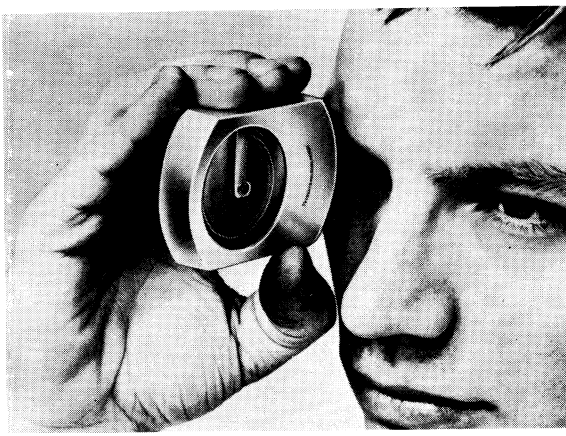
OPTICAL READING CLINOMETER PM-5

optique à CLINOMETRE



A slope angle and height meter of high precision for

ENGINEERS
SURVEYORS
ARCHITECTS
BUILDERS
GEOLOGISTS
CARTOGRAPHERS
FORESTERS
EXPLORERS
CONTRACTORS
INSPECTORS

▲

SUUNTO

Precision Instruments

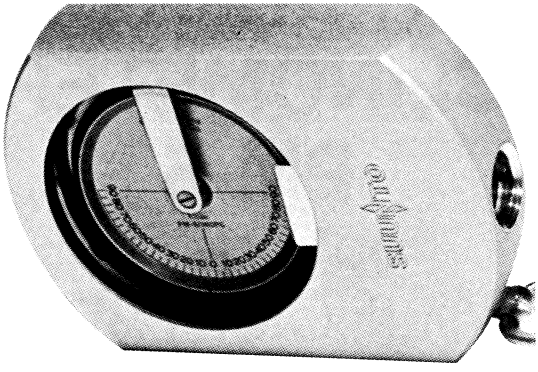
Important notice

The axes of the eyes of some people are not parallel, a condition called heterophoria. This can even vary in time and be dependant on different factors too. Therefore, in order to be sure that said phenomenon does not affect the accuracy of readings, it is suggested that the operator checks this possibility before taking the actual readings as follows:

Take a reading with both eyes open and then close the free eye. If the reading does not change appreciably there is no disalignment of the eye axes, and both eyes can be kept open.

Should there be a difference in the readings, one has to keep the other eye closed and to sight partly past the instrument body making use of the optical illusion.

PM-5



The sturdy pocket-size construction renders the SUUNTO CLINOMETER most suitable for every type of work. Easy of rapid reading through a parallax-free lens is incorporated into the design.
Sighting and scale reading are done simultaneously. There are no screws to turn, no bubbles to center, and nothing to adjust.
This is a one-hand operation.
Where space is limited, as in geological and mineralogical work, the inclination of strata and other formations can be read placing the instrument along the contour or surface of the formation and reading the angle directly through the side window.

Construction features: The framework is of corrosion resistant light-weight aluminum.
The scale card is supported by a jewel bearing assembly and all moving parts are immersed in a damping liquid inside a high strength hermetically sealed plastic container. The liquid dampens all undue scale vibrations and permits a smooth shockless movement of the scale card.
The material of the container is not attacked by sunlight or water. The liquid does not freeze in the arctic or evaporate in the tropics.

Fig. 1 here illustrates the features that are important in its use.

Specification: Weight: 4,2 oz. Dimensions: 2 3/4" x 2" x 5/8". The optical scales are graduated in degrees from 0° to ∓90°, and from 0 % to ∓150 %.
All instruments are supplied in a skylon case, by special request they can be supplied with leather case which has a belt loop. A table of cosines is imprinted on the back of the instrument.
Accuracy: Can be read directly to one degree or one per cent. Can be estimated to 10 minutes or 1/5 of 1 per cent, the latter naturally applying to readings around the zero level.

Illumination

For work under twilight conditions or even in total darkness the different PM types are also available with a built-in tritium lamp which illuminates the scale for reading. The lamp is self-powered and needs absolutely no maintenance. The tritium lamp presents no radiation hazards as the soft beta-rays do not even penetrate the glass envelope of the lamp.
When ordering instruments with illumination the letter T should be added to the code, e.g. PM-5/360 PCT.

AVAILABLE PM-5 VERSIONS

The basic PM-5/360 PC has been modified by fitting it with different scale combinations for special uses. Thus, there is available a version with a "new degree" or grade scale. Here, instead of the normal 360 degree division, the full circle is divided into 400 grades (g). The per cent scale there alongside is normal. The code is **PM-5/400 PC**
Another version is equipped with a secant scale (based on 360° division) and a percentage scale. The corresponding code is **PM-5/S PC**
A version with a secant scale and degrees scale is called **PM-5/360 S**

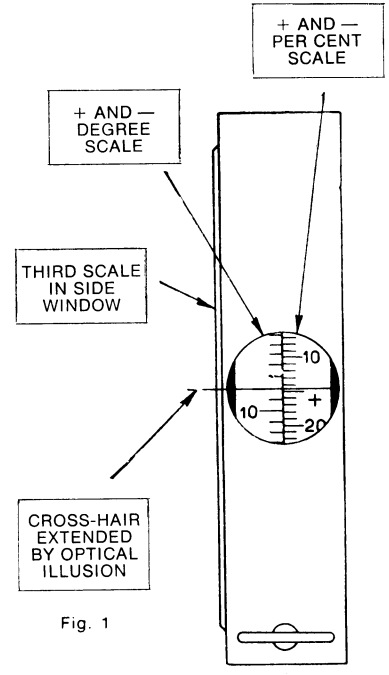
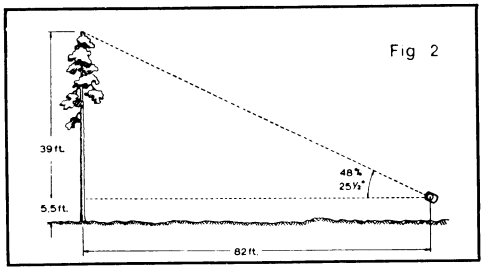


Fig. 1

Instructions for use

Readings are usually taken with the right eye as shown on the title page. Owing to differences in the keenness of the sight of the eyes and because of personal preferences the use of the left eye is sometimes easier. It is of prime importance that **both eyes are kept open.** The supporting hand must not obstruct the vision of the other eye.
The instrument is held before the reading eye so that the scale can be read through the optics, and the round side-window faces to the left. The instrument is aimed at the object by raising or lowering it until the hair line is sighted against the point to be measured. At the same time the position of the hair line against the scale gives the reading. Owing to an optical illusion the hair line (crosshair) seems to continue outside the frame and is thus easily observed against the terrain of the object, **Fig. 1.**



The left-hand scale gives the slope angle in degrees from the horizontal plane at eye level. The right-hand scale gives the height of the point of sight from the same horizontal eye level, and it is expressed in per cent of the horizontal distance. The following example illustrates the procedure.
The task is to measure the height of a tree at a distance of 82 ft. on level ground **(Fig. 2).** The instrument is tilted so that the hair line is seen against the tree-top (apex). The reading obtained will be 48 per cent (ca 25 1/2°). As the distance is 82 ft. the height of the tree is 48/100 x 82 ft. = ca. 39 ft. To this must be added the eye's height from the ground, e.g. 5 1/2 ft. Their sum is 44 1/2 ft., the height of the free.

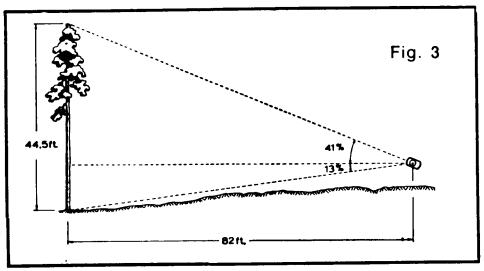


Fig. 3

In very exact measurements, and particularly on sloping ground two readings are taken, one to the top, the other to the base of the trunk. When the trunk base is below eye level the percentages obtained are added. The total height is the sum percentage of the horizontal distance. For example, if the apex reading is 41 % and the ground reading 13 %, the total height of the tree measured from a distance of 82 ft. is (41 + 13)/100 x 82 ft = 54/100 x 82 ft = ca. 44 1/2 ft. **(Fig. 3).**

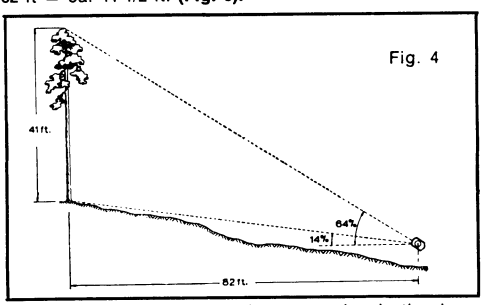


Fig. 4

When the trunk base is above eye level, the base reading is subtracted from the apex reading, and the total height is the difference percentage of the horizontal distance. For example, if the apex reading is 65 % and the base reading 14 %, the total height is (64—14)/100 x 82 ft = 50/100 x 82 ft = 41 ft **(Fig. 4).** When calculations are made mentally it is advisable to use measuring distances of 50, 100 or 200 ft. for the sake of simplicity.
All readings of the percentange scale are based on the horizontal distance. This means that if the distance on sloping terrain is measured along the ground an error is introduced, and this must be corrected for accurate results. The error is insignificant for most purposes at small ground slope angles but increases progressively as the angle increases. The trigonometrical correlation is

$$H = h \times \cos \alpha$$

where H is the true or corrected height, h is the observed height and α is the ground slope angle. With the aid of the above equation the correction can also be made in the distance. In this case h means the distance measured along the ground and H is the horizontal distance sought. If the corrected distance is used no correction in the height observed is needed.

When calculating the horizontal distance by using the ground distance and the slope angle it must be pointed out that an error is introduced if the slope is measured from eye level to the trunk base. Measuring the slope along the ground would be cumbersome and inconvenient. No error is introduced, however, when the slope angle is measured from eye level to a sighting mark made or placed on the trunk at eye level **(Fig. 5)** whereby the two lines of measurement become parallel. The true angle of slope is 9 degrees.

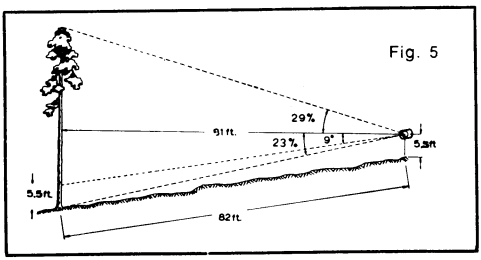


Fig. 5

The example shown in **Fig. 5** illustrates both methods of calculation.

Method 1. Measure the ground distance. This is found to be 82 ft. Then measure the slope angle. This is 9 degrees. Read percentages of top and ground points. These are 29 and 23 per cent. Calculate:

$$\frac{23}{100} + \frac{29}{100} = \frac{52}{100}$$

Take 52 per cent of 82 ft. This is 42.6 ft. Multiply this by the cosine of 9 degrees.

$$0.987 \times 42.6 \text{ ft.} = 42 \text{ ft.}$$

Method 2. Multiply the ground distance by the slope angle cosine.

$$0.987 \times 82 \text{ ft.} = 80.9 \text{ ft.}$$

Add percentage readings as above and take the sum percentage of the corrected distance.

$$\frac{52}{100} \times 80.9 \text{ ft.} = 42 \text{ ft.}$$

This example shows that a slope angle of 9 degrees causes a correction of only 2.3 per cent but when the slope angle is 35 degrees the correction means a reduction of about 18 per cent in the observed height.

Nomographic height correction

When the accompanying nomograph is used, all correction calculations become unnecessary. Only a ruler or some other convenient object with a straight edge is needed to obtain the nomographical solution. The nomograph is used by placing the ruler so that its edge intersects the angle scale on the left at the slope angle point and the observed height scale (on the right) at the pertinent point. The corrected height (or distance) is read at the point where the edge intersects the corrected height scale in the middle. When using a measuring distance of 100 ft. along the ground the correction prccedure becomes very simple. No slope angle measurement is then necessary. One needs only the reading of the top point and that of the ground point. Depending on the situation their sum or difference gives the apparent height directly in feet. This is then corrected as follows:
First, find on the right-hand scale in the nomograph the point indicating the apparent height. Secondly find on the left-hand double scale the point indicating the ground point reading. Thirdly, connect these points. The corrected reading will be found from the pertinent middle scale at the point of intersection. In this procedure the slope angle can be neglected as the left-hand ground point scale has been constructed so that both the ground slope angle and the average eye level height of 5,5 ft. have been taken into account.