

Digital Brinell Hardness Tester

For iqualitrol models SHB-3000C, iBrin-412C

USAGE Instruction Manual

PRECAUTIONS

1. It is necessary to read carefully the usage instruction manual before the operation of the present instrument in order to know the operational procedures and the precautions so as to avoid the damages to the instrument and the personal safety caused by the incorrect operation.
2. During the installment and the preoperational test, the sticking paper that protects the indenter against shock should be taken off carefully.
3. It is advisable to use the single-phase 3-pin plug for the electric connection on the present instrument. The grounding end must be according to the protective earthing requirements.
4. It is prohibited to dismount and alternate without permission all the electric component parts and the switches as well as their fixed positions. Those who do such unwarranted actions will be responsible for their consequences.
5. The rotating wheel should not be moved during the loading, dwelling and unloading of the test force.
6. Our company tries to improve the quality of the hardness testers and renew their structure continuously. In case the contents in the usage instruction manual are a bit different with the actual structure of the instrument, it is hoped and apologized for the fact that the further notice will not be given.

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1. Brief Introduction

1.1 Hardness is one of the important indices of material mechanical performance. And hardness test is the important means to determine metal material or the quality of product parts. Because of the corresponding relation between metal hardness and other mechanical performance, therefore, most metal materials can be measured the hardness to approximately calculate the other mechanical performance, such as strength, fatigue, creep and wear.

1.2 The electric of the instrument uses the loop control system; it can dynamically reflect the real changes of the test force. During the whole dwell time, the display window “test force” constantly shows the instantaneous force value, with the indenter gradually pressed into the specimen, force value decreases. And when the value is reduced to a prescribed error range, the instrument will automatically adjust that the test force will always be maintained in the specified range.

1.3 Brinell hardness test is mainly used in hardness measurement for cast iron, steel products, nonferrous metals and soft alloys, etc. Besides it can be also used in hardness measurement for some nonmetal materials, such as rigid plastics, bakelite, etc.

1.4 Brinell hardness test is to use a steel ball of a certain diameter to press on the specimen surface with specified test force (see Fig.1). After the specific time of holding test force, unload the test force and measure the average diameter of indentation of specimen surface with reading microscope. Then the Brinell hardness value can be checked out from the control table.

1.5 Brinell hardness calculating formula is as follows:

$$HB = 0.102 \times \frac{2F}{\pi D (D - \sqrt{D^2 - d^2})}$$

Where: F-----Test force (unit: N);
 D-----Diameter of ball (unit: mm);
 d-----Diameter (average) of indentation (unit: mm);
 0.102-----Special factor.

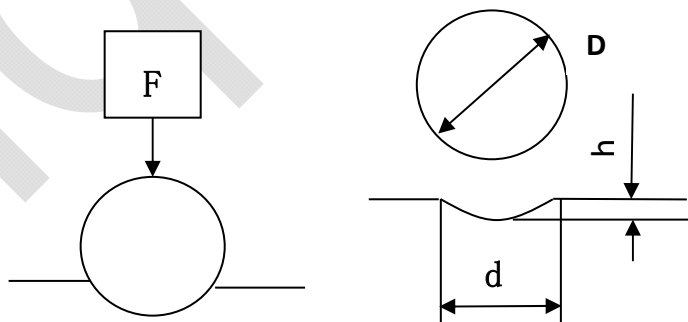


Fig.1

2. Main Technical Specifications

2.1 Test Force:

First Class	Second Class
612.9N (62.5kg)	4903N (500kg)
980.7N (100kg)	7355N (750kg)
1226N (125kg)	9807N (1000kg)
1839N (187.5kg)	14710N (1500kg)
2452N (250kg)	29420N (3000kg)

2.2 The Indenter Specifications: $\phi 2.5\text{mm}$ ball indenter; $\phi 5\text{mm}$ ball indenter; $\phi 10\text{mm}$ ball indenter

2.3 Optical System:

Objective	1 ^x
Measuring Eyepiece	20 ^x
Total Amplification	20 ^x
Resolution Rate	0.00125 mm

2.4 Maximum Height of Specimen:

225mm

2.5 Distance from the Indenter Central Point to the Instrument Body:

135mm

2.6 Time-delayed Control:

5~60 seconds, adjustable

2.7 Power Source:

 AC220V \pm 5%/50~60HZ

2.8 Overall Dimension (L \times W \times H):

 (545 \times 235 \times 790) mm

2.9 Main Body Weight:

130kg

2.10 Hardness Range:

8~650HBW

2.11 The selection of test force should make the indentation diameter in $0.25D < d < 0.6D$ range: When $d = 0.37D$, the hardness value is the most accurate. (d—indentation diameter, D—ball diameter)

2.12 Repetition and tolerance of displayed value for the hardness tester:

Standard hardness test block	Tolerance of displayed value%	Repetition of displayed value%
≤ 125	± 3	3
$125 < \text{HBW} \leq 225$	± 2.5	2.5
> 225	± 2	2

Table.1

2.13 To ensure the correctness of Brinell hardness test, it should meet the requirements in the table as follows:

Material	Brinell hardness	F/D ²
Steel, nickel alloy, titanium alloy	---	30
Cast iron	< 140	10
	≥140	30
Copper & copper alloy	< 35	5
	35~130	10
	> 130	30
Light metal & its alloy	35	2.5
	35~80	5,10
	> 80	10

F—test force (kg) ; D—ball diameter (mm)

Table.2

2.14 Correspondent relations among scale, indenter and test force:

Hardness symbol	Diameter of Indenter mm	F/D ²	Test Force N(kg)
HBW 10/3000	10	30	29420(3000)
HBW 10/1500	10	15	14710(1500)
HBW 10/1000	10	10	9807(1000)
HBW 10/500	10	5	4903(500)
HBW 10/250	10	2.5	2452(250)
HBW 10/100	10	1	980.7(100)
HBW 5/750	5	30	7355(750)
HBW 5/125	5	5	1226(125)
HBW 2.5/187.5	2.5	30	1839(187.5)
HBW 2.5/62.5	2.5	10	612.9(62.5)

Table.3

3. Installation and Testing

3.1 Operational Conditions

- 3.1.1 Room temperature within 10~30 °C;
- 3.1.2 Relative room humidity inferior to 65%;
- 3.1.3 In an environment without any shock or vibration;
- 3.1.4 In a surrounding without any corrosive medium.

3.2 Unpacking

3.2.1 Cut the packing belt, loosen the lower screws, lift up the case, and then take out the accessories kit.

3.2.2 Screw out the two M10 outer hexagon bolt at the bottom with wrench to separate the hardness tester and the bottom plate (safety first).

3.2.3 Place the instrument on a stable working table and adjust it to the horizontal. Open a hole at the appropriate position on working table (see Fig.2) in order to make the lifting screw work.

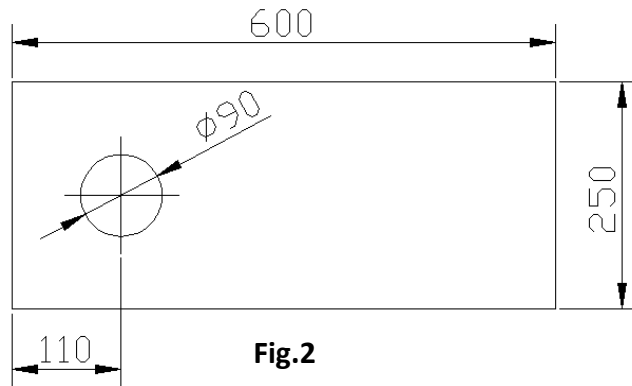


Fig.2

3.3 Installation

3.3.1 Open the upper cover and unpack the white gauzes that fix movable parts. Remove the cushion block between the lifting screw and ball indenter (see Fig 3).

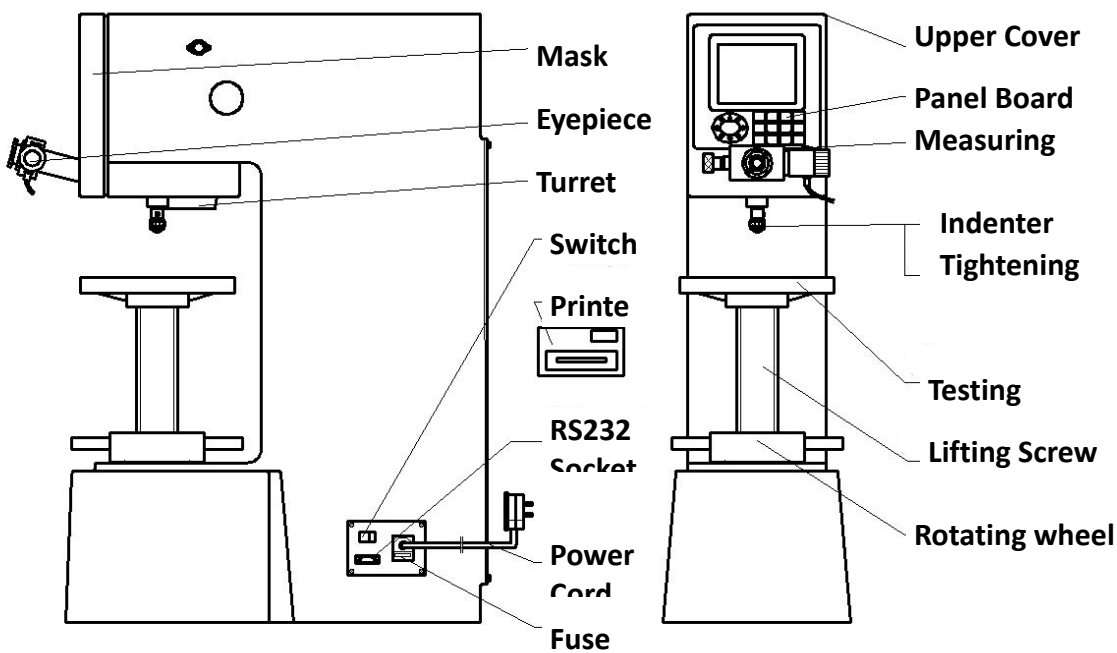


Fig.3

3.3.2 Observe the cutter head group behind the mask whether the cutter head is falling into the cutter groove. If the cutter head is not in the cutter groove, please press the main lever and suit the cutter groove on the cutter head (see Fig.4). (This generally does not occur; it happens only in the strong vibration).

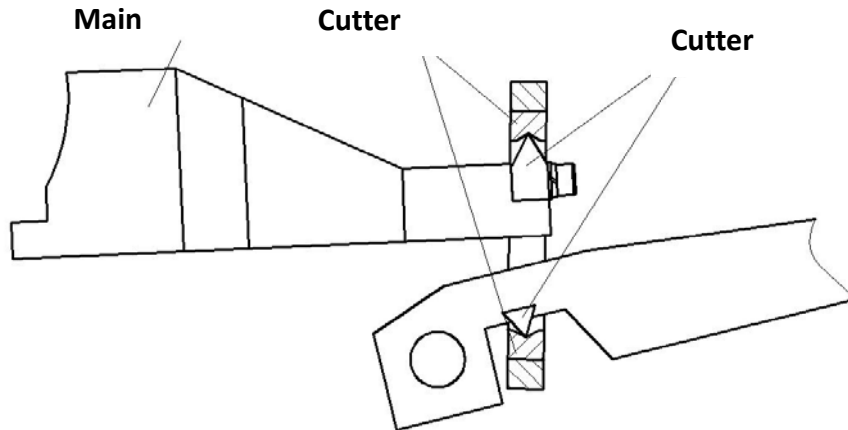


Fig.4

3.3.3 Remove the eyepiece cover and insert the eyepiece to the tube (pay attention to insert to the bottom), and connect the power cable.

3.3.4 Take out the test table and install on the lifting screw.

4. Introduction to the Panel Board and Its Functions (see Fig.5)

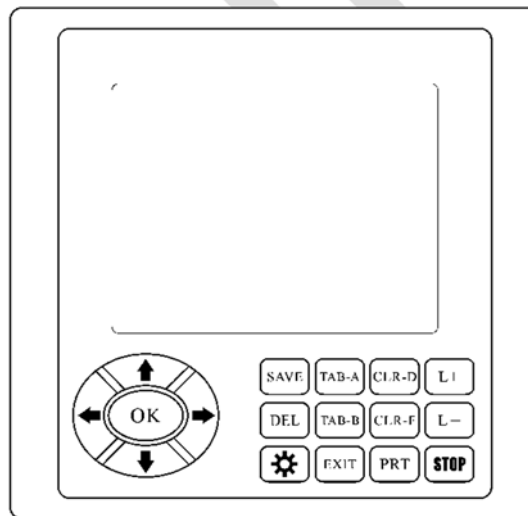
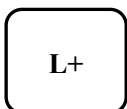


Fig.5



“L+” key: to increase the brightness of light source. The instrument emits a “Du” sound indicating that brightness is increasing. A light value changing from 0 to 100% is displayed on the lowest line of home page (see Fig.6). When it emits “Du, Du, ...” constant sound, it means maximum brightness has been reached.



“L-” key: to decrease the brightness of light source. Use as the method above.

Home Page

Measurement		Loading	
D1: 0.00mm		F: 0.0	
D2: 0.00mm		Range 95.5—653HBW	
0.0 HBW			
HRC	NO. 00	2005/03/15-15:10:06	
Loading	Indenter	Dwell	Light Change Time

Fig.6

STOP

“STOP” key: for emergency stop/display of original data. Press this key when need to stop operation during the loading period. The tester will stop loading and return back to initial settings. This key shall not be carelessly pressed other than the loading period, once pressed, then press “CLR-F” key to return back to original state.

CLR-D

“CLR-D” key: zero setting key. It is used to set zero for the two graduation lines in the eyepiece.

CLR-F

“CLR-F” key: zero setting key. If there is a residual test force left on display when the whole test force is removed (the indenter is separated from specimen), press this key to set zero.

PRT

“PRT” key: print and serial interface data loading key. Press this key to print out the data of current test or send the data through RS232 to the PC COM interface. Press “TAB-B” first if it is needed to print.

DEL

“DEL” key: to delete the current data. If you think the D1 or D2 value has errors, press this key to delete the data of the present measurement and measure again.

TAB-A

“TAB-A” key: to enter the page and choose the test force and indenter (see Fig.7). Press “OK” key to confirm and return back to the home page.

TAB-A

F/D ²	30	15	10	5	2.5	1.25	1
D (mm)	TESTER FORCE						
10■	3000■	150 0	1000	500	250	125	10 0
5	750		250	125	62.5		
2.5	187.5		62.5				
HRC		NO. 00		2005/3/15_15:15:18			
Loading	Indenter	Dwell	Light	Change	Time		
3000	10.0mm	15s	60%	HRC	YEAR		

Fig.7

TAB-B

TAB-B key: to enter the DATA SAVE page.

1. When $NO \geq 1$, press this key to open the page, showing the current hardness test data (see Fig.8). The page contains: NO standing for the test number, D standing for the average value of D1 and D2, and HB standing for the hardness value.
2. If you want to save the page, press "SAVE" key and return back to the home page.
3. If you press "OK" key, it does not save the present page, but comes back to the main page.
4. Press the up and down key to turn over the pages to check the data you have saved. The data will be canceled after shutdown.

SAVE

"SAVE" key: to save the page. Press "TAB-B" key to open the page first. When you need to save this page, press "SAVE" key and the page will be automatically numbered and saved as document forms and then return home. The page you can save is up to 6 (00 page ~ 05 page), when you want to save the 7th page, it will automatically overflow the first page. Each page can store 20 sets of data. It will cancel the saved page data after shutdown.

OK

1. When the screen shows the main page, press this key and the cursor will flash on the one of the state mode waiting for setting. After the parameters are set, press this key, the cursor will disappear.
2. When the screen shows the "TAB-A" page, select the test force and indenter and press this key to confirm and return to the home page.
3. When the screen shows the "TAB-B" page, press this key, it does not save the present page and return to the home page.

Leftward direction key: This key serves to move the cursor on the mode state to the left.

Rightward direction key: This key serves to move the cursor on the mode state to the right.

TAB-B

No	D(mm)	HB				
01	.428	15.11				
02	.426	15.49				
03	.412	18.19				
04	.423	16.00				
05	.420	16.77				
06	.422	16.26				
MIN=315.11			AV=316.30		MAX=318.19	
P=05						
34.6 HRC		NO. 06		2005/03/15_16:20:10		
Loading	Indenter	Dwell	Light	Change	Time	
3000	10.0mm	15s	60%	HRC	YEAR	

Average HB Value

Min. HB Value

Max. HB Value

Number of page

Fig.8


Upward direction key: When press "OK" key and the cursor flashes on one of the state mode, press this key to:

1. Increase the values of the year, month, day and minute in the mode of Time; Upward select the hardness scales in the mode of Change; Intensify the brilliance of the light in the mode of Light; Increase the dwell time in the mode of Dwell, each press adding 5 seconds.
2. Select the test force and indenter after opening "TAB-A" page.
3. Turn over to the previous page after opening "TAB-B" page.



1. Downward direction key: When the cursor flashes on one of the state mode, press this key to do what is in contrast with the above functions.
2. Press this key to turn over to the next page after opening "TAB-B" page.

5. Usage of the Instrument

5.1 Preparatory work

5.1.1 The instrument power source should be reliably grounded and have a voltage stabilizing device.

5.1.2 The surface of the specimen must be clean. There can't be dirty, oxide skin, pits or significant processing trace to ensure that the diagonal line of indentation can be accurately measure.

5.1.3 The minimum thickness of the specimen shall be more than 10 times the depth of the indentation. There can't be visual deformation traces on the back of specimen after testing.

Relationship between minimum thickness of specimen and hardness (see Table.4).

Average diameter of indentation d	Minimum thickness of specimen			
	Diameter of steel ball			
	D=1	D=2.5	D=5	D=10
0.2	0.08			
0.3	0.18			
0.4	0.33			
0.5	0.54			
0.6	0.8	0.29		
0.7		0.4		
0.8		0.53		
0.9		0.67		
1		0.83		
1.1		1.02		
1.2		1.23	0.58	
1.3		1.46	0.69	
1.4		1.72	0.8	
1.5		2	0.92	
1.6			1.05	
1.7			1.19	
1.8			1.34	
1.9			1.5	
2			1.67	
2.2			2.04	
2.4			2.46	1.17
2.6			2.92	1.38
2.8			3.43	1.6
3			4	1.84
3.2				2.1
3.4				2.38
3.6				2.68
3.8				3
4				3.34
4.2				3.7
4.4				4.08
4.6				4.48
4.8				4.91
5				5.36
5.2				5.83

5.4				6.33
5.6				6.86
5.8				7.42
6				8

Table.4

5.1.4 The specimen should be stably put on the testing table, and can't be moved or distorted during the test. The test force must be vertically applied on the specimen.

5.2 Usage of the instrument

5.2.1 Install the indenter into main shaft hole and make it close to the bearing surface. Aim the notch of the indenter to the screw, and then tighten the indenter and the screw.

5.2.2 Turn on the power switch, the instrument automatically adjusts into the starting position and the screen shows the home page (see Fig.6).

5.2.3 Press "TAB-A" key to open the page, select the test force and indenter for the requirements (see Fig.7), and then press "OK" to return to home page.

5.2.4 If the parameters do not meet your requirements, please press "OK" key, and the cursor flashes on the mode state, press arrow keys to modify the parameters you need, after selection press "OK" key to confirm.

NOTE: Apply the 3000kgf test force 2~3 times before normal use of the instrument and press the measuring button twice after preloading, so as to eliminate mechanical deformation amount, make electric components in normal operation and decrease test errors.

5.2.5 When preparatory work is finished, press "CLR-F" to set zero if there are remainders in test force window. Place the specimen evenly on the testing table and rotate the wheel to raise testing table. Continue rotating the wheel when the specimen touches the indenter, and the window "F" begins to display test force.

5.2.6 The instrument has ten levels and the manual loading force divides into two:

62.5kg~250kg are first class test forces, rotate the wheel to make the window display about 30kgf;

500kg~3000kg are second class test forces, rotate the wheel to make the window display about 90kgf.

5.2.7 When the instrument emits a "Du" sound, stop rotating the wheel and the instrument automatically applies the test force. If the manual force is too large, the instrument emits a "Du, Du, ..." constant sound and does not work, please descend the testing table, change the test point position and redo it.

5.2.8 When the instrument enters automatic loading state, the screen shows the blinking downward arrow.

5.2.9 After test force application finishes, dwell state begins and the dwell time shows countdown to zero.

NOTE: Dwell time of test force: 10~15 seconds for ferrous metal, 30 seconds for nonferrous metal, 60 seconds for those hardness value is less than 35HBW.

- 5.2.10 After dwell time ends, it enters unloading state and the screen shows the blinking upward arrow, the lever returns to the starting position.
- 5.2.11 Rotate the wheel reversely to make the specimen and the indenter separated, and the distance between the specimen and indenter is about 10mm.

5.3 Measurement of the indentation diameter

- 5.3.1 Rotate the turntable to make the objective face in the frontal direction of the instrument. Rotate the wheel slowly until the indentation forms a clear image in the eyepiece.
- 5.3.2 Before measuring the indentation, rotate the eye guard to enable two graduated lines clearly observed in eyepiece (see Fig.9).
- 5.3.3 Rotate the left and right drum wheel to enable inner side edges of two graduated lines move closely without limit between them, the light slot between graduated lines become smaller and smaller till reaching critical state with no light slot. Press “CLR-D” key to set zero (see Fig.10).

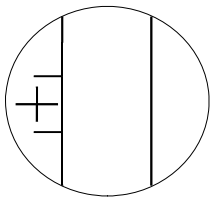


Fig.9

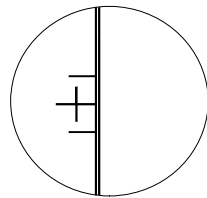


Fig.10

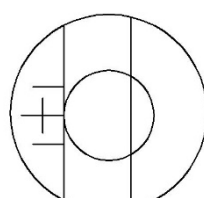


Fig.11

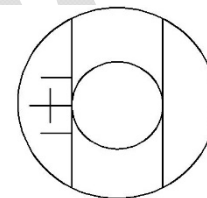


Fig.12

NOTE: The instrument has memory for setting the zero. It is necessary to reset the zero only when the instrument is re-started after it is closed. When new operator comes, please set the zero so as to keep the accuracy for the measurement.

- 5.3.4 Rotate the left drum wheel to enable the inner side of left graduated line tangent to the left tip of the diagonal line of the indentation (see Fig.11).
- 5.3.5 Rotate the right drum wheel to enable the inner side of right graduated line tangent to the right tip of the diagonal line of the indentation (see Fig.12).
- 5.3.6 Press the input measuring button on the eyepiece and the screen shows D1 value.
- 5.3.7 Turn the eyepiece clockwise 90°, during the turning operation, the eyepiece should move along the inner side of the eyepiece tube without any space between them, otherwise it would affect the correctness of the measurement. Measure other diagonal line length of indentation as same way. Press the input measuring button on the eyepiece, the screen shows D2 value. The system calculates hardness value automatically and shows testing results (HBW value) automatically as well. Thus one test ends, and test number “NO” shows 1.
- 5.3.8 If the operator is not sure of the correctness of the measurement, press “DEL” key to repeat to measure again.
- 5.3.9 The hardness test should be uniformly distributed on the specimen. The distance between two adjacent indentation’s centers should be not less than 3 times the diameter of the indentation; the distance between the indentation center and the edge of the specimen should be not less than 2.5 times the diameter of the indentation. Please test according to what mentioned above, otherwise the indentation will be asymmetric and the hardness value will be incorrect.
- 5.3.10 Each indentation diameter is measured on two vertical directions. The ratio of the diameter difference on two vertical directions and the shorter diameter should not be greater than 1%.

6. Precautions

- 6.1 Before ex-factory this instrument is up to the state standards through overall test for delivery, but due to the causes of assembly and disassembly, transportation or voltage, it may cause some changes in the instrument data. Generally it can be handled as follows:
- 6.1.1 Apply 29420N test force to press several times in each starting of the instrument, so as to eliminate mechanical deformation amount, make electric components in normal operation and decrease test errors.
 - 6.1.2 Loading and unloading signal of each level test force is feed back by the sensor, and the output signal of the sensor is very sensitive. So we equip the anti interference assembly in the circuit. But in order to ensure the instrument normal work and avoid unnecessary damage, the instrument should avoid using around strong interference source.
- 6.2 The instrument power source should be reliably grounded and have a voltage stabilizing device.
- 6.3 The instrument will issue some noise in the process of loading and unloading; it is a normal phenomenon that the loading device is automatically adjusting.
- 6.4 The active surface of such as the lifting screw should be periodically lubricated with grease.
- 6.5 Turn off the power source after the test is completed.
- 6.6 The instrument should be kept clean and covered with dust shield after finishing the test. The hardness blocks and the ball indenter should be coated with antirust oil to prevent rusting.
- 6.7 The instrument should do periodic inspection, at least once a year to ensure the accuracy of the hardness tester.