

**BMS 150-C**  
**ROCKWELL HARDNESS TESTER**



OPERATION MANUAL

**Bms Bulut Makina Sanayi Ve Ticaret Ltd. Şti.**

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# 1 Introduction

## 2 General Information

Rockwell hardness test is the rapidest, easiest and most economic testing method in mechanical performance tests. Featuring high efficiency and easy-to-operate, the hardness values can be obtained directly. In most cases, it can fulfill the work that other mechanical performance test fails.

Model BMS 150-C Rockwell hardness tester is widely used to measure the Rockwell hardness of hard alloy, quenched and unquenched steels in the labs of research institutions, colleges, factories and mines.

## 3 Principle of Test

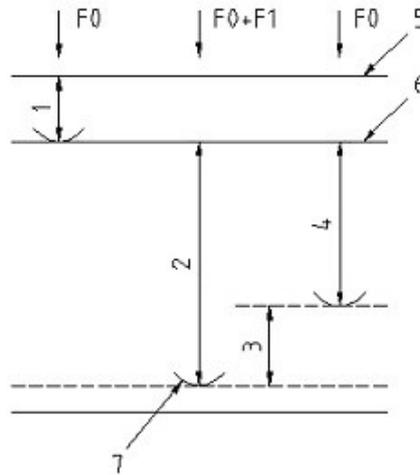


Fig-1

(Principle of Rockwell Hardness Test)

Rockwell hardness test is to apply diamond cone indenter or steel ball indenter to the specimen surface in two steps as shown in Fig-1, which shall be retained for a certain period of time, and measure the residual indentation depth under preliminary test force after the main test force is removed. The Rockwell hardness is calculated by formula (1) as per the h value, the constant N and S (see Table 1).

Rockwell hardness value =  $N - h/S$  ..... Formula (1)

Table 1 Symbols and Descriptions

Symbols	Descriptions	Units
F0	Preliminary test force	N
F1	Main test force	N
F	Total test force	N
S	Unit of given scale	mm
N	Hardness value of given scale	
h	Residual indentation depth under preliminary test force after main test force is removed	mm
HRA	Rockwell hardness = $100 - h/0.002$	
HRC		
HRB		Rockwell hardness = $130 - h/0.002$

- 1----Indentation depth under preliminary test force F0;
- 2----Indentation depth under main test force F1;
- 3----Depth of elastic come-back after main test force F1 is removed;
- 4----Residual indentation depth h;
- 5----Specimen surface
- 6----Measurement datum;
- 7----Position of indenter.

## 4 Technical Parameters

Main technical parameters are listed in Table 2 and Fig. 2.

### 4.1 Table 2 Main Technical Parameters

Pre-load (kgf)	<i>10</i>
Test Loads	<i>60, 100, 150</i>
Load selection	<i>By load selector disc</i>
Test method	<i>Rockwell</i>
Load Application	<i>Hydraulic</i>
Max. Test height (mm) (B)	<i>210</i>
Depth of throat (mm) (A)	<i>165</i>
Machine dimensions (mm)	<i>729 (H)x522(L)x293(W)</i>
Case dimensiond (mm)	<i>820x620x500</i>
Weight (net/gross) kg	<i>98 / 120</i>

### 4.2 Standart Accessories

- Rockwell diamond indenter 1
- 1/16" ball indenter 1
- HRC test block 1
- HRB test block 1
- Flat testing table 1
- V Testing anvil for round parts 1
- Hardness conversion table 1
- Wooden case for accessories 1
- Allen spanner 2
- Instruction manual 1
- Calibration certificate 1

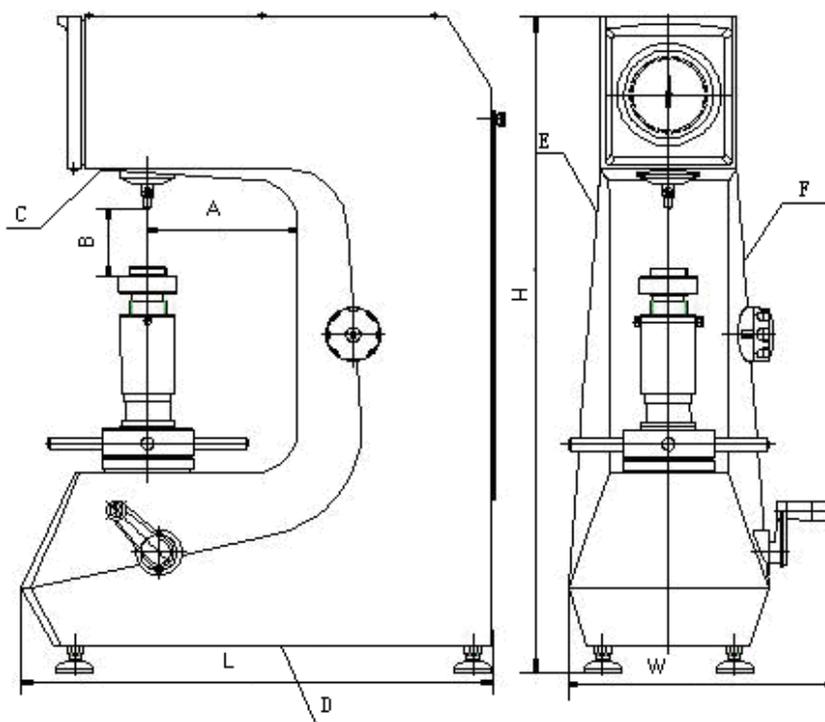


Fig-2  
(Schematic Diagram Of Overall Dimensions)

## 5 Descriptions of Mechanism Parts

The tester is composed of machine body (1), indenter (20), loading and unloading mechanism (2), measurement mechanism (21), load changeover mechanism (15), specimen support mechanism (5), and buffer mechanism (19) and so on (see Fig-3).

The test force applied onto the main shaft is amplified by the composition of weights and lever, i.e. indenter penetrates into the specimen surface under the guidance of buffer with the load amplified by the large lever. At the same time when the indenter penetrates into the specimen, the vertical shift produced by the main shaft is transmitted to the reading device through the measurement lever and hardness value is indicated therein.

The machine body (1) is the shell of the tester, where other parts are fitted directly or indirectly onto the machine body. Except the worktable (23), elevating screw rod (5) and operation handle (2), all the other mechanisms are fitted inside the shell, easy to keep clean.

Total test force is composed of main test force plus preliminary test force. The preliminary test force is produced by the weight of parts including large lever (9), and main shaft (7). The weights (16) are hanged on the large lever (9) through hoist ring (12), producing main test force by the lever principle.

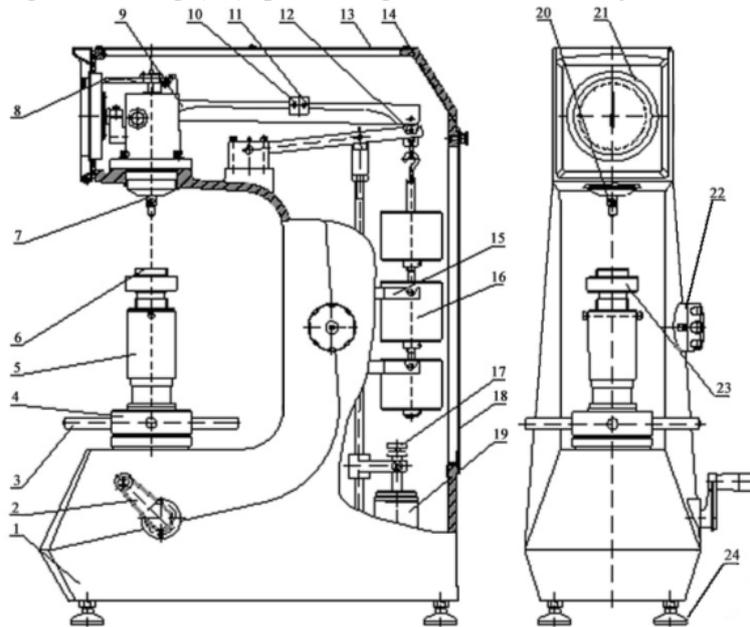


Fig-3  
(Schematic Diagram of Parts)

1. Machine body	13. Top cover
2. Loading and unloading handle	14. Screw
3. Elevating handle	15. Weight changeover support
4. Hand wheel	16. Weight
5. Screw rod sleeve (screw rod inside)	17. Oil needle
6. Specimen to be tested	18. Rear cover
7. Main shaft	19. Buffer
8. Small lever	20. Indenter
9. Large lever	21. Indication dial gauge
10. Adjustment block	22. Load changeover handle
11. Location mark	23. Worktable
12. Hoist ring	24. Foundation screw

The top end-face of indenter (20) bears the total test force and the sharp tip penetrates into the surface of the object to be tested.

Load changeover handle (22) can be turned to different positions, which simultaneously regulates the positions of weight changeover support (15), resulting in different composition of weights which makes up three different total test forces such as 588N/60kgf, 980N/100kgf and 1470N/150kgf.

Loading and unloading handle (2) is to apply and remove main test force.

The application of main test force can be kept at certain speed by regulating the oil needle (17) of buffer (19), avoiding any impact.

Test value can be read directly from the dial gauge (21) of measurement mechanism.

Specimen support mechanism including worktable (23), screw rod (5) and hand wheel (4) is used for bearing hardness blocks or the parts to be tested.

## 5.1 Package Opening, Transportation, Installation and Commissioning

### 5.1.1 Preparation

The working surroundings of the tester should be clean and dry, free of corrosive gases.

The working surroundings of the tester should be free of foreign mechanical vibration.

The temperature of the working surroundings should be between 10°C to 30°C.

The test table (made by the buyer) should be built up with cements or metal, having certain stiffness and strength as well as being capable to bear hardness tester and its auxiliary parts. Its surface should be fitted with a hole of  $\phi 70\text{mm}$  for the screw rod to pass through, as illustrated in Fig-4 (the sizes on the diagram are for reference only). The levelness of the surface should be within 0.2/1000.

Enough space should be left around the tester for necessary work such as installation, commissioning and maintenance.

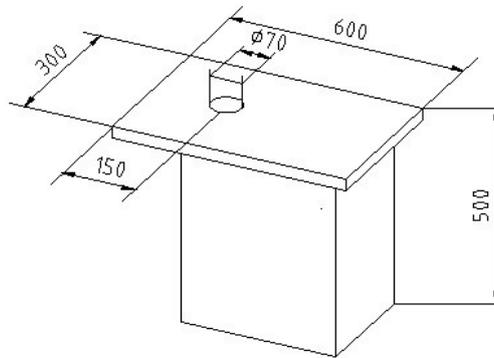


Fig-4  
(Schematic Diagram of Test Table)

## 5.2 Installation and commissioning

Before installation and commissioning, the spanner, level meter and worktable should be standby.

Place the tester onto the test table prefabricated and the screw rod of the tester should be right into the hole of the test table. Take out the four foundation screws (24) from the accessory box and fit them onto the four holes at the bottom of the instrument.

Remove the screws to take down the top cover and the rear cover.

Remove the rope fastening the large lever (9) (see Fig-5).

Remove the rope fastening the small lever (8) (see Fig-6).

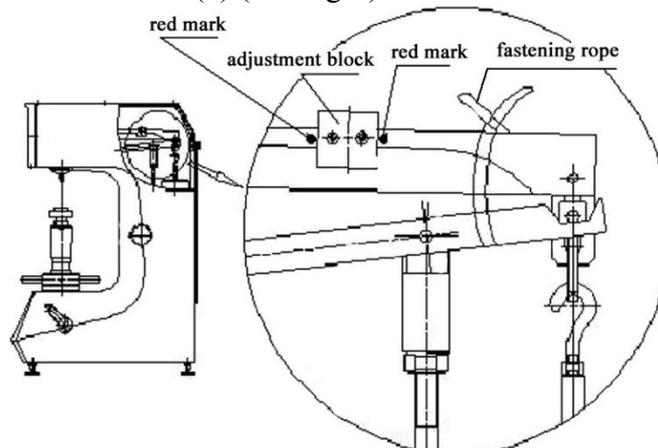


Fig-5  
Removing the rope fastening large lever

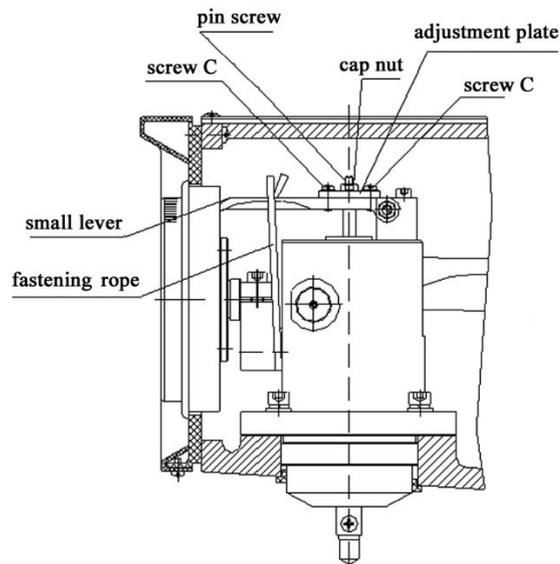


Fig-6  
(Removing the Rope Fastening Small Lever)

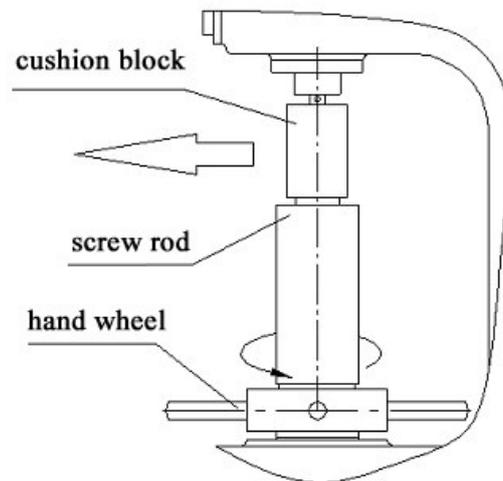


Fig-7  
(Removing the Cushion Block)

Turn the hand wheel (4) anticlockwise to let the screw rod (5) down and then remove the cushion block of the indenter (see Fig-7). In case that the screw rod does not descend by turning the hand wheel, but to the opposite, the hand wheel rises with the screw rod and the cushion block not removable, maybe the screw rod and its seat (under the hand wheel) are adhered together by anti-rust oil. This can be solved by rotating the hand wheel anticlockwise to rise up to 20mm or so, pressing down the hand wheel by hand with force so that the screw rod and its seat are disengaged.

Remove the protective sleeve around the screw rod, clean the screw rod and hand wheel by anti-rust oil with kerosene, fill adequate amount of lubricants into the contact surface between the screw rod and hand wheel, and then resume the protective sleeve.

Make sure that the adjustment block on large lever (9) is located between the two red marks (see Fig-5). Place the large anvil into the hole over the screw rod and then the level meter onto the anvil. If necessary, adjust the four foundation screws at the bottom of the instrument to make the tester is in good levelness (the levelness in two directions should be within 0.2/1000).

Put the hoist rod hanged with weights into the hoist ring of machine. Turn the load changeover handle (22) one loop, then the weights shall be in the middle of rod and the pins at two ends be in the slot of fork support.

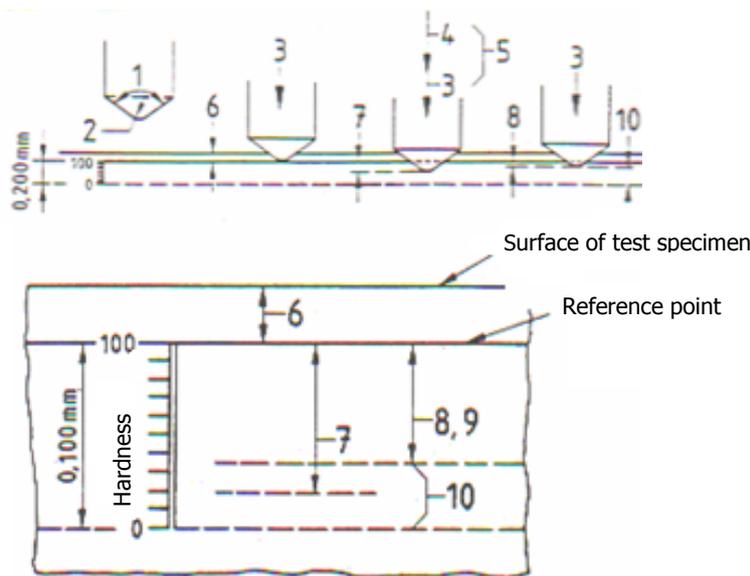
Turn the knurled chrome-plated shell of indication dial gauge (21) to make the "C" point right on the top. Should the larger pointer not point to "C", it shall be adjusted as Fig-6: loosen the cap nut, adjust the pin screw until the larger pointer points to the "C" and then retighten the cap nut.

## 6 Rockwell Hardness Testing (EN 6508-1, ASTM E18)

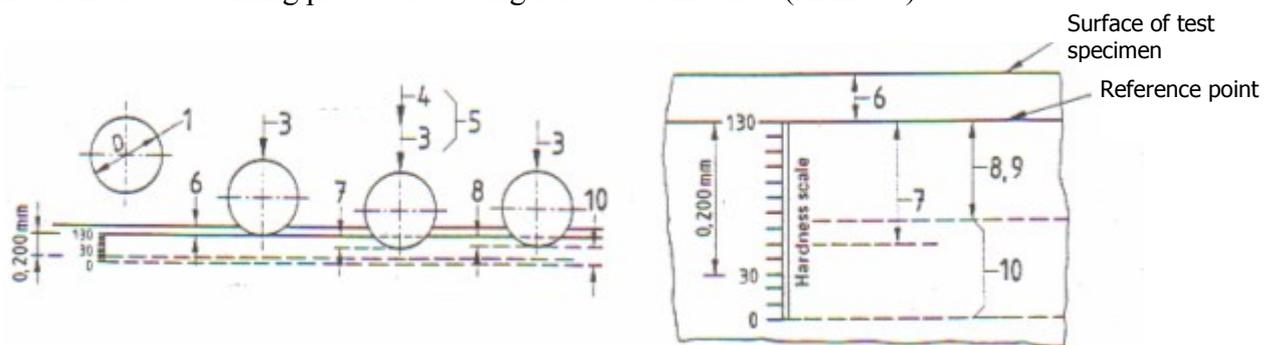
Rockwell Hardness testing method is evaluated from penetration depth of 120° diamond cone or ball indenter with different dias (please refer to table enclosed).

Below application shows working procedures using Rockwell diamond cone (HRC-HRA etc)

Nr	Symbol	Description
1	0	120 ° Diamond cone
2	0	Radius of diamond tip= 0,2 mm
3	F <sub>0</sub>	Pre-Load
4	F <sub>1</sub>	Additional Load
5	F	Total load F <sub>0</sub> + F <sub>1</sub>
6	t <sub>0</sub>	Depth of penetration under pre-load, mm
7	t <sub>1</sub>	Depth of penetration under additional load, mm
8	t <sub>b</sub>	Increase in depth of penetration from F <sub>1</sub> to F <sub>0</sub> , mm
9	E	Equality as of 0,002 mm increase of depth of penetration e= t <sub>b</sub> / 0,002
10	0	Rockwell hardness = 100-e



Below application shows working procedures using 1/16" ball indenter (HRB etc)



Nr	Symbol	Description
1	D	Ball dia=1/16" =1,5875 mm
3	F <sub>0</sub>	Pre-load
4	F <sub>1</sub>	Additional load
5	F	Total load =F <sub>0</sub> +F <sub>1</sub>
6	t <sub>0</sub>	Depth of penetration under pre-load, mm
7	t <sub>1</sub>	Depth of penetration under additional load, mm
8	t <sub>b</sub>	Increase in depth of penetration from F <sub>1</sub> to F <sub>0</sub> , mm
9	E	Equality as of 0,002 mm increase of depth of penetration e= t <sub>b</sub> / 0,002
10	HRB/HRF	Rockwell hardness= 130-e

## 7 NORMAL OPERATION

Before test, the kind of scale has to be determined upon the specimen. The following operation takes scale C as an example without specific notice, i.e. to test with diamond cone indenter and total test force up to 150kgf. It can be referred to for other scales.

### 7.1 Preparation prior to normal operation

First of all, spend some time on studying the functions of every parts of the indication dial gauge, where there are hardness readings, division lines, long pointer, short pointer, etc.

Black division lines are for hardness indication. The black digits at outer ring are for hardness indication of scales A and scale C while red digits at inner ring are for scale B. Different scales can be composed of by changing the indenter and the weights

The short pointer indicates the load of preliminary test force.

The long pointer indicates the hardness value of tested specimen.

The letters B and C are the symbols of scales. The position of Letter C is the zero point of division value of scale C or A. The position of Letter B is that of division value 30 for scale B.

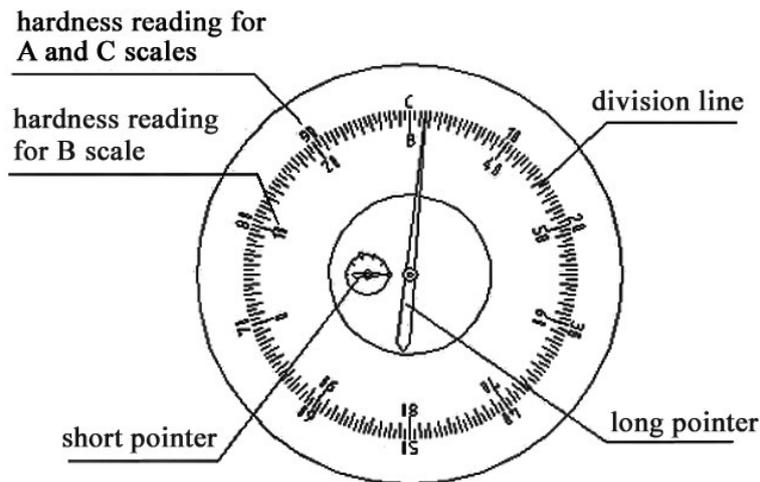


Fig-8

(Schematic Diagram of Indication Dial Gauge)

### 7.2 Regulate the loading speed of main test force

a) - Make sure that the loading and unloading handle (2) is at the position of unloading. Otherwise, turn it to unloading position slowly (2 to 3 seconds or so) as per the unloading direction shown on the unloading label (see Fig-9).

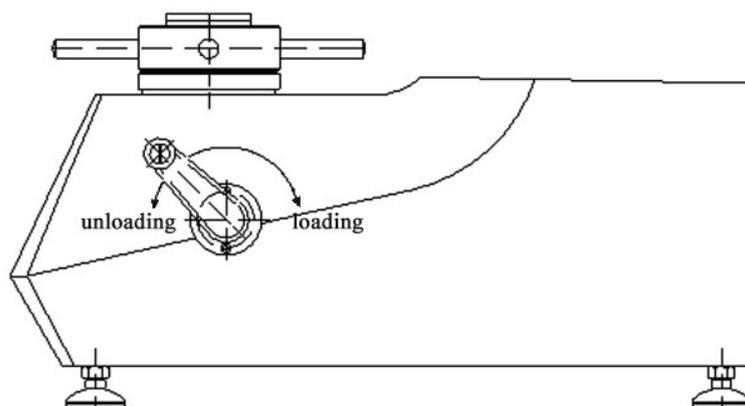


Fig-9

(Loading and Unloading Handles)

b) - Turn the load changeover handle (22) to the position of 150kgf and make sure that the Number 150 on the handle aligns with the red mark, as shown in Fig-10.

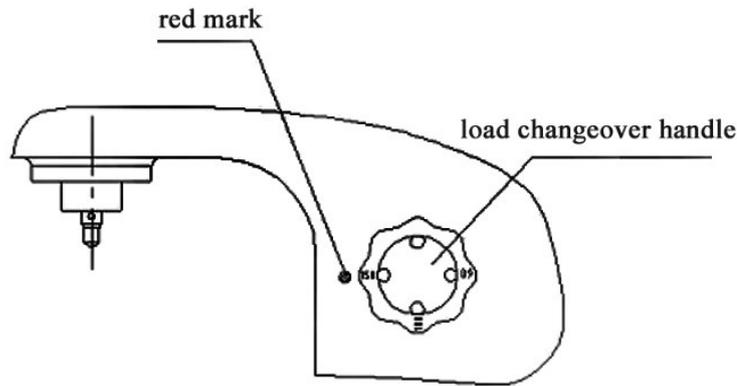


Fig-10  
(Test Force Selection)

- c) - Place the standard HRC hardness block onto the worktable
- d) - Turn the hand wheel (4) so that the hardness block raises the indenter until the short pointer points to red mark, thus the preliminary test force is applied.

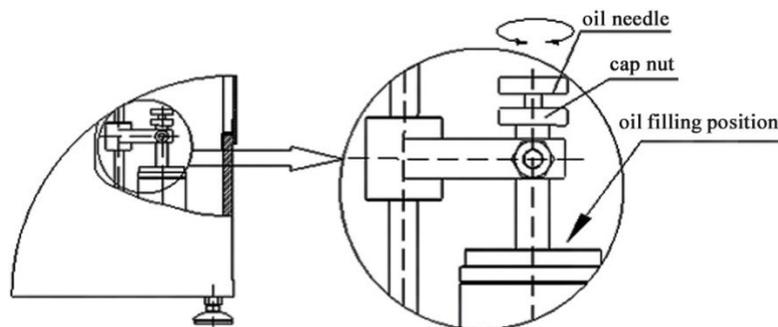


Fig-11  
(Regulating the Oil Needle)

- e)- As per the loading direction on loading label, turn the loading and unloading handle (2) slowly towards the back of the machine body (approximately 4 seconds) to the limit position, and thus the main test force is applied.
- f) - Keep eyes on the longer pointer of indication dial and make sure that it takes 4 to 8 seconds for it from starting till stopping. Otherwise, regulate it by turning oil needle as follows: first, loosen the cap nut on the buffer (see Fig-11), turn the oil needle lightly. To turn it anticlockwise, the loading speed will rise while the loading speed will slow down to turn it clockwise. Repeat the above steps until everything is ok, and then tighten the cap nut.

### 7.3 Test force selection

Turn the load changeover handle until the number of selected test force points to the red mark (see Fig-10).

Note: ⚠ While changing the test force, the loading and unloading handle must be at the unloading position (see Fig-9, i.e. at the limit position on the left hand).

### 7.4 Install Indenter (see Fig-12)

The hardness tester is fitted with a steel ball indenter on the main shaft when exiting works. The following steps should be followed when reinstalling indenter.

- a) - Put on the indenter and tighten it slightly to the extent that it will not fall down.
- b) - Place the standard block onto the worktable.
- c) - Turn the hand wheel to apply preliminary test force.
- d) - Turn the loading and unloading handle clockwise to apply main test force on the indenter (see Fig-12).
- e) - Tighten the screw. That's all for the installation.

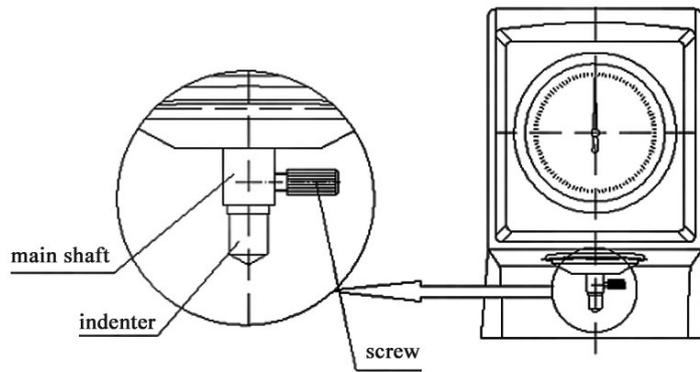


Fig-12

## 7.5 Install the Indenter

a) - The surface to be tested should be flat generally. If it is a curved face and the radius of curvature is not too big, the test result should be corrected.

b) - The surface of specimen should be polished with the finish no less than  $\sqrt{1.6}$ . The polishing should not influence the hardness, i.e., no hardening or tempering phenomena after processing. The surface finish of supporting face should  $\sqrt{3.2}$  be no less than. The surface to be tested, supporting surface and worktable surface should be kept clean. The specimen shall be placed on the worktable reliably and no movement should happen during testing.

c) - Be sure that the test force applied should be perpendicular to the surface to be tested. To test the specimens with curved shapes or other abnormal shapes, specialized anvil should be adopted and proper position should be selected. For example, V-shaped anvil shall be used for cylindrical specimen. To test the specimens hollow inside, much attention should be paid not to produce deformation by test force, or the measured hardness value will be incorrect.

## 8 Testing Procedures

1)-Clean the top surface of screw rod and both sides of worktable, place the worktable into the insertion hole of screw rod. Proper worktable should be chosen according to the size of the parts to be tested.

2) - Clean the supporting surface of specimen and place it onto the worktable, turn the hand wheel to lift up the worktable slowly to push up the indenter. No stop or reverse action is allowed from the start until the short pointer points to the red mark and the long pointer point's right upwards after three loops of clockwise turning. The allowance for long pointer is  $\pm 5$  division lines. If it is more than 5 division lines, the test spot should be invalid and make test again by choosing other spots. Clockwise turning is all right).

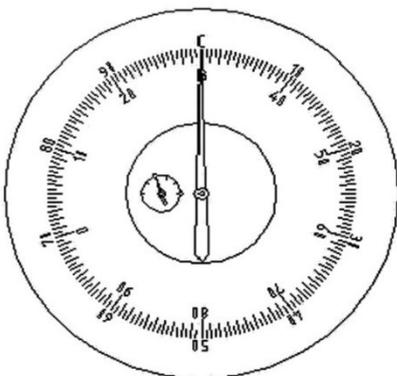


Fig-13

3)- Turn the outer shell of indication dial gauge until the long pointer aligns with the long division line between Letter C and Letter B. (see Fig-13, either anticlockwise or

4)- As per the loading direction on the loading and unloading label, turn the loading and unloading handle (2) towards the back of machine body slowly (around 4 seconds) up to the right-handed limit position (see Fig-9, apply main test force, then the long pointer will rotate (see Fig-14.)

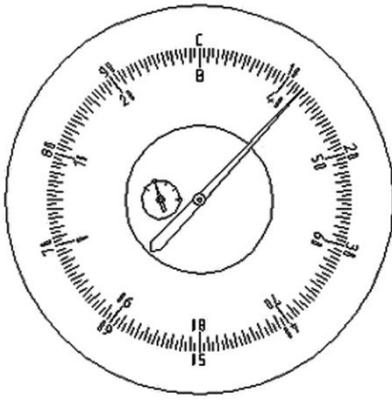


Fig-14

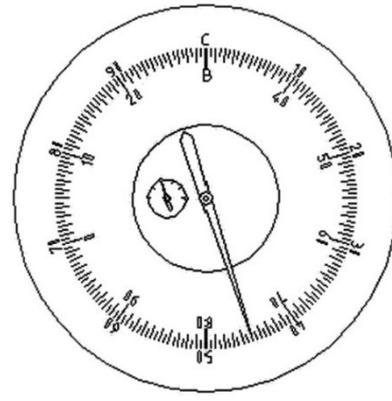


Fig-15

5)- After the long pointer stops rotating obviously, remove the main test force by turning slowly (2 to 3 seconds) the loading and unloading handle anticlockwise to the left-handed limit (see Fig-9). Get the readings from corresponding scales on the indication dial gauge. For diamond indenter, read from the black digits at the outer ring. As for steel ball indenter, read from the red digits at the inner ring. The hardness value for this example (see Fig15) shall be 45HRC. Turn the hand wheel to let the specimen down until the surface being tested is separated from the indenter. Then move the specimen and carry on new test by repeating the above steps from 2) to 5). Please be advised that the supporting surface of specimen shall not be away from the worktable.

6) - The protective sleeve of screw rod is designed to prevent dust from the screw rod. It shall be kept around the screw rod when the tester is not in use or the height of specimen is smaller than 140mm. When the height of specimen is over 210mm, it must be removed; otherwise the worktable will be propped up, resulting in invalid test.

Note:  During the step 4) and step 5), the load changeover handle should not be turned so as to prevent damaging the tester.

After any item among indenter, specimen and worktable is changed, the first test should be regarded invalid.

## 8.1 Maintenance

### Cleaning and Lubrication

Cover the tester with dust-proof when it is not in use for a long time.

Fill adequate amount of machine oil into the contact face between screw rod and hand wheel periodically.

### Oil filling to the buffer

If the pointer of indication dial gauge rotates rapidly at the beginning and then slowly later on when applying main test force, it means that the buffer is lack of machine oil. Fill with clean machine oil No. 32. At the same time, turn the loading and unloading handles several times (see Fig-9) to let the piston move up and down so that the air inside the buffer is completely got rid of, until there is oil overflowing from the top when the piston falls down to the bottom (see Fig-11).

### Calibration

Inspect the accuracy with the standard hardness block supplied with the tester.

The tester should be calibrated regularly, no longer than 12 months for once time generally.

Clean the worktable and standard hardness block and carry out the test on the working face of the block. It is not allowed to make a test on the supporting surface.

If the reading error is too much, besides the conventional inspection listed in Table 7, check whether the supporting surface of standard hardness block is burry. If yes, please polish it with edge stone.

When carrying on the test on different spots at standard block, it shall be pulled along the worktable rather than removed away from it.

## 9 Hardness Value Correction

Since the measured value for convex specimen is decreased, correction should be added. To the opposite, as for the concave specimen, correction should be deducted.

## 10 Test Method

Test method	Indentor	Pre-load (kgf)	Total load (kgf)	Field of application
HRA	Diamond cone	10	60	Surface hardened parts with thin cases (0,4 mm)
<b>HRB</b>	1/16" ball	10	<b>100</b>	Non ferrous metals,unhardened steels
HRC	Diamond cone	10	150	Hardened steels
HRD	Diamond cone	10	100	Surface hardened parts with medium cases
<b>HRE</b>	1/8" ball	10	<b>100</b>	Aluminium amd magnesium alloys,antifriction metals,synetic metals
<b>HRF</b>	1/16" ball	10	<b>60</b>	Annealed cupper alloys,thin sheet metals (? 0,6 mm)
<b>HRG</b>	1/16" ball	10	<b>150</b>	Phospor-bronze,melleable iron of medium hardness
<b>HRH</b>	1/8" ball	10	<b>60</b>	Aluminium,zinc,lead,grinding stones
<b>HRK</b>	1/8" ball	10	<b>150</b>	Antifriction and other metals of very low hardness
<b>HRL</b>	1/4" ball	10	<b>60</b>	As HRK and hard rubber
<b>HRM</b>	1/4" ball	10	<b>100</b>	As HRK and HRL,laminated wood
<b>HRP</b>	1/4" ball	10	<b>150</b>	HRK, HRL or HRM and syntetic materials
<b>HRR</b>	1/2" ball	10	<b>60</b>	
<b>HRS</b>	1/2" ball	10	<b>100</b>	
<b>HRV</b>	1/2" ball	10	<b>150</b>	As HRK, HRL, HRM, HRP, HRR or HRS