leather folded into a small pad. No pencil marking is allowed ; lightening is done with india-rubber ; the shading is finally fixed with a wash of thin gum-water.

It is to be noted that the several scales of shade above given were devised for military maps to be drawn on a scale of not less than 4 inches to the mile and possibly much greater. The harshness and mannerism to which all line-shading by rule is liable are of less importance in maps of small areas represented on large scales than on maps of large areas on small scales. In the former the sacrifice of pictorial effect is more than compensated by the additional information regarding the slopes of the ground ; in the latter any attempt to introduce so much informa­tion would tend to crowd the map objectionably, and con­fuse the vertical with the horizontal details. The smaller the scale of a map of hill country the more necessary it is to abandon mechanical conventionalism, and to aim at achieving an artistic representation which will convey an immediate and accurate impression of the general character of the ground.

In India the topography has been mainly executed on scales of or less than 1 inch = l mile and rarely exceeding 2 inches, and, as the range of altitude varies considerably in different parts of the country, from plains and undulations little above the sea-level to mountains rising to an altitude of 29,000 feet, scales of shade were long deemed wholly unsuitable for employment. The higher mountains had necessarily to be brought into prominence over the lower by giving them a darker shade than was due simply to their slopes, and similarly the elevated plateaus had to be more lightened and illuminated than the low-lying plains. But in course of time, as the number of hands employed in the operations increased more rapidly than the available supply of artistic draughtsmen, the in­troduction of a scale of shade became necessary, in order that the multitude of workers might be put more nearly on a par with the few. For men who have been accustomed to associate a certain depth of shade with a certain angle of slope will work together within narrower limits of error and divergence than if left entirely to their own unaided judgment and untutored proclivities. The field sketchers should therefore learn to work on a system which gives every hachure line a definite meaning, so that their sketches may be rightly interpreted and appropriately translated and ren­dered in the final representation of the ground, when it is the duty of the draughtsman to enhance the tone of the map as much as possible while maintaining its truthfulness.

*Ordnance Survey System of Delineating Ground.—*As a rule the features of the ground are sketched in the field on the 6-inch scale, and afterwards reduced and published on the 1-inch scale. The Highlands of Scotland were sketched partly on the 1-inch and partly on the 2-inch scale; in Ireland the 1-inch scale only was used ; and this scale is now being adopted for hill sketching in England and Wales. In the parts where the 6-inch scale was used the ground was first contoured instrumentally; a plan of the con­tours and of all surveyed outlines was supplied to the sketcher, who proceeded to insert the hill features with the aid of a prismatic compass, protractor, plotting scale, and a “ hill-sketcher’s scale,” graduated to show the horizontal intervals between the contours which correspond to various angles of inclination from 0° to 45°. He was required to delineate slopes up to 45° by horizontal hachures, and slopes beyond 45° by vertical hachures. The thickness and number of the strokes, the relation to light and shade, and the character of the touch were left to the skill and experience of the sketcher. The introduction of scales of shade adapted to various inclinations and altitudes was frequently mooted, with a view to securing greater uniformity ; but no such scale was adopted, for it was found that, though at first different workmen produced different results, long practice and constant comparison, together with the aid derived from the instrumental contours, effected all desirable uniformity. Thus in good sketches it was found that the maximum breadth of stroke used in the representation of very steep mountain slopes was 1/45 inch, and the minimum used in low and nearly flat country, 1/500 inch, also that the average proportions of light to shade were I to 3 at the maximum and 25 to 1 at the minimum inclinations. In the field sketches the light is supposed to fall vertically, and all slopes of like altitude and inclination are similarly expressed. The 6-inch sketches are reduced to the 1-inch scale for publica­tion by an artist working with Indian ink and the camel-hair brush on an impression in outline of the 1-inch map. He makes a careful study of the several sketches which he has to combine together, in order to determine which features should be retained and which omitted in the reduction, and he divides the ground into zones of different altitude to guide him in giving a strength of shade proportioned to the altitude rather than to the slope as in

the field sketches ; and in drawing he increases the contrasts be­tween light and shade and introduces light from a corner of the map to give a stronger relief, and to attract the eye to the highest points and enable it to distinguish readily the higher from the lower ground. His general aim is to produce a more pictorial and less mechanical study of the ground than is supplied by the field sketches. Many exquisite maps have been thus produced and afterwards engraved ; see sheets 32, 33, 38, 53, and 64 of Scotland,

38 and 48 of England, 75 of Wales, 93, 94,191, and 192 of Ireland. These sheets, however, though admirable specimens of engraving, fall short of the original drawings in tone and relief, for in them the hill-shading is necessarily shown by line-etching, and it does not produce such effective contrasts and gradations of light and shade as the original brush work.@@1

*Delineation by Instrumental Contouring.—*A very precise knowledge of the configuration of surface may be acquired by carrying true contour lines over the ground and pro­jecting them on the map of the survey. But the contours do not give a true representation of the ground, for they seldom represent actual lines on the surface, as do the lines on the map which indicate roads, watercourses, walls, enclosures, &c. ; they give, however, a conventional representation which is sufficient *per se* for the engineer and the expert, and they furnish guiding lines for all shading, whether by hachures or mezzotint, which may be subsequently executed to produce an artistic delinea­tion of the features of the ground. In instrumental con­touring we have first to decide on the vertical intervals to be maintained between the contours. They depend on the scale of the survey and the nature of the ground. In the Ordnance Survey they are made as small as from *5* to 10 feet, when special plans on large scales are being pre­pared for engineering requirements ; but for the general maps they are 50 feet up to an elevation of 100 feet above the sea-level, and 100 beyond up to 900 feet, which eleva­tion, being the practical limit of cultivation, is the highest generally marked, though in the northern counties of Eng­land and in parts of Scotland additional contours have been executed at the altitudes of 1000, 1250, 1500, 1750, 2000, 2500, 3000, &c., feet. The intervals having been deter­mined on, instrumental levelling is commenced at either the top or the bottom of those slopes which best define the general lay of the ground, or at some previously established bench mark of which the height above the sea is known. Points are marked out on the slopes with pickets at the prescribed vertical intervals, and then the contour lines of the horizontal planes passing in succession through each of these points are traced with a levelling instrument and staff and surveyed by traverse, the two processes being performed either simultaneously or consecutively as may be most convenient.

The instruments generally used in the Ordnance Survey are a 5-inch theodolite—employed as a levelling instrument—and a con­touring staff, 8 feet long, provided with a sliding vane which may be fixed at any required height ; the staff is shifted about until the vane is brought into the horizontal plane of the theodolite, when the bottom of the staff will be on the contour line. A serviceable contouring instrument of very simple construction is the water- level, which consists of a pair of transparent phials partially filled with water ; the phials are placed upside down at the ends of a hollow bar fixed on a rotatory vertical axis, and have their mouths connected with piping of any available material,— brass, tin, or gutta-percha. The water in both phials is in free communication, and the water surfaces indicate the horizontal plane naturally, without any mechanical contrivance. The instrument is well suited for short sights not requiring a telescope, and may be readily mani­pulated by persons ignorant of the use of instruments of a higher class. Eye-reflecting levels, clinometers, orometers, and other light instruments, which may be held in the hand and do not require a fixed support, are frequently employed for interpolating minor between major contours. In military sketching on large scales hypothenusal inclinations and lengths are sometimes measured ; the bases and perpendiculars are deduced on the spot from a table

@@@1 With certain exceptions, principally of a military nature, the hill features are now sketched on the 1-inch scale, on photographic reduc­tions of the 6-inch contoured sheets, faintly printed in orange colour, as a guide to the sketchers.