THE USE OF THE INTERFERENCE OF LIGHT FOR THE MEASUREMENT OF BASE LINES

Professor Y. VÄISÄLÄ, of the Finnish University at Turku, has for several years been conducting investigations for the purpose of measuring geodetic base-lines by use of the interference of light. He published some notes on the subject in 1923 in Publication N° 2 of the Finnish Geodetic Institute, in 1927 in the *Zeitschrift für Instrk.* 47, pp. 398 - 402, and in 1930 in Publication N° 14 of the Finnish Geodetic Institute (*Suomen geodeettisen laitoksen julkaisuja*).

With this process he has measured a length of 192 meters but he believes that it should be possible to measure very much greater lengths. The only factor which limits the use of the process lies in the agitation of the air; clear weather with rapid variations in the temperature are very unfavourable conditions. This method appears to be of particular interest for the measurement of short bases which are used to calibrate the invar wires employed for the rapid measurement of geodetic base lines by the JÄDERIN process. We know that a calibration of the wire immediately before and immediately after the measurement operations is very essential if the JÄDERIN method is to furnish the greatest accuracy of which it is capable. For the determination by interference of a length as short as that of the invar wire (24 metres) the state of tranquillity of the atmosphere is of slight importance.

The new method is also very convenient for comparisons of standards of length, for verifying the experimental bases established in the laboratories of the different countries and for studying the constancy of their length.

The principle of the process is based on the use of the interference of white light and allows the reproduction or the multiplication of the distance between two parallel mirrors as far as the tranquillity of the atmosphere permits. The length of the first distance is measured either by means of rules designed for the terminal measurements which have been very carefully calibrated, or else, if the distance is very small, directly by means of the wave-lengths of the light.

The complete measuring device is not costly if we consider its accuracy. Mirrors which are heavily silvered are used. It appears that an accuracy of the order of 10^{-7}, or about 0.1 $^{m}/_{m}$. per kilometre, may be obtained.

It is well known that, with the use of a bundle of rays of white light, the various interference phenomena are visible if the phase difference of the interfering rays falls within a distance of a few wave-lengths only. The interference fringe corresponding to a phase difference of zero is practically white, while the following are more and more coloured at the edges the greater the difference in phase. If this phase difference continues to increase, the fringes soon become indistinct and then disappear altogether.

Inversely, if we divide the light from a source into two bundles which are afterwards re-united after they have been made to traverse two different paths by means of reflection from several mirrors, we may conclude that the two paths are equal if we obtain a white interference fringe between symetrically coloured fringes.

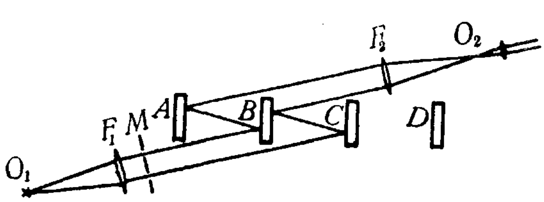

Fig. 1

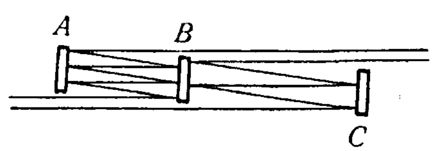

Fig. 2

Fig. 1 showe diagramatically one of the arrangements employed. The point source O_1 at the focus of the lens F_1 furnishes two parallel rays which pass through the openings of the screen M. One is reflected by the mirrors A and B and the other by the mirrors B and C. They then fall on the lens F_2 and are re-united at the focus O_2. If the mirrors A, B and C are parallel and equidistant from each other, the path of the two rays will be equal. We make the distances between the mirrors equal by gradually displacing the mirror *C* until the interference fringes appear with a white line at the centre. One may then move *A* to *D*, or also *B* to a distance from *C* equal to *AC* (taking into account the thickness of the mirrors), and continue in this manner to increase the base by a process of *addition*.

A process of multiplication may also be used (*See* Figure 2). If, for instance, the first ray is reflected three times between the first two mirrors, while the second is reflected only twice between the second and third mirrors, we shall have equal paths and consequently the aspect of the interference fringes described above, if the distance of the last two mirrors is to that of the first two in the ratio of 3 to 2. One may then continue by moving the mirror *B* to a distance *C* which is a multiple of the distance *AC*. The mirrors are brought into parallelism very easily by the use of a third ray which is caused to be reflected a different number of times (generally much fewer) or which is directly observed. The mirrors will be parallel if the images of the three rays are formed at a single point.

We cannot enter into the details of the special arrangements to which the practical application of these principles has led Professor VÄISÄLÄ, nor of the spectroscopic occulars or the compensating prisms by means of which the distance between the mirrors may be adjusted in a few minutes; but it appeared to be of interest to draw attention to this new method of measuring the base lines — a method which may have a certain future in store.

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