

TERRY COLEMAN

**THE RAILWAY
NAVVIES**

*A history of the men who
made the railways*



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TO MY FATHER, AN ENGINEER

William Hardwick (Trump), who did not; George Hatley, learning to read in a shanty camp, and Redhead, eating nothing but potatoes; Denis Salmon, Irishman, beaten up with a pick shaft, and John Hobday, Englishman, transported for fifteen years for doing it; Mary Warburton, who ran off with a navvy, and Rachel Foulkes, navvy nurse, who died of cholera; Thick-lipped Blondin the thief, Ene-Eyed Conro the forger, Devil-driving George the seducer; Bible John who was gored to death by a cow, Alexander Anderson who wrote bad verse, William Lee who died slowly of a broken back, and Happy Peter the navvy preacher who dropped dead one hot day as he said amen.

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The Works

THE engineering of the early railways was like nothing before. Only the cathedrals were so audacious in concept and so exalted in their architecture, but they were few and the building of one, in God's good time, could take a hundred years: the railways were many, and made in the contractor's good time, which was money. True, there were roads in Britain before the railways came, but since the Romans they were only little roads, and few. Even the turnpikes were made in bits and pieces from here to there, with no sense of a system. The Liverpool and Manchester Railway was built before there was any decent road between the two cities. Only the canals of the eighteenth century can compare in any way with the railways that so soon killed them. Only the cathedrals before were so vast in idea: nothing before was so vast in scale.

It is easy to forget this vastness, or never to see it at all. The same visitor to Bristol who sees Brunel's suspension bridge at Clifton, and will not forget it, may quite possibly, on the way down in the train from London, have remained unaware of the same engineer's gigantic railway tunnel at Box, near Bath. Passengers to Bournemouth do not see Locke's great cuttings between Basingstoke and Winchester; the traveller through Stockport does not notice that the broad viaduct on which his train stands, ninety feet high, cuts the town in two and dominates everything for miles; the passenger from Manchester to Liverpool never even glances up at the sheer rock walls of George Stephenson's cutting at Olive Mount. Nowadays a motorway may be admired, but the railways have been there too long to be considered, though as a feat of engineering the M.1 is nothing to the London and Birmingham Railway, completed 120 years before. There is hardly a branch line in Britain whose earthworks would not be marvelled at if they were those of a new road or an ancient

fort. John Ruskin called them, 'Your railway mounds, vaster than the walls of Babylon.'

These earthworks are so much greater than those of roads because a railroad is more than a simple road with rails on it. A road, even a good road, can curve, and climb hills. A railway, by its nature, cannot do this. There are two things to consider. First, the lack of friction between metal wheel and metal rail, and second, the result of the first, the much heavier loads which can be hauled on a railway than on an ordinary road surface. On the level this is fine, but when a railway comes to any slope at all there is trouble. The very lack of friction between wheel and rail which enabled bigger loads to be pulled now becomes a lack of traction. The wheels cannot get a grip to haul the big load up a slope against the pull of gravity. In 1833 experiments showed that if a locomotive would draw sixty-seven tons on the level, it could draw only fifteen tons on an incline of 1 in 100, and could not move at all on 1 in 12. In the early days it was estimated that to overcome a gradient of 1 in 300 required a tractive power nearly twice as great as was needed to move the same load at the same speed on a level, and that to ascend an elevation of thirty feet required as much power as would move the same load along a mile of level line.

So a railway must be level and also, because a train cannot safely take curves at any speed, as near straight as the engineer can devise. Across the plains of Canada a railway was easy to lay, and gangs could put down an average of two miles a day and sometimes much more, but over even the easiest of country in Britain a railway was difficult. A line from London to Southampton or Birmingham was an immense undertaking. Lecount, who made many ingenious calculations, reckoned that the London and Birmingham was unquestionably the greatest public work executed in ancient or modern times. If its importance was estimated by labour alone, perhaps the Great Chinese Wall might compete with it, but if the immense outlay of capital, the great and varied talents of the men who worked on it (Lecount meant the engineers, himself among them), and the unprecedented engineering difficulties were

taken into account, then, he said, the gigantic work of the Chinese sank totally into the shade. Perhaps hoping to impress by sheer weight of numbers, he went on to compare the railway with the Great Pyramid of Egypt - 'that stupendous monument which seems likely to exist to the end of all time'. The labour expended on the pyramid was equivalent to lifting 15,733,000,000 cubic feet of stone one foot high. This was performed, according to Diodorus Siculus, by 300,000 or, according to Herodotus, 100,000 men, and took twenty years. To build the railway 25,000,000,000 cubic feet of material was lifted one foot high, or 9,267,000,000 cubic feet more than for the pyramid. Yet this had been done by 20,000 men in less than five years. Mr Lecount did not want to dispraise the pyramid; he made generous allowances.

'From the above calculations,' he said,

has been omitted all the tunnelling, culverts, drains, ballasting and fencing, and all the heavy work at the various stations, and also the labour expended on engines, carriages, wagons, etc.; these are set off against the labour of drawing the materials of the pyramid from the quarries to the spot where they were to be used - a much larger allowance than is necessary.

Not content with having vanquished the Chinese Wall and the pyramid, he then remarked that if the circumference of the earth were taken in round figures to be 130,000,000 feet, then the 400,000,000 cubic feet of earth moved in building the railway would, if spread in a band one foot high and one foot broad, go round the equator more than three times.

This was the way an engineer saw the London and Birmingham. Charles Dickens also saw part of the line while it was still being built, and in *Dombey and Son* he wrote this description of the cutting at Camden Hill, in North London:

The first shock of a great earthquake had, just at that period, rent the whole neighbourhood to its centre. Traces of its course were visible on every side. Houses were knocked down; streets broken through and stopped; deep pits and trenches dug in the ground; enormous heaps of earth and clay thrown up; buildings that were undermined and shaking, propped by great beams of wood. Here, a chaos of carts, overthrown and jumbled together,

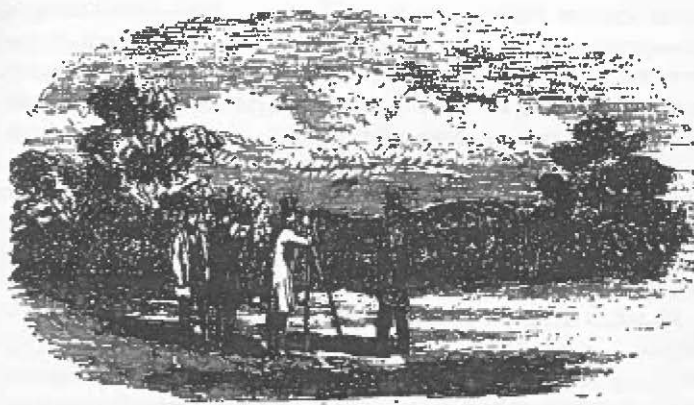
lay topsy-turvy at the bottom of a steep, unnatural hill; there, confused treasures of iron soaked and rusted in something that had accidentally become a pond. Everywhere were bridges that led nowhere; thoroughfares that were wholly impassable; Babel towers of chimneys, wanting half their height; temporary wooden houses and enclosures, in the most unlikely situations; carcasses of ragged tenements, and fragments of unfinished walls and arches, and piles of scaffolding, and wildernesses of bricks, and giant forms of cranes, and tripods straddling above nothing. There were a hundred thousand shapes and substances of incompleteness, wildly mingled out of their places, upside down, burrowing in the earth, aspiring in the air, mouldering in the water, and unintelligible as any dream. Hot springs and fiery eruptions, the usual attendants upon earthquakes, lent their contributions of confusion to the scene. Boiling water hissed and heaved within dilapidated walls, whence, also, the glare and roar of flames came issuing forth; and mounds of ashes blocked up rights of way, and wholly changed the law and custom of the neighbourhood. In short, the yet unfinished and unopened Railroad was in progress; and, from the very core of all this dire disorder, tailed smoothly away, upon its mighty course of civilization and improvement. But as yet, the neighbourhood was shy to own the Railroad. One or two bold speculators had projected streets; and one had built a little, but had stopped among the mud and ashes to consider further of it. A bran-new Tavern, redolent of fresh mortar and size, and fronting nothing at all, had taken for its sign The Railway Arms; but that might be rash enterprise – and then it hoped to sell drink to the workmen. So, the Excavators' House of Call had sprung up from a beer shop; and the old-established Ham and Beef Shop had become the Railway Eating House, with a roast leg of pork daily, through interested motives of a similar immediate and popular description. Lodging-house keepers were favourable in like manner; and for the like reasons were not to be trusted. The general belief was very slow. There were frowsy fields, and cow-houses, and dunghills, and dust-heaps, and ditches, and gardens, and summer-houses, and carpet-beating grounds, at the very door of the Railway. Little tumuli of oyster shells in the oyster season, and of lobster shells in the lobster season, and of broken crockery and faded cabbage leaves in all seasons, encroached upon its high places. Posts, and rails, and old cautions to trespassers, and backs of mean houses, and patches of wretched vegetation, stared it out of countenance. Nothing was the better for it, or thought of being so. If the miserable waste ground lying

near it could have laughed, it would have laughed it to scorn, like many of the miserable neighbours.

But before a railway could get that far, before it even started, the surveyors came to decide the route. Even here the navvies had their part. Many proprietors opposed the railway, because it ran through their orchards, or would dry up their cows, or set their ricks on fire, or scare away the foxes and ruin the hunt, or because railways were the devil's device anyway. Many owners hoped, by their reluctance to sell their land, to increase the compensation they would get. For many reasons the railway surveyors were unwelcome, and navvies were sometimes used to persuade landowners of the value of the projected lines. As one Victorian commentator said:

In some cases large bodies of navvies were collected for the defence of the surveyors; and being liberally provided with liquor, and paid well for the task, they intimidated the rightful owners. The navvies were the more willing to engage in such operations because the project, if carried out, afforded them the prospect of increased labour.

Having completed his survey, and collected the information of his assistants, the engineer then decided the line the route



A. A levelling party

should take. Rivers and streams were crossed as near their source as possible, hills, valleys, and undulating ground were passed or only touched, towns and places where the land was expensive approached with caution, pleasure grounds and gentlemen's seats avoided.

The engineer and his surveyors chose the easiest route, but still there were hollows to fill in with embankments or span by viaducts, rising ground to penetrate by cuttings, hills to tunnel through. Such railway engineering would not have been easy at any time, but it was made specially difficult in the early days by the limited performance of the first steam locomotives. On the Liverpool and Manchester Railway George Stephenson included gradients of 1 in 96 and 1 in 89 near Rainhill, but these proved so awkward that lightly loaded trains could at first only crawl up the incline. In the years immediately after this, in the late 1830s, the railway-makers were more cautious. Robert Stephenson included no gradient more severe than 1 in 330 on the London and Birmingham Railway, except for the initial climb out of Euston station as far as Camden, where the trains were at first not drawn by locomotives at all but hauled up on the end of ropes which were wound in by stationary engines. And on the Great Western to Bristol, Brunel laid the line nearly dead level for the first eighty-five miles out of London. Only a few years later, in the 1850s and 1860s, locomotives had improved so greatly that lines could be much more severely graded. The classic contrast between an early line and one constructed only a little later is that between the original London and South Western line from London to Southampton, and the later London to Portsmouth line. On the first line, built by Joseph Locke and completed in 1840, the easy gradients were achieved only by some stupendous cuttings between Basingstoke and Winchester. (Even this line itself was, when it was proposed, regarded as severe compared with the G.W.R. to Bristol. On the Southampton line, Litchfield is nearly 400 feet above the termini at London and Southampton, and one gradient of 1 in 250 runs for a distance of seventeen miles.) Twenty years later, when the Portsmouth line was

completed, through Woking, Guildford, and Petersfield, the engineer permitted gradients of 1 in 80 and thus carried the line, with few earthworks of any size, uphill and downhill over the South Downs.

But the main lines were almost all built early, and so were almost all massively engineered. After that the improved performance of locomotives made things easier, but even with the steeper gradients then permissible some lines of the 1870s, like the celebrated Settle and Carlisle, passed over country whose severity demanded huge tunnels and viaducts. So it happens that British railways, with few exceptions, are carried over and through great earthworks.

Robert Stephenson put it this way at a dinner in Newcastle upon Tyne in August 1850. It was, he said, but yesterday that he had been engaged as an assistant in tracing the line of the Stockton and Darlington Railway. Since that period the Liverpool and Manchester, the London and Birmingham, and a hundred other great works, had sprung into vigorous existence. So suddenly, so promptly, had they been accomplished, that it appeared to him like the realization of fabled powers, as by a magician's wand. Hills had been cut down, and valleys filled up; high and magnificent viaducts had been erected. Where mountains intervened tunnels of unexampled magnitude had been unhesitatingly undertaken. Works had been scattered over the face of the country, bearing testimony to the indomitable enterprise of the nation.

All this was done with navvies and horses. Brassey said that a full day's work for a man was fourteen sets. A set was a number of wagons, a train. These wagons were drawn by horses up to the works, the cutting or embankment, on a temporary line of rails which was extended as the earthworks grew. Each wagon in this train was filled by two men working together. If the train was filled and carted away fourteen times in a day then each pair of men would have filled fourteen wagons, and each individual navvy seven. A wagon was reckoned to hold two and a quarter cubic yards of muck, which was the navvy name for all kinds of earth and rock, so each man would lift nearly twenty tons of earth a day on a

shovel over his own head into a wagon. This was the fourteen-set day. Some men did sixteen.

But before the men could come to the more conspicuous earthworks the level ground had to be prepared to take the permanent way, which was not always easy: the ground might not be firm enough to take the weight of a loaded train. This was the trouble at Chat Moss, on the Liverpool and Manchester line. Chat Moss is a bog six miles out of Manchester, and it was said, when the Bill for the railway first came before a parliamentary committee in 1825, that no carriage could stand on the Moss short of the bottom. After the Act was obtained, and when George Stephenson started work on Chat Moss in June 1826, he found that the pessimists were very nearly right. The surface was coarse, ridgy grass, tough enough to walk upon about half-leg deep. In places the soggy soil went down thirty-four feet and then rested on layers of clay and quicksand until it reached solid bottom more than forty feet below the surface. Local farmers, who feared their cattle might stray there, shod them with wooden pattens. Stephenson said he would float the road across the Moss, and he did. At some points embankment after embankment disappeared gradually and silently into the Moss. His men shod themselves with planks, like skis, to sustain their weight by spreading its pressure. Sometimes they made little or no progress with the work and had to report that the Moss had swallowed down the results of their labour. Yet at last Stephenson conquered the Moss by the Moss. On overlapping hurdles made of branches and of the heather and brushwood that grew there, he laid sand, earth, and gravel, thickly coated with cinders, until at last he got a firm but elastic road to carry the railway.

Even where the land was not bog, rain could turn the churned-up soil into liquid mud. In February 1847, after heavy and lasting rains, the soil at Brockenhurst, in Hampshire, became dangerous to men and horses. The *Poole and Dorsetshire Herald* reported that in one week, 'two horses, celebrated for their sagacity in carrying out the intentions of their owners, were killed through being unable to extract

themselves from the soil'. Altogether eleven horses were similarly destroyed on the line between Brockenhurst and Osmansley Ford that season.

But the principal works of the navvies were banking, cutting, and tunnelling. In embanking the aim was always to extract the necessary soil from the nearest possible place, and the engineers would have allowed for this when they first surveyed the way. One method was to take the earth from a side cutting, so that the finished work would consist of a raised embankment with a ditch running on one or both sides. This was done where there was no other feasible way of getting the soil wanted, but the more frequent method was to cart the soil to an embankment from a cutting a little farther back. This was done by tipping. A light tram road was made from the cutting to the edge of the embankment, and at the extreme verge a stout piece of timber was fastened to prevent the wagons toppling over the edge when they discharged their contents. A train of loaded trucks was then brought up to



B. Making an embankment

This was a little cutting just large enough to take a row of wagons which were used to take the earth away. In this gullet the wagons could be brought alongside the navvies who were working on the banks just above the temporary line. Meanwhile, as the muck was removed by the navvies on both sides, the gullet was continued into the hill by those ahead. This was the method used when the soil from the cutting was needed for an embankment farther along the line, to which the stuff was carted off in horse-drawn trains of wagons.



E. Making the running

Sometimes, when there was no use for the soil, it had to be lifted up the sloping walls of the cutting and dumped at the sides. This was done by barrow runs, and this 'making the running' was the most spectacular part of navvy work, and one of the most dangerous. The runs were made by laying planks up the side of the cutting, up which barrows were wheeled. The running was performed by the strongest of the men. A rope, attached to the barrow and also to each man's belt, ran up the side of the cutting, and then round a pulley at the top, where it was attached to a horse. When the barrow was loaded, a signal was given to the horse-driver at the top,

and the man was drawn up the side of the cutting, balancing the barrow in front of him. If the horse pulled steadily and the man kept his balance everything went well. The man tipped his barrow-load on to the top of the cutting, turned round, and went down the side of the cutting again, this time drawing his barrow after him and with his back to it, while the horse all the time kept the rope taut and took most of the weight of the empty barrow.

But if, on the upward climb, the horse slipped or faltered, or if the man lost his balance on the muddy plank, then he had to do his best to save himself by throwing the loaded barrow to one side of the plank, and himself to the other. If both toppled over on the same side the barrow and its contents might fall on the man. In the Tring Cutting, on the London and Birmingham Railway, which runs through chalk at a depth of forty feet for two and a half miles, there were thirty to forty horse-runs, and nearly all the navvies were thrown down the slope several times, but they got so used to it, and became so sure-footed, that only one man was killed. One engineer invented a moving platform to take the stuff up the side of the cutting without a navvy having to go with it, but the men thought it was a machine designed to cut their wages, and broke it.

Excavating was done almost entirely by hand, by pick and shovel, by row on row of navvies. One of Brassey's time-keepers said:

I think as fine a spectacle as any man could witness, who is accustomed to look at work, is to see a cutting in full operation, with about twenty wagons being filled, every man at his post, and every man with his shirt open, working in the heat of the day, the gangers looking about, and everything going like clockwork. Another thing that called forth remarks was the complete silence that prevailed among the men.

But things were different when the line ran through hard rock, and the engineers blasted their way through. Bugles were blown to give warning of the blasts, and the twanging of horns, the grating noise of the iron borers, and the heavy

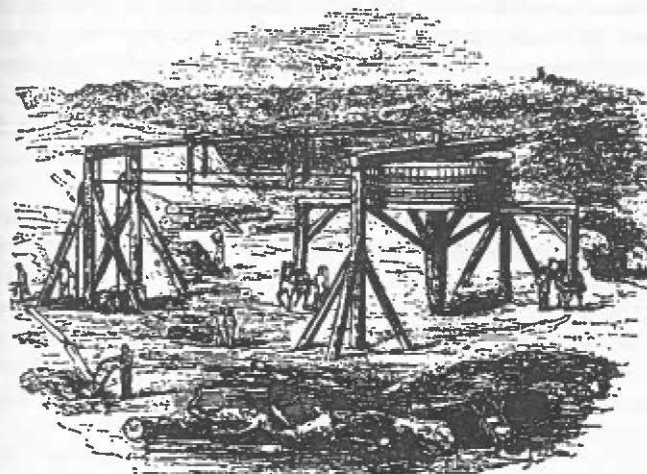
incessant explosions on all sides might have induced a traveller, said one engineer, to believe he was in the neighbourhood of a sharp engagement.

The engineers could blast their way through nearly everything. Round Down Cliff, on the South-Eastern Railway, between Folkestone and Dover, was 375 feet high, and it was in the way of the railway. To tunnel through would have been difficult, to dig it down would have taken a year and cost £10,000, to go round it was impossible because this would have meant carrying the line into the sea, so the only way was to blast the cliff away. This the engineer, William Cubitt, decided to do. What he had to move was a mass of chalk 300 feet wide and about seventy feet deep, and to do the job he planted in the cliff 19,000 lb. of gunpowder. At the time appointed for the blasting the railway directors and their guests assembled at a marquee on the top of another cliff about a quarter of a mile from the point of explosion. The fuses were inspected, and the spectators exchanged bad jokes in their nervousness. What, asked one, if the explosion should go wrong? 'We shall all,' answered another, 'be swallowed up.' 'Swallowed down,' said a third. As two o'clock approached, the time for the detonation, a silence fell in which the choughs and crows were clearly heard. The sea was calm. Flags were hoisted. A warning shell was thrown over the cliff where it burst with an echoing report which bounced from the hills around like rifle-fire. The flags were hauled down. It was one minute to firing.

When it came the explosion was a dull, muffled boom, and the earth jolted. The foot of the cliff appeared to dissolve. The mass above slowly separated from the mainland and sank to the beach. In two minutes the cliff had gone. The volleys of ejected chalk rolled inwards upon themselves, great boulders crashed into the sea, broke, and then reappeared above the surface as crushed and coalescing bits, fermenting. There was no roaring explosion, no bursting out of fire, no wreath of smoke, for the gunpowder had exploded under a pressure which almost matched its energies, under a million tons of chalk. When the turf from the top of the cliff reached

the level of the beach the stream of debris was 1,200 feet across and covered fifteen acres of sea and sand.

The most hazardous job of all was tunnelling. The miners worked deep in the earth, often soaked by muddy water, in constant peril from their own explosions, breathing foul air made fouler by the fumes of gunpowder, and working twelve hours a shift, day and night.



F. The horse gin

If the tunnel was short the miners bored in from one end, or from both ends; but in a longer tunnel work would also proceed from shafts bored vertically into the earth along the line of the tunnel. These shafts were bored by a machine called a gin, which was powered at first by horses attached to a great wheel, and later by steam engines. This boring of the shaft was itself a feat of engineering: most shafts were eight to ten feet across and some were as deep as 600 feet. When the bore was completed men descended to its foot in huge buckets and began to excavate the main tunnel, working in two directions at once from the bottom of the shaft. The soil and the men were brought up in the same buckets. When the tunnel was completed the shafts served as air holes, creating a strong

draught, so that the men putting the finishing touches to the masonry of the tunnel worked in a constant gale of wind, a contrast to the fug in which they had laboured for so long before.

The first of the great railway tunnels was that bored under Liverpool in 1827. Henry Booth, treasurer of the Liverpool and Manchester Railway, wrote that in some places the substance excavated was a soft blue shale, with abundance of water; in other places a wet sand appeared, requiring great labour and contrivance to support until the masonry which was to form the roof was erected. Under Crown Street, near the Botanic Garden, the whole mass of earth above the tunnel fell in from the surface, to a depth of thirty feet of loose moss, earth, and sand. No one was hurt.

Sometimes the miners refused to go on, and the engineers had to chivvy them back to work. Nor, said Booth, was this surprising. The men bored their way almost in the dark, with the water streaming around them, and uncertain whether the props and stays would bear the pressure from above until the arch work was completed. Those who had been through the tunnel after it was completed, when it was lit by gaslight and traversed by horses, carriages, and crowds of passengers, could not, he said, easily picture to themselves the original dark and dangerous cavern, with the roof and sides supported by shores, while the miners worked by the light of a few candles, whose feeble glimmer, glancing on the water which ran down the sides, or which spread out in a sheet below, was barely enough to show the dreariness of the place.

The tunnel was a mile and a quarter long, and was the work of 300 miners. During its construction it was one amusement of the bolder citizens of Liverpool to walk part way through to see how the work was getting on. The *Liverpool Mercury* of 16 February 1827, after reporting that the shafts were sixty feet in depth, added that the visitor might descend them in one of the buckets with perfect safety, and that it was an interesting and novel sight to those who had never seen mining in its grander operations. Though numerous candles were burned by the workmen, 'the darkness of the cavern was but made

visible', and the sound of busy hammer, and chisel, and pickaxe, the rumblings of the loaded wagons along the railway leading from the farther ends of the cavern to the pit, and the frequent blasting of the rock, mingling with the hoarse voices of the miners whose sombre figures were scarcely distinguishable, formed, so the report said, an interesting *tout ensemble* of human daring, industry, and ingenuity.

One visitor said of the men that their numerous candles twinkled in the thick obscurity like stars on a gloomy night, marking out their figures here and there in dark profile while they flung about their brawny arms -- all this, together with the frequent explosions and the fumes of gunpowder, 'conveying no contemptible idea of some infernal operation in the region of Pluto'. This same observer, James Scott Walker, afterwards wrote that parties of workmen were employed at each of the six shafts and at each end of the tunnel, and that, guided by the mariner's compass, they met each other with astonishing precision at the lines of cutting. Though each party had cut about five hundred yards, the levels of the tunnels seldom varied above an inch at the joins. 'And the sensations,' said Walker,

of the workmen and contractors when, after so long and perilous a working in 'the bowels of the harmless earth', they were enabled by the removal of the stone barriers between them to shake hands with each other in regions never visited by the light of day, may be more easily conceived than described.

The methods of tunnelling remained, throughout the century, much the same as they were at Liverpool. A visitor who went down a shaft of the Belsize Tunnel, London, in 1865, said that at the bottom you could see a kind of light and hear strange sounds from both sides. He followed the newly excavated tunnel in one direction and after about eighty yards reached the lights and found a dozen men at work, half of them with pickaxes, tearing away at the rough clay and accompanying every stroke with a noise that was half grunt, half groan. After these navvies had cleared away a length of twelve feet the centre supports were put up and the bricklayers took over.

All these men worked day and night in relays, some of the labourers working for two days and the intervening night without more than an occasional break for food.

Tunnels were the hardest work, but out in the open country a viaduct is perhaps the most spectacular kind of railway engineering to look at. To create an embankment of much the same size would have been a greater labour, but such an embankment, after more than a hundred years, and covered with trees and shrubs, looks like a natural rise. Indeed, railway earthworks very soon became part of the landscape. In *A Laodicean*, a novel published in 1881, Thomas Hardy described the mouth of a tunnel which had been built only a few years before:

The popular commonplace that science, steam, and travel must always be unromantic and hideous, was not proven at this spot. On either slope of the deep cutting, green with long grass, grew drooping young trees of ash, beech, and other flexible varieties, their foliage almost concealing the actual railway which ran along the bottom, its thin steel rails gleaming like silver threads in the depths. The vertical front of the tunnel, faced with brick that had once been red, was now weather-stained, lichened, and mossed over in harmonious rusty-browns, pearly greys, and neutral greens, at the very base appearing a little blue-black spot like a mouse-hole – the tunnel's mouth. Mrs Goodman broke the silence by saying, 'If it were not a railway we should call it a lovely dell.'

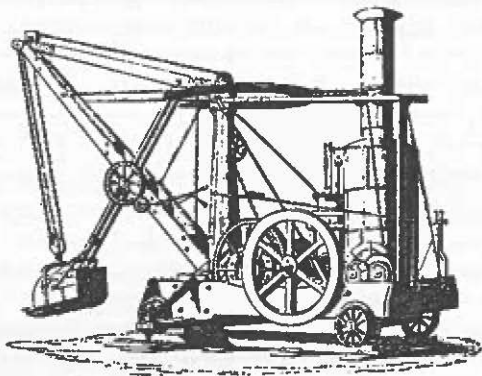
But a viaduct is wood or stone or metal, and distinctly man made. Viaducts were, however, most frequently built in and near towns, where their advantages were many. In a built-up area the soil for embankments would have to be brought in from miles off, and the company would have to buy whole tracts of expensive land on which to put up its earthworks. Viaducts, on the other hand, were made of bricks and iron, materials easily got, and could be erected by masons and builders, who were also easily found. The company needed to buy only the narrow strip of land over which the line would pass. Many of the London lines, for instance that from London Bridge to Greenwich, were virtually viaduct lines all the way, and though they were more expensive to build than lines on

level ground, they were less costly than embankment railways would have been, and were easier to maintain. There were other advantages. As one early railway historian said, the vacant spaces beneath the arches could be let for tenements, shops, or warehouses, fitted up as ragged schools or as nightly homes for the homeless, or used for other purposes. In 1849 a body calling itself The Samaritan Society of England set out to shelter and 'reclaim' destitute people and discharged prisoners. It announced that it would rent arches from London railway companies and fit them out with first, second, and third class compartments for men, and first and second for women. The tenements would be warmed by hot water, lit by gas, and supervised by the police. The first class would have iron bedsteads, flock mattresses, and blankets and cost twopence a night; the second class wooden boards, pillows, and rugs for a penny a night; and the third class clean straw, for nothing. It was proposed to turn some of the second class arches into day schools on the plan of the Rev. Mr Queckett, who had already leased three arches from the Blackwall Railway in which to teach 600 children.

Bridges were generally not navvy work, or, at least, they were not commonly erected by the same men who built the other works of a railway. The railway company often made the bridges itself, or, if these works were contracted out, they were retained by the principal contractor, who himself employed a separate force of masons, carpenters, and ironworkers to construct them.

In an age which well knew how to exploit mechanical inventions, and in which great works of engineering became commonplace, it seems at first astonishing that the chief tools used to build the railways were picks, shovels, and gunpowder. Powered tools of any kind were hardly used at all, and this is not because there were none to be had. As early as 1843, John Weale, in his book *Ensamples of Railway Making*, wrote about a steam shovel which – though it was, he admitted, not the English practice – he commended to the British and Irish public. He included an illustration of a newly patented excavator, originally an American invention, which

could cut and level the earthwork for a railway at a cost considerably below that of manual labour, and which had the additional advantage, guaranteed by the patentee, of saving much time. These advantages would, he hoped, be proved when the machine was adopted in Britain. It would be an important consideration in the making of less costly railways and was 'a desirable object for immediate use'. With an engineman and his assistant, together with six men to cart away the removed earth, it could be made to excavate 1,500



G. Mechanical digger, 1843

cubic yards in twelve hours, at a cost for fuel of twelve shillings a day. The machine itself cost £1,500.

Perhaps this capital cost is one reason why steam excavators were rarely used in Britain, but the principal reason is that, except for a few years of the first and second railway manias, labour was easy to come by, and contractors, who already took enough risks, preferred the traditional navvy to the untried machine. In the United States and Canada, where labour was scarce and expensive, mechanical diggers were used. In the States the machine tradition became so strong that today the word navvy is understood to mean not a man but a steam shovel. But in Britain and Europe men and spades were always there for the asking.

It was only at the tag end of the railway age that machines

were at all widely used here. In 1887 Frederick McDermott wrote in his biography of Joseph Firkbank, the contractor, that the steam excavator was fast encroaching on the province of the navvy, and was to be seen working on many contracts. It had, he said, been estimated that one of these steam navvies could fill 240 wagons, nearly 1,000 cubic yards, in a day of ten hours. To excavate by hand only 600 yards a day, at the same rate as the steam navvy, would have taken 100 men, and since only thirty men were required to work with the machine, it could be said to do the work of seventy.

But this was at the end. Almost all the railways had been long built – with picks and shovels.