

: BASE LINE MEASUREMENTS

There are two forms of base measuring apparatus : (A) Rigid bars, and (B) Flexible apparatus.

(A) Rigid Bars

Before the introduction of invar tapes, rigid bars were used for work of highest precision. The rigid bars may be divided into two classes :

(i) *Contact apparatus*, in which the ends of the bars are brought into successive contacts. Example : The Eimbeck Duplex Apparatus.

(ii) *Optical apparatus*, in which the effective lengths of the bars are engraved on them and observed by microscopes. Example: The Colby apparatus and the Woodward Iced Bar Apparatus.

The rigid bars may also be divided into the following classes depending upon the way in which the uncertainties of temperature corrections are minimised :

(i) *Compensating base bars*, which are designed to maintain constant length under varying temperature by a combination of two or more metals. Example : The Colby Apparatus.

(ii) **Bimetallic non-compensating base bars**, in which two measuring bars act as a bimetallic thermometer. Example : The Eimbeck Duplex Apparatus (U.S. Coast and Geodetic Survey), Borda's Rod (French system) and Bessel's Apparatus (German system).

(iii) **Monometallic base bars**, in which the temperature is either kept constant at melting point of ice, or is otherwise ascertained. Example : The Woodward Iced Bar Apparatus and Struve's Bar (Russian system).

The Colby Apparatus (Fig.) This is compensating and optical type rigid bar apparatus designed by Maj-Gen. Colby to eliminate the effect of changes of temperature upon the measuring appliance. The apparatus was employed in the Ordinance Survey and the Indian Surveys. All the ten bases of G.T. Survey of India were measured with Colby Apparatus. The apparatus (Fig.) consists of two bars, one of steel and the other of brass, each 10 ft. long and riveted together at the centre of their length. The ratio of co-efficients of linear expansion of these metals having been determined as 3 : 5. Near each end of the compound bar, a metal tongue is supported by double conical pivots held in forked ends of the bars. The tongue projects on the side away from the brass rod. On the extremities of these tongues, two minute marks a and a' are put, the distance between them being exactly equal to 10' 0". The distance ab (or $a'b'$) to the junction with the steel is kept $\frac{3}{5}$ ths of distance ac (or $a'c'$) to the brass junction. Due to change in temperature, if the distance bb' of steel change to b_1b_1' by an amount x , the distance cc' of brass will change to c_1c_1' by an amount $\frac{3}{5}x$, thus unaltering the positions of dots a and a' . The brass is coated with a special preparation in order to render it equally susceptible to change of temperature as the steel. The compound bar is held in the box at the middle of its length. A spirit level is also placed on the bar. In India, five compound bars were simultaneously employed in the field. The gap between the forward mark of one bar and the rear bar of the next was kept constant equal to 6" by means of a *framework* based on the same principles as that of the 10' compound bar. The framework consists of two microscopes, the distance between the cross-wires of which was kept exactly equal to 6". To start with, the cross-wires of the first microscope of the *framework* was brought into coincidence with the platinum dot, let into the centre of the one extremity of the base line. The platinum dot a of the first compound bar was brought into the coincidence with the cross-hairs of second microscope. The cross-hairs of the first microscope of the second framework (consisting two microscopes 6" apart) is then set over the end a' of the first rod. The work

is thus continued till a length of $(10' \times 5 + 5 \times 6") = 52' 6"$ is measured at a time with the help of 5 bars and 2 frameworks. The work is thus continued till the end of the base is reached.

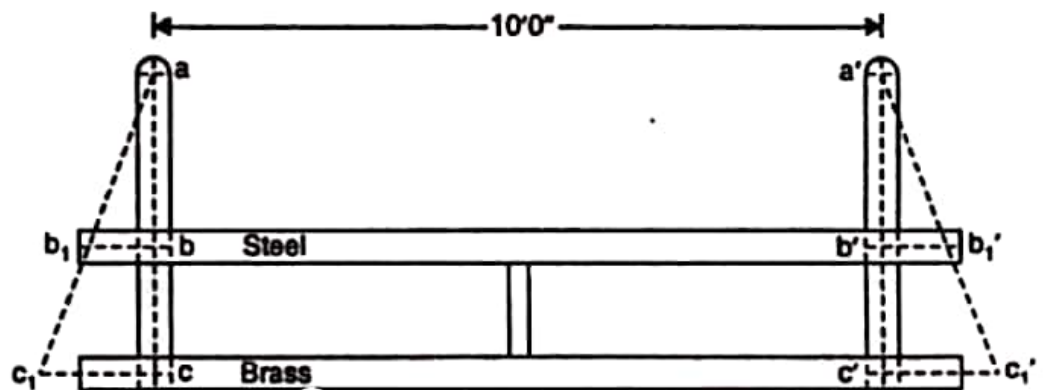


FIG THE COLBY APPARATUS.

(B) Flexible Apparatus

In the recent years, the use of flexible instruments has increased due to the longer lengths that can be measured at a time without any loss in accuracy. The flexible apparatus consists of (a) steel or invar tapes, and (b) steel and brass wires. The flexible apparatus has the following *advantages* over the rigid bars :

(i) Due to the greater length of the flexible apparatus, a wider choice of base sites is available since rough ground with wider water gaps can be utilised.

(ii) The speed of measurement is quicker, and thus less expensive.

(iii) Longer bases can be used and more check bases can be introduced at closer intervals.

Equipment for base line measurement :

The equipment for base line measurement by flexible apparatus consists of the following:

1. Three standardised tapes : out of the three tapes one is used for field measurement and the other two are used for standardising the field tape at suitable intervals.
2. Straining device, marking tripods or stakes and supporting tripods or staking.
3. A steel tape for spacing the tripods or stakes.
4. Six thermometers : four for measuring the temperature of the field and two for standardising the four thermometers.
4. A sensitive and accurate spring balance.

The Field Work

The field work for the measurement of base line is carried out by two parties :

(1) *The setting out party* consisting of two surveyors and a number of porters, have the duty to place the measuring tripods in alignment in advance of the measurement, and at correct intervals.

(2) *The measuring party*, consisting of two observers, recorder, leveller and staffman, for actual measurements.

The base line is cleared of the obstacles and is divided into suitable sections of $\frac{1}{2}$ to 1 kilometre in length and is accurately aligned with a transit. Whenever the alignment changes, stout posts are driven firmly in the ground. The setting out party then places the measuring tripods in alignments in advance of the measurement which can be done by *two methods* :

(i) Measurement on Wheeler's method by Wheeler's base line apparatus.

(ii) Jaderin's method.

(i) Wheeler's base line apparatus

The marking stakes are driven on the line with their tops about 50 cm above the surface of the ground, and at distance apart slightly less than the length of the tape. On the tops of the marking stakes, strips of zinc, 4 cm in width, are nailed for the purpose of scribing off the extremities of the tapes. Supporting stakes are also provided at interval of 5 to 15 metres, with their faces in the line. Nails are driven in the sides of the supporting stakes to carry hooks to support the tape. The points of supports are set either

on a uniform grade between the marking stakes or at the same level. A weight is attached to the other end of the straining tripod to apply a uniform pull.

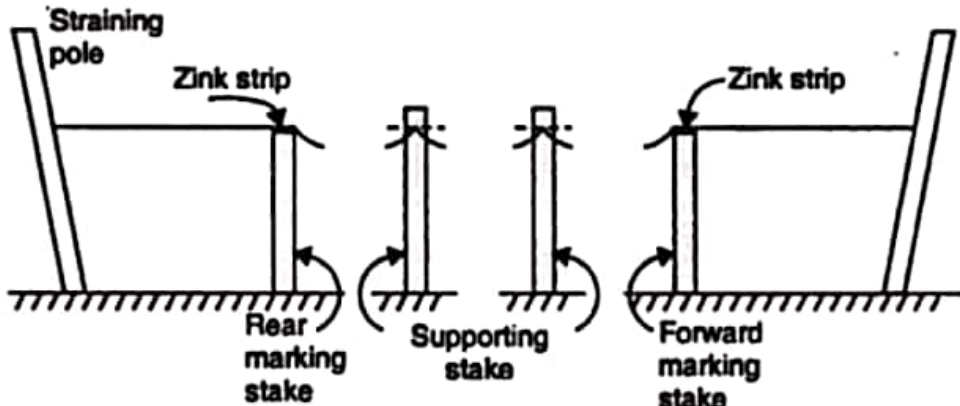
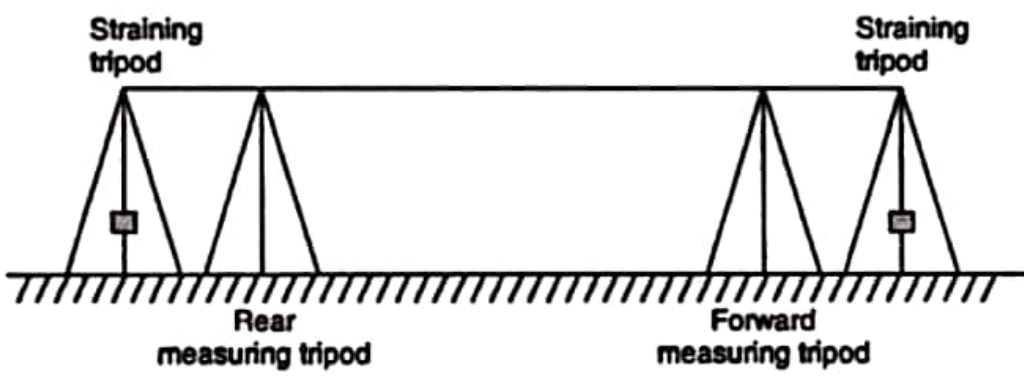


FIG WHEELER'S BASE LINE APPARATUS.

To measure the length, the rear end of the tape is connected to the straining pole and the forward end to the spring balance to the other end of which a weight is attached. The rear end of the tape is adjusted to coincide with the mark on the zinc strip at the top of the rear marking stake by means of the adjusting screw of the side. The position of the forward end of the tape is marked on the zinc strip at the top of the forward marking stake after proper tension has been applied. The work is thus continued. The thermometers are also observed.

(ii) Jaderin's method

In this method introduced by Jaderin, the measuring tripods are aligned and set at a distance approximately equal to the length of the tape. The ends of the tapes are attached to the straining tripods to which weights are attached. The spring balance is used to measure the tension. The rear mark of the tape is adjusted to coincide with the mark on rear measuring tripod. The mark on the forward measuring tripod is then set at the forward mark of the tape. The tape is thus suspended freely and is subjected to constant tension. An aligning and levelling telescope is also sometimes fitted to the measuring tripod. The levelling observations are made by a level and a light staff fitted with a rubber pad for contact with the tripod heads. The tension applied should not be less than 20 times the weight of the tape.



JADERIN'S METHOD.