latitude in order to form a geodetic arc, with the addition of astronomically determined latitudes at certain of the stations. The base-lines were measured with chains and the principal angles with a 3-ft. theodolite. The signals were cairns of stones or poles. The chains were somewhat rude and

their units of length had not been determined originally, and could not be afterwards ascertained. The results were good of their kind and sufficient for geographical pur­poses; but the central meridional arc—the “ great arc ”—was eventually deemed inadequate for geodetic requirements. A superior instrumental equipment was introduced, with an improved *modus operandi,* under the direction of Colonel Sir G. Everest in 1832. The network system of triangulation was superseded by meridional and longitudinal chains taking the form of gridirons and resting on base-lines at the angles of the gridirons, as repre­sented in fig. I. For convenience of reduction and nomenclature the triangulation west of meridian 92° E. has been divided into five sections—the lowest a trigon, the other four quadrilaterals distinguished by cardinal points which have reference to an ob­servatory in Central India, the adopted origin of latitudes. In the north-east quadrilateral, which was first measured, the meridional chains are about one degree apart; this distance was latterly much increased and eventually certain chains—as on the Malabar coast and on meridian 84° in the south-east quadrilateral—were dispensed with because good secondary triangulation for topography had been accomplished before they could be begun.

All *base-lines were* measured with the Colby apparatus of com­pensation bars and microscopes. The bars, 10 ft. long, were set up horizontally, on tripod stands; the microscopes, 6 in. apart, were mounted in pairs revolving round a vertical axis and were set up on tribrachs fitted to the ends of the bars. Six bars and five central and two end pairs of microscopes—the latter with their vertical axes perforated for a look-down telescope—constituted a complete apparatus, measuring 63 ft. between the ground pins or registers. Compound bars are more liable to accidental changes of length than simple bars; they were therefore tested from time to time by comparison with a standard simple bar; the microscopes were also tested by comparison with a standard 6-in. scale. At the first base-line the compensated bars were found to be liable to sensible variations of length with the diurnal variations of tempe­rature; these were supposed to be due to the different thermal conductivities of the brass and the iron components. It became necessary, therefore, to determine the mean daily length of the bars precisely, for which reason they were systematically compared with the standard before and after, and sometimes at the middle of, the base-line measurement throughout the entire day for a space of three days, and under conditions as nearly similar as possible to those obtaining during the measurement. Eventually thermo­meters were applied experimentally to both components of a compound bar, when it was found that the diurnal variations in length were principally due to. difference of position relatively to the sun, not to difference of conductivity—the component nearest the sun acquiring heat most rapidly or parting with it most slowly, notwithstanding that both were in the same box, which was always sheltered from the sun’s rays. Happily the systematic comparisons of the compound bars with the standard were found to give a sufficiently exact determination of the mean daily length. An elaborate investigation of theoretical probable errors *(p.e.)* at the Cape Comorin base showed that, for any base-line measured as usual without thermometers in the compound bars, the *p.e.* may be taken as ± 1∙5 millionth parts of the length, excluding unascertainable constant errors, and that on introducing thermometers into these bars the *p.e,* was diminished to ± 0∙55 millionths.

In all base-line measurements the weak point is the determination of the temperature of the bars when that of the atmosphere is rapidly rising or falling; the thermometers acquire and lose heat more rapidly than the bar if their bulbs are outside, and more slowly if inside the bar. Thus there is always more or less lagging, and its effects are only eliminated when the rises and falls are of equal amount and duration; but as a rule the rise generally predominates greatly during the usual hours of work, and whenever this happens lagging may cause more error in a base-line measured with simple bars than all other sources of error combined. In India the probable average lagging of the standard-bar thermometer was estimated as not less than 0∙3° F., corresponding to an error of —2 millionths in the length of a base-line measured with iron bars. With compound bars lagging would be much the same for both com­ponents and its influence would consequently be eliminated. Thus the most perfect base-line apparatus would seem to be one of com­pensation bars with thermometers attached to each component; then the comparisons with the standard need only be taken at the times when the temperature is constant, and there is no lagging.

The *plan of triangulation* was broadly a system of internal meridional and longitudinal chains with an external border of oblique chains following the course of the frontier and the coast lines. The design of each chain was necessarily much influenced by the physical features of the country over which it was carried. The most difficult tracts were plains, devoid of any commanding points of view, in some parts covered with forest and jungle, malarious and almost uninhabited, in other parts covered with towns and villages and umbrageous trees. In such tracts triangulation was impossible except by constructing towers as stations of observation, raising them to a sufficient height to overtop at least the earth’s curvature, and then either increasing the height to surmount all obstacles to mutual vision, or clearing the lines. Thus in hilly and open country the chains of triangles were generally made “ double ” throughout, *i.e.* formed of polygonal and quadrilateral figures to give greater breadth and accuracy; but in forest and close country they were carried out as series of single triangles, to give a minimum of labour and expense.. Symmetry was secured by restricting the angles between the limits of 30° and 90°. The average side length was 30 m. in hill country and 11 in the plains; the longest principal side was 62·7 m., though in the secondary tri­angulation to the Himalayan peaks there were sides exceeding 200 m. Long sides were at first considered desirable, on the prin­ciple that the fewer the links the greater the accuracy of a chain of triangles; but it was eventually found that good observations on long sides could only be obtained under exceptionally favourable atmospheric conditions. In plains the length was governed by the height to which towers could be conveniently raised to surmount the curvature, under the well-known condition, height in feet = 2/3 × square of the distance in miles; thus 24 ft. of height was needed at each end of a side to overtop the curvature in 12 m., and to this had to be added whatever was. required to surmount obstacles on the ground. In Indian plains refraction is more frequently negative than positive during sunshine; no reduction could therefore be made for it.

The *selection of sites for stations,* a simple matter in hills and open country, is often difficult in plains and close country. In the early operations, when the great arc was being carried across the wide plains of the Gangetic valley, which are covered with villages and trees and other obstacles to distant vision, masts 35 ft. high were carried about for the support of the small reconnoitring theodolites, with a sufficiency of poles and bamboos to form a scaffolding of the same height for the observer. Other masts 70 ft. high, with arrangements for displaying blue lights by night at 90 ft., were erected at the spots where station sites were wanted. But the cost of transport was great, the rate of progress was slow, and the results were unsatisfactory. Eventually a method of touch rather than sight was adopted, feeling the ground to search for the obstacles to be avoided, rather than attempting to look over them: the “ rays ” were traced either by a minor triangulation, or by a traverse with theodolite and perambulator, or by a simple alignment of flags. The first method gives the direction of the new station most accurately; the second searches the ground most, closely; the third is best suited for tracts of uninhabited forest in which there is no choice of either line or site, and the required station may be built at the intersection of the two trial rays leading up to it. As a rule it has been found most economical and expeditious to raise the towers only to the height necessary for surmounting the curvature, and to remove the trees and other obstacles on the lines.

Each *principal station* has a central masonry pillar, circular and 3 to 4 ft. in diameter, for the support of a large theodolite, and around it a platform 14 to 16 ft. square for the observatory tent, observer and signallers. The pillar is isolated from the plat­form, and when solid carries the station mark—a dot surrounded by a circle—engraved on a stone at its surface, and on additional stones or the rock *in situ,* in the normal of the upper mark; but, if the height is considerable and there is a liability to deflection, the pillar is constructed with a central vertical shaft to enable the