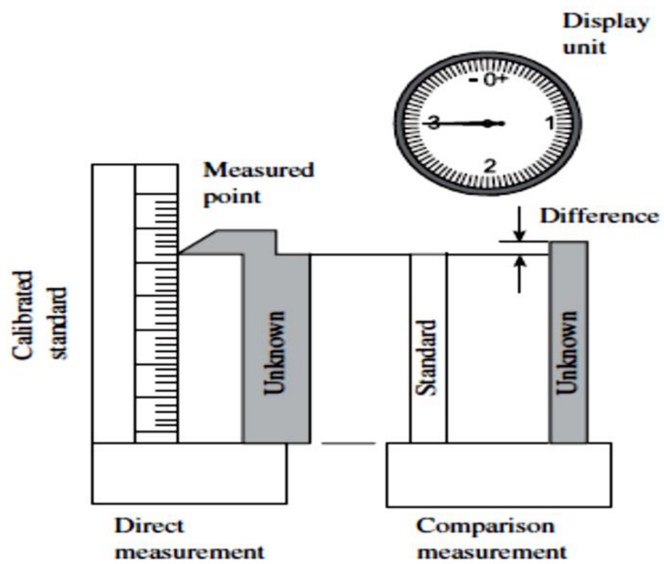
Chapter 5: Comparators

5.1 Introduction

On the other hand, in certain devices the standards are separated from the instrument. It compares the unknown length with the standard. Such measurement is known as *comparison measurement* and the instrument, which provides such a comparison, is called a *comparator*. Comparators are generally used for linear measurements, and the various comparators currently available basically differ in their methods of amplifying and recording the variations measured. Illustrates the difference between direct and comparison measurements.

- Comparators can give precision measurements, with consistent accuracy by eliminating human error.
- They are employed to find out, by how much the dimensions of the given component differ from that of a known datum?
- If the indicated difference is small, a suitable magnification device is selected to obtain the desired accuracy of measurements.
- It is an indirect type of instrument and used for linear measurement.
- If the dimension is less or greater, than the standard, then the difference will be shown on the dial.
- It gives only the difference between actual and standard dimension of the workpiece

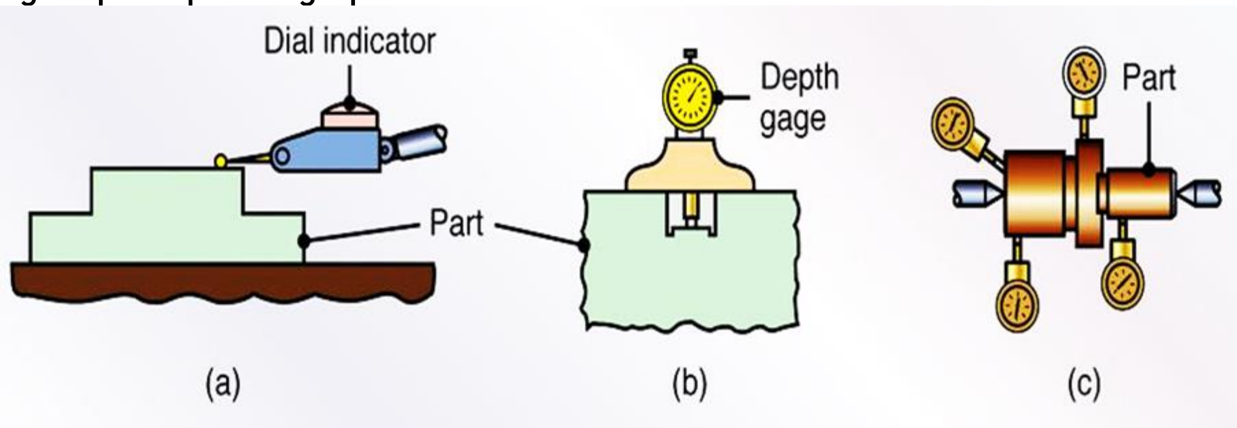


Direct measurement versus comparison Measurement

5.1.1 NEED FOR A COMPARATOR

1) In mass production, where components are to be checked at a very fast rate.

2) As laboratory standards from which working or inspection gauges are set and correlated.
3) For inspecting newly purchased gauges.
4) Attached with some machines, comparators can be used as working gauges to prevent work spoilage and to maintain required tolerances at all stages of manufacturing.
5) In selective assembly of parts, where parts are graded in three or more groups depending upon their tolerances.



5.2 Function Requirements

A comparator has to fulfil many functional requirements in order to be effective in the industry. We can summarize the major requirements of a comparator as follows:

1. A comparator should have a high degree of accuracy and precision.
2. The scale should be linear and have a wide range.
3. A comparator is required to have high amplification.
4. A comparator should have good resolution, which is the least possible unit of measurement that can be read on the display device of the comparator.
5. There should be a provision incorporated to compensate for temperature effects.
6. Finally, the comparator should be versatile. It should have provisions to select different ranges, attachments, and other flexible means, so that it can be put to various uses.

5.2.1 Characteristics of Good Comparators

1) Compact.
2) Easy to handle.
3) Quick response or quick result.
4) Reliable, while in use.
5) No effects of environment
6) Less weight.
7) Cost
8) Availability

9) Sensitivity
10) It should be linear in scale so that it is easy to read and get uniform response.

5.3 Classification of Comparators

We can classify comparators into mechanical device and electrical device on the basis of the means used for comparison. With respect to the principle used for amplifying and recording measurements, comparators are classified as follows:

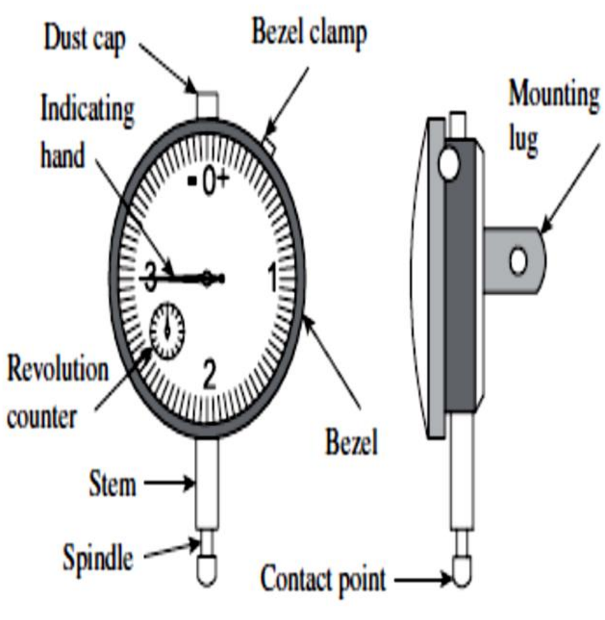
1. Mechanical comparators
2. Mechanical–optical comparators
3. Electrical and electronic comparators
4. Pneumatic comparators
5. Other types such as projection comparators and multi-check comparators each of these types of comparators has many variants, which provide flexibility to the user to make an appropriate and economical selection for a particular metrological application.

5.4 Mechanical Comparators

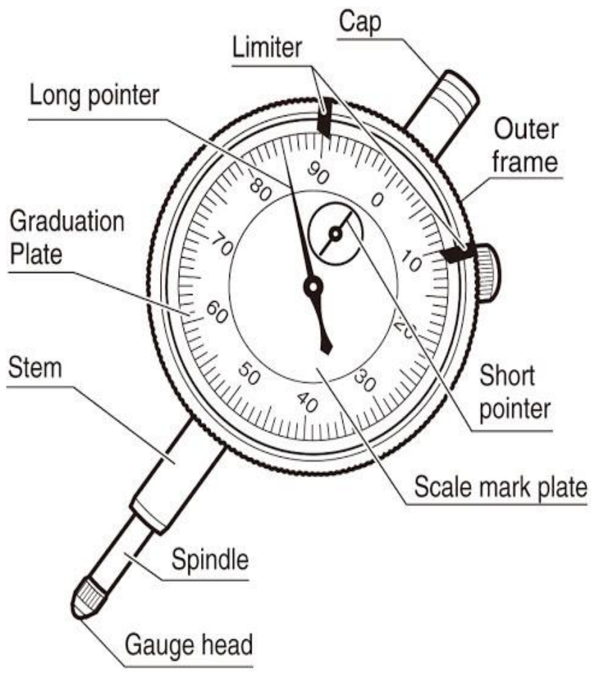
Mechanical comparators have a long history and have been used for many centuries. The following are some of the important comparators in metrology.

5.4.1 Dial Indicator

The dial indicator or the dial gauge is one of the simplest and the most widely used comparator. It is primarily used to compare workpieces against a master.

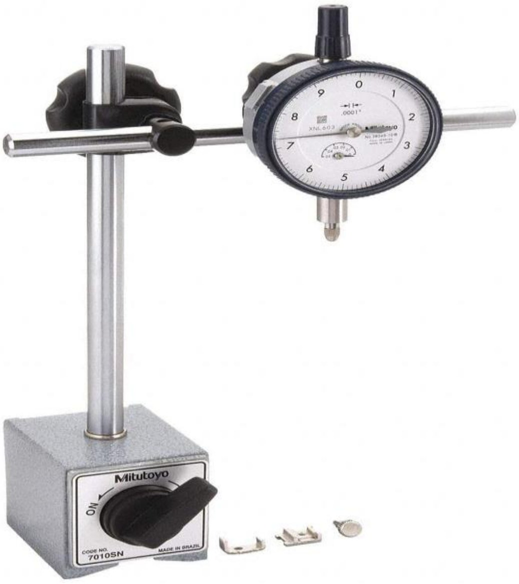


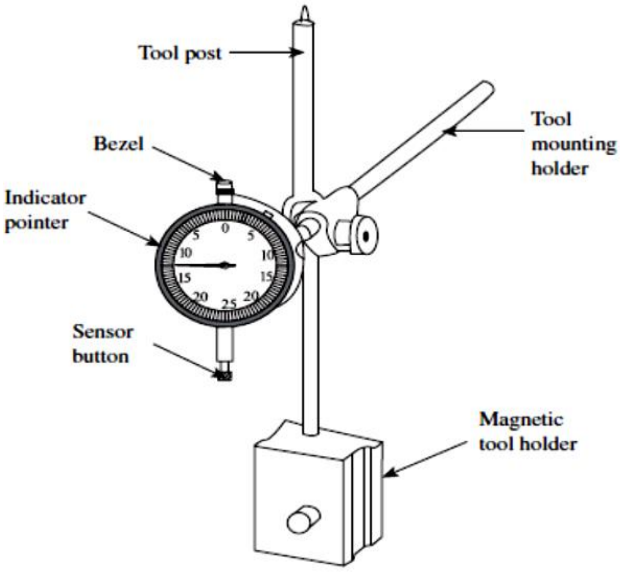
Functional parts of a dial indicator



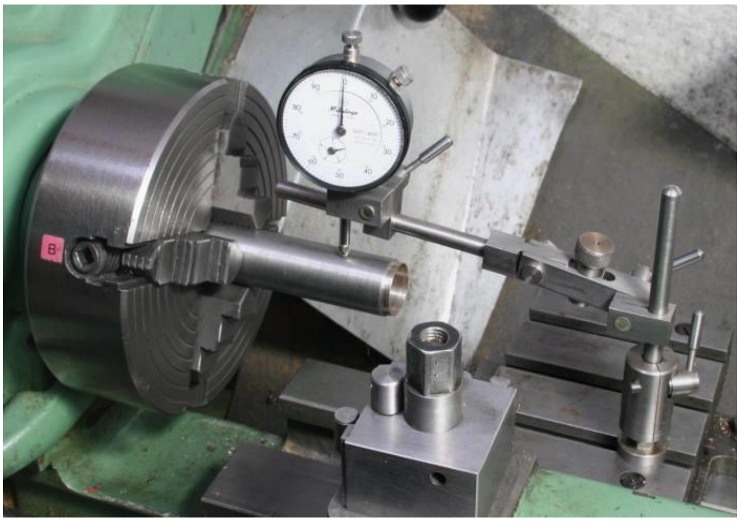
Method for designating numbers

- Use of Dial Indicators



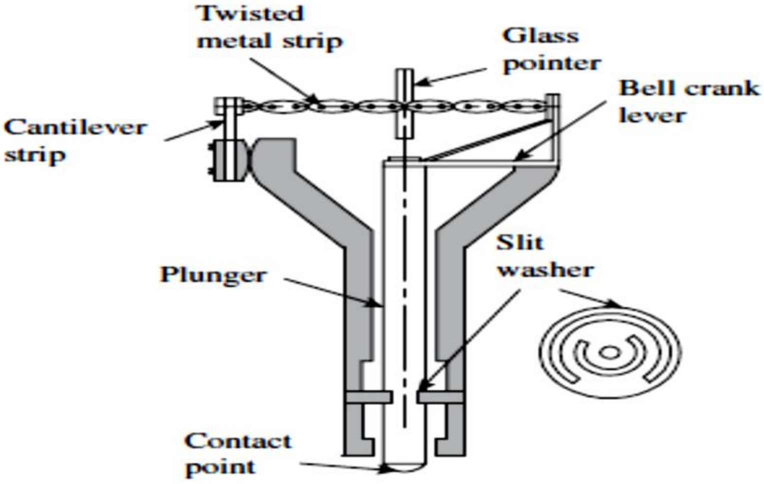


Dial indicator mounted on a stand



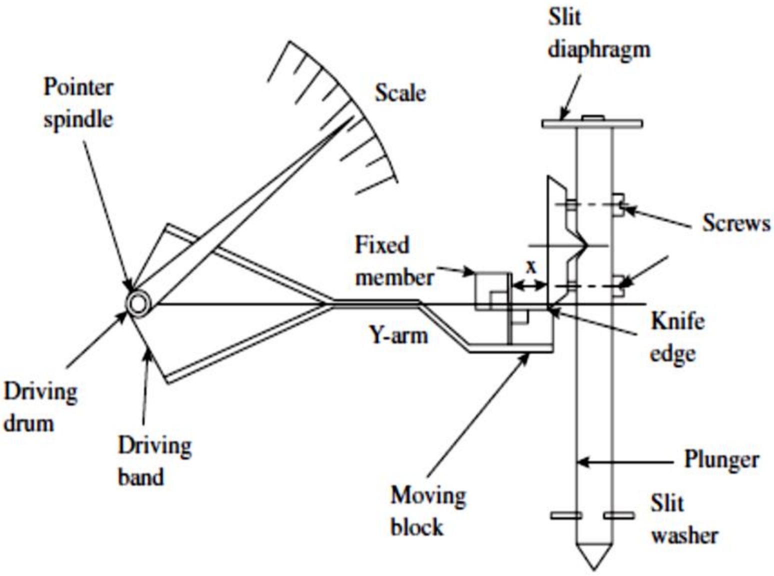
5.5 Johansson Mikrokator

The two halves of the thin metal strip, which carries the light pointer, are twisted in opposite directions. Therefore, any pull on the strip will cause the pointer to rotate.



5.6 Sigma Comparator

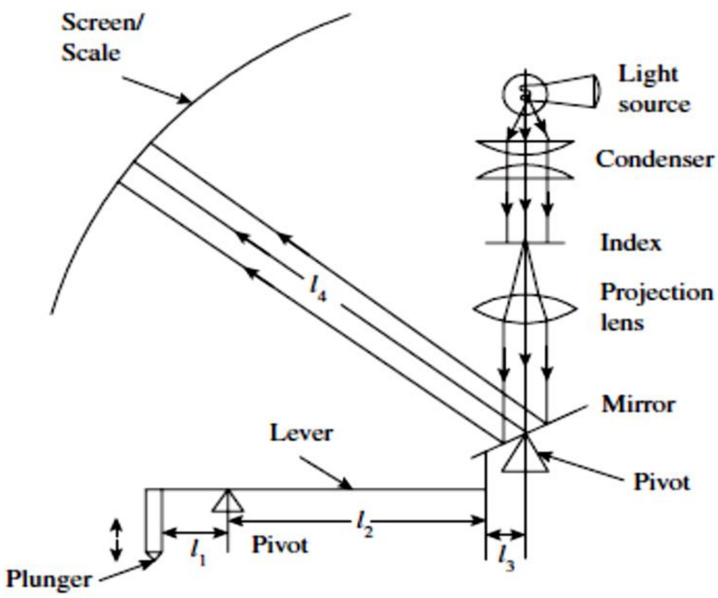
A linear displacement of a plunger is translated into the movement of a pointer over a calibrated scale.



Sigma mechanical comparator

5.7 Mechanical-Optical Comparators

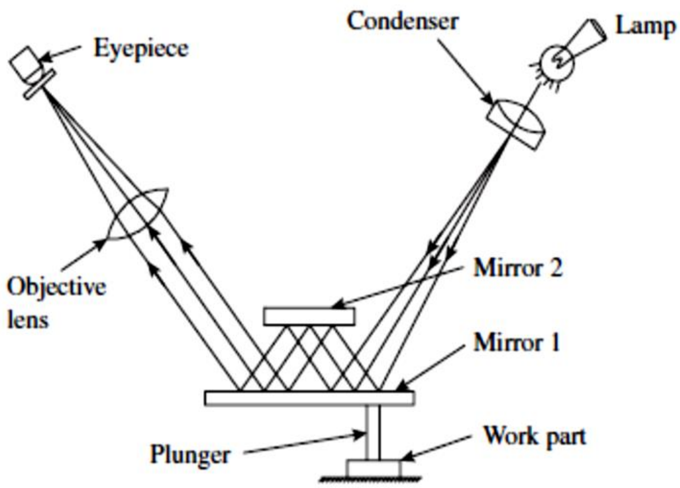
This is also termed as Cooke's Optical Comparator. As the name of the comparator itself suggests, this has a mechanical part and an optical part. Small displacements of a measuring plunger are initially amplified by a lever mechanism pivoted about a point. The mechanical system causes a plane reflector to tilt about its axis. This is followed by a simple optical system wherein a pointed image is projected onto a screen to facilitate direct reading on a scale.

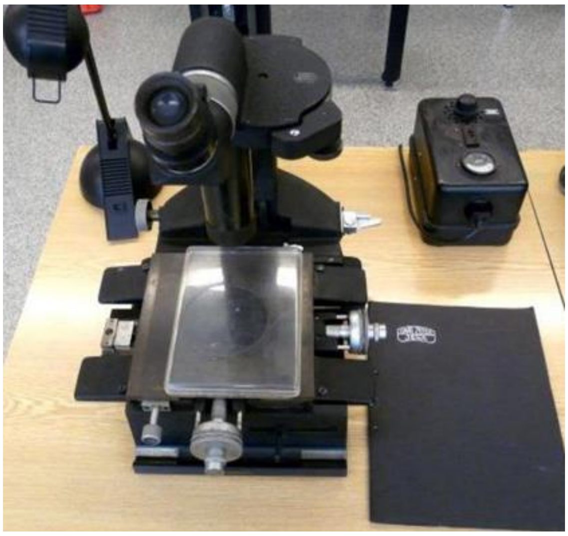


Principle of a mechanical optical comparator

5.8 Zeiss Ultra-optimeter

The Zeiss ultra-optimeter is another mechanical optical comparator that can provide higher magnification than the simple mechanical optical comparators. This magnification is made possible by the use of two mirrors, which create double reflection of light.

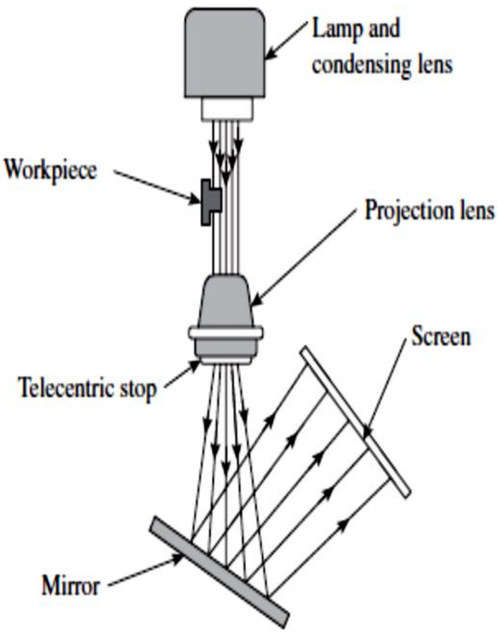


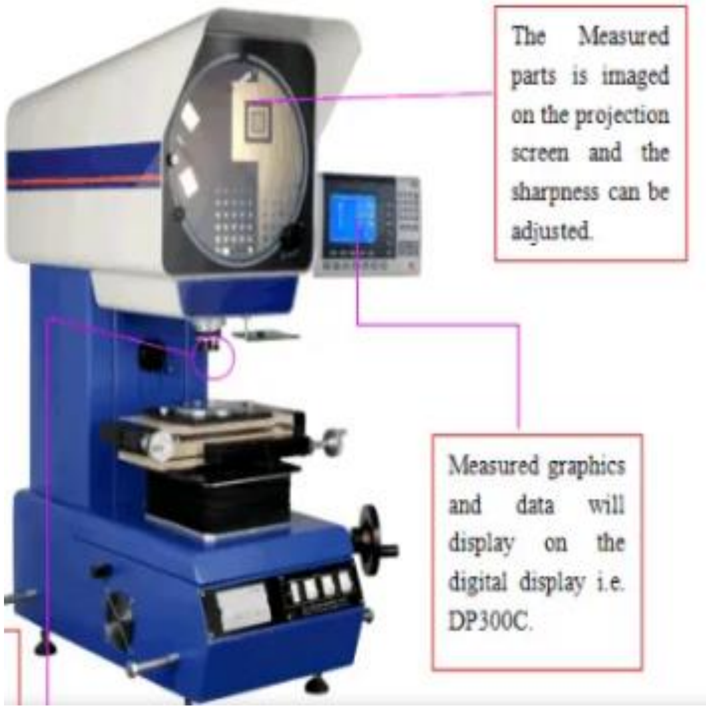


Zeiss Ultra-Optimeter

5.9 Optical Projector

An optical projector is a versatile comparator, which is widely used for inspection purpose. It is especially used in tool room applications. It projects a two-dimensional magnified image of the workpiece onto a viewing screen to facilitate measurement.

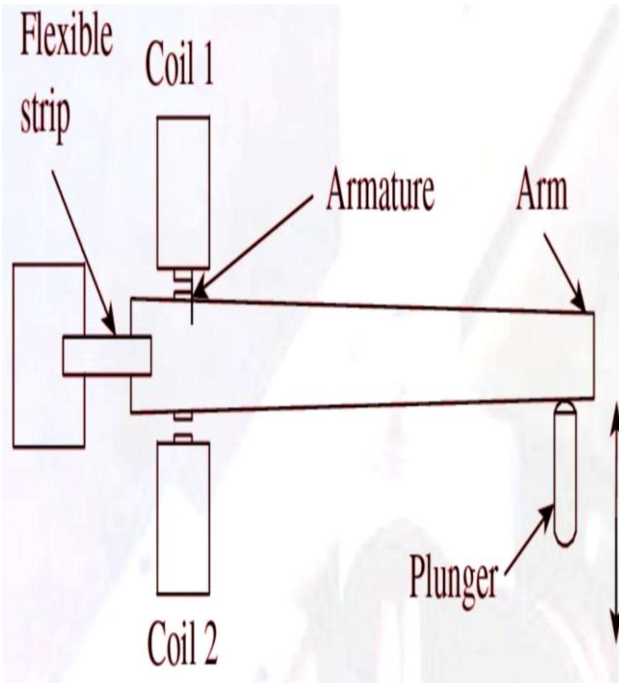


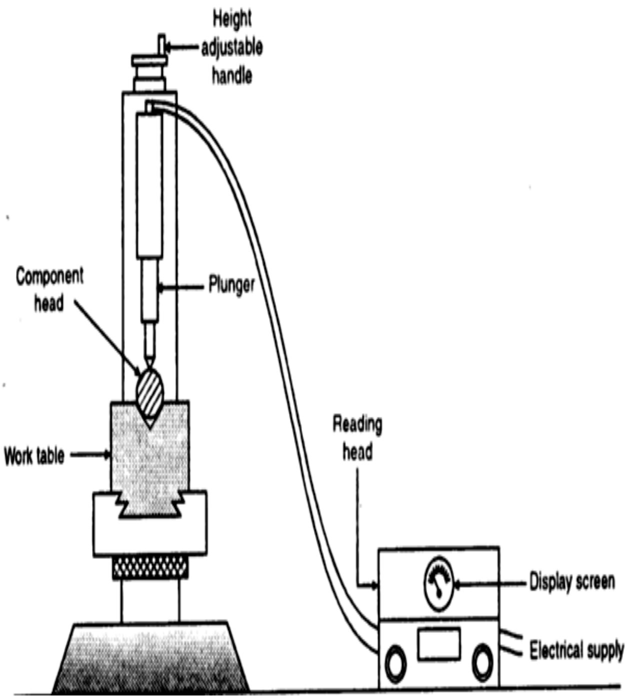


Optical projector

5.10 Electrical Comparators

An electronic comparator, in particular, can achieve an exceptionally high magnification of the order of 105:1 quite easily. Electrical and electronic comparators mainly differ with respect to magnification and type of output. However, both rely on mechanical contact with the work to be measured.





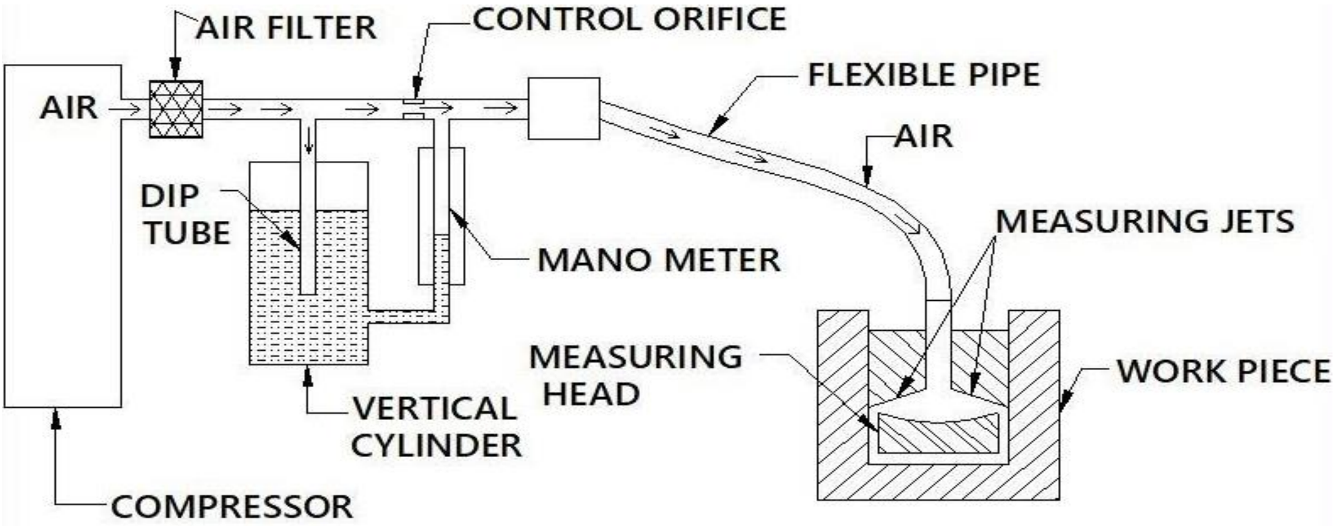
Elements of an electrical comparator

5.11 Pneumatic Comparators

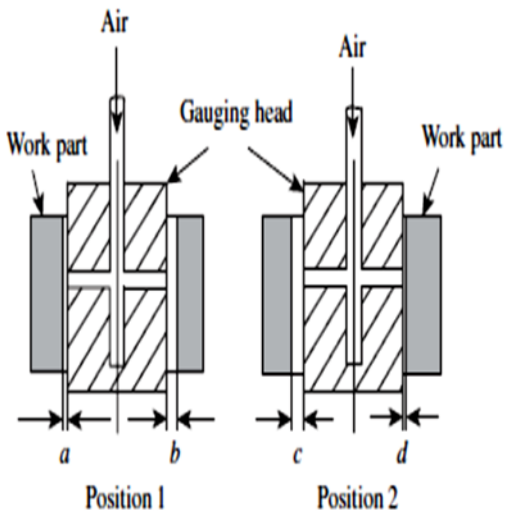
Pneumatic comparators use air as a means of measurement. The basic principle involved is that changes in a calibrated flow respond to changes in the part feature. However, similar to electronic comparators, amplification is achieved by application of power from an external source. Hence, a pneumatic comparator does not depend on the energy imparted to the pick-up element by contact with the component being inspected.

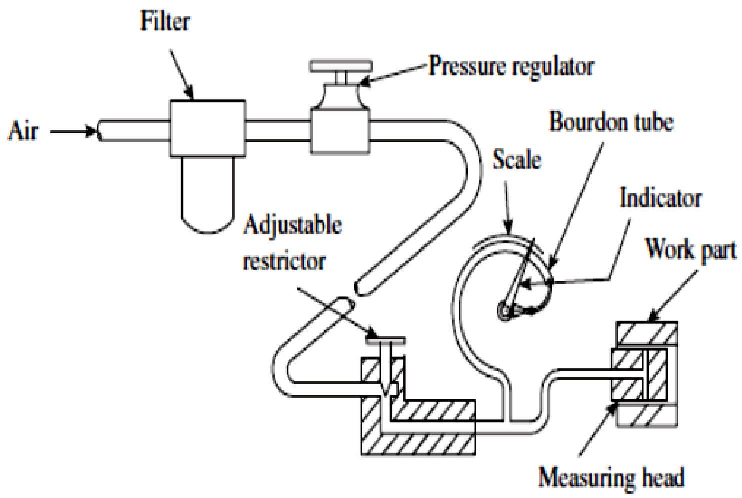
Back Pressure Gauge

This system uses a two-orifice arrangement. While the orifice O_1 is called the control orifice, the orifice O_2 is referred to as the measuring orifice. The measuring head gets compressed air supply at a constant pressure P, which is called the source pressure.



Free flow air gauge





Principle of a back pressure gauge

Back pressure gauge