



**HDT-VE SERIES
DIGITAL VIVKERS HARDNESS TESTER
OPERATION MANUAL**



1.Introduction

1.1 Machine Overview

First of all, thank you for choosing our company's products and browsing this manual.

The Vickers hardness tester is suitable for testing metal structures, including small parts, thin sheets, metal foils, wires, thin hardened layers, and electroplated coatings. It can also be used to test non-metallic materials such as glass, jewelry, and ceramics that cannot be tested using the Rockwell test method and other relatively high test forces. Especially, it can follow the structure of metals and test the internal hardness of materials such as induction hardening or carburization.

Vickers hardness tester is a high-tech product that integrates optics, mechanics, and electronics. The hardness tester has a novel design, good reliability, operability, and repeatability, and is an ideal product for testing Vickers hardness.

This machine adopts C language programming, high magnification optical measurement system, optical dual channel structure, and new technologies such as optoelectronic and optoelectronic sensing. By pressing buttons, it is possible to input the length of the indentation for measurement, display the hardness value on the LCD screen, convert the scale, test force, test force retention time, and measurement times.

The hardness tester can also be configured according to the special needs of users, capable of taking photos of the measured indentation and material metallographic structure, using a visual measurement device and an automatic indentation measurement device, as well as measuring Knoop hardness.

1.2 The Principles of Vickers Hardness and Knoop Hardness

1.2.1 Vickers HV

The Vickers hardness test involves using a 136 ° rhombic diamond indenter to press the surface of the tested object with a specified test force (F). After maintaining the test force for a specified time, the test force is removed, and the indentation diagonal (d) on the surface of the test piece is measured using a micrometer eyepiece. The average pressure (N/mm²) borne by the conical surface area of the indentation is calculated, which is the Vickers hardness value. (See Figure 1.1 for details).

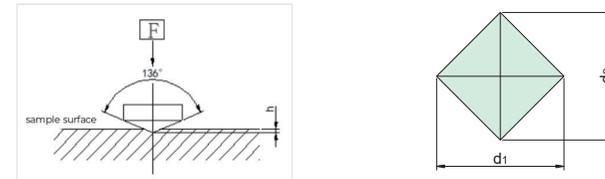


Figure 1.1 Vickers Test Principle

Vickers hardness calculation formula:
$$HV = 0.1891 \frac{F}{d^2}$$
 formula (1-1)

In the formula:

HV—Vickers hardness

F --N

d-- Indentation of two diagonal lines (d1,d2) Average length, mm

HV The relationship between indentation depth h and diagonal d: $h=d/7$
formula (1-2)

Note that when the test force is kgf:

$$HV = 1.854 \frac{F}{d^2}$$
 (formula 1-3)

1.2.2. knoop HK

The experimental principle of Knoop is the same as that of Vickers, except that the indenter is different from Vickers. Knoop is a pyramid shaped diamond indenter with a diamond base. The indentation perpendicular to the surface of the test piece is a diamond in shape, and the ratio of the lengths of the two diagonal lines is approximately 7:1 (See

Fig1.2) 。 Due to the geometric characteristics of the Knoop indenter, the diagonal accuracy measured at low test forces is relatively high. The depth of the indentation is shallow, approximately 1/30 of the long diagonal. Due to this characteristic, the Knoop test is very suitable for testing the hardness of thin coatings, surface hardened layers, metal flakes, decarburized layers, and hard brittle metals. 。

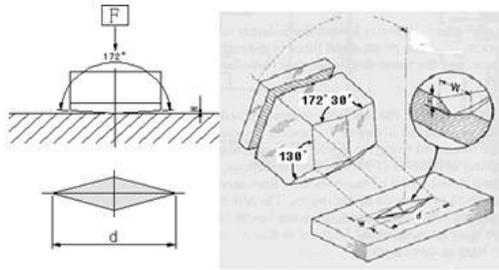


Fig 1.2 Knoop test principle

Knoop hardness calculation formula: $HK = 1.4509 \frac{F}{d^2}$ (formula 1-4)

In the formula:

HK—Knoop hardness

F --N

d-- Indentation diagonal length, mm

The relationship between HK indentation depth h and diagonal d: $h=d/30$ (formula 1-5)

Note that when the test force is kgf:

$HK = 14.229 \frac{F}{d^2}$ (formula 1-6)

2.Main technical parameters

2.1 HDT-VE03 specification

Test force	0.3kgf, 0.5kgf, 1kgf,2kgf, 3kgf, 5kgf
Vickers scales	HV0.3,HV0.5,V1,HV2, HV3, HV5
Converted scales	HRA,HRB,HRC,HRD,HRF,HV,HK,HBW,HR15N,HR30N, HR45N, HR15T, HR30T, HR45T
Range	8-3000HV
Length measurement resolution	0.5um
Objective/indenter switch	motor driven turret
Stage lifting	manual
Load dwell time	1-60 second
Objective	10X,20X
Eyepiece	10X
Total magnification	100X(for measurement or observation), 200X(for measurement)
Max.workpiece height	175mm
Max. testing width	135mm
Power supply	220V,50/60HZ
Dimension	580x320x660mm
Weight	55kg

2.2 HDT-VE14 specification

Test force	0.3kgf, 0.5kgf, 1kgf,3kgf, 5kgf, 10kgf
Vickers scales	HV0.3,HV0.5,HV1,HV3,HV5,HV10
Converted scales	HRA,HRB,HRC,HRD,HRF,HV,HK,HBW,HR15N,HR30N, HR45N, HR15T, HR30T, HR45T
Range	8-3000HV
Length measurement resolution	0.5um
Objective/indenter switch	motor driven turret
Stage lifting	manual
Load dwell time	1-60 second
Objective	10X,20X
Eyepiece	10X
Total magnification	100X(for measurement or observation), 200X(for measurement)
Max.workpiece height	175mm
Max. testing width	135mm

Power supply	220V,50/60HZ
Dimension	580x320x660mm
Weight	55kg

2.3 HDT-VE35 specification

Test force	1kgf, 3kgf, 5kgf,10kgf, 20kgf, 30kgf
Vickers scales	HV1, HV3,HV5HV10,HV20,HV30
Converted scales	HRA,HRB,HRC,HRD,HRF,HV,HK,HBW,HR15N,HR30N, HR45N, HR15T, HR30T, HR45T
Range	8-3000HV
Length measurement resolution	0.5um
Objective/indenter switch	motor driven turret
Stage lifting	manual
Load dwell time	1-60 second
Objective	10X,20X
Eyepiece	10X
Total magnification	100X(for measurement or observation), 200X(for measurement)
Max.workpiece height	175mm
Max. testing width	135mm
Power supply	220V,50/60HZ
Dimension	580x320x660mm
Weight	55kg

2.4 HDT-VE56 specification

Test force	1kgf, 5kgf, 10kgf,20kgf, 30kgf, 50kgf
Vickers scales	HV1,HV5,HV10,HV20,HV30,HV50
Converted scales	HRA,HRB,HRC,HRD,HRF,HV,HK,HBW,HR15N,HR30N, HR45N, HR15T, HR30T, HR45T
Range	8-3000HV
Length measurement resolution	0.5um
Objective/indenter switch	motor driven turret
Stage lifting	manual
Load dwell time	1-60 second
Objective	10X,20X
Eyepiece	10X
Total magnification	100X(for measurement or observation), 200X(for measurement)

Max.workpiece height	175mm
Max. testing width	135mm
Power supply	220V,50/60HZ
Dimension	580x320x660mm
Weight	55kg

3.Installation and debugging of instruments

3.1. Working conditions of hardness tester

- a. Within the range of room temperature (23 ± 5) °C;
- b. Horizontal placement on a stable foundation;
- c. In a vibration free environment;
- d. There is no corrosive medium around;
- e. The indoor relative humidity shall not exceed 65%.

3.2 Installation and adjustment of instruments

3.2.1 Remove the four nuts at the bottom of the box, lift and remove the box, and take out the accessory box;

2.2 Lift the bottom plate, use a wrench to unscrew the two M10 bolts under the bottom plate, and detach the hardness tester from the bottom plate.

2.3 Place the hardness tester on a stable workbench and open holes at appropriate positions on the workbench (Figure 1) to ensure the normal operation of the screw;

2.4 Take out the adjustment screw (1) from the accessory box and screw it at the bottom of the main body (Figure 2), and adjust it to the horizontal position;

2.5 Rotate the rotating wheel (2) to ensure that the screw (3) can smoothly pass through the hole opened by the dedicated workbench.

The specific size of the workbench hole is:

Figure1

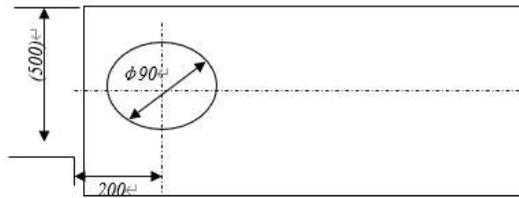
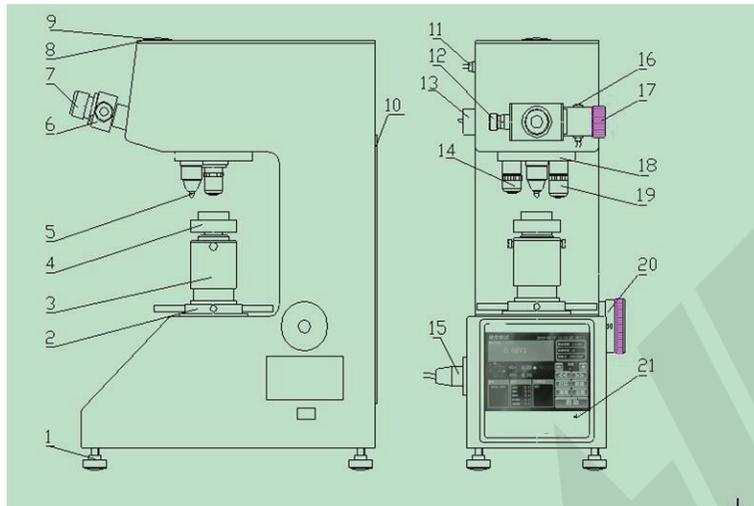


Figure (2) Appearance of the hardness tester host and names of each component



Name of each component

- 1. Adjusting screw 2. Rotary wheel 3. Screw 4. Test bench 5. Pressure head
 - 6. Eyepiece 7. Eye mask 8. Upper cover 9. Camera cover 10. Rear cover
 - 11. Electronic collection cable socket 12. Left drum wheel 13. Lamp chamber
 - 14. Objective lens 10X 15. Power switch 16. Electronic collection button
 - 17. Right large drum wheel 18. Transfer 19. Objective lens 20X 20. Variable load handwheel 21. Operation panel
- 2.6 Open the upper cover (8), remove all the gauze straps attached to the lever, and then cover the upper cover.
- 2.7 Remove the test bench (4) from the accessory box and place it in the hole of the screw (3). Insert one end of the eyepiece (6) into the eyepiece tube hole

and fully insert it. Insert the eyepiece wire plug into the circular socket (11).

3. Installation of weight group (Figure 3)

3.1 Open the back cover (10), remove the gauze tape between the suspension rod (21) and the fork frame (22), take out the weights in the accessory box, and wipe them clean. Turn the variable load handwheel (20) to the required force position of the standard block of the matching machine, so that the fork frame (22) is horizontal.

3.2 Place weight 1 (21), weight 2 (22), weight 3 (23), and weight 4 (24) on the four forks (20) in sequence, and then rotate the variable load handwheel (20) to the required force on the machine standard block. When the weights are suspended, they must not touch the inner wall of the forks (20). Reverse the handwheel (11) to 1kgf and observe whether the cylindrical pins on both sides of the weight are placed in the grooves of the fork frame (20). After placing them, install the rear cover (10).



(Figure 3)

- 19. Hanger 20. Fork 21. Weights (1) 22 Weights (2) 23 Weights (3) 24 Weight (4) 25 Small weight

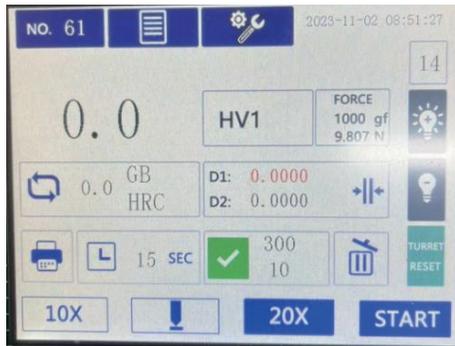
4.Introduction to Panel Key Functions

4.1 Functions of each key

Figure 4-1 shows the front panel of the touch color screen digital Vickers hardness tester. The part in the figure is an

LCD, and its details will be explained in later chapters of this manual. This chapter will provide a detailed explanation of the functions of each key on the interface (this book only introduces the Chinese interface, and the same applies to English operations).

1) Introduction to Main Interface Functions:



(1) To display the operation panel normally



(2) When manually entering diagonal lines, the dialogue window displays the interface

Press the face key to automatically switch between 10,

indenter, 20x objective, and indenter; Press the face key or key to increase or decrease the brightness of the light; Pressing the face button to print will print out all current test data; Pressing the face key data will display all current measurement data. Pressing the face key hardness conversion key can select the conversion scale, pressing the face key can set the holding time, pressing the face key can set the upper and lower limit values, and pressing the face key current measurement data; Pressing the reset button serves as a reset function during digital measurement and a reset function during data input; Press the setting interface key to enter the main menu function setting interface (see introduction below); Press the start button to automatically enter the loading and testing state of the machine. When clicking on d1 and d2, a digital dialogue window will be displayed. Input the diagonal length to display the measured value.

2) Introduction to menu interface and functions:



- a. Load holding time setting: After pressing the load holding time surface key, a number surface key will be displayed. When the time is less than 10, directly press the number surface key you want to adjust (for times of 10 and above, press the individual digits and 10 digits in order), and then press the confirm surface key. (Time in seconds)
- b. Control hardness setting: Press the control hardness surface key to enter the

menu, and all convertible hardness value units will be displayed. Press the desired conversion surface key, and then press the return key.

c. Hardness mode setting; Load unit setting; Language settings; The method for setting and selecting 1K and 2K objective magnification is the same as in (2).

d. Current data: Press the button below to view all current measurement data. If you need to save, press the save button in the upper right corner. If not saved, the shutdown will automatically reset to zero.

e. Storage data: Press the following key to enter the menu, where you can view all saved grouped storage data and print it.

4.2 Selection of test force

When you rotate the test force change handwheel on the instrument to select a new test force, the test force value in the upper right corner of the main menu immediately changes. After selecting the test force, the new test force is loaded into the system.

4.3 Energy saving mode

After 5 minutes of use, this hardness tester will automatically enter energy-saving mode and turn off the light source. Users can activate the energy-saving mode of the hardness tester by pressing any key on the operating keyboard for normal testing.

5. Use of hardness tester:

5.1 Operation and use of hardness tester:

The working process of measuring hardness with a hardness tester is shown in Figure 5.1

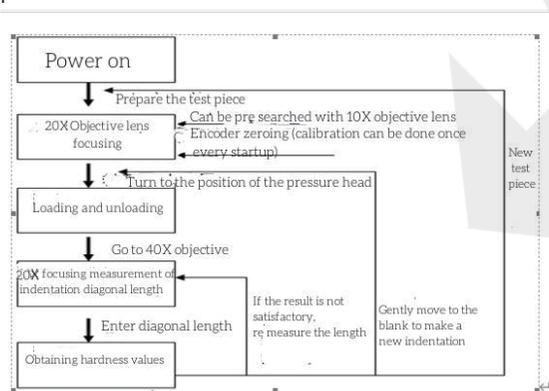


Figure 5.1 Measurement process of Vickers hardness tester

5.1.1 Testing process:

1) Plug in the power and turn on the power switch. The interface appears on the screen, at which point the data can be modified.

For example, selecting hardness scales (HV, HK), hardness conversion, holding time, and light on/off can meet the requirements by pressing the button.

2) Rotate the change handwheel (11) to ensure that the test force meets the selection requirements. The force value of the change handwheel (11) is consistent with the force value displayed on the screen. When rotating the handwheel (11), it should be done carefully and slowly. When the rotation reaches the maximum force value, the rotation position is already at the bottom and cannot continue to rotate forward. Instead, it should be rotated in the opposite direction; When turning to the minimum force value, the rotation should also be reversed.

3) Rotate the turret (19) to make 20 × Or the 10X objective (20) is in the forward position (the total magnification of the optical system is 200 × Or 100X, in measurement state).

4) Place the standard test block or test piece on the working test bench (4), rotate the rotating wheel (2) to raise the test bench. When the test piece is about 2mm away from the lower end of the objective lens (20) (do not touch the objective lens), then observe with your eyes close to the eye mask of the micrometer eyepiece (6). A bright spot appears in the field of view of the micrometer eyepiece, indicating that the focusing surface is about to arrive. At this point, the test bench should slowly rise or fall slightly until a clear image of the sample surface is observed in the eyepiece, and the focusing process is completed. Due to the very smooth surface of the standard test block, it is difficult for beginners to find the surface of the test piece. Therefore, you can turn the test piece over (with the rough surface facing upwards) and wait until the surface of the test piece is found before turning it back to the test surface.

Note: When testing irregular specimens, be careful to prevent the indenter from hitting the specimen and damaging it.

5) Turn the indenter (5) to the forward position and feel that the turret (19) has been positioned. When rotating, it should be done carefully and slowly to prevent rapid impact. At this time, the distance between the top of the indenter and the focused specimen plane is about 0.4-0.5mm.

6) Press the "Start" button, apply the test force (motor starts), and a loading and unloading progress bar will appear on the screen; When the progress bar is completed and the machine emits a beep, the motor operation ends and d1:0 appears on the screen waiting for measurement.

Warning: When the motor is in operation, it is not allowed to move the test piece or rotate the turret again. It must wait for the loading and unloading to end before moving, otherwise it may damage the instrument.

7) Add 20 × Or turn the 10X objective lens to the front, and then measure the diagonal length of the indentation in the micrometer eyepiece (6). If the indentation is not clear, slowly raise or lower the test bench to make it clear; If the two lines inside the micrometer eyepiece (6) are blurry, the eye mask on the

micrometer eyepiece can be adjusted according to each person's vision.
 8) Rotate the right drum wheel and move the reticle in the eyepiece, gradually bringing the two reticles closer together. When the inner side of the reticle is infinitely connected
 Near term (the inner side of the reticle is in a critical state without light gap, but the two reticles must not overlap). See Figure 5.3

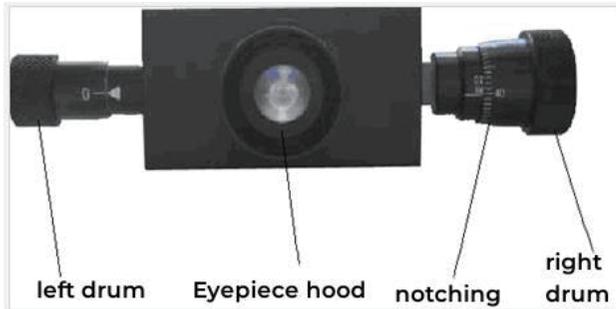


Figure 5.3 Measurement eyepiece

Before starting the measurement, the interface will prompt for a reset action. Press the reset OK button, and the d1: value on the main screen will be zero, which is the zero position in the terminology. Then the diagonal length of the indentation can be measured in the eyepiece. **(Every time the machine is turned on, it must be reset to zero position)**

9) Rotate the right drum (18) to separate the scoring lines, then move the left drum (15) to move the left scoring line,
 When the inner side of the left scoring line is tangent to the intersection point of the left contour of the indentation, move the right scoring line again to make the inner side tangent to the intersection point of the indentation contour, as shown in Figure 5.4.

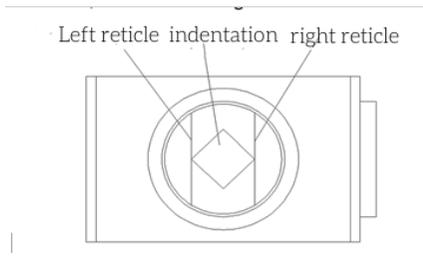


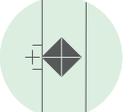
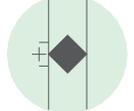
Figure 5.4 Long measurement indentation diagram

Press the measurement button (19) on the eyepiece to complete the measurement of the diagonal length d1; Rotate the eyepiece (9) 90 ° and measure the diagonal length d2 using the above method. Press the

measurement button (19), and the screen will display the displayed values for this measurement and the converted hardness values. If you believe there is an error in the measurement, you can repeat the above procedure to measure again.

The specific measurement methods for indentation are listed below:
 please refer to Table 5.1

Table 5.1 Specific measurement methods for indentation

<p>1. Observe the two lines in the field of view from the eyepiece and rotate the eye mask to make the lines clear. Note: Rotating the eye mask may cause blurry imaging of the indentation. After the two notches are clear, rotate the lifting wheel to make the imaging of the indentation clear, as shown in Figure 5.5;</p>	 <p>Figure 5.5</p>
<p>2. Rotate the drum wheels on both sides of the micrometer eyepiece to make the inner sides of the two lines infinitely close, that is, when the light transmission between the inner sides of the two lines gradually reaches a critical state of light and no light, press the "Clear" key. At this time, the D1 value on the main screen is zero, which is the zero position in the terminology. (Each time the machine is turned on, it must be reset to zero position) as shown in Figure 5.6;</p>	 <p>Figure 5.6</p>
<p>3. Rotate the two drum wheels of the micrometer eyepiece in reverse, gradually separating the two notches. Rotate the left drum wheel of the eyepiece so that the inner side of the left notches is tangent to the left edge of the indentation, as shown in Figure 5.7</p>	 <p>Figure 5.7</p>
<p>4. Rotate the right measuring drum so that the inner side of the right scoring line is tangent to the edge on the right side of the indentation, as shown in Figure 5.8. Press the measurement button (19) D1 on the eyepiece to complete the measurement.</p>	 <p>Figure 5.8</p>
<p>5. Rotate the micrometer eyepiece by 90 ° (note that it should be tightly attached to the eyepiece tube during rotation), rotate the drum so that the inner side of the lower scoring line is tangent to the edge of the lower edge of the indentation, as shown in Figure 5.9;</p>	 <p>Figure 5.9</p>

6 . Rotate the measuring drum to make the inner side of the upper scoring line tangent to the edge of the indentation, as shown in Figure 5.10. Press the measurement button (19) D2 on the eyepiece to complete the measurement. The instrument automatically calculates the hardness value and displays it. The number of tests automatically increases by one, and one measurement is completed.



Figure 5.10

5.1.2 Test process of touch color screen digital display automatic turret model

When using this machine, please always be careful not to touch any objects when rotating the turret

- 1) Power on
- 2) You can press to turn the turret to the desired objective position.

3) Place the test piece on a cross workbench and focus to find the focal plane.

When the focal plane is found, if the specimen is irregular, please manually rotate the turret. The pressure head should not touch any objects before continuing with step 4.

- 4) Press START to start, and the pressure head will turn to the front and start testing regardless of its position. At this time, do not take any action and wait for the testing to be completed.
- 5) After loading and unloading, the turret will automatically rotate to a 40x objective lens. At this point, the hardness value can be obtained by measuring diagonally. The measurement method refers to the touch color screen digital display manual turret model.

6. Maintenance and operation precautions of hardness tester

6.1. Light source maintenance (usually new LED light source)

LED light adjustment method

1. As long as the three external screws are adjusted, when one is loose, the other two can be tightened. Repeatedly adjusting a few times can make the field of view light converge, the brightness is uniform, and it can be locked tightly.
2. When replacing the lamp, you can contact technical guidance for operation.

6.2 Replacement of fuses

When the machine fuse is broken, please replace it as follows:

- 1) Cut off the power supply, unplug the power cord from the socket, insert a flat screwdriver into the middle of the connector as shown, and pry out the fuse holder.
- 2) Remove the fuse holder from the incoming connector. Take out the fuse and check if the fine wires inside are broken. If you cannot determine whether the fuse is broken, you can use an ohmmeter to check if the fine wire is good
- 3) Replace with a new fuse and install it properly. The fuse is installed in the fuse holder to protect the hardness tester from damage caused by power voltage or internal short circuits. If there is any situation that causes the fuse to repeatedly burn out, please contact the maintenance personnel immediately.

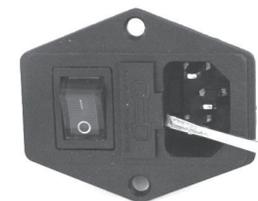


Figure 6.6 Knocking on the fuse holder



Figure 6.7 Replacing the fuse

6.3 Diamond Indenter

- 1) The pressure head (7) and pressure head shaft are very important parts of the instrument, so be very careful not to touch the pressure head during operation.
- 2) To ensure testing accuracy, the indenter should be kept clean. When it is contaminated with oil or dust, a degreased cotton can be dipped in alcohol (industrial use) or ether, and the tip of the indenter should be carefully wiped clean.
- 3) If you want to replace the pressure head, please do not disassemble it yourself. Please contact a repairman

6.4 micrometer eyepiece

- 1) Due to the disparity of each person, the lines in the field of view of the observation micrometer eyepiece may be blurry. Therefore, when changing people, the observer should first slightly rotate the eye mask on the eyepiece to make the lines in the field of view clear.
- 2) When inserting the micrometer eyepiece into the eyepiece tube, it should be inserted to the bottom without leaving any gaps, otherwise it will affect the accuracy of measurement. When measuring the diagonal of the indentation, the vertex must be measured, and then rotated 90 ° before measuring another pair of vertices.
- 3) Zero point: Every time the machine is turned on, it must be reset to zero point. Refer to page 13.

6.5 sample

- 1) If you suspect that the machine hardness is not accurate, you can use a standard hardness block for proofreading. When proofreading, the

- hardness block should face upwards and the oil stains on the hardness block should be wiped out before measurement. Generally, the first test point is not counted, and the second point is only effective.
- 2) The surface of the sample must be clean. If there is grease and dirt on the surface, it will affect the measurement accuracy. When cleaning the sample, alcohol or ether can be used to wipe it.
 - 3) When the sample is a fine wire, thin piece, or small piece, it can be clamped using a fine wire clamping platform, a thin piece clamping platform, and a flat mouth clamping platform respectively, and placed on a cross test bench for testing; If the test piece is too small to grip, the test piece should be embedded and polished before proceeding with the test.
 - 4) To ensure the correctness of the test, it is necessary to ensure the thickness of the sample. According to national standards, the thickness of the test piece must not be less than 8-10 times the depth of the indentation. So how do you know if the test piece meets the specified requirements? Here are several methods to introduce.
 - a) Direct observation method:
Test the specimen according to the specified requirements, and observe whether there are any signs of deformation on the edges and back (support surface) of the specimen after the test is completed. If there are traces, the test results are invalid. The thickness of the test piece is too thin to meet the requirements of the test. There are two options: one is to remake the test piece, and some parts cannot be changed. The second option is to choose a smaller test force, which can only be carried out within the specified requirements.
 - b) Formula calculation method:
The calculation formula for the thickness of Vickers hardness specimens: $h \approx d/7$.

6.6 Selection of force and indentation size

When measuring Vickers hardness, as long as the conditions of the specimen allow, try to use a large test force, and the measurement is relatively accurate. Generally, hard materials require significant testing force; Soft materials require less testing force.

According to convention, measuring the diagonal length of the indentation is most convenient when it is around 50um, but also considering the thickness of the material.

Reference: Material thickness \geq 1.5×Indentation diagonal length

For example, if the material thickness is 0.1mm, the diagonal length of the indentation cannot be greater than 0.066mm.

Here: $0.1 \geq 1.5 \times 0.066$ 。

Note: Before installing and operating the machine, please read this manual carefully, especially the bold parts, otherwise it may cause adverse human damage and the consequences will be borne by oneself.