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**HDT-RW160  
MANUAL ROCKWELL HARDNESS TESTER  
OPERATION MANUAL**



**Attention**

- ◆ This Instruction Manual shall be carefully read through in prior to use of the apparatus to clearly understand the detailed operation steps and special notes, and avoid apparatus damage or personal injury caused by improper use.
- ◆ Fastening tapes and cushion materials shall be carefully removed before installation and calibration of the apparatus.
- ◆ Never rotate the pressure selecting hand-wheel or turn-wheel when applying, keeping or removing the testing pressure.
- ◆ We are making continuous renovation in design of the hardness tester to improve its performance. Small change may be found in apparatus design without notification.

**Description**

- ① HDT-RW160 Rockwell Hardness Tester is an universalized apparatus for Rockwell hardness determination. It can be used in the test of Rockwell hardness of various materials. The applying speed of test pressure can be adjusted by a buffering device, and the change of pressure is obtained by rotating a pressure selecting hand-wheel. Operation of the tester is quite easy, while the performance is stable and thus the tester can be used in a wide range.
- ② Working principle of the Rockwell hardness tester. The test procedure employs a conical diamond indenter or ball indenter of a certain diameter to press into the specimen, an initial test pressure  $P_0$  and a main test pressure  $P_1$  will be applied on the indenter in sequence, and the total pressure ( $P_0 + P_1$ ) will be kept for a certain period, then the main pressure is to be removed, only the initial pressure will be left. A difference  $e$  between the indent depth  $h_1$  by this time and the indent depth  $h_0$  under the action of initial pressure, is recorded as a permanent increment of indent depth. Every 0.002 mm of this increment represents a unit of Rockwell hardness. This is a quick test and only trivial indent will be caused, so it is widely used to determine the hardness of specimen.
- ③ Calculation formula of Rockwell hardness test:  
$$\text{HRA(C)} = 100 - e/0.002$$
$$\text{HRB} = 130 - e/0.002$$
$$e = h_1 - h_0$$
- ④ Descriptions of Mechanism Parts  
The tester is composed of machine body (1), indenter (21) loading and unloading mechanism (2, 20), measurement mechanism (23), load changeover mechanism (24), specimen support mechanism (5), buffer mechanism (19) and so on (see Fig-2).

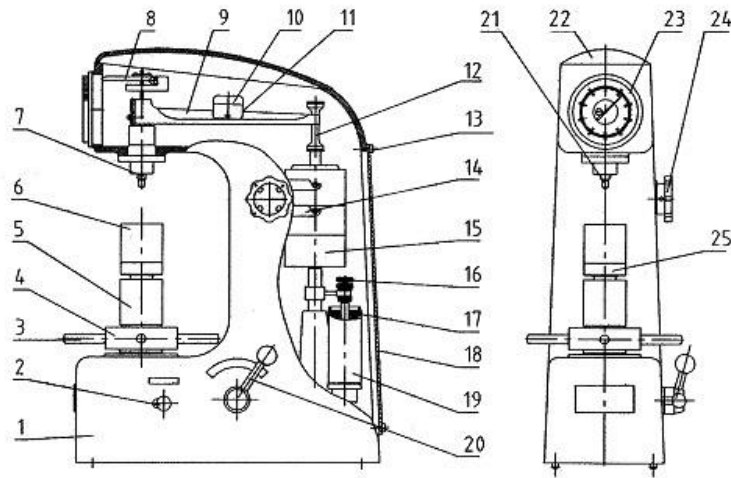


Fig-2 Schematic diagram of parts

- |                            |  |                           |
|----------------------------|--|---------------------------|
| 1. machine body            | 2. loading handle  | 3. elevation handle       |
| 4. hand wheel              | 5. elevating screw rod sleeve (elevating screw rod inside) | 6. specimen to be tested  |
| 7. main shaft              | 8. smaller lever   | 9. larger lever           |
| 10. adjustment block       | 11. position mark  | 12. hoist ring            |
| 13. screw                  | 14. weight changeover support bracket                      |                           |
| 15. weight                 | 16. oil needle   | 17. oil carpet            |
| 18. rear cover             | 19. buffer   | 20. unloading handle      |
| 21. indenter               | 22. top cover  | 23. indication dial gauge |
| 24. load changeover handle | 25. worktable  |                           |

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 larger lever. At the same time when the indenter presses into the specimen, the vertical displacement produced by the main shaft is transmitted to the reading device through the measurement lever and hardness value is indicated therein.

- ◆ The machine body is the shell of the tester, where other parts are fitted directly or indirectly onto the machine body. Except the worktable (25), elevating screw rod (5) and operation handle, all the other mechanisms are fitted inside the shell, convenient for cleaning.
- ◆ The 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 larger lever (9), and main shaft (7). The weights (15) are hanged on the larger lever through hoist ring (12), producing main test force by the lever principle.
- ◆ The top end-face of indenter (21) bears the total test force and the sharp tip penetrates into the surface of the object to be tested.
- ◆ The load changeover handle (24) can be turned to different positions, which simultaneously regulates the positions of weight changeover support bracket (14), resulting in different composition of weights which makes up three different total test forces such as 588N/60kg, 980N/100kg and 1470N/150kg.
- ◆ The loading handle (2) is to apply main test force.
- ◆ The unloading handle (20) can be pushed back as per the direction shown on the label, removing the main test force. The application of main test force can be kept at certain speed by regulating the oil needle (16) of buffer (19), avoiding any impact.
- ◆ Test value can be read directly from the indication dial gauge (23) of measurement mechanism.
- ◆ The specimen support mechanism including worktable (25), elevating screw rod (5) and hand wheel (4) is used for bearing hardness blocks and the parts to be tested.

### Installation

- ① Working conditions of the tester:
  - ◆ Under ambient temperature, i.e. between 10-30 °C;
  - ◆ The relative humidity in test room shall not be over 65%;
  - ◆ In an environment free from vibration;
  - ◆ No corrosive medium in surrounding.

- 2 Tester unpacking:
- ◆ Open the packing box cover and take out all cushion materials. Remove the accessory box.
  - ◆ Lift the bottom plate, unscrew the two M 10 bolts under the bottom plate with a spanner, to separate the hardness tester from bottom plate, all steps shall be done in a safe manner.
  - ◆ After unpacking, the tester shall be placed on a stable bench with levelness deviation less than 1 mm/m. A hole shall be drilled at an appropriate location on the bench (see figure 1) to enable the lifting screw to operate properly.

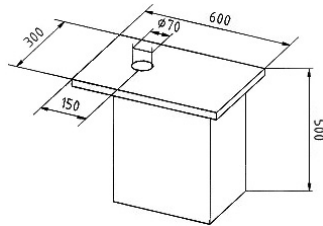


Figure 1

- 3 Place the tester onto the prefabricated test table and the elevating screw rod of the tester should fall into the hole of the test table.

Remove the packing belt on the tester.

Take down the top cover (22), remove the screws (13) on the rear cover and then remove the rear cover (18).

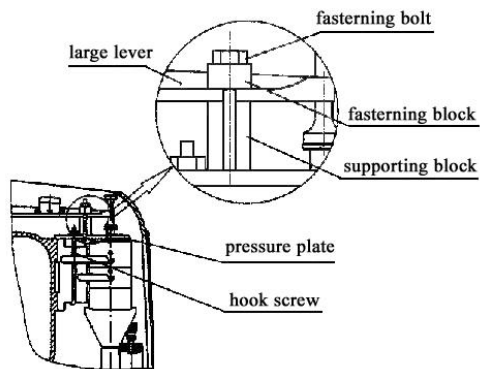


Figure 2

- 4 Remove the fastening bolt by the spanner, take down the fastening block and supporting block. Loosen the nut on the hook screw by a spanner, remove the hook screw and then pressure plate fastening the weights (see Fig 2).
- 5 Hold the hoist ring with hands, lift up the group of weights slowly and at the same time remove the supporting block. Place them lightly so that the cylindrical pin on the weights group just falls onto the groove on the bracket plate which brackets the weights group (see Fig 3).

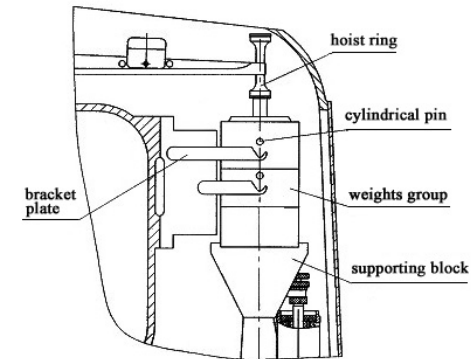


Figure 3

- 6 Take off the retaining rope binding the smaller lever (8), see Fig 4

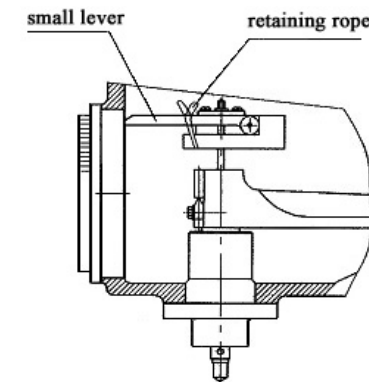


Figure 4

- 7 Turn the hand wheel (4) anticlockwise to let the elevating screw rod (5) down and then remove the cushion block of the indenter (see Fig 5). In case that the elevating screw rod does not descend by turning the hand wheel, but to the opposite, the hand wheel rises with the elevating screw rod and the cushion block not removable, maybe the elevating 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 20 mm or so, pressing down the hand wheel by hand with force so that the elevating screw rod and its seat are disengaged. Remove the protective sleeve around the elevating screw rod, clean the elevatingscrew rod and hand wheel off anti-rust oil with kerosene, fill adequate amount of lubricants into the contact positions between the elevating screw rod and hand wheel, and then reassemble the protective sleeve.

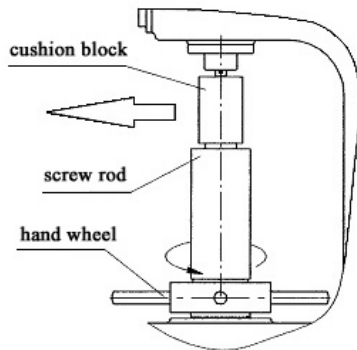


Figure 5

- 8 Make sure that the adjustment block on larger lever (9) is located between the two red marks (see Fig 6). Otherwise place it to the correct position. Place the larger anvil into the hole over the elevating screw rod and the level meter onto the anvil. If necessary, insert metallic cushion into the bottom seat of machine body so that the levelness in two directions are within 0.2/1000.

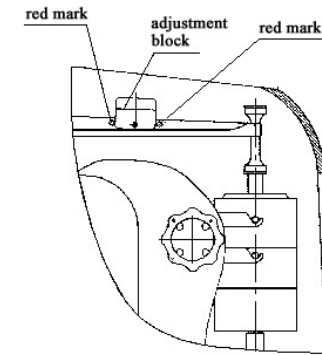


Figure 6

- 9 It may happen that the indication dial gauge (23) is loose during transportation. In this case, first loosen the retaining screw A on machine body, remove the indication dial gauge, tighten the three screws B at the back of the dial gauge and put the dial gauge on again (see Fig 7). Turn the knurled chrome-plated shell of indication dial gauge (23) to make "C" point right on the top. Should the larger pointer not point "C" as shown in Fig 8, it shall be adjusted as follows: loosen the screw cap, adjust the pin screw (see Fig 7) until the larger pointer points to the "C" (see Fig 8), and then retighten the screw cap.

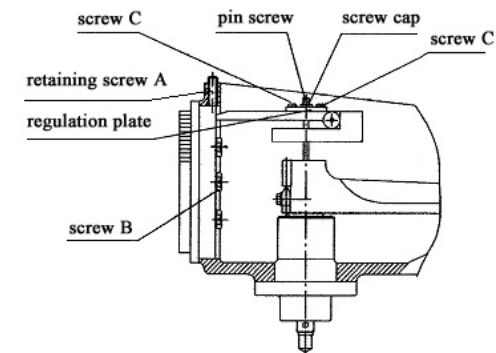


Figure 7

- 10 If the reading error exceeds the allowance due to transportation, regulate as follows (see Fig 7):
  - ◆ Make test with the higher hardness block and lower hardness block of HRC separately. If the reading is on the high side, loosen the two screws C on the regulation plate and move the regulation plate lightly rightwards (pay attention not to move the pin screw in the middle of regulation plate), then retighten screws C. If the reading is still on the high side, repeat the above steps once again until the reading is within the range of allowance. If the reading is on the low side, move the regulation plate leftwards as per above-mentioned method.
  - ◆ After calibrated with both higher hardness block and lower hardness block of HRC, in general, HRA and HRB scale will also be precise.
  - ◆ While carrying out the above adjustment, the following test should not be done until the two screws C are retightened every time when the regulation plate is moved.
  - ◆ The above method is only suitable for minor regulation when the reading error is within  $\pm 5$  HRC or  $\pm 5$  HRA.
  - ◆ If slight error is found for scale B, it may be due to the steel ball. Replace the steel ball inside the steel ball indenter and try again. Put on top cover (22) and rear cover (18).

### 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.

- 1 Preparation prior to the use:
 

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, longer pointer, shorter pointer, etc. (see Fig 8)

- ◆ Black division lines are for hardness indication. The black digits at outer ring are for hardness indication of scales A and 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 shorter pointer indicates the load of preliminary test force.
- ◆ The longer 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.

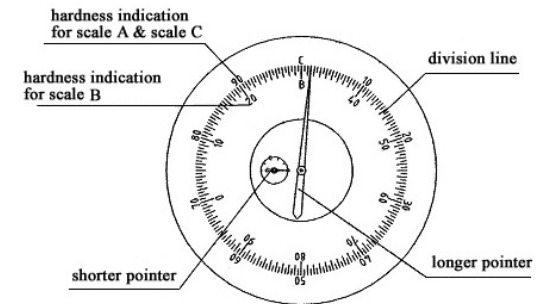


Figure 8

- 1.1 Regulate the loading ratio of main test force
  - a. Make sure that the unloading handle (20) 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).

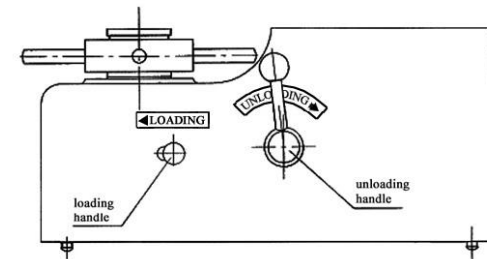


Figure 9

- b. Turn the load changeover handle (24) 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.

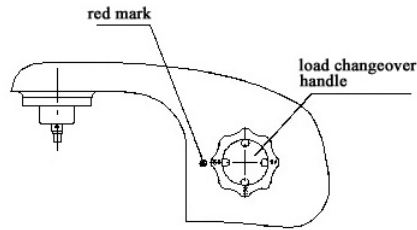


Figure 10

- c. Place the standard hardness block 40~50HRC onto the worktable
- d. Turn the hand wheel (4) so that the hardness block raises the indenter until the shorter pointer points to red mark, and then the preliminary test force has been applied.
- e. As per the loading direction on loading label, pull the loading handle (2) slowly towards the front of the machine body (approximately 4 seconds) to the limit position, and then the main test force has been applied.
- f. Keep eyes on the longer pointer of indication dial gauge and make sure that it takes 4 to 8 seconds for it to start turning till stop. Otherwise, regulate it by turning oil needle as follows: First, loosen the bolt cap on the buffer (see Fig 11), turn the oil needle lightly. To turn it anticlockwise, the loading speed will rise, while to turn it clockwise, the loading will slow down. Repeat the above steps until everything is ok, and then tighten the bolt cap.

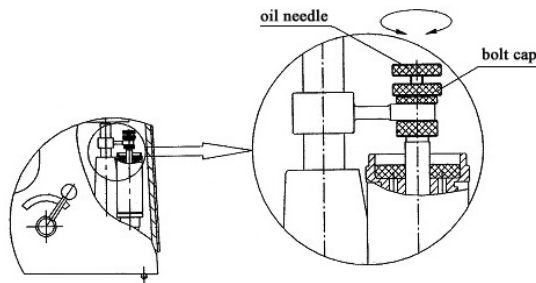


Figure 11

### 1.2 Test force selection

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

Note: When changing the test force, the unloading handle must be at the unloading position (see Fig 9, i.e. at the limit position on the right hand). Otherwise it will cause damage to the hardness tester.

### 1.3 Install indenter (see Fig 12)

The tester is equipped with a steel ball indenter when exiting works. Following steps should be followed when reinstalling.

- 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. Pull the loading handle leftwards to apply main test force on the indenter (see Fig 9).
- e. Tighten the screw. That's all for the installation.

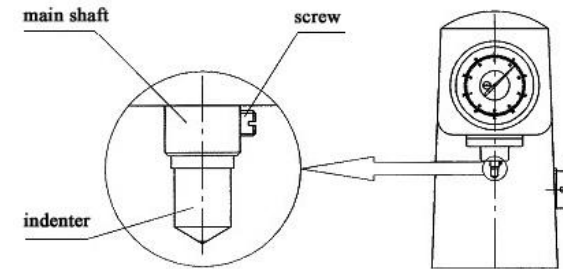


Figure 12

### 1.4 The specimen should meet the following requirements

- a. Surface of the specimen to be tested must be smooth and clean, free from dirt, scaling, indentation or significant marks resulted from machining. Scale, Indenter, Testing Pressure and Applicable Range for Rockwell Hardness Test.
- b. Minimum thickness of the specimen shall be larger than 10 times the depth of indenture. No obvious deformation shall be seen on back of the specimen after hardness test.
- c. The specimen to be tested shall be placed in stable state on top of the test stock. It shall be fixed during the test process. Ensure that the test pressure is perpendicularly exerted on the specimen.



Scale	Indenter	Initial Pressure (N)	Combined Pressure (N)	Applications
A	Diamond indenter conical angle: 120° spherical radius at vertex: 0.2 mm	98.07	588.4	hard alloy, carbide for surface quenched steel, hard steel sheet
D			980.7	thin steel sheet, surface quenched steel
C			1471.0	quenched steel, tempered steel, hard cast iron
F	588.4		cast iron, aluminum, magnesium alloy, bearing alloy, annealed copper alloy, mild steel sheet	
B	Ball indenter diameter: 1.5875mm (1/16in)		980.7	mild steel, aluminum alloy, copper alloy, malleable cast iron, annealed steel
G			1471.0	phosphorus iron, beryllium bronze, malleable cast iron
H	Ball indenter diameter: 3.175mm (1/8in)		588.4	aluminum, zinc, lead etc.
E			980.7	bearing alloy, tin, hard plastics, and other soft materials
K			1471.0	

The most commonly used scales for Rockwell hardness test are A, B and C.

② Hardness tester operation procedure:

- 2.1 Clean the top end of elevating screw rod and both sides of worktable, place the worktable into the insertion hole of elevating screw rod. Proper worktable should be chosen according to the size of the parts to be tested.
- 2.2 Clean the binding 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 shorter pointer points to the red mark and the longer pointer point right upwards after three circles of clockwise turning. The allowance is ±5 division lines. If it is more than 5 division lines, the spot should be invalid and repeat the test by choosing other spot.

2.3 Turn the outer shell of indication dial gauge until the longer pointer aligns with the long division line between Letter C and Letter B (see Fig 13, either anticlockwise or clockwise turn is all right).

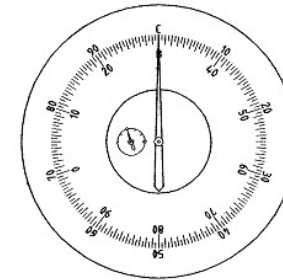


Figure 13

2.4 As per the loading direction on the loading label, pull the loading handle (2) towards the front of machine body slowly (around 4 seconds) up to the left-handed limit position (see Fig-9), then the main test force has been applied and the longer pointer will rotate (see Fig 14).

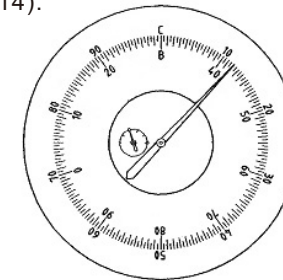


Figure 14

2.5 After the longer pointer stops rotating obviously, remove the main test force by pushing slowly (2 to 3 seconds) the unloading handle clockwise to the right-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 shall be 45 HRC (see Fig 15 ). Turn the hand wheel to let the specimen down until the surface being tested is separated from the indenter. Move the specimen



and carry on new test by repeating the above steps from 2) to 5). Please be advised that the binding bottom surface of specimen shall not be away from the worktable.

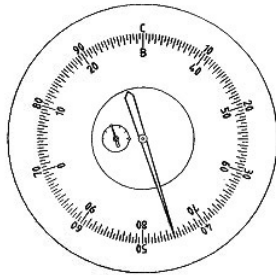


Figure 15

2.6 The protective sleeve of elevating screw rod is designed to prevent dust from the elevating screw rod. It shall be kept outside the elevating screw rod when the tester is not in use or the height of specimen is smaller than 100mm. When the height is over 100mm, it must be removed; otherwise the worktable will be propped up, resulting in invalid test.

**CAUTIONS:**

**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 replaced, the first test should be regarded invalid.**

Repeatability & Tolerance of Rockwell Hardness Display Value:

Scale	Hardness of Standard Blocks	Display Tolerance	Allowable Display Repeatability <sup>a)</sup>
A	20HRA - ≤75HRA	±2HRA	≤0.02(100-H) or 0.8 Rockwell Unit <sup>b)</sup>
	>75HRA - ≤88HRA	±1.5HRA	
B	20HRB - ≤45HRB	±4HRB	≤0.04(130-H) or 1.2 Rockwell Unit <sup>b)</sup>
	>45HRB - ≤80HRB	±3HRB	
	20 HRC - ≤70HRC	±1.5HRC	
C	20 HRC - ≤70HRC	±1.5HRC	≤0.02(100-H) or 0.8 Rockwell Unit <sup>b)</sup>

<sup>a)</sup> Where H is the mean hardness value.  
<sup>b)</sup> Take the larger one of these two values as basis.

**Maintenance**

- 1 The operator shall operate the tester by following the instructions contained in this manual. Frequent calibration against standard blocks is necessary before and after actual tests. For tester not frequently used, several pre-tests shall be done on the standard blocks after the tester is turned on.
- 2 During a hardness test, it is strictly prohibited to turn the pressure selecting hand-wheel when applying, keeping or removing the testing pressure.
- 3 Use of the standard blocks can only be done on their working surface. A minimum distance of 3 mm between two successive test spots or between the center of indent and edge of the specimen is necessary. Life period of a standard block is limited to 2 years.
- 4 When handling the hardness tester, the extension rod shall be fixed, and the weights and hanger shall be removed.
- 5 The hardness tester shall be kept in clean state. After completion of testing procedure, the tester shall be covered with a dust cover. Hardness block and indenter shall be coated with antirust oil after use to prevent rust and corrosion.
- 6 Periodical verification shall be done, at least once a year, on the tester so as to ensure its accuracy.
- 7 Fill adequate amount of machine oil into the contact face between elevating screw rod and hand wheel periodically. 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. Lift up the oil carpet over the buffer and fill with clean machine oil. At the same time, pull and push the loading and unloading handles several times to let the piston move up and down so that the air inside the buffer is completely get rid of, until there is oil overflowing from the top when the piston falls down to the bottom (see Fig 16).

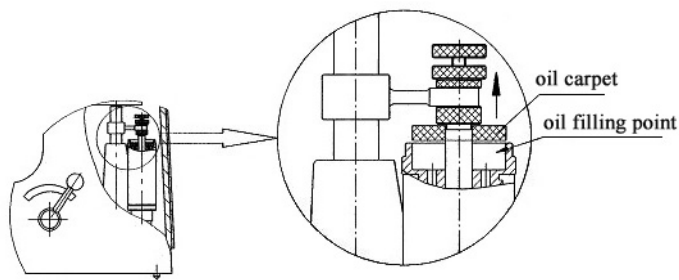


Figure 16

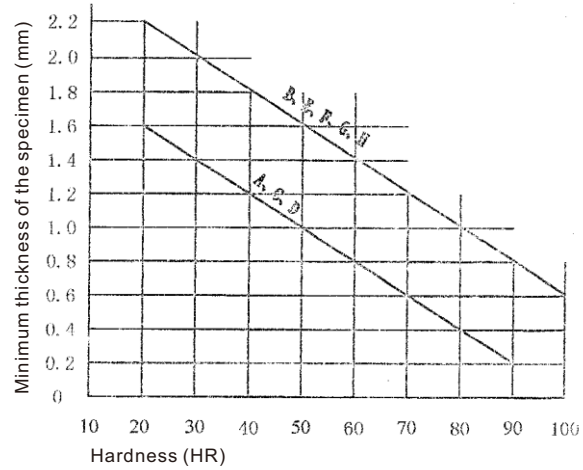
8 When the tester breaks down, the following contents can help you predict the troubles and recommend the trouble shooting methods. If the problems remain unsolved, please contact with our after-sale service department rather than dismantle the tester by yourself.

Phenomena	Reasons	Remedies
Elevating screw rod is held back	Rusted or chips	Get rid of the chips on elevating screw rod and hand wheel, fill with lubricants
Main test force can not be applied	Oil needle of buffer locked	Adjust oil needle to eliminate locking
	Weights not hanged properly	Adjust the position of weights as per operation manual
Larger pointer trembles when applying main load	The levelness of worktable not right	Adjust the levelness
Hardness value not precise	Test force	Check whether selected test force conforms to the requirements of the scale
	Distance of indention	Check whether the distance between the centers of two adjacent indentions is too near

Phenomena	Reasons	Remedies
Hardness value not precise	Indenter	Check whether the indenter conforms to the requirements of the scale
		Check whether the clearance between the indenter and main shaft is removed
		Replace the indenter if damaged
	Worktable	Check whether there are impurities between worktable and elevating screw rod
		Check whether selected worktable is suitable for this specimen
		Check whether protective sleeve props up worktable
	Specimen	Check whether the surface tested is perpendicular to the direction of test force
		Check whether the rear surface is burry
		Check whether the specimen is too thin
	Environment	Check whether there is mechanical vibration resources around
Check whether the temperature is kept at 10-30 °C		
Others	Calibrate the hardness tester by standard block supplied	

### Appendix

1 Minimum thickness of the sample shall be larger than 10 times the depth of indenture. No obvious deformation shall be seen on back of the sample after hardness test. The relationship between minimum thickness of the sample and its hardness are shown in the following table .



Hardness Value (HRB)	Diameter of Cylindrical Specimen (mm)						
	6	10	13	16	19	22	25
Offsets (HR) to Rockwell Scale B							
20				4.5	4.0	3.5	3.0
30			5.0	4.5	3.5	3.0	2.5
40			4.5	4.0	3.0	2.5	2.5
50			4.0	3.5	3.0	2.5	2.0
60		5.0	3.5	3.0	2.5	2.0	2.0
70		4.0	3.0	2.5	2.0	2.0	1.5
80	5.0	3.5	2.5	2.0	1.5	1.5	1.5
90	4.0	3.0	2.0	1.5	1.5	1.5	1.0
100	3.5	2.5	1.5	1.5	1.0	1.0	0.5

2 Offsets for Rockwell hardness test when diameter of the specimen is less than 38 (25) mm.

Hardness Value (HRC) (HRA)	Diameter of Cylindrical Specimen (mm)								
	6	10	13	16	19	22	25	32	38
Offsets (HR) to Rockwell Scale C & A									
20				2.5	2.0	1.5	1.5	1.0	1.0
25			3.0	2.5	2.0	1.5	1.0	1.0	1.0
30			2.5	2.0	1.5	1.5	1.0	1.0	0.5
35		3.0	2.0	1.5	1.5	1.0	1.0	0.5	0.5
40		2.5	2.0	1.5	1.0	1.0	1.0	0.5	0.5
45	3.0	2.0	1.5	1.0	1.0	1.0	0.5	0.5	0.5
50	2.5	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5
55	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0
60	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
65	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
70	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0	0
75	1.0	0.5	0.5	0.5	0.5	0.5	0	0	0
80	0.5	0.5	0.5	0.5	0.5	0	0	0	0
85	0.5	0.5	0.5	0	0	0	0	0	0
90	0.5	0	0	0	0	0	0	0	0