iBrin-3000WL Brinell Hardness Tester

Instruction Manual



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1.General Description

1.1Brief:

Hardness is an important parameter of mechanical performances for metallic and alloy materials. It usually refers to the resistance capacity of a material against the indentation of the other harder material with certain shape which is pressed into its surface without residual deformation by itself.

Brinell Hardness Tester Model Mikrosize-uBrin-W can be used to measure the Brinell hardness of unquenched steels, cast irons, nonferrous metals and other bearing alloys in the laboratories of factories, research institutions and colleges.

1.2. Testing Principles

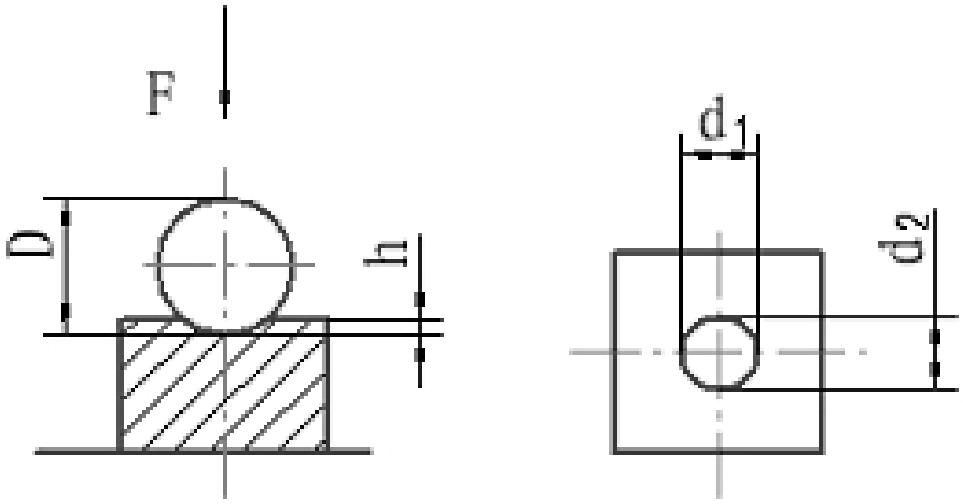
Brinell hardness testing is to apply specified test forces onto the surface of test specimen through a quenched steel ball of certain diameter (Figure 1) and retain it for a specified period of time, then remove it and measure the diameter of indentation on the surface of specimen. The Brinell hardness is shown by the average pressure (kgf/mm2) on the surface area of ball impression on the specimen (Table 1) and calculated as per the following formula (1):

$$\text{Brinell hardness} = 0.102 * \frac{2F}{\pi D(D - \sqrt{D^2 - d^2})} \qquad \text{---------- formula (1)}$$

Table 1 Symbols and Descriptions

Symbols	Descriptions	Unit
D	Diameter of hard alloy steel ball	mm
F	Test forces	N
d	Average diameter of indentation	mm
d1, d2	Diameters of indentations along two perpendicular directions	mm
h	Depth of indentation	mm
HBW	Brinell hardness	

1.General Description



To apply specified test forces onto the surface of test specimen through a hard-alloyed ball of certain diameter, retain test force for a specified period of time, then remove it and measure the diameter of indentation on the surface of specimen, referring to Fig 1.

For example, 350HBW5/750 means that the hardness is 350 measured with a hard-alloy ball of diameter 5mm, under a test force of 7.355 KN which is retained for 10 to 15 seconds.

*For detail, please refer to GB/T 231.1-2002:《Metallic Brinell Hardness Test》.

1.3. Range of Application

The standard terms and conditions of Brinell Hardness Test often uses hard alloy indenter with a diameter of 10mm and test force of 3,000 Kgf (Fig 2), which fully symbolizes the characteristics of Brinell hardness. However, due to the fact that the specimens vary in hardness and size, one test force and one kind of steel ball can't meet the requirements. Only when the ratio of test force divided by the square mean of steel ball diameter is a constant, can the same hardness of same specimen with steel ball of different diameters and different test forces be obtained. For detail, please refer to Table 2.

1.General Description

Ratio of test force F and steel ball diameter D2	Steel ball diameter D					Range of hardness	Range of Applications
30	3000	750	187.5	46.9	30.0	140-(945)	Steel, aluminum and gray cast iron
10	1000	250	62.5	15.6	10.0	48-315	
5	500	125	31.2	7.8	5.0	23.8-158	Annealed aluminum
2.5	250	62.5	15.6	3.9	2.5	11.9-79	Bearing alloy
1.25	125	31.2	7.8	2.0	1.2	6.0-39	Conductor wires

Table 2 Selection of steel ball diameters and test forces in Brinell Hardness Test

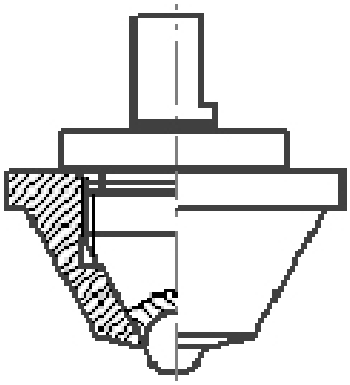


Fig-2 Hard alloy indenter

1.4. Technical Parameters

Main Technical Parameters are included in Fig-3 and Table 3:

Table 3 Main Technical Parameters

Item(code)						Content		
Height(H)						842mm		
Width(W)						268mm		
Length(L)						700mm		
Maximum height of specimen (with sleeve)(B)						230mm		
Distance between center of indenter and wall of instrument (A)						120mm		
Net weight						210kg		
Unit	Grades of test force (kgf)					Hard alloy indenter (mm)		
Brinell	187.5	250	750	1000	3000	2.5	5	10

1.General Description

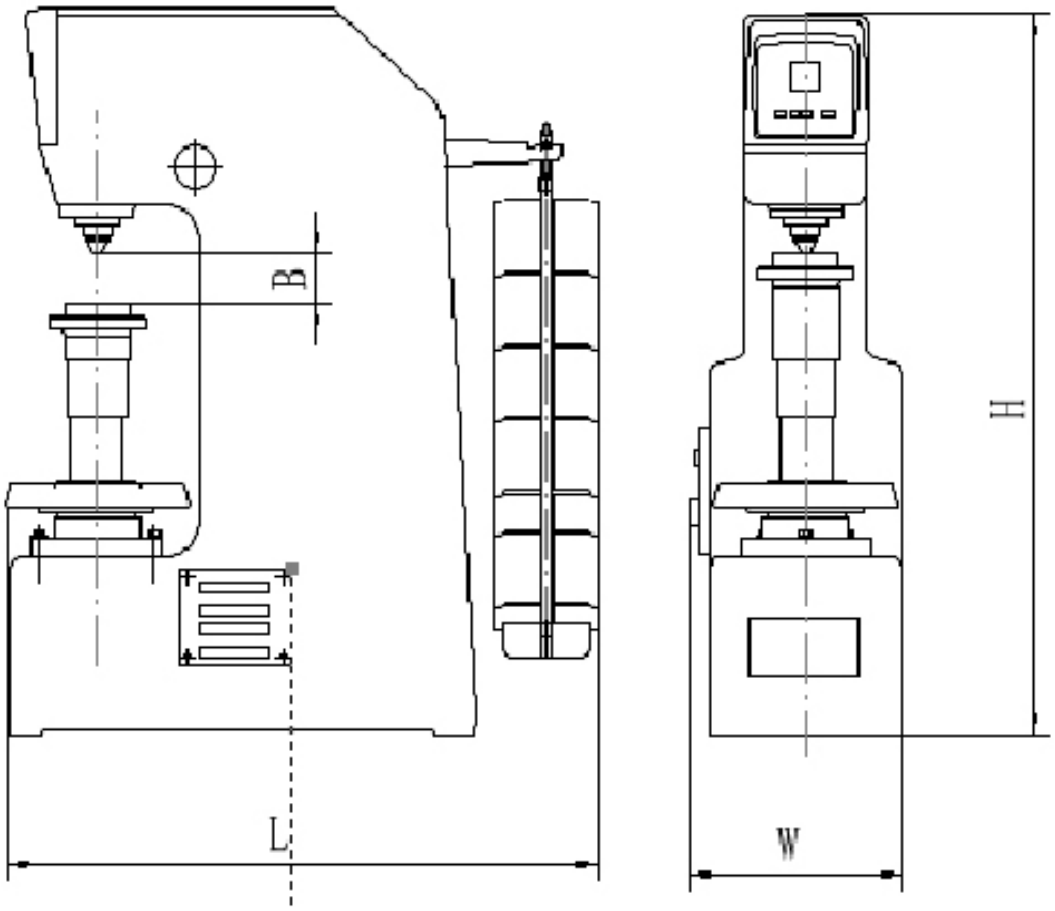


Fig-3 Diagram of Overall Dimensions

1.5. Mechanism

This tester is of lever structure, which features compact dimensions and easy operation. So it is widely used in the workshops.

The tester is composed of elevation parts, main shaft parts, lever system, decelerator parts and electronic control system, referring to Fig-4.

For normal operation, the specimen is placed on the platform and the hard alloy steel ball indenter is fitted at the bottom of main shaft. The test forces are amplified by the lever system and applied onto the steel ball and presses the steel ball into the surface of specimen. After the test forces are removed, the diameter of indentation shall be measured, by which the hardness value is obtained.

1.General Description

▲In the front of main machine body (9) made of cast iron, the screw lever seating (1) is fitted, inside which screw lever (2) is fitted. Over the screw lever, there is replaceable work table (3). The elevation of work table is subject to the elevation of screw lever, which is enabled by hand wheel (7) and nut (4). There fitted an elastic locator (5) for steel ball between hand wheel and nut. When the indenter contacts the specimen, producing certain pressure, the elastic locator becomes invalid and relative slide is produced between hand wheel and nut so that the contact pressure will be kept within certain range.

▲Lever mechanism is composed of large lever (14), smaller lever (16), hoist ring (15) and press shaft (18). The ratio of large lever is 1:12.5 while that of smaller lever is 1:4, so totally 1:50.

▲Test force is applied onto the specimen via lever system. Replaceable weights (10) are hanged on the hoist ring along the arm of large lever. The composition of weights makes up the following test forces: 1839, 2452, 7355, 9807 and 29420 N (187.5, 250, 750, 1000, 3000Kgf). The application of test forces is carried out by the motor (6) which is fitted inside the machine body. The rotation of motor is transferred to the connecting rod (13) through the decelerator. When the connecting rod descends, the test force is passed onto the indenter via large lever (14), smaller lever (16), press shaft (18) and main shaft sleeve.

▲Press shaft parts are composed of spring (19), press shaft (18) and main shaft sleeve (20). At idle conditions, the spring limits the main shaft sleeve on the main shaft seating and the press shaft is pressed closely against the knife support in the center of smaller lever so as to maintain the precise position of press shaft. When the specimen contacts the indenter, the main shaft sleeve is propped up so that the position of press shaft is determined to ensure that the specimen and the center of indenter are aligned.

▲The decelerator consists of two level worm mechanism whose transmission ratio is

1:40. So the total transmission ratio is 1:40*40=1600. The crank (11) is driven by the decelerator and composed of crank connecting rod, fork rod (12). When the motor is reverse rotating, the connecting rod is lifted up, which removes the test force from press shaft.

▲Electronic control system: it is consisted of front display screen, wiring board and Honeywell switches. When the button is pressed, the motor starts to rotate and the indicator of test force application lights up. The decelerator drives the connecting rod to turn and the fork rod moves downward. The roller is disengaged from the large lever, which means the test force application is over. At the same time, the indicator of test force retaining lights up and the motor stops rotating. When the test force is retained for a certain time(12s, 30s, 60s), the motor rotates reverse and the indicator of test force unloading lights up. The connecting rod will prop up the large lever. When the crank rotates to block the Hall switch, the motor stop running and the test force is unloaded.

2.Box Opening and Transportation

2.1. Preparation

The hardness tester should be placed in a clean and dry room without any corrosive gases. a room with no foreign mechanical vibrations.

The ambient temperature should be around 10-30ºC.

The platform should be made of cement or metal with certain strength and stiffness to carry the tester and its auxiliaries. As shown in Fig-5 (the dimensions are for your reference only), a hole of φ70mm is made for the screw lever to pass through. The levelness of the platform should fall within 0.2/1000.

Enough space should be reserved around the tester for the convenience of installation, repair and commissioning.

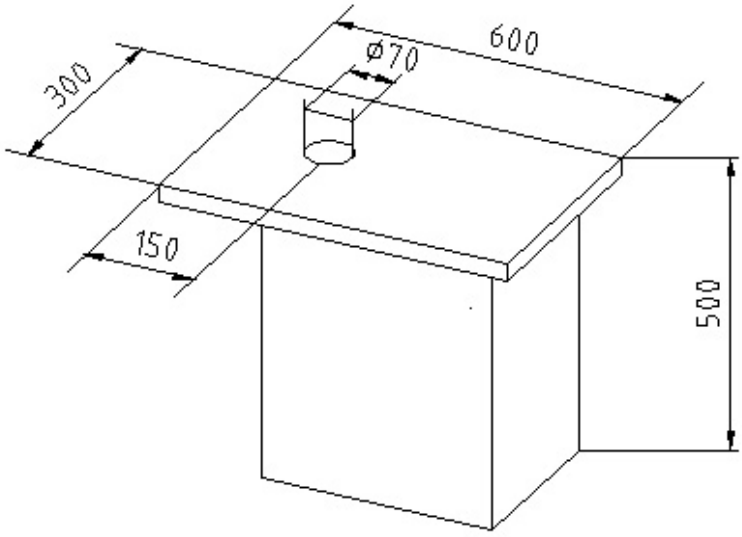


Fig-5 Schematic diagram of platform

2.2. Box Opening

(1)Remove the packing belts wrapping the outer box with tools if necessary, as shown in Fig-6.

(2)Remove the wooden screw fastening the shell and the bottom with pliers, and lift up the shell.

(3)Take out the document bag and verify that it is complete with Operation Instruction,

2.Box Opening and Transportation

Packing List and Certificate of Quality.

(4)Loosen the nuts of hooks fastening the accessory box with a spanner, and remove the accessory box. Check the parts in accordance with the Packing List.

(5)Remove the nuts fastening the weights box;

(6)Remove the nuts fastening the magnifier scope;

(7)Remove the dust cover on the tester;

(8)Remove the 4 foundation bolts fastening the tester to the bottom of package box.

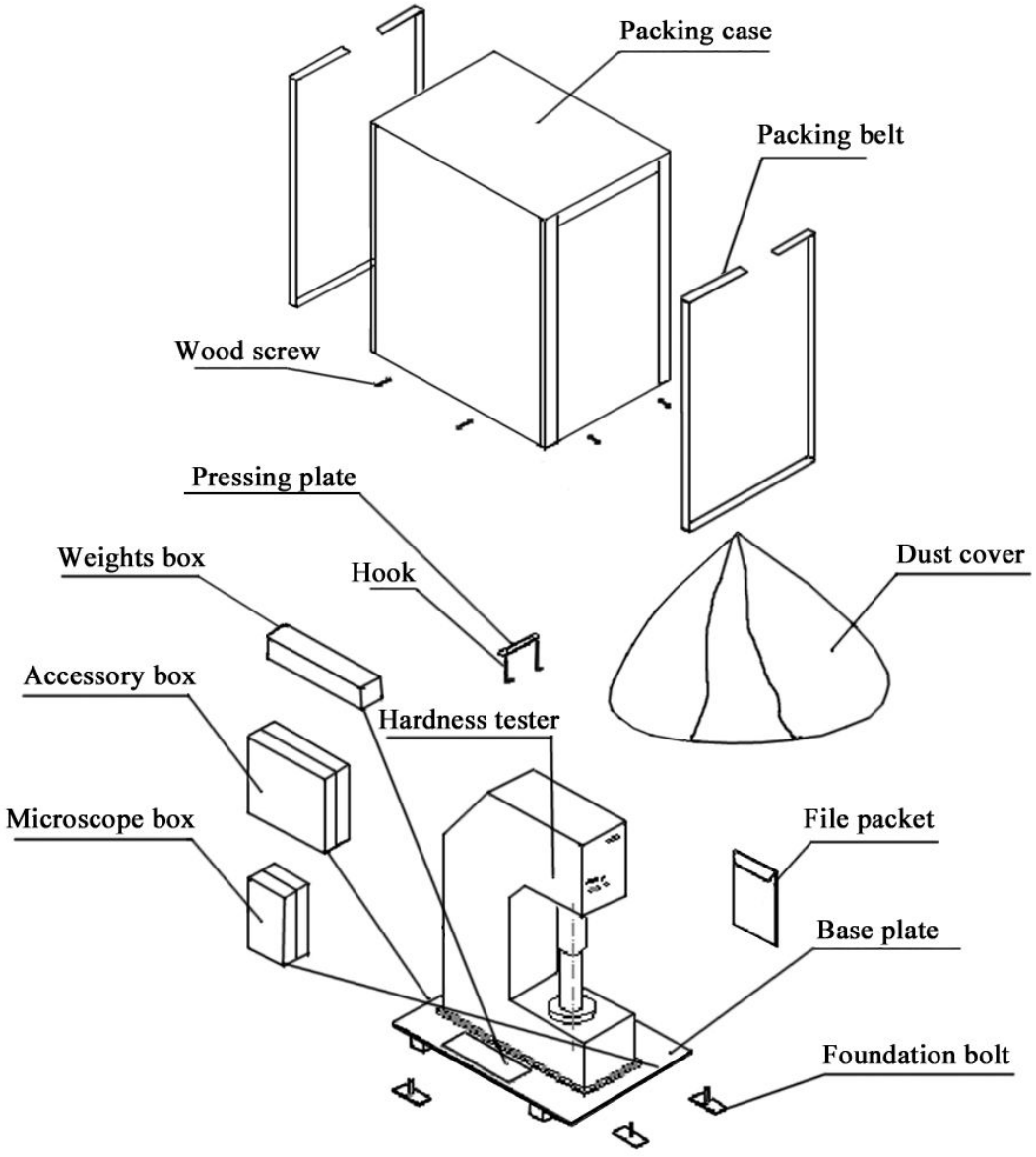


Fig-6 Schematic diagram of Box Opening

3.Installation and Commissioning

3.1. Precautions of Transportation

▲Don't try to move the tester by yourself. Or it may damage the tester and bring about personnel injury. Therefore, the tester shall be moved by two or more skilled personals.

▲During transportation, the axial line between the indenter and the lead screw shall not be more than 15ºslanted.

▲During transportation, it is prohibited to contact all the other parts and faces except the outer surface so as not to affect the accuracy.

▲The tester should be gently lift up and placed to prevent any collision or impact.

3.2. Installation and Commissioning

Before installation, get the spanner, level meter and larger anvil read for use.

(1)Place the tester on the prefabricated platform in the way that the lead screw falls into the hole of platform.

(2)Loosen the nuts of U hook and remove it with a spanner (Fig-7)

(3)Remove the wood cushion and wedges.

(4)Tear apart the package paper of large lever.

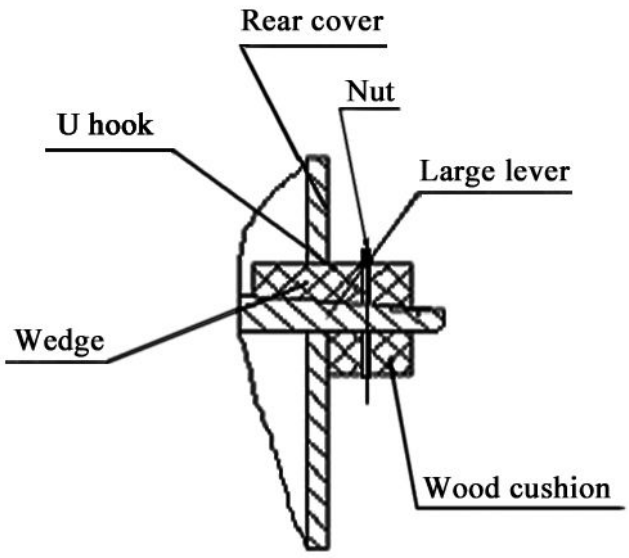


Fig-7 Removal schematic diagram of large lever packing

3.Installation and Commissioning

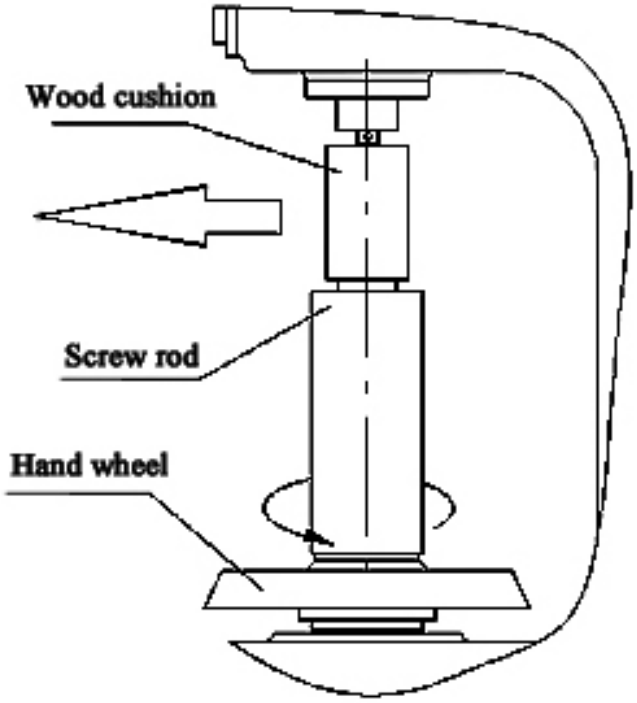


Fig-8 Removing wood cushion of the indenter

(5) Removing wood cushion of the indenter: Turn the hand wheel anticlockwise so that the lead screw descends and the wood cushion can be removed therein (Fig 8). Should the lead screw fail to descend when the hand wheel is turned, to the contrary that the hand wheel rises up with lead screw and the wood cushion can't be removed, it is because the lead screw and its seating are bonded together during transportation. In this case, the lead screw and its seating should be disengaged by turning hand wheel anticlockwise to rise around 20mm and then press with force the hand wheel.

(6) Remove the protective sleeve around the lead screw, clean away the antirust grease on the lead screw and hand wheel with kerosene, fill some lubricants to the contacts between lead screw and hand wheel, and then resume the protective sleeve.

(7)The larger anvil is put into the hole at the top of lead screw, and then places the level meter onto the larger anvil. Metallic pads are put at the bottom of the tester so that the levelness along two cross directions shall be within 0.2/1000.

4.Operation

4.1. Preparation before operation

Take time to have some understanding of functions of control panel which includes set key, start key, selection key and display window, etc. (Fig-9)

"SET" key is used for selecting different test force retaining time: the test force retaining times are classified into three shifts 0, 1 and 2 whose corresponding retaining times are 12s, 30s, and 60s separately. The retaining times can be changed from 0 to 1 or 2 by continuously pressing the "SET" key. Each process is shown in the display window.

"START" key is used to confirm the selected test force retaining time and start normal testing. In 10s after the end of selection, the tester can make confirmation automatically or to press "START" key to confirm the selection compulsorily.

" △▽ " selection key can be used to adjust the current retaining time of each shift. The adjustment can be confirmed automatically in 10 seconds or to press "START" to confirm compulsorily.

The display window can indicate corresponding shift, retaining time and test progress.

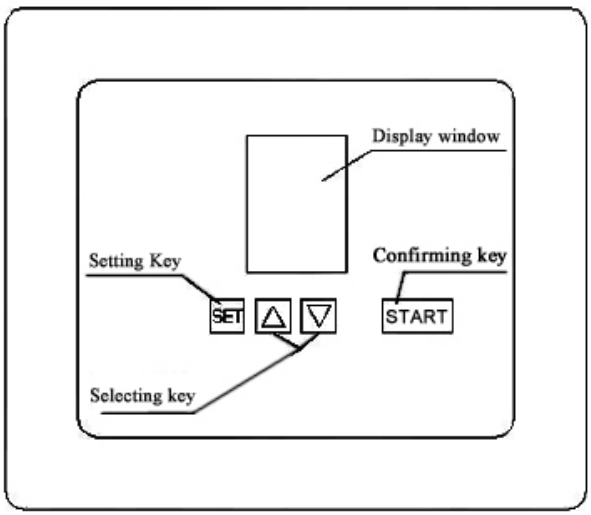


Fig-9 Schematic Diagram of Control Panel

(1)Selection of indenter (Table 4)

Table 4: Correlation Table of steel ball diameters and test forces for Brinell Hardness Test

4.Operation

a) Selection of Indenters: It can be understood from the above table that the steel balls and test force can be selected randomly for Brinell Hardness Test. However, only when the ratio of test force against the square of steel ball diameter is a constant, is it possible to obtain the same hardness or comparable results if steel ball with different diameter and different test force is applied to the same specimen.

b) Cleaning: Remove the antirust grease with acid-free gasoline and clean with cotton or soft gauze.

(2)Fitting indenter

a) Fit the indenter and tighten the screw lightly.

b) Place the standard hardness block onto the platform.

c) Hang the weights onto the knife at end of large lever.

Materials	Range of Hardness	Thickness of Specimen	Ratio of test force against diameter	Steel ball diameter (mm)	Test force F (Kgf)	Test force retaining time (s)
Ferrous metals	140-650	＞6	F/D2=30	10	3000	12
		6-3		5	750	
		＜3		2.5	187.5	
Ferrous metals	＜140	＞6	F/D2=30	10	3000	30
		6-3		5	750	
		＜3		2.5	187.5	
Non-ferrous metal and alloys (copper, bronze and others)	31.8-140	＞6	F/D2=10	10	1000	30
		6-3		5	250	
		＜3		2.5	62.5	
Non ferrous metals and alloys (aluminum bearing alloy)	8-35	＞6	F/D2=2.5	10	250	60
		6-3		5	62.5	
		＜3		2.5	15.6	

d) Turn hand wheel to apply test force until relative slide is produced between hand wheel and nut.

e) Tighten the screw so that it is tightly pressed against the flat part of fixing rod.

(3) Check and make sure that the AC 380V voltage shall be complete with phases. In case that the large lever rise up and then come down at the beginning of test force loading, this can be resolved by exchanging the two phases of the three phases.

(4) Selection of test forces:

a) Select test forces as per Table 4. The test force 187.5kgf can be selected by simply hanging the weights onto the knife at end of large lever. For test force 250 Kgf, the weights of 62.5 Kgf shall be added. For test force 750 Kgf, another 500 Kg weights shall be added and so on and so forth.

b) Selection of test force retaining time: First turn power on, and select the retaining time as per Table 4, and then press the corresponding keys to select 12s, 30s or 60s.

(5) The specimen shall meet the following requirements:

a)The specimen shall be polished with smooth surface so that the edges of indentation are clear enough to ensure the accuracy of measurement. The surface shall be free from oxide skins, oil dirt and any defects. Its hardness should not be changed due to heating or processing.

b)The surface to be tested shall be parallel to the supporting face so that the test force is perpendicularly applied to the specimen surface.

c)The thickness of specimen shall be no less than 10 times to the depth of indentation. Otherwise stipulated, the thickness shall be at least no less than 8 times to the depth of indentation. The depth of indentation shall be equal to 0.102F/πDHBW. If deformations are found at the edges of specimen and its back face, the test shall be regarded invalid and new test shall be done with smaller steel ball and relevant test force.

d)The distance between the center of indentation and edge of specimen shall be no less than 2.5 times to the diameter of indentation. The distance between the centers of two

adjacent indentations shall be more than 4 times to the diameter of indentation. Besides, the distances shall be larger than specified herein for soft metals.

e)After test, the diameters of indentations shall be $0.24D < d < 0.6D$. Otherwise, the test results are invalid and new test shall be done with corresponding test forces.

f)During the process of testing, the axial line of indenter must be perpendicular to the specimen or its tested surface. The test forces shall be applied stably, without any impact or vibration.

g)The diameter of indentation shall be measured along two directions perpendicular to each other and their arithmetic means shall be accepted. The difference of two diameters shall be less than 2% of the smaller one.

4.2. Testing procedures

(1)Clean the top end of lead screw as well as the upper and lower surface of the anvil. Put the anvil into the hole of lead screw. The right anvil should be selected according to the size of specimen.

(2)Clean the supporting surface of specimen and put it onto the anvil. Turn the hand wheel to move the anvil up slowly until the relative slide is produced between the specimen and indenter.

(3)Turn power on and select suitable figure of test force retaining time, then press "START".

(4)Check and confirm test results: at the end of test, turn the hand wheel, remove the specimen, measure the diameters of indentations with reading microscope supplied with the tester, and find out the hardness vale with reference to the table.

(5)Reading Microscope: Please read the Operation Instruction of Reading Microscope. Special attention shall be paid to the optical resources when measuring with microscope. Usually it is much better to measure under natural light at noon. The influence of light to the diameter of indentation shall be taken into consideration when measuring under fluorescent lights.

5.Repair and Maintenance

5.1. Maintenance and Lubrication

Protect the tester with dust-proof cover when it will not be used for a longer period of time.

Fill adequate machine oil to the contacts between lead screw and hand wheel periodically.

The friction surfaces should be lubricated regularly, 2 times per month.

The decelerator should be filled with grease once every half year. (industrial Vaseline)

Inspect the burning or scorching of changeover switch and clean it or replace with a new one if necessary.

At end of all the tests, the weights should be removed and the levers should be fixed before moving to prevent damage.

5.2. Operation precautions

(1) Fitting Indenter: All the indenters are composed of fixing rod, fixing nut and steel ball (Fig 2). Before fitting indenters, the slots and the steel ball must be cleaned with acid-free gasoline and make it dry. Paint some acid-free Vaseline into the slot, fit the steel ball and tighten the fixing nut. During the testing, check occasionally whether the steel ball is loose in the indenter. Otherwise, the test is invalid.

(2) Applying test force: The process is divided into three phase: loading, retaining and unloading. The loading phase starts from pressing “START” to the time when the indicator of test force retaining is on; The unloading phase starts from the indicator off to end of testing. Therefore, it must be checked whether the retaining time conforms to that time selected.

(3) Turning direction on start-up: As soon as the tester is power-on, first of all check whether the turning direction is correct or not.

(4) Selection of power voltage: the voltage should be 380V and must be grounded properly.

(5) Adjusting retaining time: the retaining time need not adjusting once again if the hardness values are the same for several tests. Otherwise, it need adjusting for each specimen.

(6) Temperature of specimen: The temperatures of specimen shall be kept constant during the testing. In other circumstances, the temperature of ferrous metals should not exceed 100°C, but that of non-ferrous metals must be kept under ambient temperature.

5.3. Calibration

Check the accuracy of test force retaining time with a stopwatch. The allowances for it are 12±2 seconds, 30±2 seconds, 60±2 seconds.

(1) Allowance inspection: it shall follow the terms and conditions marked on the standard hardness block. The ratio of the difference between arithmetic mean obtained from five tests at different points on the standard block and the nominal value divided by the nominal value should not beyond ±3%. If the reading allowances are beyond the stipulated, the test forces of the tester must be inspected with a standard dynamometer. Its allowances should be kept within ±1%.

(2) Inspecting the pressure produced by the locator of hand wheel: Remove the weights at end of large lever, turn the hand wheel so that the work table rises up and contacts the main shaft sleeve. Keep on turning hand wheel until it slides, therein the large lever should be propped up. And then let the work table come down, hang the weights to the end of large lever, turn hand wheel so that the work table rises up. When the hand wheel slides, the large lever should be propped up.

(3) Usually calibrate the tester once every three months.

(4) Diameter of steel ball: when the diameter is 2.5mm and 5mm, the tolerance should not be more than ±0.005mm. When the diameter is 10mm, the tolerance should be less than ±0.01mm. No defects should be observed on the surface under a magnifier 5x. The surface finish should be no more than 0.05 micron.

6.Troubleshooting

In case of breakdown, the following may be of help to find out the breakdowns and remedies are recommended. If not successful, contact our aftermarket service department rather than dismantle the tester by yourself.

Table 7 Troubleshooting Guideline

Breakdowns	Reasons	Remedies
Lead screw not elevating fluently	Rusty or chips	Remove the chips around lead screw and hand wheel, and then fill some lubricants
Test results not precise	Distance of indentations	The centers of two adjacent indentations are too close to each other
	Indenter	Replace the indenter if damaged
/	Work table	Check whether there are foreign materials at the contacts of work table and lead screw
		The selected anvil is suitable for the specimen or not
		The protective sleeve of lead screw has propped up the work table
	Specimen	Test force is applied to the specimen perpendicularly or not
		Whether there are burrs on the back
		Too thin
	Surroundings	Mechanical vibration around
		Ambient temperature kept at 10-30ºC
	Others	Calibrate with standard hardness block

7. Packling List

No.	Descriptions	Specification	Quantity	Remarks
1	Brinell Hardness Tester		1 set	
2	Large flat anvil		1	
3	Small flat anvil		1	
4	V-notch anvil		1	
5	Hoisting ring		1	
6	Weight	500kg	5	
7	Weight	250kg	1	
8	Weight	62.5kg	1	
9	Penetrator	¢ 2.5mm	1	
10	Penetrator	¢ 5mm	1	
11	Penetrator	¢ 10mm	1	
12	Carbide ball	¢ 2.5mm	1	Spares
13	Carbide ball	¢ 5mm	1	Spares
14	Carbide ball	¢ 10mm	1	Spares
15	Brinell standard block	100±25HBW	1	
16	Brinell standard block	200±50HBW	1	
17	Readout microscope	20X	1	
18	Accessory box		1	
19	Dust cover		1	
20	Operation Instruction		1	
21	Certificate		1	
22	Packing list		1	

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