

# Digital Brinell Hardness tester

**SHB-3000D**

**Instruction Manual**



## Special Attentions

1. A single-way three-pole socket is to be used as the power supply for this apparatus, and the earth-connected terminal shall be connected in accordance with the requirements of protective grounding.
2. This Instruction Manual shall be carefully read through prior to the use of the apparatus to clearly understand the detailed operation steps and special notes, and avoid the apparatus damages or personal injuries caused by improper uses.
3. All the components, switches and sockets shall be dismantled or the location changed only by qualified professionals, otherwise accidents might be caused.
4. Mechanism or appliances in the apparatus shall never be wantonly changed without the permission of the manufacturer, otherwise the manufacturer shall bear no liability for apparatus damages or personal injuries thus caused.
5. During the operation of loading and unloading the carriage, it is not allowed to rotate the rotary wheel.
6. Our company intends to improve the quality of the hardness testers by renovating the structure from time to time. If the Instruction Manual describes the contents and the structure somewhat different from the actual contents and structure, please give us pardon if no notice is given.

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# Introduction

1.1 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 non-ferrous materials , such as plastics, bake-lite, etc.. It is applicable to factory, workshop, laboratory, university and college, and scientific research institution.

1.2 The digital Brinell hardness test is to use a steel ball of a certain diameter to press on the substance surface to be tested with specified test force (fig.1). Through the specific time of holding test force, remove it and measure the diameter of the indentation of the specimen surface with reading microscope. Take the two points d1 and d2 and input them and on the LCD screen appears the Brinell hardness value.

1.3 Brinell hardness value can be obtained from the following calculating formula.

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

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

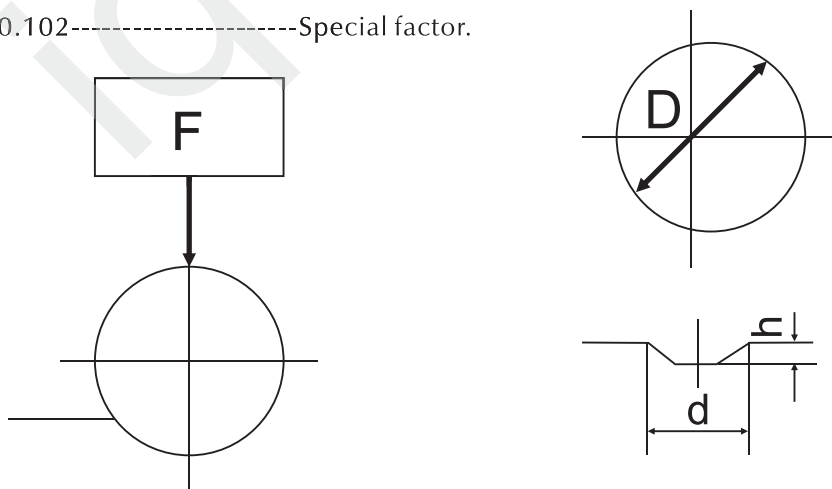


Fig 1

## Main Technical Specifications

### 2.1 Testing Force:

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 Value –Indicating precision (Table 1)

**Table 1**

Standard hardness test block	Max error of the indicated value	Repetition error of the indicated value
$\leq 125$	$\pm 3\%$	3%
$125 < \text{HBW} \leq 225$	$\pm 2.5\%$	2.5%
$> 225$	$\pm 2\%$	2%

### 2.3 Correspondent Relations among Scale, Indenter and Test Force (Table 2)

**Table 2**

Hardness Symbols	Diameter of Indenter (mm)	F/D <sup>2</sup>	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 5/250	5	10	2452(250)
HBW 5/125	5	5	1226(125)
HBW 5/62.5	5	2.5	612.9(62.5)
HBW 2.5/187.5	2.5	30	1839(187.5)
HBW 2.5/62.5	2.5	10	612.9(62.5)

### 2.4 Specifications of Indenter : Steel Ball $\varnothing 2.5\text{mm}$ , $\varnothing 5\text{mm}$ , $\varnothing 10\text{mm}$ :

### 2.5 Hardness Measurement Range: 8~650 HBW

### 2.6 Amplification of Reading Microscope: 20x

### 2.7 Minimum Division Value of Micrometer Drum Wheel: 0.00125mm

### 2.8 Maximum Height of Sample: 220mm

### 2.9 Distance from Indenter's center to instrument Body: 135mm

### 2.10 Voltage of Power Source : AC220V $\pm 5\%$ , 50~60Hz

### 2.11 Dimension of Tester (L $\times$ W $\times$ H): 542 x 205 x 753mm

### 2.12 Weight of Tester: About 123kg

## Installation and Test of the Instrument

### 3.1 Working conditions

- 3.1.1 Under room temperature within  $23 \pm 5^\circ\text{C}$ ; If the temperature is superior to the range, it should be indicated in the test report.
- 3.1.2 Placed in an environment free of vibration;
- 3.1.3 Placed in an environment free of corrosive medium;
- 3.1.4 Installed and leveled on a stable base. (Its shape and size are only for reference) Levelness should not exceed 0.2/1000. Drill a  $\phi 90\text{mm}$  hole on the working table for the lever elevation. (fig 2)

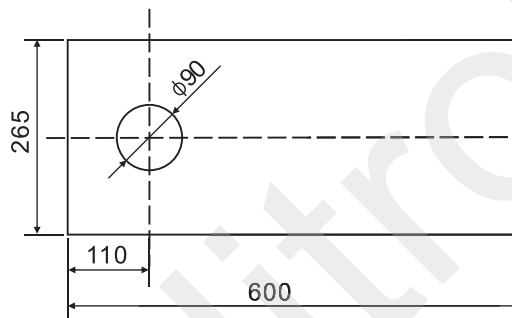


Fig 2

### 3.2 Unpacking & Installation

- 3.2.1 Remove the packing box and take out the main machine and accessory box.
- 3.2.2 Place the tester on the working table, remove the spacer between the elevating lead-screw and clean the lifting lever with gasoline, and the after drying, coat it with moderate amount of thin machine oil for lubrication.
- 3.2.3 Open the top cover, and remove the anti-shock foamed plastic spacer beside the lever, and watch the knife mat shelf, the knife point must be in the knife mat; if not, please press the main lever to place the knife spacer supporter on the knife mat, fig 3. (It won't occur without violent vibrations or shocks.) Replace the top cover.
- 3.2.4 Plug the power cord for the microscope and turn on the switch. The tester is now ready for the operation. (see Fig. 3)

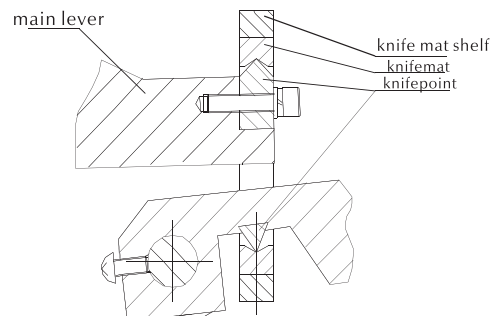


Fig 3

### 3.3 Introduction to the Functions of the Operational Panel

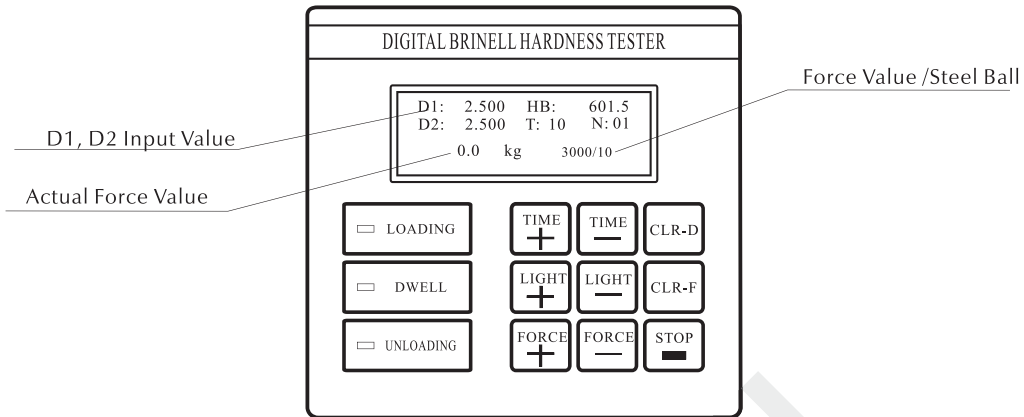


Fig .4

3.3.1 The indication of the output value is made by LCD indicator and the LED. The screen shows the input values D1 and D2, the HB hardness value, the actual test force (the instantaneous value), the test force/the steel ball, the dwell time, the number of the hardness tests and the state of loading and unloading.

3.3.2 Force Value Display: when the test with the carriage loading is being made, the instrument shows the actual force value (the instantaneous force value, unit: kg.), as 3000kg.

3.3.3 Dwell Time: when the loading is completed, the dwell time is shown by back-counting, with the dwell time range is 05~60 seconds, 12 durations in all. Generally speaking, the dwell time is set at 15s.

3.3.4 Testing status display: in testing it is divided into 3 stages: in loading stage **LOADING** the lamp lights up; the holding loading stage **DWELL** the lamp lights up; the unloading stage **UNLOADING** the lamp lights up.

3.3.5 Input Function Key: 9 keys are installed on the panel, two dwell time increasing or reducing keys, two test force increasing or reducing keys, and two illumination increasing or reducing keys. Whenever push the key once, it will emit a “du” sound. In selecting the maximum or minimum, push it once again, it will emit a long “du……” sound, it indicates that the value is up to the maximum value or the minimum value.

- TIME +** Dwell time increasing key, push it once, you will increase 5 sec.
- TIME -** Time decreasing key---- push it once, you will decrease 5 sec. accompanied by a “Du” sound.
- LIGHT +** Light intensity increasing key. Press it once and you will hear a “ Du ”sound, showing the light intensity is increasing.
- LIGHT-** Light intensity decreasing .Press it once and you will hear a “Du” sound, showing the light intensity is decreasing.
- FORCE+** Test Force (kg)/steel Ball (mm) selecting key. The pressure on the key will increase the test force within the range shown in Table 2.Note: Take care to change the steel ball.

- FORCE-** Test force (kg)/steel ball (mm) selecting. One pressure on the key will decrease the test force for the selection within the range as described above.
- CLR-D** Zero setting key, the digital microscope is set at zero.
- CLR-F** Zero setting key. When all the carriage is unloaded (with the working parts and the indenter disengaged), and the screen shows there are still some remaining rest force value, use the key to set zero.
- STOP** Stopping key, when the hardness tester finishes the test or needs to be stopped, press the key. With the pressure of the key, the carriage returns to its original position.

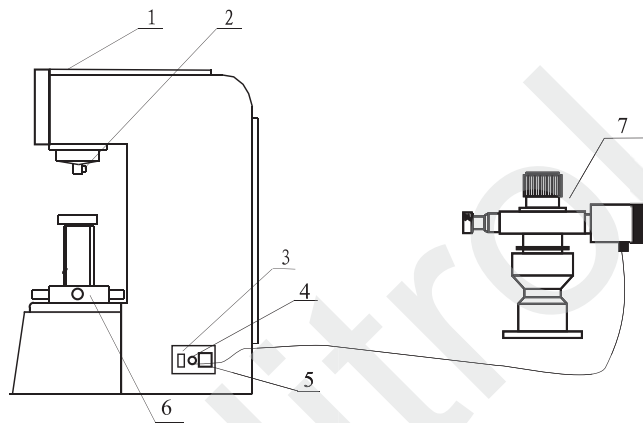


Fig 5

- 1. Top Cover
- 2. Tightening Screw
- 3. Switch
- 4. Socket for the Microscope
- 5. Socket for the Alternative Electric Source
- 6. Rotary Wheel
- 7. Digital Microscope

### 3.4 Usage of the Tester (Fig.5)

- 3.4.1 Take the digital microscope out of the accessories box and insert the plug into the tester's socket (4).
- 3.4.2 Take care when the indenter is installed :It is necessary to set the test force at  $\geq 500\text{kg}$ , and then rotate the rotary wheel (6) to lift the testing table slowly up and when the specimen touches the indenter, tighten up the screw (2) at the flat of the indenter and the lower down the testing table.
- 3.4.3 Place the specimen firmly on the testing table and make sure that there occurs no offsetting or bending during the operation.
- 3.4.4 Turn on the power switch and the lever automatically enters its initial working position. At this point, the front panel shows D1: and D2:, HB:. If the test forces leave a residual value, press the CLR-F key to clear it. For the start of the instrument the test force is set at 3000kg, using an indenter with the diameter 10mm and the dwell time set at 15 seconds. If you want to select other test force and dwell times, please refer to the introduction to the functions of the operational panel described before.

The instrument provides 12 test forces in 2 groups:

The first group: 62.5kg~250Kg, test force  $> 30\text{kg}$  set manually, and the instrument automatically loads the carriage. The second group: 500kg~3000kg, test force  $> 90\text{kg}$ , set manually and the instrument automatically loads the carriage.



3.4.5 When the preparations before the test are made, place the specimen firmly on the working table, turn the hand wheel to make the indenter touch the specimen lightly. At this time, the test force is shown. When the test force rises up slowly to the automatic carriage level, the instrument produces a “Du” sound. At this point, stop turning the hand wheel. The carriage loading lamp [LOADING] lights up, and the instrument automatically loads the carriage up to the selected value; at the time of the instrument reaching the selected value, the dwell time lamp [DWELL] lights up, showing the instrument enters the back-counting dwell time. When the dwell time is up, the dwell time lamp goes off and the carriage unloading lamp [UNLOADING] lights up, showing the instrument starts to unload the carriage. When the unloading is finished and the indicating lamp goes off, turn the rotary wheel in a reverse way to make the indenter lift from the specimen. At this point, the level returns to its initial position. The test is completed.

**Note: When the first group of test forces are applied, and your operation adopts too great a force to make the automatic carriage value set at  $\geq 40\text{Kg}$ , the instrument will not work. At this time, please turn the hand wheel in a reverse way to unload all the carriage and repeat the correct operation with the processes described above. When the value closes up to the automatic loading value, you should turn the hand wheel slowly.**

3.4.6 The instrument adopts the closed-loop system for its electric control of the machine, and hence it dynamically reflects the actual conditions of the loading variations at the phase of loading the carriage. During the entire dwell time, the carriage showing tube continuously shows the instant test force value, while the indenter gradually enters the specimen, the test force decreases gradually until the minimum set value, and then instrument carries out the compensation in order to keep the carriage within the range of the set values.

3.4.7 The selection of the test force should keep the diagonal of the indentation within the following range:

$$0.25D < d < 0.6D$$

d----the diagonal of the indentation    D----the diagonal of the steel ball

3.4.8 In order to assure the correct test of the Brinell hardness, it is necessary to meet the requirements set in Table 3.

**Table 3**

Material	Brinell Hardness	F/D <sup>2</sup>
Steel and Cast Iron	<140	10
	$\geq 140$	30
Copper & Copper Alloy	<35	5
	35~130	10
	>130	30
Light Metals & their Alloys	35	2.5
	35~80	5,10
	>80	10

F—Test Force (kg)    D—Diameter of Steel Ball(mm)

**Table 4**

Average Diameter of Indentation d	Minimum Thickness of Test Sample			
	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

- 3.4.9 The minimum thickness of the specimen should be greater than the 10 times of the indentation depth. After the test, no deformed appearance should be seen on the back of the specimen, otherwise the test should be regarded as invalid. And then it is necessary to select the right diameter of the steel ball or the test force again the relations between the minimum thickness and the hardness are shown in (Table 4)
- 3.4.10 The dwell time of the test force: 10~15 Second for ferrous metals, 30 seconds for non-ferrous metals while 60 seconds are set for the hardness inferior to 35 HBW.
- 3.4.11 The distance of the indentation center away from the edge of the specimen should not be less than 2.5 times of the indentation diameter, whereas the distance between the two adjacent indentation centers should not be less than 3 times of the average diameter of the indentation. When the hardness is inferior to 35HB, the distance mentioned above should be 3 times and 6 times of the average diameter of the indentation respectively. If the test is carried out not according to this norm, an unsymmetrical phenomenon will appear on the indentation, and the hardness value will be either too low or too high, and hence the test won't yield a correct test data.
- 3.4.12 The correct way is to measure the indentation diameter from the two directions which are vertical to each other, and take their arithmetic average value, the difference of the two indentation diameters thus measured should not exceed 2 per cent of the smaller diameter.
- 3.4.13 The specimen should be made with a smooth surface whose roughness should not be inferior to, if the diameter of the steel ball is  $\phi 2.5\text{mm}$ , the roughness of the specimen surface should be, so as to have a clear edge of the indentation and produce a correct test result. The specimen surface should not have any oxide-coating, any electroplated coating, or any dirt caused by the heating, or other kind of dirt.

## Adjustment & Special Attentions

- 4.1 During the overall test of the instrument before it is turned out of the factory, all the technical specifications are made to meet the norms set up by the State, but due to the causes of assembly, disassembly and transportation, there might appear some variations in the test values of the hardness tester. Thus it is hoped that before the use of the instrument, some adjustments may be made with the methods described as follows:
- 4.1.1 The hardness tester should be placed in an environment with the temperature within the range of  $(23 \pm 5)^{\circ}\text{C}$ , and before the testing operation, the instrument should be connected with the power source and put into the preparatory state for half an hour so as to pre-heat all the component parts of the machine before the test with the objective of assuring the test precision.
- 4.1.2 Apply 29400N test force to press several times when you start the machine so that it may avoid the mechanical deformation and the electric components may operate normally so as to decrease the test errors.
- 4.1.3 The signal of the loading and unloading of each level of the test forces can be obtained from the feedback of the sensor, but the output signal of the sensor is quite feeble, and therefore an anti-interference module has been installed in the circuit. In order to ensure the normal operation of the instrument and avoid the possible occurrence of unnecessary damages to the machine, please get off the strong current interference in the surrounding area of the instrument during the operation and close the instrument as soon as the test is completed.
- 4.2 All the screws and their caps of the hardness tester are tightened before it is turned out of the factory, but during the operation of loading and unloading the carriage, the shaft is constantly in the right and reverse movements, and so if by any chance there occurs an abnormal sound in the revolution, please check to see whether the two screw-caps of the belt wheel are loosen. If so, tighten the caps with a tool. (See Fig.6)
- 4.3 The power source of the instrument should have a trustful ground-connected cable and a voltage stabling apparatus.
- 4.4 During the operation of loading and unloading the carriage, the instrument may produce a slight sound, which is a normal phenomenon as the loading device is making an automatic self-adjustment.

## Maintenance of the Hardness Tester

- 5.1 All the active surfaces, such as the ascending and descending axle, should be periodically lubricated with grease.
- 5.2 After the test is completed, the power source should be turned off.
- 5.3 The hardness tester in disuse should be covered with a dust-preventing cover, so as to prevent the dust from entering into the interior of the machine.
- 5.4 If the instrument has rested in disuse for a period of time, and then it is to be used again, after the starting the machine it should take some time for the interior electric devices to be pre-heated so as to insure the operational precision.
- 5.5 The lifting and lowering of the lever of the Brinell hardness tester has a limit position. A magnet is placed at the tail of the lever, and a sensor is installed at the upper limit position and the lower limit position each ( see Fig.7) After the start of the instrument, the motor works and the lever goes up. The upper limit position receives the signal and the motor stops and the rotate again and the lever returns to its initial position. Take care not to shift the upper and lower limit positions.

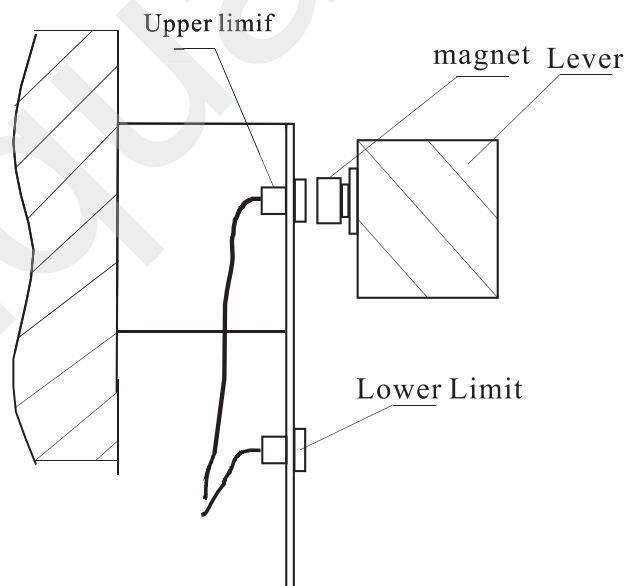


Fig.7

## Usage and Application of the Digital Microscope

6.1 Usage of the Digital Microscope (see Fig.8): The digital microscope supplier is mainly used for the measurement of the indentation of the Brinell hardness. Its structure is simple and its operation is easy. When the indentation diameters  $d_1$  and  $d_2$  are input, the LED screen directly shows the Brinell hardness.

6.2 Technical parameters of the Digital Microscope:

6.2.1 Amplification of the Digital Microscope : 20x

6.2.2 Minimum Reading, ( graduation value ) of the Drum Wheel: 0.00125mm

6.3 Usage Methods

6.3.1 Put the microscope over the test block or the specimen, regulate the illumination in the range of Light+ or Light-, and then in the vision you will see clearly the characters and the lines on the graduated plate.

6.3.2 Rotate the drum wheels on both sides of the microscope and you can see the two graduated lines move closer to each other. When the edges of the lines are very close to each other and no light passes through the chink, press the key "CLR-D"(the zero setting key) to set it at the zero position.

6.3.3 Rotate the drum wheel to make the inner side of the left graduated line touch the **left edge** of the indentation and then make the **inner side of the right** graduated line touch the **right edge of the indentation**, and press down the button on the objective. The measurement of  $D_1$  is completed and the displaying screen shows the data of  $D_1$  (see Fig.9)

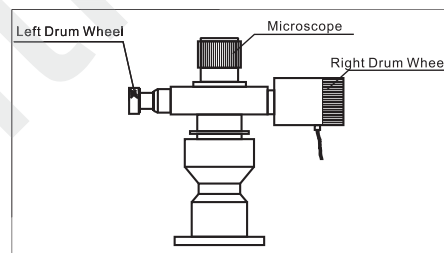


Fig 8

6.3.4 Rotate the microscope by  $90^\circ$  (attention: when you rotate the microscope rotate it closely you the microscope tube), and use the above-mentioned method to measure another diameter. Press down the button on the microscope and the displaying screen shows the data of  $D_2$  and the HB hardness value at the same time. The hardness value is the arithmetic average of the two lengths of diagonals .A test is thus completed.

6.3.5 The reading precision of the microscope is just regulated at the time when the instrument is turned out of the factory. It is prohibited to dismantle it, otherwise the precision is not insured, and the client should take up the responsibility.

6.3.6 During the deposit and the use of the microscope, it should not be placed in a humid environment which should be free from dust and corrosive air.

6.3.7 If there is some dirt on the surface of the microscope, use the absorbent cotton on the glass cleaning paper to clean it. When it is dirtied with oil stains, use the absorbent cotton with little alcohol and ether to erase it lightly.

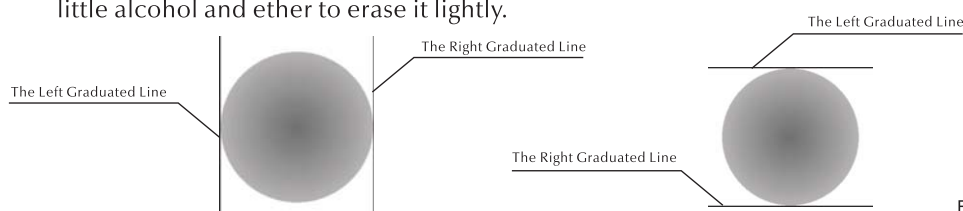


Fig 9

## The Accessories (The Packing List)

No.	Description of Goods	Code#	Quantity
1	Instrument Main Body	831-121	1 PC
2	20x Digital Microscope	831-221	1 PC
3	Hardness Block HBW/3000/10	831-601	1 PC
4	Hardness Block HBW/750/05	831-611	1 PC
5	φ10mm Ball Indenter	831-411	1 PC
6	φ5mm Ball Indenter	831-421	1 PC
7	φ2.5mm Ball Indenter	831-431	1 PC
8	φ200mm Flat Anvil	831-551	1 PC
9	φ60mm Flat Anvil	831-501	1 PC
10	φ55mm V-shape Anvil	831-521	1 PC
11	Power Cable	831-801	1 PC
12	Accessories Box	831-901	1 PC
13	Anti-dust Cover	831-911	1 PC
14	Level Screw	831-931	1 PC
15	Instrument Manual	SHB-3000D	1 Copy



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