Abstract:

This experiment consisted of three parts:

The first part was theoretical calculation training on how to use the minimum number of block gauges measurement devices when you are given the final required length

In the second one, a linear measurement device; namely, micrometer screw gauge was examined for zero error and then used to measure the length of some (given-lengths) block gauges to an accuracy of $\pm$0.005mm.

Finally, Vernier Caliper was used to measure the height of a metal piece to an accuracy of $\pm$0.01 then,this piece of metal was placed in a mechanical comparator where it's two arrows were fixed to surround the pointer's reading of the piece height, block gauges were then fixed together by sliding or ringing to fit in the mechanical comparator giving a reading that lies between the two arrows.

Micrometer screw gauge had a zero error drift of 0.111mm and an error between block gauges and micrometer readings that ranges between 2-10%.

Objectives:

1- To learn linear measurement using micrometer screw gauge and vernier caliper
2- To learn how to use block gauges with a mechanical comparator for linear meaurements
   -using minimum number of blocks.

Apparatus :

1) Vernier height gauge :

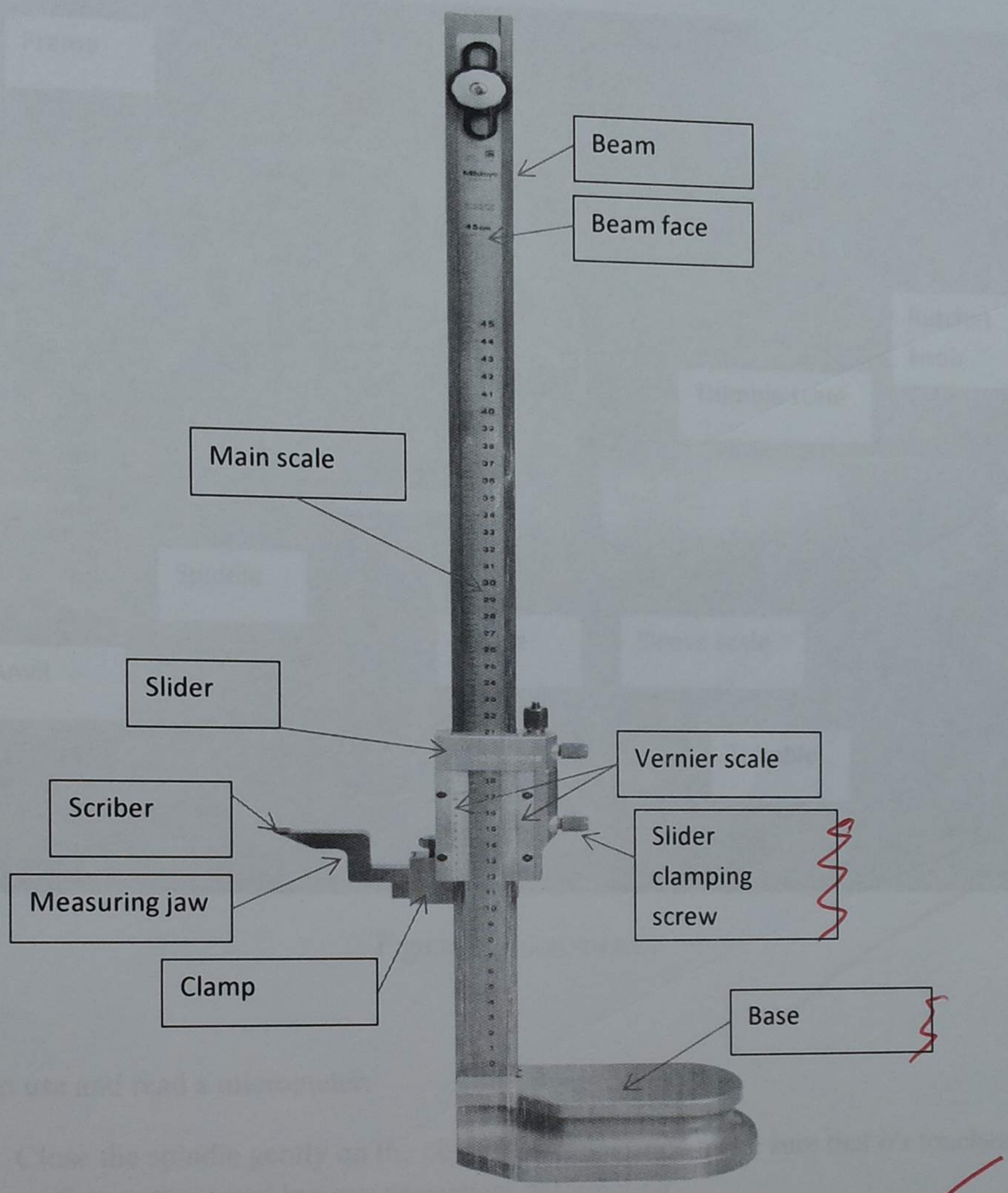


Figure1: vernier height gauge

Procedure to use and read Vernier caliper:

- Get the object between the caliper jaw and the table surface.
- Then close the jaw slowly on the object.
- Read the centimeter mark on the main scale.
- Take the reading on the vernier scale and multiply it by proper scale.
- Write down the height of the work piece after summing the two readings.

2) The Micrometer :

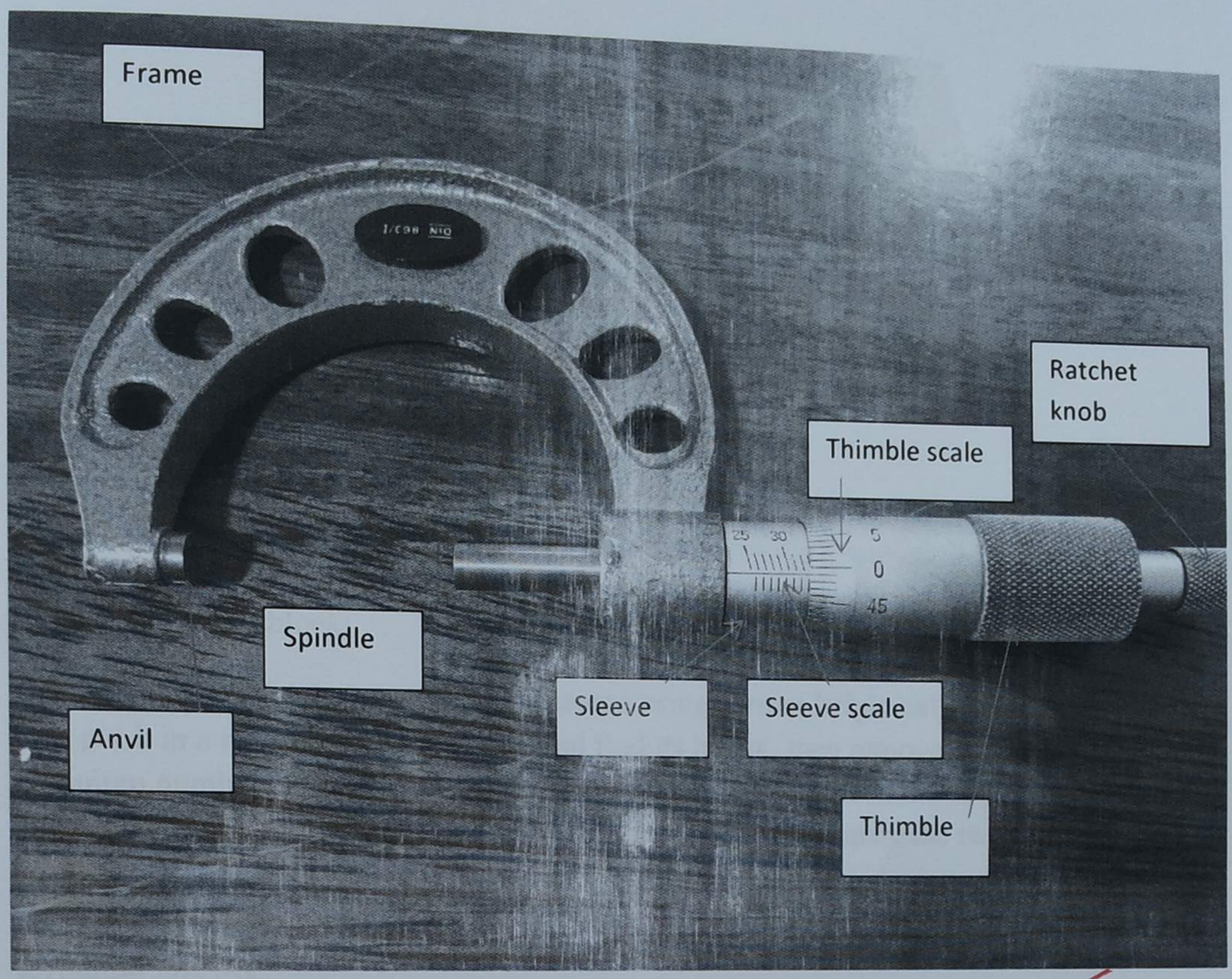


Figure 2 : micrometer .

How to use and read a micrometer:

- Close the spindle gently on the object to be measured make sure that it's touches the surface without making any permanent deformation.
- Write down the sleeve scale reading .
- Write the thimble scale reading and multiply it by the proper scale.
- Then add two reading together.

- 3) Gauge block:

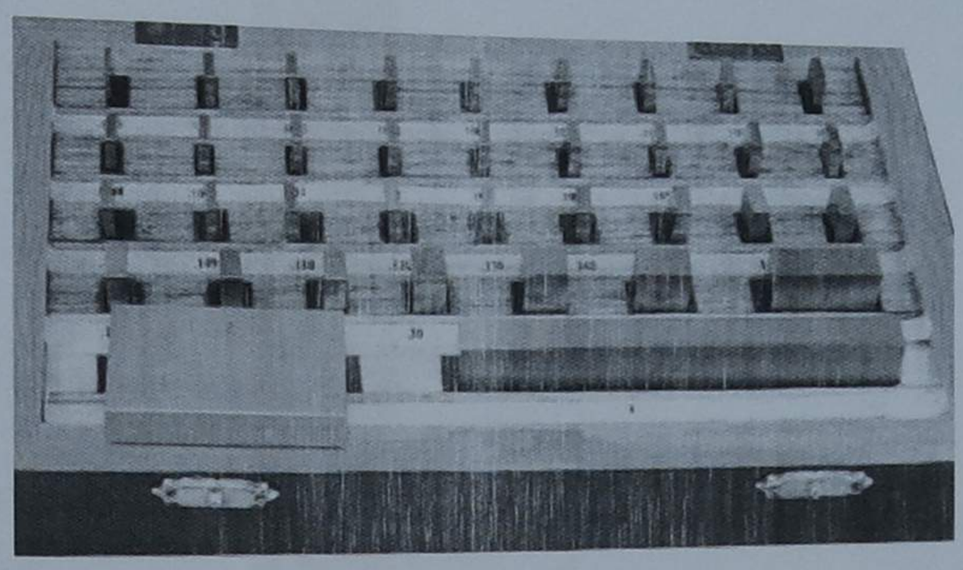

Figure3: block gauges box.

How to use gauge block:

Take the piece which height is to be measured using vernier height caliper and write it down, then put it in a mechanical comparator and find its height, then remove the piece and put minimum number of block gauges until reached the desire value in the acceptable error range. Finally record the block gauges standard height and compare the two heights.

Wringing process:

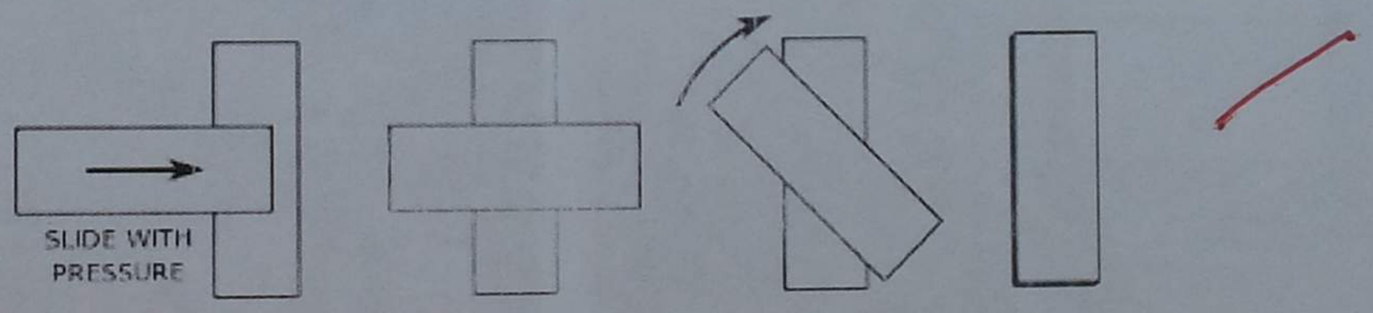


Figure 4: wringing method.

The process of wringing and releasing :

1. Slide the block perpendicularly across the other block while applying moderate pressure until they form a cruciform.
2. Rotate the block until it is in line with the other block.
3. To release the two blocks just rotate it in the same direction .

Mechanical comparator :

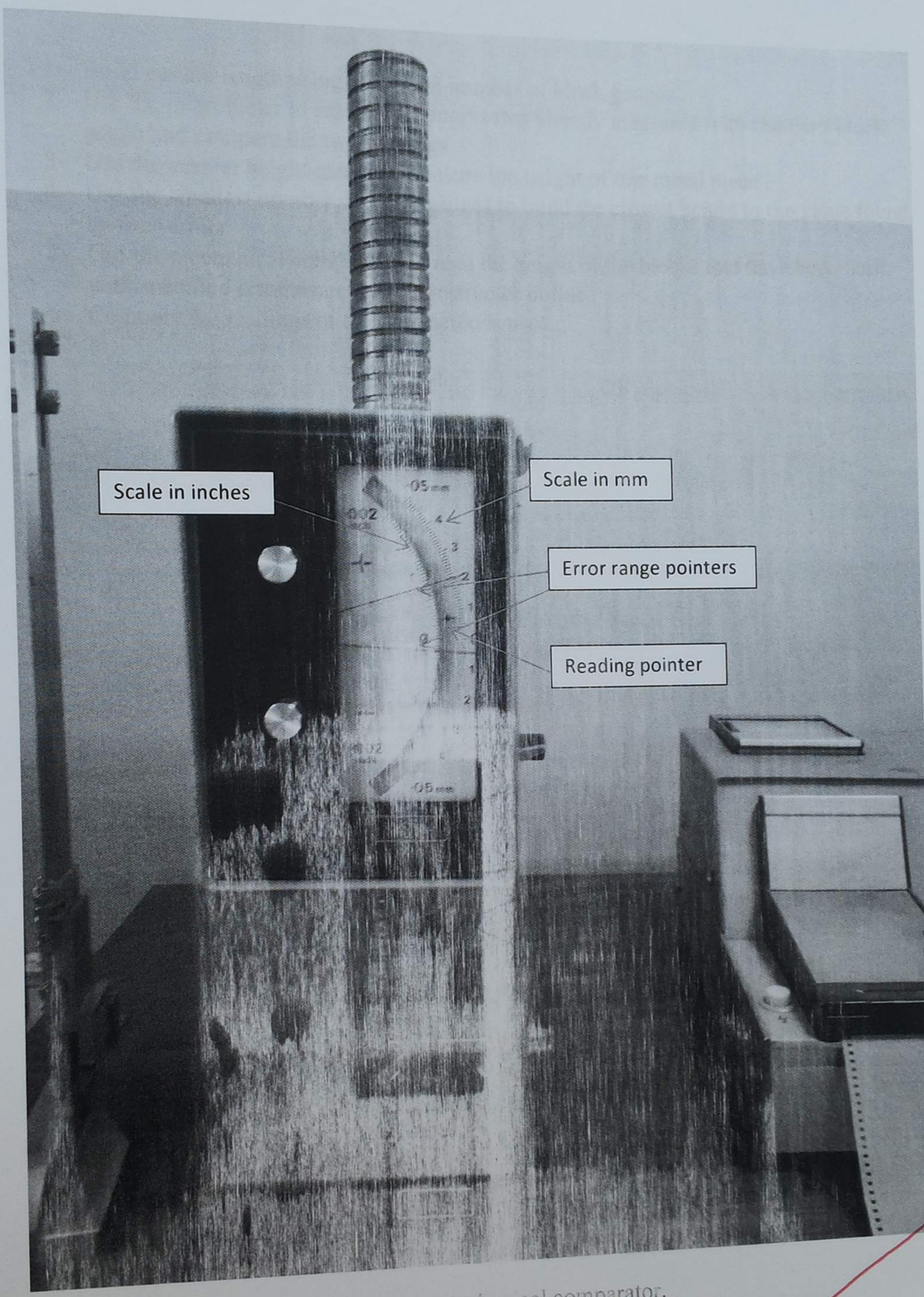


Figure 5: Mechanical comparator.

Procedure:

1- Build certain length using minimum number of block gauges .
2- Use the micrometer to read some lengths that already measured with standard block gauge and compare the two readings .
3- Use the vernier height gauge to measure the height of one metal piece .
4- Use the smallest number of block gauges to build the closest height to the value found by the vernier.
5- Use the mechanical comparator to read the height of the blocks that have been built with specified error range that the instructor define .
6- Compare the readings of the two methods used.

Results and discussion:

Table (1):Minimum number of block gauges to build different size lengths

| Number of gauges | 59.876 mm | 41.389 mm | 9.999 mm |
|---|---|---|---|
| 1St piece | 1.006 | 1.009 | 1.009 |
| 2Nd piece | 1.37 | 1.38 | 1.49 |
| 3Rd piece | 7.50 | 30.0 | 7.50 |
| 4Th piece | 50.0 | 9.0 | - |

Table 2:Readings of different block gauges in (mm) using a micrometer

| Standard block gauge (mm) | Standard block gauge with error(mm) | Reading of micrometer | Errors% |
|---|---|---|---|
| 0.000 | 0+0.0005<br>0-0.0005 | 0.221 | |
| 3.000 | 3+0.0005<br>3-0.0005 | 2.689 | 10.37 |
| 5.000 | 5+0.0005<br>5-0.0005 | 4.631 | 7.38 |
| 10.000 | 10+0.0005<br>10-0.0005 | 9.648 | 3.52 |
| 15.000 | 15+0.0005<br>15-0.0005 | 14.708 | 1.95 |
| 20.000 | 20+0.0005<br>20-0.0005 | 19.621 | 1.89 |

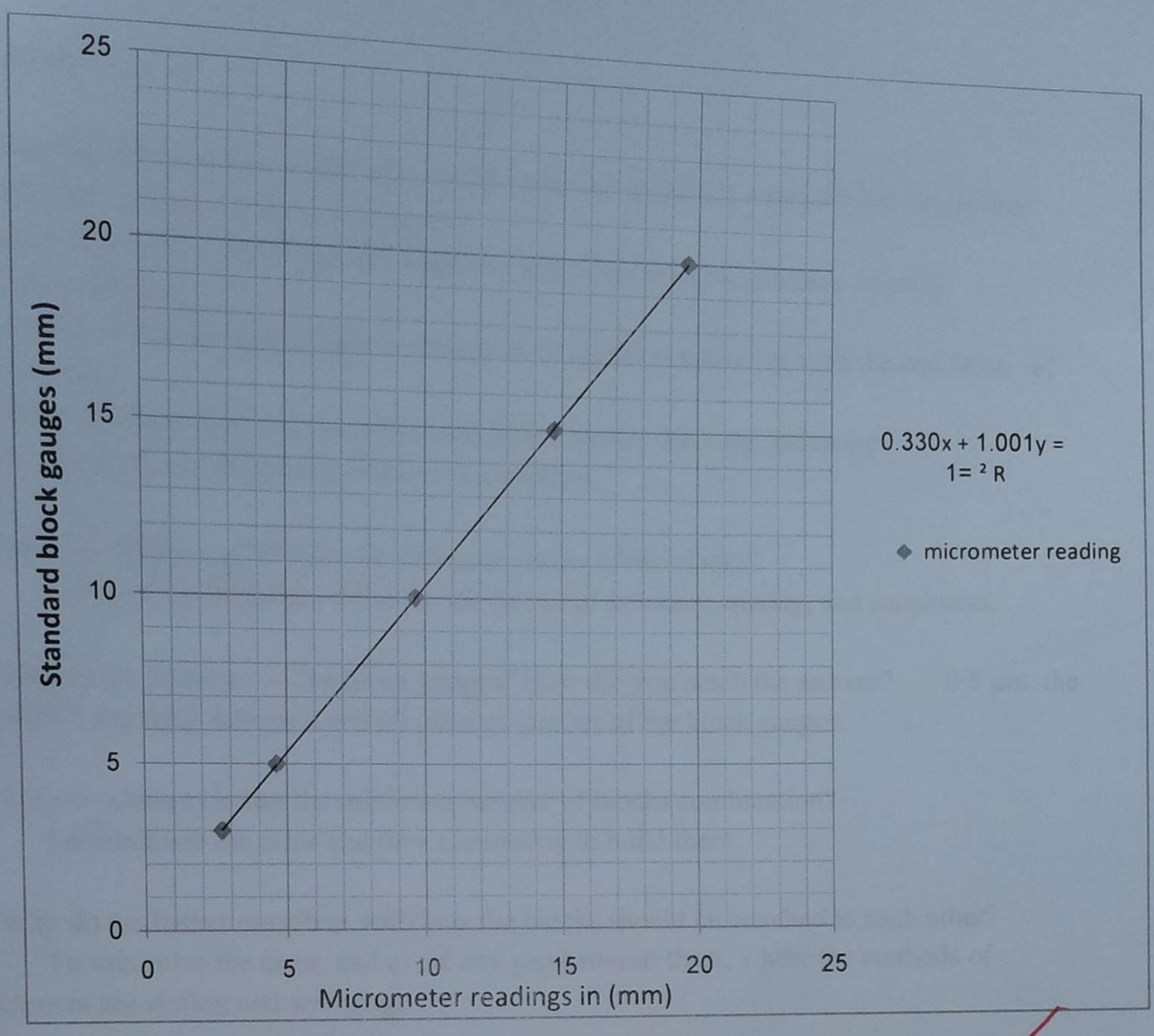


Figure 6:calibration curve for the micrometer.

* Maximum error is 10.37%.

Mechanical comparator:

Vernier height gauge reads 40.5 mm
block gauges used to build an equivalent height are:

30mm+8.5mm+1.07mm=39.57mm.

Discussion :

1. State the difference between end standard and line standard? And state the reason that make the end standard more accurate?
   Line standard in which the unit length is defined as being the distance suitably engraved lines.

End standard in which the unit length is defined as being the distance between the end faces of the standard.

End standards they are specially machined and therefore they have the following characteristics; straightness, flatness, parallelism.

2. State the difference between the different grades of the blocks?
   Types of block gauges differ by the degree of accuracy, quality, and roughness.

3. What is the accuracy of the block gauges? How did you reach the answer? 0.5 µm, the ASME standard defines it and all other properties of the block gauges.

4. Why do always choose the minimum number of blocks combination?
   To minimize the error and time consuming to build them.

5. Why do we bather ourselves with how the blocks should be attached to each other?
   To minimize the error, and avoid any gap between them, where the methods of attachment are sliding and wringing.

6. Suggest other applications for block gauges?
   Pressure measurement, Calibration, Comparison method for linear measurement instruments.

7. In the comparator measuring method what do we compare with?
   The height of work piece has been measured using vernier height gauge and standard block gauges with limited error range.

Sample Calculations:

* Using Block gauges:

The following example explains the procedure to build a (59.876mm) using the minimum number of blocks:

59.876

1.006 - _____

58.870

1.370 -

57.500 _____

7.500 - _____

50.000

50.000- _____

0.000

So, four blocks are used to build the desired length.

*Using micrometer:

Standard block gauge (20.000)

Sleeve reads full mm = 19.00 mm

Sleeve reads ½ mm = 0.50 mm

Thimble reads = 12mm

Additional vernier scale on the sleeve reads = 1 mm

Accuracy = 0.5/50 =0.01

The final measurement is = 19.5+12*0.01+0.001*1=19.621 mm

Error= (theoretical – actual) / theoretical = (20.0 – 19.621) / 20 =0.01895=

1.895%

Summary and conclusion:

There are two types of length standards:

1-line standard

2-end standard

In this experiment block gauges (end standard) were used to calibrate dernier caliber and micrometer.

Block gauges gives high accuracy and because of that it is used to calibrate measurement tools.

A comparison was made between vernier caliber and mechanical comparator with small range of error.

As a result of this experiment vernier caliber and micrometer should be calibrated to avoid the error in readings.

Uncertainty Analysis:

ω=±(0.5*smallest division) -For all the measuring devices used in the experiment;

For the micrometer :

0.5*0.05= ±0.025 mm.

For verniar caliper :

Uncertainty Analysis: ω=±(0.5*smallest division) 0.5*1= ±0.5mm.

Source of error:

1. Wear on the surface of blocks due to repeated usage.
2. The temperature of the room could cause a change in the dimension of the blocks.
3. Not using the minimum number of block gauges to measure the desired length .

References:


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2. http://www.technologystudent.com/equip1/microm1.htm .
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