which *φ* is the same), and the distance from O along OT will be proportional to the reading on the staff. Thus if the staff be suitably graduated, the distance from O can be immediately deduced from the reading. Also, as before, if the telescope be inclined at an angle α to the horizontal, the distance OT inferred from the number of graduations in ST must be multiplied by cos2 α to give the horizontal distance of O from T, and the horizontal distance so obtained must be multiplied by tan α to obtain the vertical distance of T from O.

The inconvenience of the reduction work necessary to obtain the horizontal and vertical distances produced the Wagner-Feunel tacheometer, by which the distances can be read directly from the instrument. As is seen from fig. 7, three scales are provided, to measure the inclined distance, the horizontal distance, and the vertical distance respectively. All three are arranged in a plane parallel to the plane in which the telescope turns. The inclined scale is attached to the telescope exactly parallel to its line of collimation, and moves with it. The horizontal scale is fixed to the upper horizontal plate of the theodolite. The vertical scale is on the vertical edge of a right-angled triangle, which can be slid along on the top of the horizontal scale. The inclined scale carries a slide which is provided with two verniers. One of these is parallel to the inclined scale, and is for the purpose of setting off on the scale (in terms of the divisions on the scale) the inclined distance of the staff from the axis of rotation of the telescope. The other turns on a pivot whose centre is accurately in the edge of the inclined scale at the point where the zero division of the inclined vernier cuts the edge, and is for the purpose of reading the vertical scale; it can be turned on its pivot so as to be vertical whatever may be the inclination of the telescope. Moreover, since the distance from the centre of the pivot to the zero of the vernier is always constant and known, the vertical scale can be graduated so that the reading of the vernier gives the height (in terms of the division on the scale) of the staff above the axis of rotation of the telescope. The horizontal scale attached to the horizontal plate of the theodolite is read by means of a vernier carried by the triangle. To ascertain the horizontal and vertical distances of the point on the staff which is cut by the middle wire in the diaphragm of the telescope from the rotation axis of the telescope, the inclined distance of the point on the staff is read by means of the wires, as in Porro’s tacheometer. This distance (in terms of the divisions) is then set off on the inclined scale by means of the inclined vernier, and the vertical scale on the triangle is moved up to the vertical vernier, which is adjusted to its edge. With proper graduation of the horizontal and vertical scales the horizontal and vertical distances can be at once read off on the scales. This method, however, requires that the staff be held so that its face is perpendicular to the line of sight, which is more troublesome than holding the staff vertical.

Authorities.—Brough on “ Tacheometry,” *Proc. Inst. C.E.,* vol. xci. Pierce on the “ Use of the Plane Table,” *ibid.* vol. xcii. Kennedy on the “ Tacheometer,” *ibid.* vol. xcix. Airy on the “ Probable Errors of Surveying by Vertical Angles,” *ibid.* vol. ci. Middleton on “ Observations in Tacheometry,” *ibid.* vol. cxvi. Young on " Surveying with the Omnimeter,” *ibid.* vol. cxvii. J. Bridges Lee on “ Photographic. Surveying,” *Trans. Soc. Engin.,* vol. for 1899. “The Ziegler-Hager Tacheograph,” *Engineering,* vol. lxv. (W. Ay.)

**TACHIENLU,** a town of China, in the province of Sze-ch 'uen. It is the great tea mart for Tibet, and from Tachienlu the two trade-routes. the Gya lam and the Chang lam, diverge, the former to Ladakh and the latter to Kashgar.

**TACHYLYTES,** or Tachylites (from Gr. *τaχus,* swift, λύαιv, to dissolve, meaning “ easily fused,” though some have erroneously interpreted it as “ easily soluble in acids ”), in petrology, the vitreous forms of the basic igneous rocks; in other words, they are basaltic obsidians. They arc black in colour, dark brown in the thinnest sections, with a resinous lustre and the appearance of pitch, often more or less vesicular and sometimes spherulitic. They are very brittle, and break down readily under the hammer. Small crystals of felspar or of olivine are sometimes visible in them with the unaided eye. All tachylytes weather rather easily, and by oxidation of their iron become dark brown or red. Three modes of occurrence characterize this rock. In all cases they are found under conditions which imply rapid cooling, but they are much less common than acid volcanic glasses (or obsidians), the reason being apparently that the basic rocks have a stronger tendency to crystallize, partly because they are more liquid and the molecules have more freedom to arrange themselves in crystalline order.

The fine scoria ashes or “ cinders ” thrown out by basaltic volcanoes are often spongy masses of tachylyte with only a few larger crystals or phenocrysts imbedded in black glass. Such tachylyte bombs and scoria are frequent in Iceland, Auvergne, Stromboli, Etna, and are very common also in the ash beds or tuffs of older date, such as occur in Skye, Midlothian and Fife, Derbyshire, and elsewhere. Basic pumices of this kind are exceedingly wide­spread on the bottom of the sea, either dispersed in the “ red clay ” and other deposits or forming layers coated (with oxides of man­ganese, precipitated on them from the sea water. These tachylyte fragments, which are usually much decomposed by the oxidation and hydration of their ferrous compounds, have taken on a dark red colour. This altered basic glass is known as “ palagonite ” ; con­centric bands of it often surround kernels of unaltered tachylyte, and are so soft that they are easily cut with a knife. In the. pala­gonite the minerals also are decomposed, and are represented only by pseudomorphs. The fresh tachylyte glass, however, often con­tains lozenge-shaped crystals of plagioclase felspar and small prisms of augite and olivine, but all these minerals very frequently occur mainly as microlites or as beautiful skeletal growths with sharply- pointed corners or ramifying processes. Palagonite tuffs are found also among the older volcanic rocks. In Iceland a broad stretch of these rocks, described as “ the palagonite formation,” is said to cross the island from south-west to north-east. Some of these tuffs are fossiliferous ; others are intercalated with glacial deposits. The lavas with which they occur are mostly olivine-basalts. Palagonite tuffs are found in Sicily, the Eifel, Hungary, Canary Islands, &c.

A second mode of occurrence of tachylyte is in the form of lava flows. Basaltic rocks often contain a small amount of glassy ground-mass, and in the limburgites this becomes more important and conspicuous, but vitreous types are far less common in these than in the acid lavas. In the Hawaiian Islands, however, the volcanoes have poured out vast floods of black basalt, containing felspar, augite, olivine, and iron ores in a black glassy base. They are highly liquid when discharged, and the rapid cooling which ensues on their emergence to the air prevents crystallization taking place completely. Many of them are spongy or vesicular, and their upper surfaces are often exceedingly rough and jagged, while at other times they assume rounded wave-like forms on solidification. Great caves are found where the crust has solidified and the liquid interior has subsequently flowed away, and stalactites and stalag­mites of black tachylyte adorn the roofs and floors. On section these growths show usually a central cavity enclosed by walls of dark brown glass in which skeletons and microliths of augite, olivine and felspar lie imbedded. From the crater of Kilauea thin clouds of steam rise constantly, and as the bubbles of vapour are liberated from the molten rock they carry into the air with them thin fibres of basalt which solidify at once and assume the form of tachylyte threads. Under the microscope they prove to be nearly completely glassy with small circular air vesicles sometimes drawn out to long tubes. Only in the Hawaiian Islands are glassy basaltic lavas of this kind at all common.

A third mode of occurrence of tachylyte is as the margins and thin offshoots of dikes or sills of basalt, dolerite and diabase. They are sometimes only a fraction of an inch in thickness, resembling a thin layer of pitch or tar on the edge of a crystalline dolerite dike, but veins several inches thick are sometimes met with. In these situa­tions tachylyte is rarely vesicular, but it often shows very pronounced fluxion banding accentuated by the presence of rows of spherulites which arc visible as dark brown rounded spots. The spherulites have a distinct radiate structure and sometimes exhibit zones of varying colour. The non-spherulitic glassy portion is sometimes perlitic and these rocks are always brittle. The commonest crystals are olivine, augite and felspar, with swarms of minute dusty black grains of magnetite. At the extreme edges the glass is often per­fectly free from crystalline products, but it merges rapidly into the