handle and fasten it with screws. Pressure release valve repair is limited to this, the pressure release valve nut cannot be removed by the user.

5. Filter clogging

When the instrument afterloading time is significantly extended, the filter may be clogged,

and the filter should be replaced at this time.
When replacing the filter, first remove the cross nut, screw it into the threaded hole at the top of the filter with an M3 screw, pull out the filter, and then insert a new filter, filter should be paid attention to the positioning pin and hole at the bottom of the positioning hole alignment, and then install and reset the cross nut.
Generally, the filter should be replaced at the same time when replacing the hydraulic oil.

6. Battery failure

If the usage times of the battery are obviously reduced after being fully charged, and it can no longer meet the requirements, it can be considered that the battery has failed and a new battery pack should be replaced.
The method of replacing the battery pack is as follows: remove the battery compartment cover, pull out the power cord connector from the circuit board, and pull out the battery pack from the battery card slot. Insert the new battery pack into the battery card slot (note that the power cord should be at the top), insert the power cord connector into the socket of the circuit board, press the "power key" to verify whether it is installed correctly, and then reset the battery compartment cover.
The new battery pack can be bought at manufacturer.

Important note:
The repair, maintenance and correction that can be performed by the user are limited to the contents listed in this service manual. Any maintenance beyond the contents of this service manual and disassembly of the instrument are not allowed. If the instrument is damaged, the user may have to pay more for maintenance, and some important parts or the whole instrument may be in danger of being scrapped.

Appendix 3

Packing and transportation

This instrument is a precise mechanical and electronic product, and its performance and measurement accuracy are realized by the precise coordination and fine debugging of some precise parts. Any carelessness in packaging and transportation may cause damage to the instrument.

Upon receipt of this instrument, the buyer shall check whether the outer packaging of the instrument is damaged. If any damage that may cause damage to the instrument is found, the buyer shall keep the evidence and contact the freight forwarder.

The original packaging of this instrument is special, safe enough and irreplaceable. After receiving the instrument, the buyer shall properly keep the instrument package for future maintenance and delivery. As a precision instrument used in the production site, it is inevitable that it will be damaged and returned to the manufacturer for maintenance. It is unwise to discard the special packaging of the instrument.

Instruments shipped without the original packaging are not entitled to warranty treatment, and the shipper shall be responsible for the damage in transit.

The package and packing sequence of the instrument are shown in Figure 6. You can refer to it when repackaging.

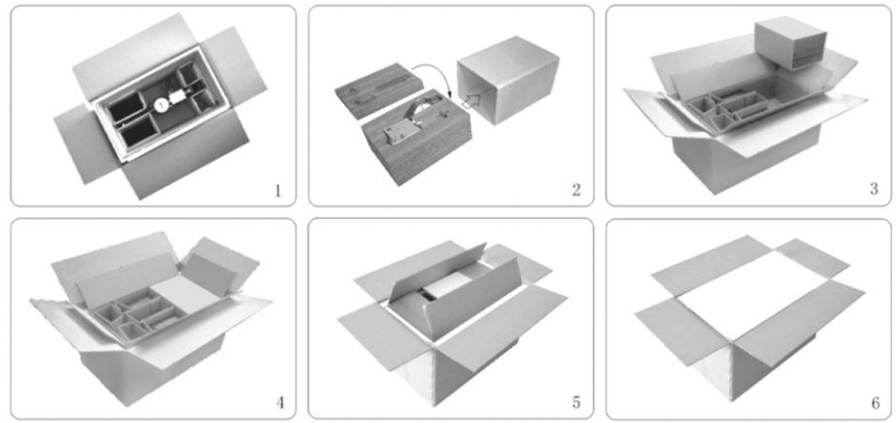

Figure 6. Schematic diagram of instrument packaging

Table 1: Table of Brinell hardness values

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness HBW	
2.40	1.200	653	218
2.41	1.205	648	216
2.42	1.210	643	214
2.43	1.215	637	212
2.44	1.220	632	211
2.45	1.225	627	209
2.46	1.230	621	207
2.47	1.235	616	205
2.48	1.240	611	204
2.49	1.245	606	202
2.50	1.250	601	200
2.51	1.255	597	199
2.52	1.260	592	197
2.53	1.265	587	196
2.54	1.270	582	194
2.55	1.275	578	193
2.56	1.280	573	191
2.57	1.285	569	190
2.58	1.290	564	188
2.59	1.295	560	187
2.60	1.300	555	185
2.61	1.305	551	184
2.62	1.310	547	182
2.63	1.315	543	181
2.64	1.320	538	179
2.65	1.325	534	178
2.66	1.330	530	177
2.67	1.335	526	175
2.68	1.340	522	174
2.69	1.345	518	173
2.70	1.350	514	171
2.71	1.355	510	170
2.72	1.360	507	169
2.73	1.365	503	168
2.74	1.370	499	166
2.75	1.375	495	165
2.76	1.380	492	164
2.77	1.385	488	163
2.78	1.390	485	162
2.79	1.395	481	160
2.80	1.400	477	159
2.81	1.405	474	158
2.82	1.410	471	157
2.83	1.415	467	156
2.84	1.420	464	155

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness HBW	
2.85	1.425	461	154
2.86	1.430	457	152
2.87	1.435	454	151
2.88	1.440	451	150
2.89	1.445	448	149
2.90	1.450	444	148
2.91	1.455	441	147
2.92	1.460	438	146
2.93	1.465	435	145
2.94	1.470	432	144
2.95	1.475	429	143
2.96	1.480	426	142
2.97	1.485	423	141
2.98	1.490	420	140
2.99	1.495	417	139
3.00	1.500	415	138
3.01	1.505	412	137
3.02	1.510	409	136
3.03	1.515	406	135
3.04	1.520	404	135
3.05	1.525	401	134
3.06	1.530	398	133
3.07	1.535	395	132
3.08	1.540	393	131
3.09	1.545	390	130
3.10	1.550	388	129
3.11	1.555	385	128
3.12	1.560	383	128
3.13	1.565	380	127
3.14	1.570	378	126
3.15	1.575	375	125
3.16	1.580	373	124
3.17	1.585	370	123
3.18	1.590	368	123
3.19	1.595	366	122
3.20	1.600	363	121
3.21	1.605	361	120
3.22	1.610	359	120
3.23	1.615	356	119
3.24	1.620	354	118
3.25	1.625	352	117
3.26	1.630	350	117
3.27	1.635	347	116
3.28	1.640	345	115
3.29	1.645	343	114

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness HBW	
3.30	1.650	341	114
3.31	1.655	339	113
3.32	1.660	337	112
3.33	1.665	335	112
3.34	1.670	333	111
3.35	1.675	331	110
3.36	1.680	329	110
3.37	1.685	326	109
3.38	1.690	325	108
3.39	1.695	323	108
3.40	1.700	321	107
3.41	1.705	319	106
3.42	1.710	317	106
3.43	1.715	315	105
3.44	1.720	313	104
3.45	1.725	311	104
3.46	1.730	309	103
3.47	1.735	307	102
3.48	1.740	306	102
3.49	1.745	304	101
3.50	1.750	302	101
3.51	1.755	300	100
3.52	1.760	298	99.5
3.53	1.765	297	98.9
3.54	1.770	295	98.3
3.55	1.775	293	97.7
3.56	1.780	292	97.2
3.57	1.785	290	96.6
3.58	1.790	288	96.1
3.59	1.795	286	95.5
3.60	1.800	285	95.0
3.61	1.805	283	94.4
3.62	1.810	282	93.9
3.63	1.815	280	93.3
3.64	1.820	278	92.8
3.65	1.825	277	92.3
3.66	1.830	275	91.8
3.67	1.835	274	91.2
3.68	1.840	272	90.7
3.69	1.845	271	90.2
3.70	1.850	269	89.7
3.71	1.855	268	89.2
3.72	1.860	266	88.7
3.73	1.865	265	88.2
3.74	1.870	263	87.7

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness HBW	
3.75	1.875	262	87.2
3.76	1.880	260	86.8
3.77	1.885	259	86.3
3.78	1.890	257	85.8
3.79	1.895	256	85.3
3.80	1.900	255	84.9
3.81	1.905	253	84.4
3.82	1.910	252	83.9
3.83	1.915	250	83.5
3.84	1.920	249	83.0
3.85	1.925	248	82.6
3.86	1.930	246	82.1
3.87	1.935	245	81.7
3.88	1.940	244	81.3
3.89	1.945	242	80.8
3.90	1.950	241	80.4
3.91	1.955	240	80.0
3.92	1.960	239	79.5
3.93	1.965	237	79.1
3.94	1.970	236	78.7
3.95	1.975	235	78.3
3.96	1.980	234	77.9
3.97	1.985	232	77.5
3.98	1.990	231	77.1
3.99	1.995	230	76.7
4.00	2.000	229	76.3
4.01	2.005	228	75.9
4.02	2.010	226	75.5
4.03	2.015	225	75.1
4.04	2.020	224	74.7
4.05	2.025	223	74.3
4.06	2.030	222	73.9
4.07	2.035	221	73.5
4.08	2.040	219	73.2
4.09	2.045	218	72.8
4.10	2.050	217	72.4
4.11	2.055	216	72.0
4.12	2.060	215	71.7
4.13	2.065	214	71.3
4.14	2.070	213	71.0
4.15	2.075	212	70.6
4.16	2.080	211	70.2
4.17	2.085	210	69.9
4.18	2.090	209	69.5
4.19	2.095	208	69.2

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness	HBW
4.20	2.100	207	68.8
4.21	2.105	205	68.5
4.22	2.110	204	68.2
4.23	2.115	203	67.8
4.24	2.120	202	67.5
4.25	2.125	201	67.1
4.26	2.130	200	66.8
4.27	2.135	199	66.5
4.28	2.140	198	66.2
4.29	2.145	198	65.8
4.30	2.150	197	65.5
4.31	2.155	196	65.2
4.32	2.160	195	64.9
4.33	2.165	194	64.6
4.34	2.170	193	64.2
4.35	2.175	192	63.9
4.36	2.180	191	63.6
4.37	2.185	190	63.3
4.38	2.190	189	63.0
4.39	2.195	188	62.7
4.40	2.200	187	62.4
4.41	2.205	186	62.1
4.42	2.210	185	61.8
4.43	2.215	185	61.5
4.44	2.220	184	61.2
4.45	2.225	183	60.9
4.46	2.230	182	60.6
4.47	2.235	181	60.4
4.48	2.240	180	60.1
4.49	2.245	179	59.8
4.50	2.250	179	59.5
4.51	2.255	178	59.2
4.52	2.260	177	59.0
4.53	2.265	176	58.7
4.54	2.270	175	58.4
4.55	2.275	174	58.1
4.56	2.280	174	57.9
4.57	2.285	173	57.6
4.58	2.290	172	57.3
4.59	2.295	171	57.1
4.60	2.300	170	56.8
4.61	2.305	170	56.5
4.62	2.310	169	56.3
4.63	2.315	168	56.0
4.64	2.320	167	55.8

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness	HBW
4.65	2.325	167	55.5
4.66	2.330	166	55.3
4.67	2.335	165	55.0
4.68	2.340	164	54.8
4.69	2.345	164	54.5
4.70	2.350	163	54.3
4.71	2.355	162	54.0
4.72	2.360	161	53.8
4.73	2.365	161	53.5
4.74	2.370	160	53.3
4.75	2.375	159	53.0
4.76	2.380	158	52.8
4.77	2.385	158	52.6
4.78	2.390	157	52.3
4.79	2.395	156	52.1
4.80	2.400	156	51.9
4.81	2.405	155	51.6
4.82	2.410	154	51.4
4.83	2.415	154	51.2
4.84	2.420	153	51.0
4.85	2.425	152	50.7
4.86	2.430	152	50.5
4.87	2.435	151	50.3
4.88	2.440	150	50.1
4.89	2.445	150	49.8
4.90	2.450	149	49.6
4.91	2.455	148	49.4
4.92	2.460	148	49.2
4.93	2.465	147	49.0
4.94	2.470	146	48.8
4.95	2.475	146	48.6
4.96	2.480	145	48.3
4.97	2.485	144	48.1
4.98	2.490	144	47.9
4.99	2.495	143	47.7
5.00	2.500	143	47.5
5.01	2.505	142	47.3
5.02	2.510	141	47.1
5.03	2.515	141	46.9
5.04	2.520	140	46.7
5.05	2.525	140	46.5
5.06	2.530	139	46.3
5.07	2.535	138	46.1
5.08	2.540	138	45.9
5.09	2.545	137	45.7

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness	HBW
5.10	2.550	137	45.5
5.11	2.555	136	45.3
5.12	2.560	135	45.1
5.13	2.565	135	45.0
5.14	2.570	134	44.8
5.15	2.575	134	44.6
5.16	2.580	133	44.4
5.17	2.585	133	44.2
5.18	2.590	132	44.0
5.19	2.595	132	43.8
5.20	2.600	131	43.7
5.21	2.605	130	43.5
5.22	2.610	130	43.3
5.23	2.615	129	43.1
5.24	2.620	129	42.9
5.25	2.625	128	42.8
5.26	2.630	128	42.6
5.27	2.635	127	42.4
5.28	2.640	127	42.2
5.29	2.645	126	42.1
5.30	2.650	126	41.9
5.31	2.655	125	41.7
5.32	2.660	125	41.5
5.33	2.665	124	41.4
5.34	2.670	124	41.2
5.35	2.675	123	41.0
5.36	2.680	123	40.9
5.37	2.685	122	40.7
5.38	2.690	122	40.5
5.39	2.695	121	40.4
5.40	2.700	121	40.2
5.41	2.705	120	40.0
5.42	2.710	120	39.9
5.43	2.715	119	39.7
5.44	2.720	118	39.6
5.45	2.725	118	39.4
5.46	2.730	118	39.2
5.47	2.735	117	39.1
5.48	2.740	117	38.9
5.49	2.745	116	38.8
5.50	2.750	116	38.6
5.51	2.755	115	38.5
5.52	2.760	115	38.3
5.53	2.765	114	38.2
5.54	2.770	114	38.0

Ball Diameter D/mm		0.102xF/D²	
		30	10
		Test Force F/kN (kgf)	
10	5	29.42 (3000) 7.355 (750)	9.807 (1000)
Indentation Diameter D/mm		Brinell Hardness	HBW
5.55	2.775	114	37.9
5.56	2.780	113	37.7
5.57	2.785	113	37.6
5.58	2.790	112	37.4
5.59	2.795	112	37.3
5.60	2.800	111	37.1
5.61	2.805	111	37.0
5.62	2.810	110	36.8
5.63	2.815	110	36.7
5.64	2.820	110	36.5
5.65	2.825	109	36.4
5.66	2.830	109	36.3
5.67	2.835	108	36.1
5.68	2.840	108	36.0
5.69	2.845	107	35.8
5.70	2.850	107	35.7
5.71	2.855	107	35.6
5.72	2.860	106	35.4
5.73	2.865	106	35.3
5.74	2.870	105	35.1
5.75	2.875	105	35.0
5.76	2.880	105	34.9
5.77	2.885	104	34.7
5.78	2.890	104	34.6
5.79	2.895	103	34.5
5.80	2.900	103	34.3
5.81	2.905	103	34.2
5.82	2.910	102	34.1
5.83	2.915	102	33.9
5.84	2.920	101	33.8
5.85	2.925	101	33.7
5.86	2.930	101	33.6
5.87	2.935	100	33.4
5.88	2.940	99.9	33.3
5.89	2.945	99.5	33.2
5.90	2.950	99.2	33.1
5.91	2.955	98.8	32.9
5.92	2.960	98.4	32.8
5.93	2.965	98.0	32.7
5.94	2.970	97.7	32.6
5.95	2.975	97.3	32.4
5.96	2.980	96.9	32.3
5.97	2.985	96.6	32.2
5.98	2.990	96.2	32.1
5.99	2.995	95.9	32.0
6.00	3.000	95.5	31.8