

disposed of at the ground level. Thus, at F and G the earth would be thrown on to the bottom platform (known as the *first lift* or *throw*), a man working on this platform shovels the material on to the top platform (or *second lift*) from which it is thrown out of the trench. In large excavations the soil is often shovelled into receptacles which are lifted by a crane and deposited where required on the site or emptied direct into a lorry in which it is conveyed to the nearest convenient tip.

TRENCHES IN LOOSE AND/OR WATERLOGGED SOIL.—Great care must be exercised to prevent the caving in of trenches formed in bad ground. The soils which come under this class are soft plastic clay, certain conditions of sand, silt, wet chalk and peat. Damp sand is not difficult, but it can be most troublesome if it is in a very wet condition or is fine and dry. The latter is not easy to confine, as it readily "flows" through small spaces between timbers; the escape of such loose material may cause settlement and the total collapse of the timbering. Such bad ground is retained by either (a) horizontal sheeting or (b) vertical timbers called *runners*.

(a) *Sheeting* (see L and M).—The section at L shows a stratum of wet sand between two beds of moderately firm ground. This, therefore, shows the application of a composite system of timbering.

The lower portion is timbered with middling boards, as described on p. 57, and the upper setting may also consist of these boards. As an alternative, however, poling boards with two frames instead of one have been shown as the support in the upper setting.

The sheeting is fixed in easy stages, as described on p. 83, Vol. I. Any small openings between the boards, as at T, should be *stemmed* by the packing of wads of grass or straw between the timbers. Whilst this does not stop the flow of water, it does prevent the infiltration of particles of sand. Puncheons should be used, as indicated. The sides of the trench are shown battered, a practice which is sometimes adopted if there is a tendency for the soil to shrink. Whilst this does not prevent the struts from working loose, it does tend to prevent the collapse of the timbering. Careful supervision is necessary, and the strut wedges must be adjusted as required.

(b) *Runners* (see N and P).—These are generally preferred to sheeting, especially for deep excavations in bad ground. Runners are roughly sawn timbers from 2 to 3-in. thick, 6 to 9-in. wide and up to 20-ft. long. They may be square edged, as shown at P, rebated, or tongued and grooved (see Q). Rebated runners are very effective for close timbering, but the t. and g. type is not now favoured, as the grooves and tongues are readily damaged and small stones are apt to clog the grooves and impede the driving operation. The lower ends or toes are bevelled and shaped as shown to give a cutting edge; this facilitates insertion and forces each runner against the edge of that previously driven. These runners are driven in by blows from a heavy mallet, and their heads are often bound with hoop iron to protect them from damage. The toes are also sometimes shod with steel or hoop iron, especially if the runners are to be driven through a hard stratum.

In the section at N, the upper 4-ft. of soil is moderately firm and is supported by a setting of middling boards. But below this, wet clay or soil which lacks cohesion necessitates the employment of close timbering. Horizontal *continuous guides*, consisting of two 3-in. by 1½ or 2-in. stuff, are nailed to the top lips with a space between through which the runners are passed. The top frame for the runners is fixed, the walings being packed out from the sides to enable the runners to pass down behind them. The runners are driven down, one at a time, as far as possible without exerting such force as would damage their heads. The excavation is then proceeded with, leaving about 9 to 12-in. of their lower ends buried. Driving is recommenced, followed by the removal of more soil. When the excavation has been lowered to some 4-ft. below the top runner frame, a second frame is fixed and puncheoned; the lower walings serve as an additional guide and ensure the vertical driving of the runners. The latter are driven in this manner until the necessary depth is reached, frames being fitted at about 4-ft. intervals. In some soils, the runners, because of their weight, can be forced into the ground for several feet before driving is resorted to. The sides of the excavation must always be supported, and hence the importance of not exposing the feet of the runners. A partially driven runner is shown at N and P, the toe of which is about a foot below the bottom of the intermediate cutting indicated by a broken line at R; the pile must be driven farther before more soil is excavated. Pages are inserted behind the walings as required (see N). These and the strut wedges are slightly eased to facilitate the driving and prevent disturbance of the walings and struts. It is often necessary to provide scaffolding for the men when driving the runners. Such may be dispensed with if the ground will permit the employment of an upper setting of middling boards and correspondingly reduced length of runners. If the runners are required to extend for the full depth of the excavation, the top frame is fixed at the surface, and the continuous guides are strutted at some 2 or 3-ft. above the ground.

*Drainage*.—The admission of water to trenches will add discomfort to the men working in them (and thereby affect adversely the quality of the work) and may cause the timbering to collapse by converting the soil (such as loamy clay or chalk) into a liquid consistency. Steps should therefore be taken to exclude surface water, and remove any which would otherwise accumulate in the trenches. Surface water is dealt with by cutting small channels or *grips* which are given a fall away from the excavations. A trench in a waterlogged soil is usually drained by means of a grip cut at the bottom and along one side of the excavation, and given a fall towards a convenient point where a hole or *sump* is formed to receive the water which is removed by pumping.

LARGE EXCAVATIONS (see S).—This shows the application of timbering to the sides of an excavation such as is required for the construction of the basement of a large building. Mechanized plant is now available for the general or *bulk* excavation of such sites. As much of the ground as possible is excavated, the sides being sloped off at a steep inclination (see thick broken line). The excavation near the sides is then proceeded with, the vertical faces being supported temporarily by middling boards, etc., depending upon the nature of the soil.