at each end after the tunnelling has sufficiently advanced. These excavations should be turfed, if possible, as soon as they are finished ; and if turf is not to be had, they must be soiled at least eight inches thick, and sown at the proper season with equal parts of rye and clover seed, in the pro­portions of three pounds of the mixed seed per acre.

The top of the slopes and the ends of the tunnel should be protected with a ditch, a wood-railing, and a line of quicks. The ditch should be five feet wide at the top, two feet deep, and with slopes that will stand according to the nature of the soil, which, if very bad, will render it neces­sary to widen the top. The earth from the ditch will form a mound to be neatly turfed, having the best of the vegetable soil in its middle, where a double row’ of three years old quicks, two years transplanted, should be set in the propor­tion of twelve quicksets to a lineal yard. The fence of split oak is to be set on the inner edge of the ditch, as before described. The quicks should be weeded and cleaned twice a year, and others planted in the room of those which have not taken root.

A brick drain should be laid the whole length of the tun­nel, in Roman cement, with the end-joints open half an inch for the passage in of water from the ballasting ; and if the shafts let in water, a conveyance half-round pipe must be fitted to the bottom of them, to lead the water down the side of the tunnel into the drain.

With respect to the spoil, if made into banks, the turf should first be removed, to be afterwards put on the top. Convenient sites should be found, so that the spoil shall be useable for agricultural purposes ; and where turf enough to cover it cannot be had, it must be soiled and sown with seed at the proper season.

All damages to the adjoining land must be paid by the contractor ; but if the parties making the tunnel arc, as is usually the case, a public company, under an act of parlia­ment, they should assist the contractor in getting the ne­cessary land, with the powers of their act. It is understood that the contractor has the full use of the one chain in width along the line of the tunnel, free of all charge, on which to erect any buildings or machinery he may require, laying railways or roads for conveying away spoil and bring­ing in materials, lifting-engines, pumping-engines, or any other apparatus ; and it is also understood, that if any ma­terial turns up fit for making bricks, he is to have the ad­vantage of applying it to that purpose.

In case of having any roads to divert, or new ones to make, the ground should be excavated the required width, and one foot deep ; when, if it is moist, brushwood should be placed upon the bottom, and then gravel, till the centre, when the whole is well beaten, is two feet above the exca­vated bottom, with a rounding of six inches on the surface. None of the gravel or broken stones should be larger than will go through a two-inch ring. A ditch, railing, and quicks, as before described, are then to be put up.

The engineer is in all cases to be the judge of the thick­ness of the brick-work, which should be provided for in the schedule of prices; as also, whether laid in cement or mor­tar. It should also be clearly defined whether or not the contractor is to be liable for any damage done to the land from the falling of the surface during the execution of the works, or if the regular continuity of the brick-work is de­stroyed, arising from irregular shrinking or settlement in the arch, imperfection in the centring, or any other cause. He should also be bound to remove all the temporary fencing, and clear the surface after the works are completed.

The materials should all be of the very best kind. The bricks should be sound, hard, and well shaped, being mould­ed taper wherever the form of the tunnel requires it. The sides may be built in English bond, or alternate heading and stretching; but the arch and the invert must be in con­centric half-brick rings. The mortar should be of the best lime and sharp sand, in the proportions of three to one, and passed through a pug-mill, the lime being ground under edge-stones in its dry or unslacked state. The Roman cement should be perfectly fresh burnt, and capable of setting hard ; it should be mixed with an equal quantity of sand, and none used which has set. The stone should be of a sound and hard quality, perfectly free from flaws. The cast iron employed in the curbs for the shafts should be of the best No. 2 iron, and the castings perfectly clean and cleared from air-bubbles or pin-holes, and no stopping or packing should be allowed. The whole of the malleable iron-bolts, &c. employed, should be made of the best scrap- iron. The bolts for retaining the tunnel fronts should he tested to twenty-five tons, and tested in pairs to try the couplings. When concrete is used, it should be five mea­sures of clean riddled gravel, and one measure of lime, and not mixed till immediately before it is required to be placed in its intended situation.

There should be a specified time for the contractor to begin and finish each portion, such as the working shafts, the ventilating shafts, the excavation, &c. ; and he should be bound to execute a given quantity of tunnelling per week, sending the engineer a weekly return of all descriptions of men employed on the works, distinguished into classes.

When the rails, chairs, blocks, and other permanent-way materials are delivered to the contractor, he is then respon­sible for them. They need not be delivered till the tunnel is complete. Ballasting is to be used of broken stone or gravel for bringing up the blocks to the required height, without any mixture of clay or other substance capable of containing water ; it should set quite hard. If broken stones are used, they should be passed through a two-inch ring. The ballasting, which may, if required, be shot down the shafts, an inclined plane at the bottom canting it the right way, should be spread over the invert, and beaten into a firm and solid mass, by means of heavy beaters, worked by at least two men, till it is consolidated at the proper height to receive the blocks or sleepers, which are also to be im­bedded as firmly as possible. The contractor will have to drill two holes in each block to receive the treenails, and to cut a proper bed for the chairs on the sleepers. No spikes should be driven into sleepers till proper holes are bored. The sleepers should be imbedded by beaters, and the blocks by lifting them one foot high by a spring lever, and then letting them fall till no difference of level is perceived. The rails must be laid perfectly level and parallel, and the joints even and true, with an allowance for expansion and contraction suitable to the temperature to be furnished by the engineer. The utmost care and attention should be paid to so essential a point as the laying of the permanent way.

ln excavating the working or ventilating shafts, it will be the best method to sink with a roll till they are fifty or sixty feet deep: this is worked by hand, and then with a horse-gin. Fig. 13, Plate CCCCXCIV. If the ground is hard, the roll should be used longer, as this will be the cheapest way. The roll is worked by two men, and if they have to stand still oc­casionally for the bucket, or skip as it is termed, to be filled, it will be a less expense than if a horse, horseboy, and bank-man (to land the skip), have to wait for the fillers. In work­ing rocks, they will frequently have to wait for the blast.

A working shaft of nine feet diameter will be found suf­ficient; and in commencing it, place four cills across, as re­presented in the drawing, fig. 13, about twelve or fourteen inches square. On them place the standards for the winch, as shown ; then begin the excavation, going on till the ground discovers signs of weakness; then put in a curb (*a*), which is a wooden ring the size of the shaft, three inches thick, and as wide as the intended brick-work, for which four inches and a half will in most cases be sufficient. But if the ground is very soft, cut back into it and make the curb wider ; then brick the shaft from the curb to the top, and go on excavat-