Rockwell Hardness Tester TH300

Instruction Manual

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Contents

1 Introduction

1.1 Scope of application

The machine is a Rockwell hardness tester with Rockwell principle, it is widely used in the hardness testing of carbon steel, alloy steel, cast iron, non- ferrous metal and machinery plastic. And it features at high accuracy, widely using, auto loading/unloading of main force and display, printing of testing results and communication with computer.

The tester conforms to following standard:

ISO6508-2, Metallic Materials - Rockwell Hardness Test - Part 2: Verification and Calibration of testing machines

BSEN10109-2, Metallic Materials - Hardness Test- Part 2: Verification and Calibration of Rockwell Hardness testing machines

BSEN10109-96, Hardness Testing for Metal Materials

ASTM E18, Standard test methods for Rockwell Hardness and Rockwell Superficial hardness of Metallic Materials.
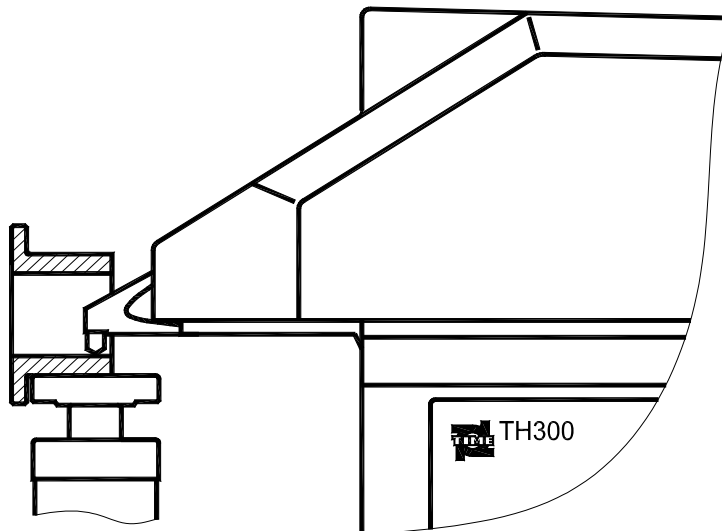
1.2 Features

Figure 1.1

- Unique structure. Adopting special indenter structure, See figure 1.1, it can be used not only to conduct the general test which can be made by traditional hardness tester, but also to test surfaces such as the inner surface of annular and pipe parts, which not possible to be tested by common hardness tester.
- Wide measurement range. It can test following 15 hardness scales: HRA, HRB, HRC, HRD, HRE, HRF, HRG, HRH, HRK, HRL, HRM, HRP, HRR, HRS, HRV,
- Powerful auxiliary functions. Besides general hardness testing, the tester has been provided with following auxiliary functions: upper and lower limit setting and warning; data statistics of mean value, standard deviation, maximum and minimum; scales conversion: the tested results can be converted into values of HB, HV, HLD and $_b$ (strength); Correction for the effect of testing on cylindrical surface and spherical surface.
- LCD display with backlight.

2 Specifications

Resolution: 0.1HR Rockwell unit
Operation temperature: 10 ~ 35
Relative humidity: no more than 45% ~ 75%
Ambient environment: clean, no vibration, no strong magnetic field, and no corrosive medium
Power supply: single phase, AC, 220V / 110V, 50 ~ 60Hz, 4A;
Net weight: 100kgs
Maximum dimension: 715mm× 790mm× 225mm

3 Basic configuration and structure

## 3.1 Configuration

Standard delivery:

|	
Main body	1
Hardness test block, scale B	1
Hardness test block, scale C	1
Steel Ball indenter (1/16)	1
Spare balls (1/16)	5
Diamond cone indenter	1
Mounting screws for indenter	2
Screwdriver	1
Large Vee anvil	1
Power supply cable	1
Dust cover	1
Protection sheath of indenter	1
Instruction manual	1
TIME Certificate	1
Warranty card	1

Optional accessories:

Short diamond indenter (TH3FJ01)
Chisel diamond indenter (TH3FJ02)
Slender diamond indenter (TH3FJ03)
1/8 ball indenter (TH3FJ04) and spare ball
1/4 ball indenter (TH3FJ05) and spare ball
1/2 ball indenter (TH3FJ06) and spare ball
Micro printer (TA220S)
Communication cable
Flat anvil 225 (TH3FJ07)
Flat anvil 150 (TH3FJ08)
Vee/point anvil 70 (TH3FJ09)
Vee/Flat anvil (TH3FJ10)
Assistant joist (TH3FJ11)
Assistant support (TH3FJ12)
Hardness reference blocks for other scales

3.2 Structure schematic diagram

The structure schematic diagram of TH300 is shown as figure 3.1. The keyboard is shown as figure 3.2. The back panel is shown as figure 3.3.
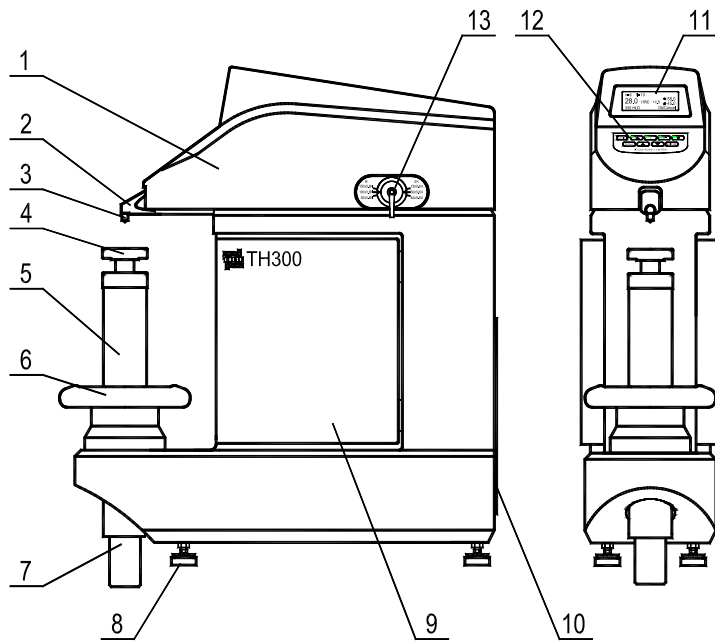
1- canopy   2- indenter base   3- indenter   4- flat anvil   5- shelter for leadscrew   6- hand wheel   7- leadscrew   8- leveling feet   9- side door
10- back panel   11- LCD   12- keyboard   13- hand-lever for load selection

Figure 3.1
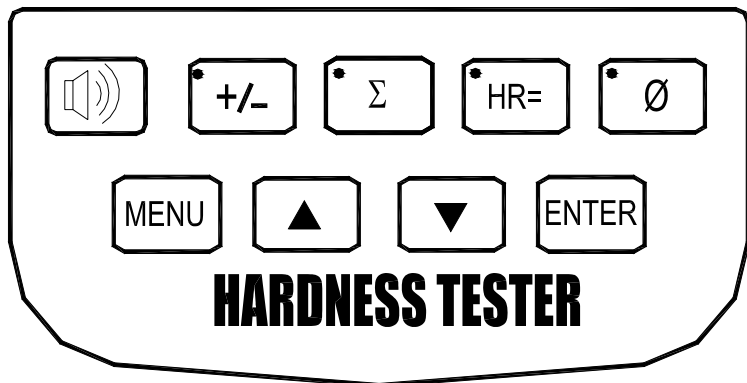
⊏⊐)) —— Key sound setting   +/- — upper/ lower limitation setting   — data statistics
HR= — scale conversion   — curved surface correcting   MENU — main menu
          — rolling direction   ENTER — confirm

Figure 3.2
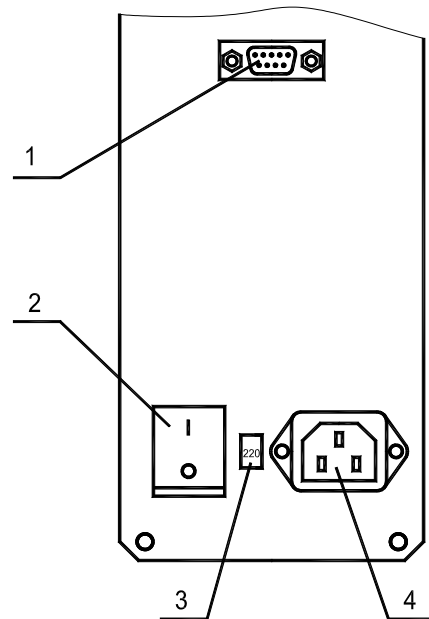
1- interface RS232   2- power supply switch   3-220V/110V switch   4- power socket

Figure 3.3

4 Installation and adjustment

4.1 Refer to figure 4.1a, b. The tester should be mounted on a stationary base platform with no vibration. The bearing capacity of the platform should be more than 150kgs. Three 12mm holes should be prepared on the platform. To ensure the free elevating of the leadscrew, the distance between the center of front holes and the margin of platform should be less than 152mm; otherwise, a 70mm annular hole should be prepared at the place 187mm away from front holes. The limitation of the leadscrew moving downward is 250mm under bench surface, and no obstacle should exist within this range. If there are walls or other obstacles behind the tester, a clearance of 70mm at least should be preserved to make the cables connecting or extracting easily.

4.2 To unpack the tester, run the hand wheel anticlockwise, remove the rubber cushion. **4.3** Place the tester on the prepared platform. Turn the hand wheel in anti clockwise to lower the anvil and remove the rubber pad. Then place a level with the precision of 0.2mm/m on the anvil. Adjust the foundation screws of tester to make the levelness to be 1mm/m and lock the nuts. Tightly fix the tester to the base platform using M10 screws. Refers to figure 4.1.

4.4 Dismantle the bolt fixing the top cover, lift up the front part of the cover a little, pull out the cable and then remove the cover complately.

4.5 There are 4 weights with marks in all for this tester. The 4 marks can be seen in figure 4.1. open the side door of the tester, remove all of the rubber protection belts. Then start installing the weights in the order of 1, 4, 3, 2, in which the weight 1 is hung in the hanging groove of underside lever and the weights 4,3,2 are all hung on the upside lever, please refer to the figure 4.2 for weights 1, 2, and figure 4.3 for weights 3, 4. Do make sure they are hung in the groove.

4.6 Connect the cable which is pull out in step 4.4, put on the cover and fit on the bolt.

4.7 select the power supply of 220V or 110V according to the local power, connect the cable properly. The primary set of power is 220V before first using.
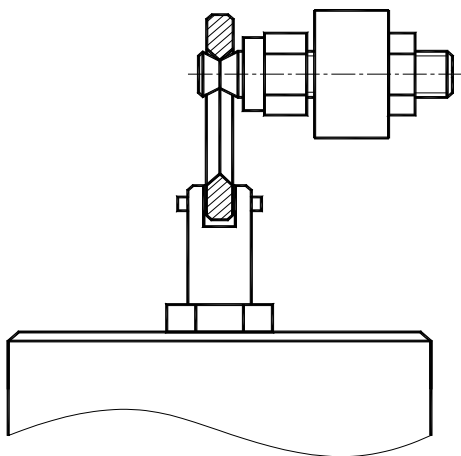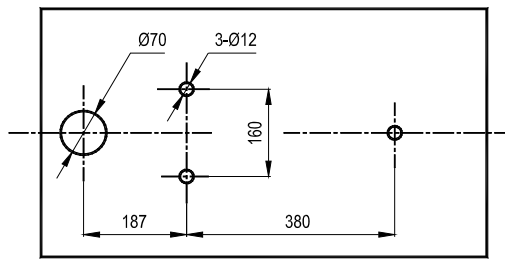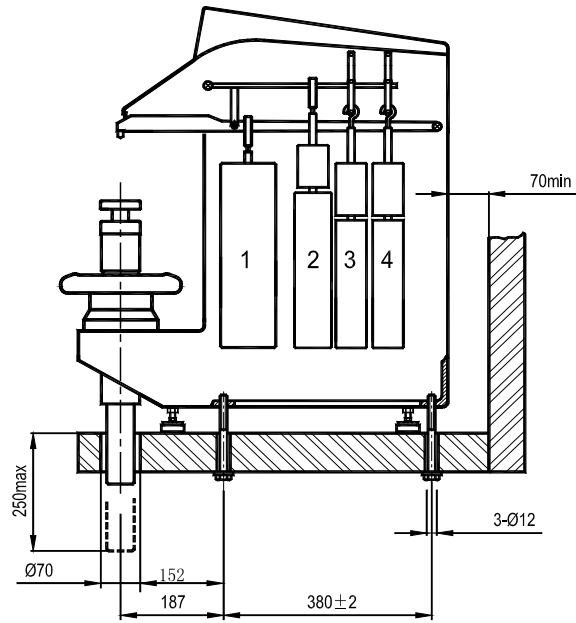
70min

250max

Ø70

152

187
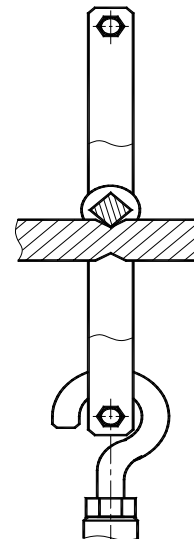
380±2

3-Ø12

Ø70

3-Ø12

160

187

380

Figure 4.2a

Figure 4.2.b

5 Operation

5.1 Test preparation

Connect the power supply cable and switch on. Current test parameters, which are stored automatically before last shutting off, will be displayed. As we can see in figure 5.1.1 and 5.1.2 , they can be switched by pressing the keys   , and show the current scale, indenter type and test force should be used according to the current scale, dwell loading and dwell reading.

```
Scale：                HRC
Diamond cone，      150kgf
```
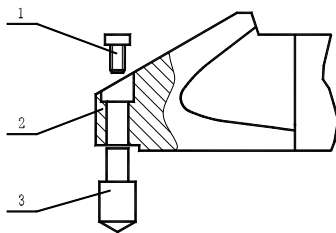
```
Dwell loading：        2s
Dwell reading：        1s
```

Figure 5.1.1   Figure 5.1.2

1- mounting bolt for indenter
2- indenter base
3- indenter

Figure 5.1.3

Pay attention that the indenter selected according to the prompt must be mounted physically on the indenter base. When installing the indenter, make sure the installing surface is clean, without foreign matters, and tightly fixed by screws. The installation method is shown as figure 5.1.3.

Examine to ensure the test force selected is proper. The selection is performed by the switch handle on the right top of the tester, which include 60kgf(588.4N), 100kgf(980.7), 150kgf(1471N).

The test can be performed directly according to the procedure 5.4 if none of the parameters above need to be modified. Following procedures should be observed if the modification is necessary:

5.2 language selection

```
language selection
CHINESE        ENGLISH

                          ↵
```

Figure 5.2.

The manual of this tester can be switched between Chinese and English language by pressing " " or " " keys

5.3 Setting of testing parameters

Press "MENU" key, figure 5.3.1 (Rockwell) or 5.3.2 (Rockwell superficial) will be shown.   It is ready to set the parameters.

```
Scale:              HRC
Dwell loading：      2s
```

```
Dwell reading：        1s
Communication port:   off
```

Figure 5.3.1

5.3.1 Scale selection

Press " " or " " key to move the cursor to "scale" in figure 5.3.1. Press "ENTER" key, then figure 5.3.2 will be showed on screen. The optional 15 Rockwell scales are listed.

```
┌─────────────────────────┐    ┌─────────────────────────────┐
│ ┌───┐                    │    │                             │
│ │HRC│ HRB   HRA   HRD    │    │  Selection :                │
│ └───┘                    │    │                             │
│  HRE   HRF   HRG   HRH   │    │                             │
│  HRK   HRL   HRM   HRP   │    │  Diamond        150kg       │
│  HRR   HRS   HRV         │    │                             │
└─────────────────────────┘    └─────────────────────────────┘
```

Figure 5.3.2   Figure 5.3.3

Press " " or " " key to move the cursor to the scale which will be selected, and press "ENTER" to finish the selection. Now the screen will show what is in figure 5.3.3 according to new selected scales, which is showing which kind of indenter and testing force to use.

Press key "ENTER" to get back to figure 5.3.1

5.3.2 Set dwell loading

Dwell loading refers to the duration of the total loading test force (i.e. time of the pre-load and the additional load actuating simultaneously). For samples without continuous deformation with time after the additional load has been loaded, the additional load is normally set as 1 3s. For samples with continuous slowly deformation with time after the additional load has been loaded, the dwell loading is normally set as 6 8s. For samples with obvious deformation with time after the additional load has been loaded, the dwell loading is normally set as 20 25s.

Press " " or " " key to move the cursor to "Dwell loading" in figure 5.3.1 or 5.3.2 and press "ENTER" key.   Figure 5.3.4 will be shown on the screen.

Press " " or " " key to reset dwell loading (1s   50s). Press the "ENTER" key to complete the selection. The display will return to figure 5.3.1

```
┌──────────────────────────┐    ┌──────────────────────────┐
│                          │    │                          │
│  Dwell loading:    2s    │    │  Dwell reading:    1s    │
│                          │    │                          │
│                          │    │                          │
└──────────────────────────┘    └──────────────────────────┘
```

Figure 5.3.4   Figure 5.3.5

5.3.3 Set dwell reading

Dwell reading refers to the time at which the final depth reading is taken after removal of the additional load. It should be normally set as 1s. However, it can be increased properly   for materials that exhibit creep.

Press " " or " " key to move the cursor to "Dwell reading" in figure 5.3.1 and press "ENTER" key. Figure 5.3.5 will be showed on the screen.

Press " " or " " key to reset dwell reading (1   50s). Then press the "ENTER" key to complete the selection. The display will return to figure 5.3.1

5.3.4 Communication status

```
┌──────────────────────────┐
│                          │
│     RS232:   off         │
│   ┌────────┐             │
│   │printer │  comms      │
│   └────────┘             │
│                          │
└──────────────────────────┘
```

Figure 5.3.6

The tester is provided with a series-digital-communication-port RS232 (baud rate 9600bps), which can be connected with a printer or external computer. Results of each test will be printed or transmitted to an external computer in real time.

The cable of printer or computer should be connected prior to using. Press " " or " " key to move the cursor to "RS232" in figure 5.3.1. Press "ENTER" key. Then, figure 5.3.6 will be showed. Press

" " or " " key to move the cursor to "printer", "comms" or "off", and then press "ENTER" key to complete the selection. The display will return to figure 5.3.1

5.3.5 Return

After the setting was finished completely, press "MENU" to return to figure 5.1.1

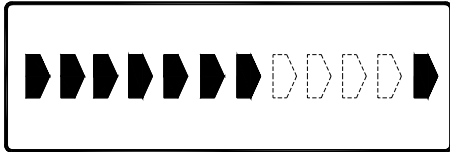## 5.4 Testing

5.4.1 Preload

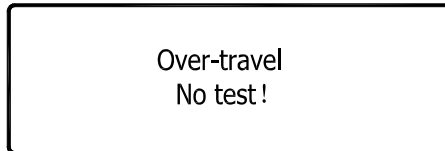Figure 5.4.1   Figure 5.4.2

Place the sample to be tested on the anvil. Smoothly rotate the hand wheel in clockwise to uplift the anvil until the sample has been contacted with indenter. The schematic diagram of indenter moving course will be showed on screen. Refer to 5.4.1, the last symbol is the end position of the pre-load. Rotate the hand wheel slowly and smoothly until the cursor in the figure reaches the end position. Buzzing warning will be given out at the same time and the rotating should be stopped at once.
Test results and precision would not be affected by the slight over-rotation of the hand wheel. In case of excessive rotation occurs, The tester will automatically warn and give prompt. See figure 5.4.2. Redo is necessary.

5.4.2 Automatic test

After the completion of the pre-load, the test will be performed automatically and the figure 5.4.3 will be displayed on screen. Following procedures will be automatically carried out in turn: loading of the main load—holding—unload—read—data processing—result display, the testing result is as figure 5.4.3
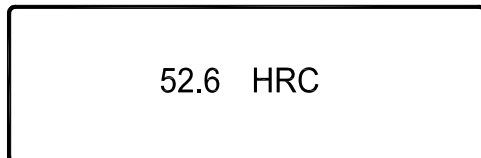

Figure 5.4.3

5.4.3 Unload

Rotate the hand wheel in anti-clockwise to low the anvil, and the test force will be unloaded completely. The display will return to figure 5.1.1. And all test parameters will be stored for the next test.

5.5 Auxiliary functions

The tester has four auxiliary functions, which can be used individually, multi selected or all selected. The setting can only be carried out in the main menu shown as figure 5.1.1 . All the data processing results can be displayed and also be printed or output. Following is the detail:

5.5.1 Upper/lower limit setting

Press " +/-" key once, the indicating light in top-left corner of the key is illuminating and figure 5.5.1 will be displayed on screen. The cursor is at "USL" at this time. Press " " or " " to set the value of upper limit, and then press "ENTER" to confirm. Also press " " or " " to set the value of lower limit behind "LSL", then press "ENTER" to return to figure 5.1.1. Make sure the lower limit value is less than the upper limit value.

```
┌─────────────────────────────┐
│  1. USL = [55.0] HRC        │
│  2. LSL = 45.0 HRC          │
│                             │
└─────────────────────────────┘
```
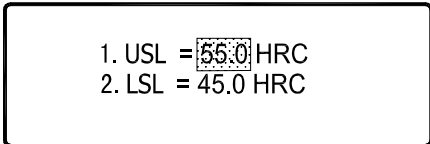Figure 5.5.1

The upper limit and lower limit will be shown simultaneously with the test result each time while this function is set available. As shown in figure 5.5.2, the test result is 55.1HRC, the upper limit is 55HRC and the lower limit is 45HRC. If the result is beyond the limitation scope, warning as in figure 5.5.3 would come forth accompanied with buzzing and the result would not be printed.
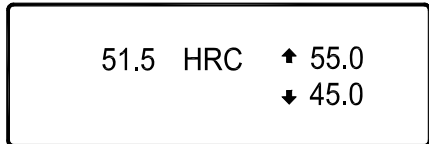
```
┌──────────────────────┐      ┌──────────────────────┐
│ 51.5  HRC   ↑ 55.0   │      │ 56.5  HRC   ↑ 55.0   │
│             ↓ 45.0   │      │             ↓ 45.0   │
│                      │      │   [Out of tolerance!] │
└──────────────────────┘      └──────────────────────┘
```
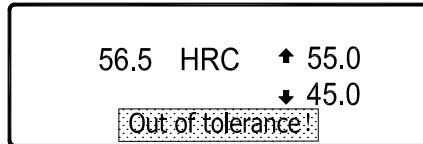　　　　Figure 5.5.2　　　　　　　　　　Figure 5.5.3

Repress " +/-" key to cancel the function, and the indicating light will go off.

5.5.2 Data statistics

The statistics for a group of data is available when press "   " key once. The indicating light in top-left corner of the key is illuminating and figure 5.5.4 will be displayed on screen. press "   " or "   " key to determine the data quantity N (the applicable scope is 1   99). Then press "ENTER" to return to figure 5.1.1.

```
┌──────────────────────┐      ┌──────────────────────┐
│                      │      │                      │
│   N=[10] (1-99)      │      │   55.0  HRC          │
│                      │      │                      │
│                      │      │          ☑  X        │
└──────────────────────┘      └──────────────────────┘
```
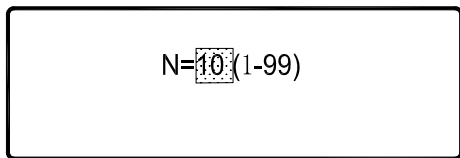　　　　Figure 5.5.4　　　　　　　　　　Figure 5.5.5

The value of serial number n and N will be showed simultaneously with the display of the test result each time after this function is set. As shown in figure 5.5.5, 10 tests will be performed totally, current test is the sixth, and the hardness value tested is 55.0HRC. In case of $n=N$, that is to say the last test has been completed, the tester will automatically calculate the mean value $\overline{X}$, standard deviation S, maximum value Max, minimum value Min and range R after unloading by turning the hand wheel anti-clockwise. The display is shown as figure 5.5.6.
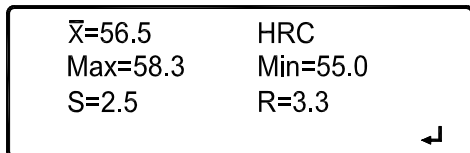
```
┌──────────────────────────────┐
│ X̄=56.5        HRC            │
│ Max=58.3      Min=55.0       │
│ S=2.5         R=3.3          │
│                         ↵    │
└──────────────────────────────┘
```
Figure 5.5.6

Of which, the mean value, standard deviation and range are calculated according to the following equations:

$$\overline{X} = \frac{1}{N}\sum X_i$$

$$S = \sqrt{\frac{1}{N-1}\sum(\overline{X}-X_i)^2}$$

$$R=Max-Min$$

Press "ENTER" key to return to figure 5.1.1. The statistics results can be output automatically if the printer or computer is connected (Refer to 5.3.4)

Normally, the serial number will plus 1 after each test until the n is equal to N (i.e. all of the N tests were completed). Then the statistical calculation begins. In case that the current test need to be cancelled due to some reasons, move the cursor to "×" as figure 5.5.5. Then unload (i.e. lower the anvil) and redo. In this case, 1 will not be added to n, and the current test will not take part in the statistical calculation, and the result will not be printed out or output.

Repress " " key, the function will be cancelled and the indicating light will go off.

5.5.3 Scale conversion

The function can convert the hardness value measured into the hardness in other scales or strength. following functions can be realized: converting the value of HRA scale into HRC, HB, HV, HR15N,HR30N, HR45N value; converting the value of HRB scale into HB10, HB30, HV, HLD, HR15T, HR30T, HR45T, $_b$ value; converting the value of HRC scale into HRA, HBS, HBW, HV, HLD, $_b$ HR15N, HR30N, HR45N value.
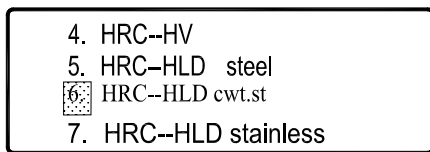
```
   4. HRC--HV
   5. HRC--HLD  steel
  |6.| HRC--HLD cwt.st
   7. HRC--HLD stainless
```
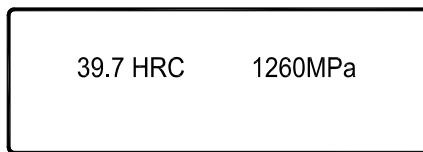
Figure 5.5.7

```
   39.7 HRC        1260MPa
```

Figure 5.5.8

For instance, if we intend to convert the HRC value of current scale into HLD, the work piece is stainless steal, the procedures are as following: Press" HR=" key once. The indicating light in top-left corner of the key is illuminating and figure 5.5.7 will be displayed. Press " " or " " key to move the cursor to "HRC—HLD stainless ", and then press "ENTER" to confirm. The display will return to figure 5.1.1.

The value will be showed simultaneously with the displaying of hardness value each time after the function is set into effect. As shown in figure 5.5.8, the hardness value is 28.0HRC, and the Leeb hardness after converting is 556Mpa. Each conversion is only performed within the applicable scope which conversion is possible. "E" will be showed in case of the converting value beyond the scope. As shown in figure 5.5.9, the hardness measured is 65.5HRC. The converted value HB is beyond the available scope, thus "E" is displayed.

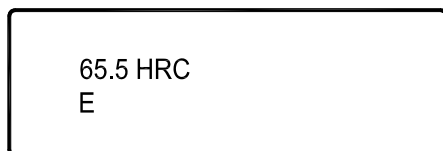Repress "HR=" key, the function is cancelled and the indicating light will go off.

```
   65.5 HRC
   E
```

Figure 5.5.9

5.5.4 Curved surface correction

```
  |1.|Cylindrical surfaces
   2. Spherical surfaces
```
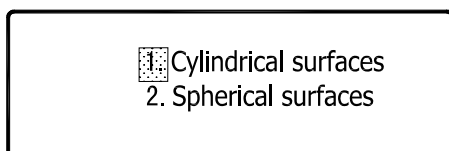
Figure 5.5.10

The measuring results should be corrected if the surface of sample is the convex surface of cylindrical part or spherical surface. press " " key once, the indicating light in top-left corner of the key is illuminating and figure 5.5.10 will be displayed on screen. Press " " or " " key to move the cursor to select correcting mode, then press "ENTER" to confirm.

In case of cylindrical surface correction, figure 5.5.11 will be displayed on screen. Press " " or " "

to determine the curvature radius (applicable scope is 3 ~ 19mm) [note 1]. Then, press "ENTER" to return to figure 5.1.1. In case of spherical surface correcting, figure 5.5.12 will be displayed on screen. Press " " or " " to determine the diameter of sphere (applicable scope is 4 ~ 25mm) [note 2]. Then press "ENTER" to return to figure 5.1.1.

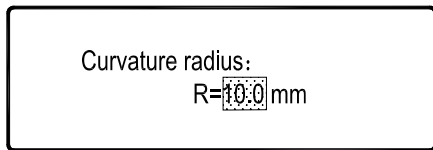Curvature radius：
R=10.0 mm

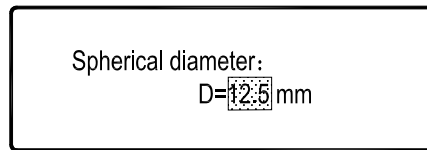Figure 5.5.11

Spherical diameter：
D=12.5 mm

Figure 5.5.12

Note 1, note 2:

In the ISO6508-2, *Metallic Materials - Rockwell Hardness Test - Part 2: Verification and Calibration of testing machines*, only cylindrical surface correction for scale A, C, D, B, F, G, N and T; and spherical surface correction for scale C, as well as the scope are regulated. However, there is no regulation for the values and scales beyond the scope. Therefore, the tester will not correct the values beyond the scope, either. Users should consider if it is necessary to correct them.

The measuring result as well as the correction value will be given in the course of each measurement after the function setting has been taken into effect. Note that the screen will display respectively testing value (the direct testing result without correcting) and correction value. As shown in figure 5.5.13, the measuring result is 38.5HRC and the correction value is "+1.5" HRC.
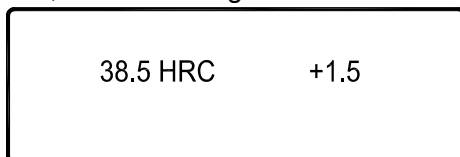

38.5 HRC   +1.5

Figure 5.5.13

Repress the " " key to cancel the function, and the indicating light will go off.

The four auxiliary functions can be all selected simultaneously. In this case, the measurement result is as 5.5.14:
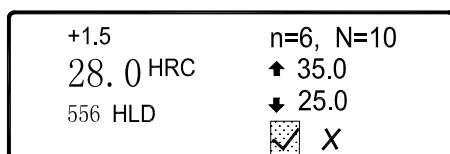

+1.5   n=6, N=10
28. 0 HRC   ↑ 35.0
556 HLD   ↓ 25.0
                   ☑ X

Figure 5.5.14

5.6 Print or communication

There is a standard communication port RS232 in the tester. Connect the cable of printer and set the communication port status as printer (referring to 5.3.4), when printing is needed. Thereafter, the test results and the calculation results of relative auxiliary functions will be printed out synchronism after the completion of each measurement.

The tester can also be connected with a computer. Set the communication port status as external communication (referring to 5.3.4). Then the test results above will be automatically sent to the computer at the same time as unloading each time. The data results can be accessed via common serial communication software, and no special software is needed. For example, as the "Super Terminal" in the "Accessory" of "Windows", it can be operated as following in turn: Starting → Program → Accessory → Communication → Super Terminal. Input the corresponding parameter according to the prompt. The test result will be transmitted in synchronism automatically after each measurement has completed.

5.7 Shut down

Remove the test force completely. Switch off the power supply. The power supply cable should be removed in case of idle for a long time.

6 Trouble shooting

6.1 The tester will perform self-checking, display the type of tester, and determine if the motor is at original position when powered on. If the anvil is not put down, the display will prompt to lower the anvil after self-checking. Figure 5.1.1 will be displayed if everything is in good condition.

6.2 If there is not any display after powering on, Check whether the power supply switch is on, whether the position of voltage selection switch on back panel is proper, whether the fuse of power supply is in good condition and is installed properly, whether the transformer output plug at the inner side of back panel is connected properly with the power supply socket board, and whether the three fuses on power supply socket board had been fused.

6.3 If the display on LCD is abnormal, check whether the position of voltage selection switch on back panel is proper, or uplift the canopy to check whether the connecting of the cables for LCD is perfect.

6.4 If a roar sound of locked motor is given out after powering on, Shut down the power immediately and contact with the supplier.

6.5 If there is no diagram indication on screen when rotate the hand wheel to load, check   whether the test was begun with the status of main menu as figure 5.1.1.

6.6 The light on the key is not illuminating or the key operation is failure. Check to determine whether the connection of cables is perfect. Or contact with the supplier.

6.7 In case of other malfunctions, no hesitate to contact with the supplier.

7 Maintenance and attentions

7.1 The weights and indenter must be removed when transporting the hardness tester. And a piece of shockproof rubber pad must be placed between the indenter base and anvil. The original package should be packed prior to a remote transport.

7.2 When perform any adjusting and checking such as loading/unloading the weights, removing the canopy, plugging/ extracting cables or opening the side door for checking, the power supply should be cut off for safety.

7.3 The changing of test force is forbidden under the status of indenter contacting with the sample measured.

7.4 When installing/uninstalling the indenter, much attention should be paid to ensure the tip to avoid damage and contaminating. And the mounting surface should be clean without any foreign matters. The indenter should be removed to store carefully in case of idle for a long term, and rust protection measures are necessary.

7.5 The surface of the anvil and Hardness reference block should be clean without contamination and scratch, scoring and bruising. Coating of rust protection oil is necessary when store.

7.6 The sample measured must be placed steadily when testing. And the supporting should be reliable to ensure no movement or distortion during the course of testing.

7.7 Dustproof and corrosive medium prevention should be considered in daily operating environment. Regular rust prevention measures should be adopted in moist area.

7.8 Regular lubrication should be carried out for the leadscrew. Steps in detail: remove the anvil and the protection ring. Loose the leadscrew protection sleeve. Drip some light oil to the leadscrew. Rotate hand wheel to elevate the leadscrew again and again to distribute the lubrication oil uniformly. Finally reassemble the parts such as the protection sleeve. Note no much lubrication oil should be dripped.

7.9 The regular verification and calibration of hardness tester should be performed according to the relevant standard and rule of state.

7.10 Not to dismantle or adjust the parts and components that are used for fastening and assembling by yourself when abnormal condition happens.   Please contact with the supplier.

8. Non-warranty parts

Indentor

Appendix 1: Test principle of Rockwell hardness

For Rockwell hardness measurement, the displacement is measured actually. And the displacement obtained under the specified testing condition will be converted into hardness value. The detail procedures are as following. Refer to attached diagram 1.
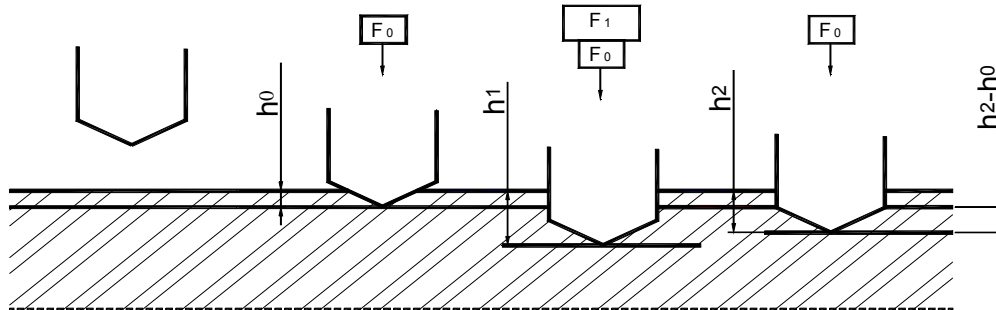
Attached diagram 1

1   First, load test force F_0 to press the indenter into the sample surface, and detect the original displacement h_0.
2   Then, load the additional load F_1 and hold for a period. The displacement of indenter is h_1 at this time. Thereafter, unload F_1.
3   Maintain the pre-load F_0, and measure the indenter displacement at this moment h_2.
4   Calculate the Rockwell hardness value according to the following equations (displacement unit: mm):

Scale	Applicable equation
A D C	$HR = 100 - \dfrac{h_2 - h_0}{0.002}$
F B G H E K P M L R S V	$HR = 130 - \dfrac{h_2 - h_0}{0.002}$

Appendix 2: Scales of Rockwell hardness

Rockwell hardness has 15 types of scales which applicable for materials with different hardness. Scale depends on the combination of indenter and test force. The corresponding relations and application scopes are as following list:

Scale	Indenter	Test force	Hardness scope	Application examples
HRA		588.4N/60kgf	20-88	Carbide alloy, superficial case hardened steel
HRD	Diamond indenter	980.7N/100kgf	40-77	Medium case hardened steel, pearlite forgeable iron and etc.
HRC		1471N/150kgf	20-70	Quenched steel, hardened and tempered steel, harden cast steel and etc.

|				
HRF	Steel ball indenter Diameter: 1.5875mm (1/16")	588.4N/60kgf	60-100	Anneal copper alloy, mild sheet plate alloy
HRB		980.7N/100kgf	20-100	Copper alloy, mild steel, aluminum alloy
HRG		1471N/150kgf	30-94	Forgeable iron, copper-nickel-zinc alloy
HRH	Steel ball indenter Diameter: 3.175mm (1/8")	588.4N/60kgf	80-100	Aluminum, zinc, lead and etc
HRE		980.7N/100kgf	58-100	Cast iron, Aluminum and magnesium alloy, bearing alloy
HRK		1471N/150kgf	40-100	Bronze, beryllium bronze
HRL	Steel ball indenter Diameter: 6.350mm (1/4")	588.4N/60kgf	50-115	Bearing alloy and other extreme mild metals, such as aluminum, zinc, lead, tin and plastic, cardboard, and so on
HRM		980.7N/100kgf	50-115	
HRP		1471N/150kgf	100-120	
HRR	Steel ball indenter Diameter: 12.70mm (1/2")	588.4N/60kgf	50-115	
HRS		980.7N/100kgf		
HRV		1471N/150kgf		

Note 1: The pre-load is 98.07N/10kgf.
Note 2: the hardness tester is suitable for the hardness measurement of plastic, excluding plastic membrane and foam plastic.

Appendix 3: Minimum thickness of the sample to be tested

The minimum thickness of sample depends on the material hardness and scale used. There should be no visual distortion on the back of sample after measurement.
Sample minimum thickness, material hardness and scale used refer to attached diagram 2 and attached diagram 3.
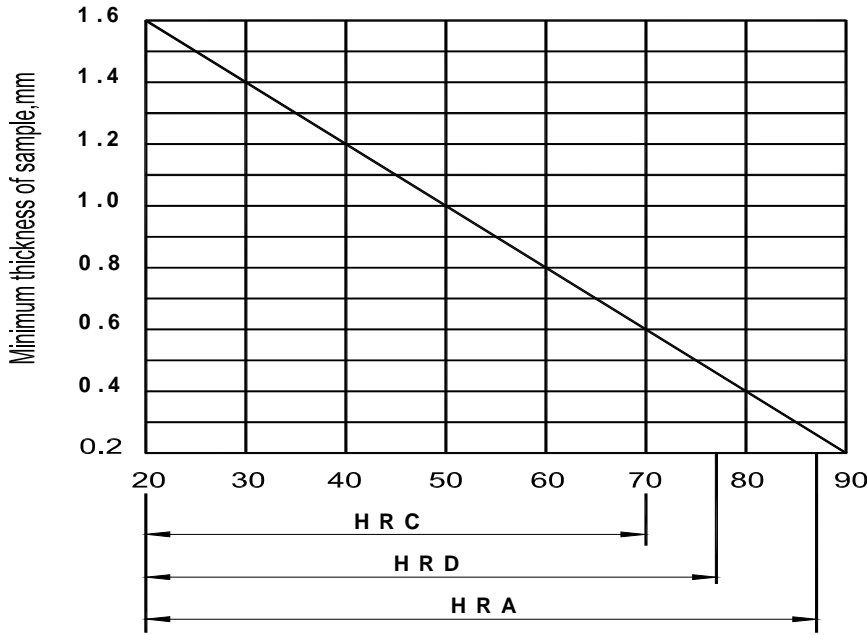
Attached diagram 2: Test with diamond indenter   HRA, HRC and HRD
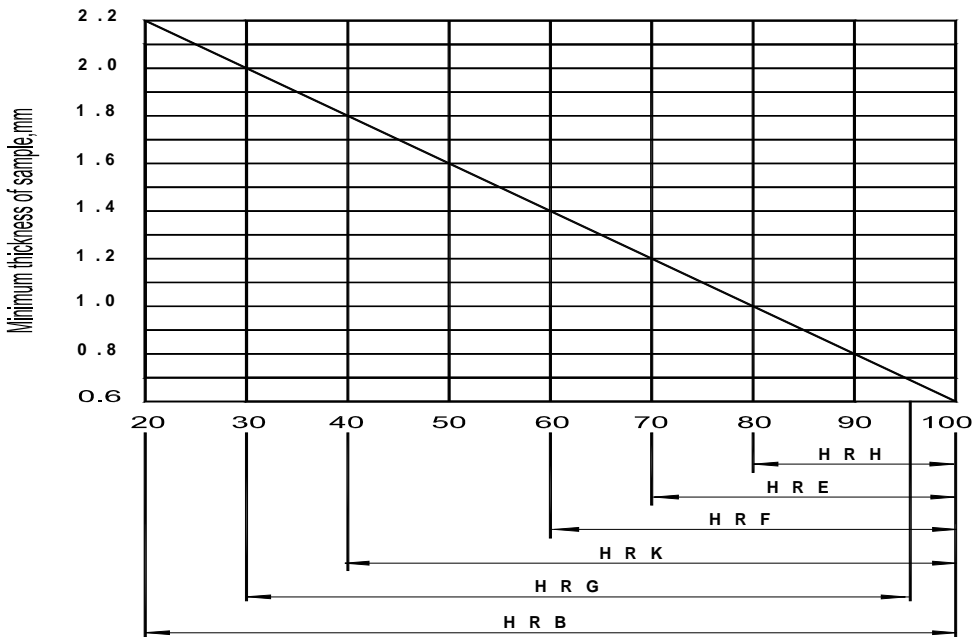
Attached diagram 3: Test with steel ball indenter   HRB, HRE, HRF, HRG, HRH and HRK

Appendix 4: Adjusting method for reading error

In general, TH300 hardness tester had been strictly calibrated prior to leaving factory, thus the adjusting by user is not necessary and forbidden. However, it can be adjusted according to following method if minute error occurs in operation due to some reasons. Following rules should be especially observed when adjusting:

1. Basic knowledge of hardness reading error and repetitiveness verification
1.1. The verification for reading error δ and repetitiveness b should be performed with the standard Rockwell hardness block and standard Rockwell superficial hardness block regulated in GB/T 2850.

The standard configuration of indenter in hardness tester includes diamond indenter and steel ball indenter (diameter 1.5875mm), therefore, three type standard blocks with high, medium and low hardness should be used for scales with "*" in table 1. Other scales should be checked as demand, and the hardness of standard blocks selected should be within the hardness scope in table 1.

Table 1: the hardness scopes of standard blocks

Rockwell hardness scale	Indenter type used and test force	The hardness scopes of standard blocks
A*	Diamond indenter 588.4N/60kgf	20 40 HRA 45 75 HRA 80 88 HRA
B*	Steel ball indenter (diameter: 1.5875mm) 980.7N/100kgf	20 50 HRB 60 80 HRB 85 100 HRB
C*	Diamond indenter 1471N/150kgf	20 30 HRC 35 55 HRC 60 70 HRC
D*	Diamond indenter 980.7N/100kgf	40 47 HRD 55 63 HRD 70 77 HRD
E	Steel ball indenter (diameter: 3.175mm) 980.7N/100kgf	70 78 HRE 84 90 HRE 93 100 HRE
F*	Steel ball indenter (diameter: 1.5875mm) 588.4N/60kgf	60 75 HRF 80 90 HRF 94 100 HRF
G*	Steel ball indenter (diameter: 1.5875mm) 1471N/150kgf	30 50 HRG 55 75 HRG 80 94 HRG
H	Steel ball indenter (diameter: 3.175mm) 588.4N/60kgf	80 94 HRH 96 100 HRH
K	Steel ball indenter (diameter: 3.175mm) 1471N/150kgf	40 60 HRK 65 80 HRK 85 100 HRK
L	Steel ball indenter (diameter: 6.350mm) 588.4N/60kgf	100 120 HRL
M	Steel ball indenter (diameter: 6.350mm) 980.7N/100kgf	85 110 HRM
R	Steel ball indenter (diameter: 12.700mm) 588.4N/60kgf	114 125 HRR

1.2 Verification should be performed according to the testing methods in GB/T 230 or GB/T 1818, and five valid impression should be made on each standard block to measure its hardness. (six time will be conducted for pressing, of which, the first impression will be omitted and the mean value of later five times will be recorded)

1.3 The reading error of hardness tester will be calculated according to equation (1):

$$\delta = \overline{HR} - HR \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

of which: $\overline{HR}$ — the arithmetic mean value of five hardness measurements;

HR — the standard value of standard Rockwell hardness block.

1.4 Repetitiveness ✪ will be calculated according to equation (2):

$$b = HR_{max} - HR_{min} \qquad\qquad \text{………………………(2)}$$

of which: HR_{max} — the maximum in five hardness measurements;

HR_{min} — the minimum in five hardness measurements;

1.5 The reading error δ of hardness tester and repetitiveness ✪ should conform to the regulations in table 2 of 5.6.

Table 2　The reading error δ of hardness tester and repetitiveness ✪

Rockwell hardness scale	Hardness scope	Reading error δ	Repetitiveness ✪ (not more than)
A	20　40 HRA 40　75 HRA 75　88 HRA	± 2.0 HRA ± 1.5 HRA ± 1.0 HRA	2.0 HRA 1.5 HRA 1.0 HRA
B	20　50 HRB 50　80 HRB 　80　100 HRB	± 3.5 HRB ± 2.0 HRB ± 1.5 HRB	3.5 HRB 2.0 HRB 1.5 HRB
C	20　35 HRC 35　55 HRC 55　70 HRC	± 1.5 HRC ± 1.2 HRC ± 1.0 HRC	1.5 HRC 1.2 HRC 1.0 HRC
D	40　63 HRD 63　77 HRD	± 2.0 HRD ± 1.5 HRD	2.0 HRD 1.5 HRD
E	58　69 HRE 70　90 HRE 90　100 HRE	± 2.2 HRE ± 2.0 HRE ± 2.0 HRE	3.0 HRE 2.5 HRE 2.0 HRE
F	60　90 HRF 　90　100 HRF	± 3.0 HRF ± 2.0 HRF	3.0 HRF 2.0 HRF
G	20　50 HRG 50　75 HRG 75　94 HRG	± 6.0 HRG ± 4.5 HRG ± 3.0 HRG	6.0 HRG 4.5 HRG 3.0 HRG
H	80　100 HRH	± 2.0 HRH	2.0 HRH
K	40　60 HRK 60　80 HRK 　80　100 HRK	± 4.0 HRK ± 3.0 HRK ± 2.0 HRK	4.0 HRK 3.0 HRK 2.0 HRK
L	100　120 HRL	± 1.2 HRL	1.5 HRL
M	85　110 HRM	± 1.5 HRM	2.0 HRM
R	114　125 HRR	± 1.2 HRR	1.5 HRR

Hardness tester had been checked and calibrated prior to leaving factory, and it can only delivery if passed. However, some error may occur due to the remote transport, the difference of standard hardness block itself, uniformity of standard block, class difference of standard block and other factors, i.e. the reading inaccuracy in popular words. What frequently occurs is good repetitiveness, however, minute deviation that can be adjusted is present between reading and standard block value. Specific method is introduced as following (taking HRC as example):

* If problems occur, which scale occurs deviation should be determined firstly. For example: HRC scale occurs deviation, the differential between testing results and standard block value is over the tolerant scope.
* Determine the hardness scope section which deviation occurs; take each 10 unit as a hardness scope section. For example: HRC scale occurs deviation; if the nominal value of standard block is 63.5, testing result is about 65, then the hardness scope section deviation occurs is 60~70.
* Determine correcting value. Measurements should be performed by six times with standard block in this hardness scope section. The procedures should be in accordance with the testing method in GB/T 230; six valid impressions will be made on each standard block; then measure and record the hardness values. The value of first impression will be omitted and the mean value of later five

impressions is required. For example: the nominal value of standard block is 63.5HRC, the mean value of five measurements is 65.2HRC, thus the correcting value should be "-1.7". Note: the standard block should be moved on the surface of sample bench, no uplift; six points should be evenly distributed on the standard block; any distance between impressions, the distance between impression and standard block margin should be not less than 2mm.

* Set out to correct. Under the initial menu status, continuously press "ENTER", "ENTER", " " and "ENTER" key in turn; picture of figure 1 displaying at this moment indicates that correcting status has entered.

```
┌─────────────────────────────┐
│  HRC   HRA   HRB   HRD       │
│  HRE   HRF   HRG   HRH       │
│  HRK   HRL   HRM   HRP       │
│  HRR   HRS   HRV             │
└─────────────────────────────┘
```
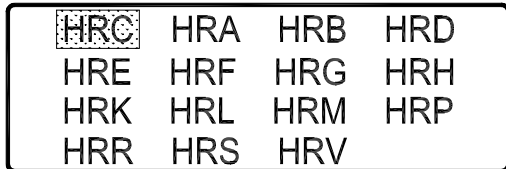
Figure 1

* Press " " and " " key to move cursor to the hardness scale needs to correct. For example: cursor has been moved to "HRC", then press "ENTER" to confirm, and picture of figure 2 will be showed.
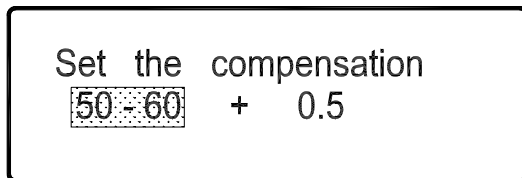
```
┌─────────────────────────────┐
│   Set  the  compensation     │
│    50－60    +    0.5         │
│                              │
└─────────────────────────────┘
```

Figure 2

* Press " " and " " key to choose the hardness scope section needs to correct. For example: press " " until "50-60" has changed into "60-70", then press "ENTER" to confirm. Cursor will be at "+" at this moment.

* Press " " and " " key to choose "+" or "-". For example: if the correcting value is "-1.7", then "-" should be selected, press "ENTER" to confirm. Cursor will be at "0.5" at this moment.

* Press " " and " " key until "0.5" has been changed into "1.7", then press "ENTER" to confirm.

* Press "MENU", screen will back to figure 1; other selection can be made to correct other scales.

* If no correcting is necessary for other scales, press "MENU" to exit correcting status; return to main menu.

* The correcting method for any scale and hardness scope section is as the same as this example.

* The correcting value of any scale and hardness scope section should be recorded for requisition later.