obtain acts of incorporation, come in most cases, ultimately out of the pockets of the public in the shape of heavier fares.

The first step in order to prevent this in other cases, will be to ascertain the fair value of the land, and of the requisite compensation, and whoever asks more than 25 per cent. above that value, hand him over to a jury that minute. If this course be in the beginning avowedly and unhesitatingly adopted, there is no doubt the interests of the company will at any rate be protected from those gross cases of pillage which have lately taken place.

In order to render this complete, the agent, or the land valuer, should be engaged with on the following terms:—Suppose 900 acres are required, and that if some greater precaution than has hitherto been taken be not put in force, then this land will average 300*l.* an acre, or the whole will cost 270,000*l.* Now, if the remuneration to the land valuer be made upon a scale which increases, while the price of the land decreases, the amount may stand as follows:—

Land valuer's pay per cent.	When the price is, or above per acre.	Total land-valuer's pay.	Saving to the compy.
$\frac{1}{4}$	L.300	L.675	nothing.
$\frac{1}{2}$	275	$1237\frac{1}{2}$	22500
$\frac{3}{4}$	250	$1687\frac{1}{2}$	45000
1	225	2025	67500
$1\frac{1}{4}$	200	2500	90000
2	175	3150	112500
$2\frac{3}{4}$	150	$3712\frac{1}{2}$	135000
4	125	4500	157500

The above per centage must only be paid in this way. For example, if the land, when totalled, is found to be between 200*l.* and 225*l.* per acre, then $1\frac{1}{4}$ per cent. is paid on a suppositious price, namely, 200*l.* per acre; when it is between 225*l.* and 250*l.* per acre, 1 per cent. is paid, rating it at 225*l.* per acre, and so in all other cases.

The scale of remuneration will require adaptation to peculiar circumstances; in fact, if the principle above laid down be adhered to, the details are immaterial; all that is necessary is by a bonus of 4000*l.* or 5000*l.* exciting the land valuer to the most rigid attention to economy, which, combined with a firm resistance to every attempt at extortion, will no doubt in most cases prevent the gross impositions which have been lately put in practice. The short-sighted land-holders, by their outrageous opposition, may have here and there driven a railway into a bad curve, but by causing so much discussion, they have mainly contributed to the rapid spread of the system.

The following extract in relation to excavation and embankment may be of interest to some of our readers.

There are several ways in which earth-work may be hastened, for instance, the use of locomotive and fixed engines to draw the earth along, both of which will be cheaper than horse-power; and as no very rapid speed is required for this work, a cheap description of locomotive engine might be constructed, fully able to take a train of earth wagons at the rate of eight or ten miles an hour, and not costing more than 700*l.* or 800*l.*—whereas a good passenger engine, made in the best manner, will cost 1500*l.* One large tube would be sufficient for all common purposes.

A common moveable steam-engine, working with a rope, will be cheaper than locomotive power, but not so convenient; if used, advantage should be taken in all cases of gravity. Loosening the ground with a plough, will be very advantageous where the soil will permit it, such as clay, marl, and sometimes shale; and as the quantity of work which can be done is limited by the tip, this must be paid every attention to. The usual mode, by running sidings out from the main line in the form of a fan, so to have as many tipping places as possible, requires modifying. At present the common practice is to take up and relay the rails as the embankment proceeds, which consumes a great deal of time, and gives a corresponding portion of trouble, instead of which, if longitudinal bearers are framed for each tipping place, these can be at once lifted up all in a piece, and carriad forward, and a rail put in behind them, in a very short space of time, and with one-fourth of the trouble which is found in the old way. When the embankment is not high, these frames may be supported from below on a railway, and be moved forward any length that may be required. A horse should be kept for tipping above, and he may take in three wagons at a time. By making the above frames to propel forward, and having a door in the bottom of the wagons, the quantity tipped may be very considerably increased.

Whenever the lead gets above $1\frac{1}{2}$ miles, and there is much to do, a locotive engine should be employed, the expense of which, including fuel, wages repairs, interest on capital, and provision for a renewal every five years, will not exceed 4*l.* per day; the engine will take 24 wagons per trip, at 10 miles per hour, while a horse taking 3 wagons will only go 15 or 16 miles per day. That a great saving will ensue is clear, and may be thus shown. Let the lead be two miles, and the contractor required to tip 1200 cubic yards per day; this would require 150 two-yard wagons, besides spare ones and as a horse with three wagons would make four trips per day, or 24 yards per day, $\frac{1200}{24}=50$ horses, besides spare ones and tipping horses.—Now these wagons are to be constantly travelling, and to keep these going there must be 24 always filling, and 24 tipping. This, with the requisite number of spare ones, will in the whole require about 220 wagons; whereas, with the engine, 24 travelling, 24 filling, 24 tipping, and 24 spare, total 96, is all that is required, say 100. Here then is a saving of 120 wagons at 20*l.* each, or 2400*l.*, which is considerably more than the cost of the engine, besides the 50 horses, which, with their harness, cannot be taken at less than 25*l.* each, or 1250*l.*

Again, take 50 horses' keep at 3s. per day, is 7*l.* 10s.; 50 boys at 1s. 6d., or 25 men going one to two trains, at 3s. is 3*l.* 15s., total 11*l.* 5s. per day, whereas the engine will not cost more than 4*l.* Under very unfavorable circumstances, a mean of 15,000 trips gave for a distance of 1969 yards, 15 wagons per train, carrying 25 cubic yards, with a consumption of coal of 245 lbs., costing 2s. 4d., wages, $11\frac{1}{4}$d., repairs and sundries, $6\frac{1}{2}$d., total 3s. $9\frac{3}{4}$d. per trip.

The old way of working at the face of an excavation, and bringing it out by lifts, is now known to be more tedious, and consequently unprofitable, than running a gullet through at once, in which as many wagons as the contractor likes can be put in and filled, both by throwing in the earth from above, or having a stage over the wagons to run barrows on. To get the greatest quantity of earth, besides ploughing it, which plough may be often worked by a steam engine, the method called "falling" may be resorted to, that is, digging underneath and then splitting it on the top with wedges, and with the help of long iron levers, bringing down a lump containing several cubic yards at once.

The contractor will find it best to provide wagons, engines and rails, and to sub-let his labor to small gangs of about a dozen men each and a ganger. The best sort of rails for a contractor's use is the T rail, inverted so that the lower flang nails down on the sleeper, and requires no chair. 30 lbs. per yard will be enough, but from 40 to 50 lbs. is better, as these will do for anything, and 30 lbs. would be too light for clayey soils.

In any place where time is an object, the tip end of the embankment ought to be made much wider and steeper than it is intended, so as to get in more roads at the tip; and as the work proceeds, this extra width is pared off and thrown down below to increase the slope, which should be left a little too narrow at the bottom on purpose.

There is another mode of increasing the tip, by which the time of forming a large embankment may be reduced one-half. This method is to form the embankment at twice in the following manner:—Carry out the earth to the required width, say 20 feet high, and then come on and complete this with a second set of tipping places, say for 30 feet more in height; the wagons must run from the 50 feet level down to the 20 feet by means of inclined planes on both sides of the upper embankment, and from the width of the lower one, a great many roads may be put in at the tip; the upper part of the embankment is brought on in the usual way, and by this means the quantity tipped may be doubled.

Under favorable circumstances, a contractor ought to move 1000 cubic yards of earth per day at each trip, and this by the above process may be doubled, in fact the limit is the tipping, for, by running a gullet into the hill getters and fillers may be placed as thick as will leave them room to work, the quantity of which depends greatly on the weather, the average number of working days being from 200 to 230, in which may be got, by having night shifts in summer, and 3, 6 and 9 hours' shifts in spring and autumn, about 3000 working hours. Under many peculiar circumstances, it will be very advantageous to lay in a line of rails, and place huts on it for the workmen on wheels; so that their place of abode always follows up, and is close to their work, in fact a moveable village. Much, of course, also depends on the nature of the soil, as to the work which will be done in this time; generally a filler will put into a wagon from 15 cubic yards per day in stiff clay, to 25 cubic yards per day in loose sand, and by falling the earth as before described, 1 getter will keep three fillers going, so that to keep up 1000 cubic yards per day, will take from 60 to 90 men according to the nature of the ground.

Where there is much rock the natural stratification of it should be closely examined and attended to in the blasting of it, as a horizontal blast would in many cases bring down ten times as much as a vertical one, and the force of the powder will be increased by mixing saw-dust with it. The strength and disposal of the blasts must entirely depend on the nature of the rock, and also in some measure, on whether it can be used in the bridges, or other erections along the line.

The contractor will find it his interest to look out sharp for clay, and either to make his own bricks, or let his clay to a respectable brickmaker to make them for him, unless he happens to be very favorably situated as to carriage; he should also do all his wagon repairs, erecting temporary carpenters' and smiths' shops in some position adjacent to his heaviest work, but being careful they are so situated that they can be let or sold at the termination of his contract; he should always work towards his greatest job, and of course so apportion his men as to bring in the whole at one time at the end.

It may sometimes happen, that from unavoidable causes, a contractor

will find it impossible to continue his work, and occasionally this will be done intentionally. To guard against the last has been already adverted to, but to guard against the first is morally impossible; for there are so many cases in which a man, with the very best intentions, is yet borne down by the uncontrollable force of circumstances, that no human foresight can by any possibility prevent an unfavorable result. As a general rule, it will be best for the directors, in every prudent way, to assist and encourage a contractor, and by every means in their power to enable him to complete his work, provided it be seen that he really is desirous to get on. If prices have risen against him, or if he has made a miscalculation, it will be most decidedly the best thing for the company to increase the amount, to remit his retained money, or by any means to get him to finish his contract. If this be not done, the consequences will be very uncomfortable. His inability will have first become manifest by his employing too few workmen. If the checks which we have explained be put in force this is seen at once. He is served with a legal notice, that under the contract, the company will employ men if he does not, and charge their expenses against him. This will probably induce him to come forward and state what his difficulties are; then if the company do not assist him, he will tell them he must give up his contract; he is perhaps, a man of no capital, and his sureties are the same, so that the company have no resource but to take the work into their own hands. In the mean time, the work having fallen in arrear, there comes the tedious admeasurement of what has yet to be done, and two or three weeks' squabbling between his lawyer and the company's, as to the terms on which he is to give up the works, and perhaps references to umpires, each taking a week; then the company have to order wagons, engines, and tools of all kinds, and to find foremen, overseers, sub-contractors, and workmen, all at a vast expense, it being the fate of almost every public company to be charged higher than individuals. While all this is going on, the work is so much delayed that the line cannot be opened at the time which was intended, the proprietors loosing the whole proceeds. Then come the enormous expenses which are requisite to redeem the time as much as possible. Land has to be bought to make side-cuttings in order to form the embankments, and, in another place, to deposit the earth from the excavation, which is now to a great extent thrown into spoil; horse-runs are established at as many places as possible, to bring up the earth in barrows, and all this in addition to the regular work at the gullet and the tip; and when these things are taken into consideration, it will at once be seen, that the company ought never to agree to finish the work themselves, but as a dernier resort. There are on one of the railways in England, six contracts which were let for 600,000*l.*, and which the company have had to take into their own hands at an expense of 1,200,000*l.* In one instance, the cost of the contract was more than trebled so that any means should be resorted to in order to assist the contractor through his job; and we again repeat, that it is decidedly bad policy to take the lowest tender in letting the contracts. A man of character alone should be selected, and ought to receive every encouragement in the execution of his work.

THEORY OF THE STEAM-ENGINE.

(Continued from page 32.)

In the calculations relative to locomotive engines we shall introduce three terms more: the first to express the resistance of the air against the train in motion, a force which, increasing in the ratio of the square of the velocity could not be neglected without error; the second to represent the resistance offered by the engine itself in the transport of its own weight on the rails;