7. *Instruments for Measurign Principal Angles.* Large theodolites were invariably employed. Repeating circles were highly thought of by French geodesists at the time when the operations in India were being commenced ; but they were not used in the survey, and have now been gener­ally discarded.

The principal theodolites are somewhat similar to the astronomer’s alt-azimuth instrument, but with larger azi­muthal and smaller vertical circles, also with a greater base to give the firmness and stability which are required in measuring horizontal angles. The azimuthal circles have mostly diameters of either 36 or 24 inches, the ver­tical circles having a diameter of 18 inches. In all the theodolites the base is a tribrach resting on three levelling foot-screws, and the circles are read by microscopes ; but in different instruments the fixed and the rotatory parts of the body vary. In some the vertical axis is fixed on the tribrach and projects upwards ; in others it revolves in the tribrach and projects downwards. . In the former the azimuthal circle is fixed to the tribrach, while the telescope pillars, the microscopes, the clamps, and the tangent screws are attached to a drum revolving round the vertical axis ; in the latter the microscopes, clamps, and tangent screws are fixed to the tribrach, while the telescope pillars and the azimuthal circle are attached to a plate fixed at the head of the rotatory vertical axis. The former system—called that of *flying microscopes—*permits the vertical axis to be readily opened out and cleaned, and presents the same clamp and tangent screw for employment during a round of angles; the latter—the system of *fixed microscopes—*necessitates the removal and replacement of all the microscopes, clamps, and tangent screws whenever the axis is cleaned, which is very troublesome, and it presents three sets of clamps and tangent screws for successive employment during a round of angles, which is a departure from true differentiality. The vertical axis is perforated for centring over the station mark with the aid of a “ look-down telescope ” instead of a plummet. The azimuthal circle is invariably read by an odd number of microscopes, either three or five, at equal intervals apart. The telescope rests with its pivots in Y’s at the head of two pillars of a sufficient height to enable it to be completely turned round in altitude. The vertical circle is fixed to the transit axis of the telescope, and is read by two microscopes 180° apart, at the extremities of arms projecting from one of the pillars. The stand is a well-braced tripod, carrying an iron ring on which the theo­dolite rests and may be turned round bodily whenever de­sired, as for shifting the position of the zero of the azimuthal circle relatively to the points under observation. The ring is 3 inches broad and of the same diameter as the circle of the foot-screws of the theodolite. In some instruments the foot-screws rest directly on the ring ; but the instru­ment can be raised off the ring and turned round with the aid of an apparatus in the centre of the stand. In others they rest in grooves at the angles of an iron triangle which sits on the ring and can be shifted in position by hand ; thus with the stand well levelled in the first instance the circle may be set within 1' of any required reading. The centring over the station mark is performed by pushing screws placed either in the drum of the stand or at the angles of the triangle.

For travelling the theodolites were packed in two cases, the larger containing the body of the instrument, the smaller the telescope and the vertical circle ; the stand constituted a third package. Each was carried on men’s shoulders as the safest method of transport ; the weights, of the heaviest 36-inch and of the lightest 24-inch instru­ments, as packed with ropes and bamboos, were, respect­ively, as follows:—body, 649 lb; telescope, 130; stand, 232; total, 1011 lb; and 300, 135, and 185, total 620 lb.

8. *Signals.—*Cairns of stones, poles, or other opaque signals were primarily employed, the angles being measured by day only ; eventually it was found that the atmosphere was often more favourable for observing by night than by day, and that distant points were raised well into view by refraction by night which might be invisible or only seen with difficulty by day. Lamps were then introduced of the simple form of a cup, 6 inches in diameter, filled with cotton seeds steeped in oil and resin, to burn under an inverted earthen jar, 30 inches in diameter, with an aper­ture in the side towards the observer. Subsequently this contrivance gave place to the Argand lamp with parabolic reflector ; the opaque day signals were discarded for helio­tropes reflecting the sun’s rays to the observer. The in­troduction of luminous signals not only rendered the night as well as the day available for the observations but changed the character of the operations, enabling work to be done during the dry and healthy season of the year, when the atmosphere is generally hazy and dust-laden, instead of being restricted as formerly to the rainy and unhealthy seasons, when distant opaque objects are best seen. À higher degree of accuracy was also secured, for the lumi­nous signals were invariably displayed through diaphragms of appropriate aperture, truly centred over the station mark ; and, looking like stars, they could be observed with greater precision, whereas opaque signals are always dim in comparison and are liable to be seen excentrically when the light falls on one side.

A signalling party of three men was usually found suffi­cient to manipulate a pair of heliotropes—one for single, two for double reflexion, according to the sun’s position— and a lamp, throughout the night and day. Heliotropem were also employed at the observing stations to flash in­structions to the signallers.

9. *Measuring Horizontal Angles.—*The theodolites were invariably set up under tents for protection against sun, wind, and rain, and centred, levelled, and adjusted for the runs of the microscopes. Then the signals were observed in regular rotation round the horizon, alternately from right to left and *vice versa* ; after the prescribed minimum number of rounds, either two or three, had been thus measured, the telescope was turned through 180°, both in altitude and azimuth, changing the position of the face of the vertical circle relatively to the observer, and further rounds were measured ; additional measures of single angles were taken if the prescribed observations were not sufficiently accordant. As the microscopes were invariably equidistant and their number was always odd, either three or five, the readings taken on the azimuthal circle during the telescope pointings to any object in the two positions of the vertical circle, “ face right ” and “ face left,” were made on twice as many equidistant graduations as the number of microscopes. The theodolite was then shifted bodily in azimuth, by being turned on the ring on the head of the stand, which brought new graduations under the microscopes at the telescope pointings ; then further rounds were measured in the new positions, face right and face left. This process was repeated as often as had been previously prescribed, the successive angular shifts of position being made by equal arcs bringing equidistant graduations under the microscopes during the successive telescope pointings to one and the same object. By these arrangements all periodic errors of graduation were eliminated, the numerous graduations that were read tended to cancel accidental errors of divi­sion, and the numerous rounds of measures to minimize the errors of observation arising from atmospheric and personal causes.

The following table (I.) gives details of the procedure at different times ; in the headings M stands for the number of microscopes