

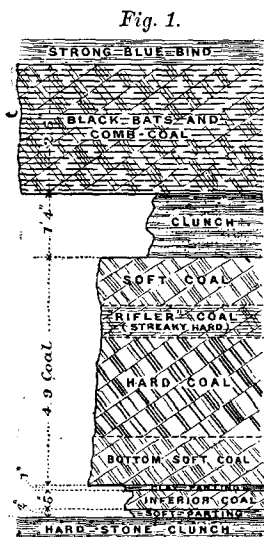
(Paper No. 2918.)

"The Surface-Plant at Kirkby Colliery."

By THOMAS GILLOTT, M. Inst. C.E.

THE "top hard" seam of coal, extending from Nottingham in the south to the neighbourhood of Wakefield and Pontefract in the north, where it is called the "Warren House" coal, is in South Yorkshire known as the Barnsley Bed. Its thickness and quality

vary considerably, the section at Kirkby in Ashfield, near Mansfield, being as shown in *Fig. 1*. The Kirkby pits, of which the lessees are the Butterley Company, were sunk to work about 10,000 acres of "top hard" coal, principally under the Duke of Portland's estate. The site of the colliery is about $\frac{1}{2}$ mile north of Kirkby Station, on the Nottingham and Mansfield line of the Midland Railway, which runs on the east side; and the Leen Valley Extension of the Great Northern Railway will, when completed, pass the colliery on the west side. The coal is worked by baring in the 16 inches of "clunch" above the seam and under the "comb coal," the latter being an inferior layer of coal and dirt about 2 feet 5 inches thick, which forms a good roof in the stalls, but is ripped in the gates. It is worked by the long-wall method nearly "on end," and the seam proper includes



Scale, $\frac{1}{4}$ inch = 1 foot.

SECTION OF "TOP HARD" SEAM, KIRKBY COLLIERY.

four distinct qualities of coal. The top and bottom soft coals are suitable for household purposes; the "rifler" coal is hard, with streaks of soft in thin layers; and the hard coal is an excellent dense coal, suitable for locomotives and for other steam raising purposes, whilst it is also used, instead of coke, for smelting iron in the blast-furnace. It is filled by hand in the pit, so that the

quantity of small coal to be dealt with on the surface, excluding that made by dressing, is only about 15 per cent.

The general arrangement of the surface of the colliery is shown in the plan of the pits, sidings, banking machinery, &c., Fig. 2, Plate 5. The store sidings for empty and loaded wagons, each having six lines of rails and capable of holding about two hundred trucks, converge to the "empty" weighing-machine, and diverge from the "loaded" machine, and are not included in the plan. There are two shafts, 15 feet in diameter and 365 yards deep, sunk through water-bearing strata in the magnesian limestone, and lined for 110 yards with cast-iron tubbing plates, so that the pits are dry and no pumping is necessary. Both shafts are arranged for drawing coal, but hitherto the south, or downcast, shaft only has been required for this purpose. When the upcast shaft has to be used for winding coal, the sorting machinery described will be repeated at the north shaft.

There are two pairs of winding-engines, one for each pit, placed in separate engine-houses, having cylinders 40 inches in diameter with a stroke of 6 feet, double-beat valves and plain drums 16 feet in diameter, each pair being capable of raising 1,800 tons of coal per working shift of eight and a half hours. The headstocks are of wrought iron, of the form shown in Fig. 3, Plate 5, and are set on brickwork and masonry pedestals 18 feet high above the rail-level, to which the feet and sills are securely anchored. The pulleys, which are 18 feet in diameter, are 74 feet 3 inches above the top of the foundations, or 92 feet 3 inches above the level of the rails. This height allows about 30 feet for overwinding from the chains when the cage is on the landing-levels, to the plate of the detaching hook. Lifting legs are provided at the top of the headstocks for placing, removing, or adjusting the pulleys, which, with their spindles, weigh 4 tons each. A staircase on one back leg, and platforms at the top provide access for oiling and attendance; and the six wire-rope cage-guides and two isolating ropes between the cages are suspended on the girders carried by the main and front legs; the latter are vertical and the former are splayed to the same plane as the back-stays. All the legs are securely braced by cross frames and channel-bar diagonals. Guides are provided on the headstocks to keep the cages securely in place before landing, and the cage-props are carried on the main sills of the headstocks. The upper members of the back-stays and the outer faces of the main legs are plated, the remaining members being of angle-bars with lattice bracing, so that all parts are accessible for painting. Two

large cast-iron shoes receive the lower ends of the back-stays. The compressive stresses do not exceed 3 tons per square inch, and the total weight of one set of headstocks is 90 tons.

The cages have two decks, each carrying two tubs of coal, of 15 cwt. nominal capacity, and unloaded simultaneously on two landings, one 7 feet 4 inches above the other. The tubs have one open end to allow of exceptionally large pieces of coal being loaded; as, although the bodies are 4 feet 10 inches long by 2 feet 9 inches wide and 2 feet 6 inches deep, there are lumps which project beyond the body of the tub, making the actual load of one tub sometimes greater than 20 cwt. A spacious covered platform, 90 feet 8 inches long by 52 feet wide, is carried by columns and girders, on which are provided the lines of rails of 2-foot 3-inch gauge, shown in Fig. 2, Plate 5—those for the upper landing being shown by full lines, and for the lower landing by dotted lines. These rails allow the tubs to be taken from one end of the cages, weighed, tipped, and returned by the “empty” lines to the opposite end of the cages.

There are two tipplers on each landing, one being of the Rigg type and the other one a rotating tippler arranged to revolve backwards, and encircled by a spiral plate to allow of a gradual emptying of the tubs. The coal after leaving the tipplers descends the shoot S, Figs. 4, Plate 5, having two superposed screens S_1 and S_2 , by which a portion of the small coal is removed, the larger pieces being delivered on to the travelling band B, Figs. 2, 3, 4 and 5, which is 280 feet long and 3 feet 3 inches wide. The slack removed by the screens S_2 (rough slack) and S_1 (fine slack), is that sent out of the pit, and is liable to contain a certain amount of small dirt. It is conveyed by creepers N_1 and N_2 into two loading-hoppers over the “nuts” and “smudge” roads, Fig. 2. The larger coal delivered on to the travelling band is freed from dirt, shale and other impurities by hand-picking. When necessary, the hard coal is cleaved from any soft in the same lump, and any pieces requiring dressing have the pyrites or other foreign matter removed by boys working on the stage at A, Figs. 2 and 5, Plate 5. The trucks for picked coal run alongside the travelling belt B on the line of rails marked “picked coal,” Figs. 2 and 6, the top of the belt being 13 feet 6 inches above the rail-level and set to the same gradient as the rails, 1 in 80. There are thirteen loading-places in the main belt, and the arrangements for loading picked coal are as shown in Figs. 5, containing a side elevation of the shoots, and a cross section of the loading and cleaning shed, belt, &c. The shoots were designed by Mr. H. Stevenson, formerly manager of

the colliery. It is not intended that all the shoots shall be in use at one time, as the irregularity in the work of loading sometimes causes intermediate trucks to be loaded before those in advance are quite filled; but by arranging the supply of empty wagons, there is always a shoot available for any one description of coal, in case other shoots are temporarily blocked by full trucks that are ready for removal. The particular size and quality of coal to be loaded is diverted from the main belt on to a curved inclined shoot C, at the end of which is a balanced vibrating shoot, suspended by chains to drums. When the vibrating shoot is empty, it is raised by a weight suspended from a drum provided with a brake-wheel. On commencing to load a wagon, the brake is released, and the shoot is brought to a nearly horizontal position and there secured by the brake. The inclination of the shoot is just sufficient (1 in 2 on the centre line) to allow the coal to slide freely, and when about $\frac{1}{2}$ ton is deposited on the vibrating shoot C₁, the brake is released and the coal descends gradually into the truck, and only requires to be trimmed by hand when the truck is nearly full. When the shoot is free from coal the weight returns the shoot for a further supply. A platform is provided for working the brake and also for inspection.

The gradient of the railway, 1 in 80 with the load, allows the trucks to be lowered without motive-power, and in case of an accidental run-away the hinging of the shoot allows it to be swept clear of a moving truck. This arrangement dispenses with the more usual practice of carrying the coal from the belt to the truck; labour is thus saved, and breakage of coal is prevented. The shoots have proved very satisfactory in working.

The coal removed on the sorting-belt comprises all of the four qualities raised of a size greater than about 5-inch cubes. The residue from the belt B is delivered on to the elevator E, and is raised to a cross-belt, Fig. 2, shown in greater detail in Figs. 6. Any further separation of dirt is effected on the upper cross-belt F, which is divided down the middle by the bar G. The object of this division is to separate all coal above $2\frac{1}{2}$ -inch or 3-inch cubes into hard and soft, the division being maintained over the jiggling screens so that the hard cobbles are delivered into trucks by one shoot M₃, and the soft cobbles by another. The nuts and small slack passing the respective screens h_2 and h_1 into hoppers M₂ and M₁ are comprised of both descriptions of coal. The screen-plate h_1 has 2-inch round holes, and that for h_2 has holes $3\frac{1}{2}$ inches in diameter. They are jigged by an independent engine I, having a cylinder 6 inches in diameter and 8 inches stroke, so that

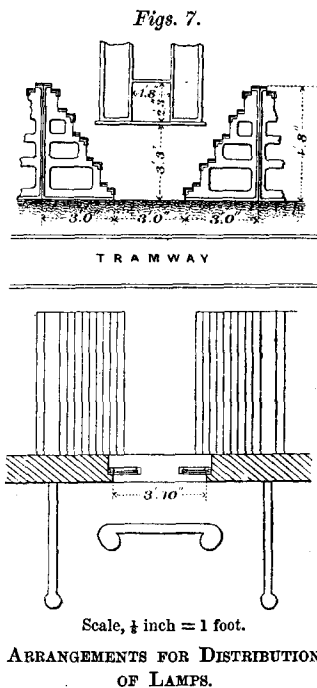
the speed can be regulated to the work. Usually the screens make sixty to seventy double vibrations of 10 inches stroke per minute, and the eccentrics for one screen are set opposite to those of the other so that no injurious vibrations are transmitted to the framework.

The main belt B, the elevator E, and the upper cross-belt F, are driven by the engine at K, Fig. 2, having a cylinder 18 inches in diameter and 2 feet 6 inches stroke, running at 80 revolutions per minute. The gearing reduces the drums so as to drive the main belt at 45 feet per minute and the elevator and cross-belt at 55 feet per minute. The smudge and nut hoppers have bottom doors, each keyed on a shaft and opened or closed by the worm wheel, worm, shaft, and hand-wheels shown at f_1 and f_2 , so as to empty the contents of the hoppers into trucks running below. The main belt is carried on brick walls; and as, for convenience of loading, the trucks have to run within 2 feet 6 inches of the belt, refuge openings are provided at intervals in the walls. The main framework for machinery, stages, and roofs are all carried by, and constructed of, iron, so that those parts liable to be damaged by fire can easily be replaced without prolonged stoppage. Thirty-two and sixteen candle-power incandescent lamps are placed at frequent intervals about the pit-top, main belt and screens; and all the picking, cleaning and loading is performed under cover.

The arrangements for the railway traffic, Fig. 2, Plate 5, are such as to allow gravitational shunting and sorting as far as possible; and the lines fall with a uniform gradient of 1 in 80 from south to north. Above the south weighing-machine the empty trucks are received from the Midland Railway by a line which diverges into six dead-end sidings. The trucks are so placed that they may be selected from any of the six sidings, the weight of all being taken at the south weighing-machine, and braked down to the "hand-picked" siding, the through road for loading at the north end, the "smudge" road, the "nut road," the "hard-cobbles" road, or the "soft-cobbles" road. The loaded trucks on the "hand-picked" road can be turned out or empty trucks turned in at the junctions shown in the Fig. After loading, all the wagons converge to the north weighing-machine and are passed into the store sidings for the loaded trucks, from which they are removed to the Midland or Great Northern Railways by the lines shown. By-pass lines are provided so that no locomotive shall pass over the weighing-machines. Other lines are provided to take smudge to the boilers, coal to the land-sale branch, timber

and stores to the workshops, and there is a brick manufactory at the south end of the empty-wagon sidings.

Safety-lamps are used in the pit, and the lamp-house, 56 feet by 19 feet, is placed in the position shown in Fig. 2, detached from all other buildings and heated by steam-pipes so as to diminish as far as possible all danger from fire. This house serves as a store for the two thousand lamps required; and also for cleaning, trimming and delivering them to the workmen. For cleaning the lamps a brushing machine, driven by a small steam-engine, is used. The lamps when cleaned are conveyed on a tramroad running down the centre of the building, trimmed, and placed, with the bottoms detached ready for lighting, on shelves as shown in *Figs. 7*. Each pair of shelves holds two hundred lamps, and this number is given out by one man at the window shown. The frames are numbered to correspond with the lamps kept on them and are of iron throughout. Over the window the range of the numbers of the lamps that are distributed at that window is indicated so that each workman knows at which window he can obtain his lamp. The time occupied in delivering each set of lamps is ten minutes. The lamps are returned at windows at one end of the building near the cleaning-machine, separate windows being provided for day men and night men.



The ventilation of the colliery is performed by a fan of the Guibal type, 36 feet in diameter and 12 feet wide, with a single inlet 15 feet in diameter, and the centre arms are set at an angle to draw the air through them. It is driven by a horizontal non-condensing engine having a cylinder 30 inches in diameter and 4 feet 8 inches stroke, and variable expansion gear. This fan circulates about 100,000 cubic feet of air per minute at 30 revolutions; but the speed will be increased as the workings are developed.

There are two groups of boilers, each group having a chimney

9 feet in diameter inside and 120 feet high. The first group of ten boilers is complete, and four boilers for the second group are in place, to which others will be added when required. All are of the Lancashire type, 7 feet in diameter, 28 feet long, and are worked at a pressure of 50 lbs. per square inch. Although water occurs at moderate depths at the colliery, it is unsuitable for use in boilers, and pumping-engines have been erected 2 miles east of the colliery, where water of excellent quality has been obtained from a well 85 feet deep sunk in the red sandstone. The water is delivered into a high-level reservoir from which the boilers can be fed without force-pumps.

The colliery workshops are placed on the west side of the pits, Fig. 2, and comprise a smiths' shop, 50 feet by 47 feet, with four fires, a 5-cwt. steam-hammer, and a punching- and shearing-machine. The mechanics' shops, 52 feet by 23 feet, contain a 12-inch sliding, surfacing and screw-cutting lathe with gap bed, a double-gearred drilling machine with 2½-inch spindle, and a screwing machine. The saw-mill is 59 feet long by 23 feet wide, with a 42-inch circular saw-bench and sharpening apparatus, and the carpenters' shop, office, and store occupy a space 60 feet by 23 feet. The machinery is driven by a horizontal non-condensing engine, with a cylinder 15 inches in diameter and 2 feet stroke. All the ordinary repairs, the conversion of timber, and the manufacture of tubs, are executed at the colliery.

The following Table shows the proportions in which coal of different kinds is produced :—

		Per Cent.
Removed by screens at tippers	{ Smudge	9.2
	{ Rough slack	6.6
Loaded by shoots from belt	{ Picked hard	11.8
	{ „ locomotive	12.5
	{ „ steam	4.7
	{ „ large cobbles (three kinds)	21.0
Removed by jigging screens	{ Smudge	5.9
	{ Nuts	8.7
	{ Hard cobbles	16.7
	{ Soft „	
	{ Dirt and waste	2.9
		<hr/> 100.0 <hr/>

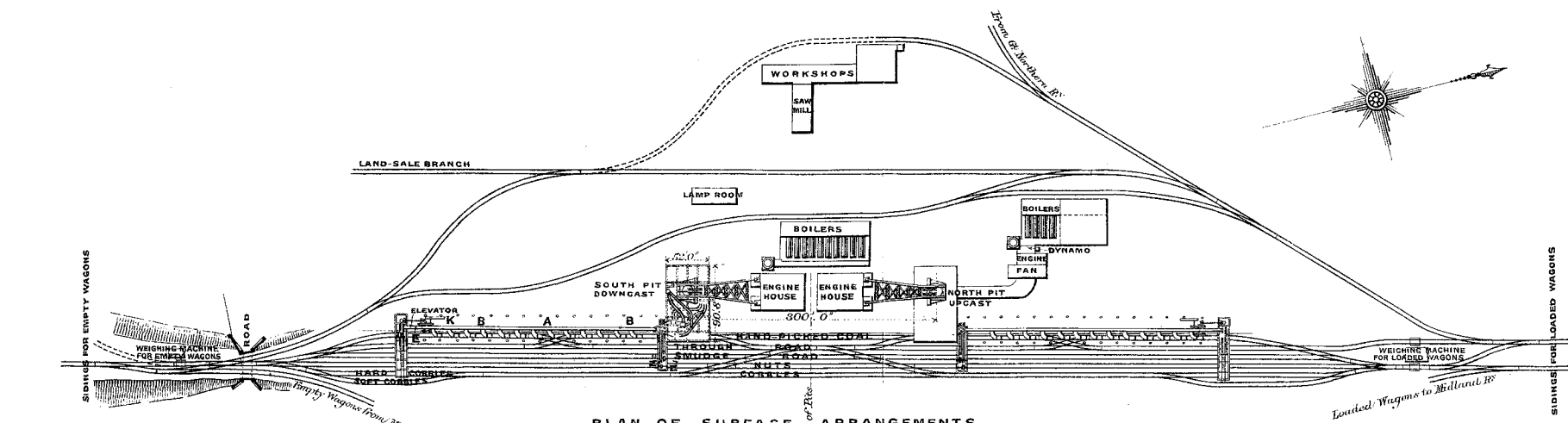
The working of the sorting-belt and screening machinery has been satisfactory. The nuts and rough slack made are much larger than usual, being as regards size and quality more valuable than the names indicate, and by reason of the size the amounts produced are correspondingly increased. The output of picked

coal is about 120 tons per shoot per day, and this quantity is capable of increase. The employment of a weighing-machine for empty wagons, instead of adopting the weights painted on the various trucks, is justified by the results in the dry-weather period of June, 1895, showing on one thousand and seventy trucks an average gain to the colliery of 2·83 cwt. per truck.

The buildings were erected by the staff of the Butterley Company, under the direction of Mr. F. C. Corfield and Mr. H. Stevenson. The boilers, engines, fan, sorting machinery, headstocks, sidings, &c., were constructed at the Butterley Iron Works from the Author's designs, and the work was erected under his supervision.

The Paper is accompanied by six tracings, from which Plate 5 and the *Figs.* in the text have been prepared.

Fig: 2.



Figs: 5.

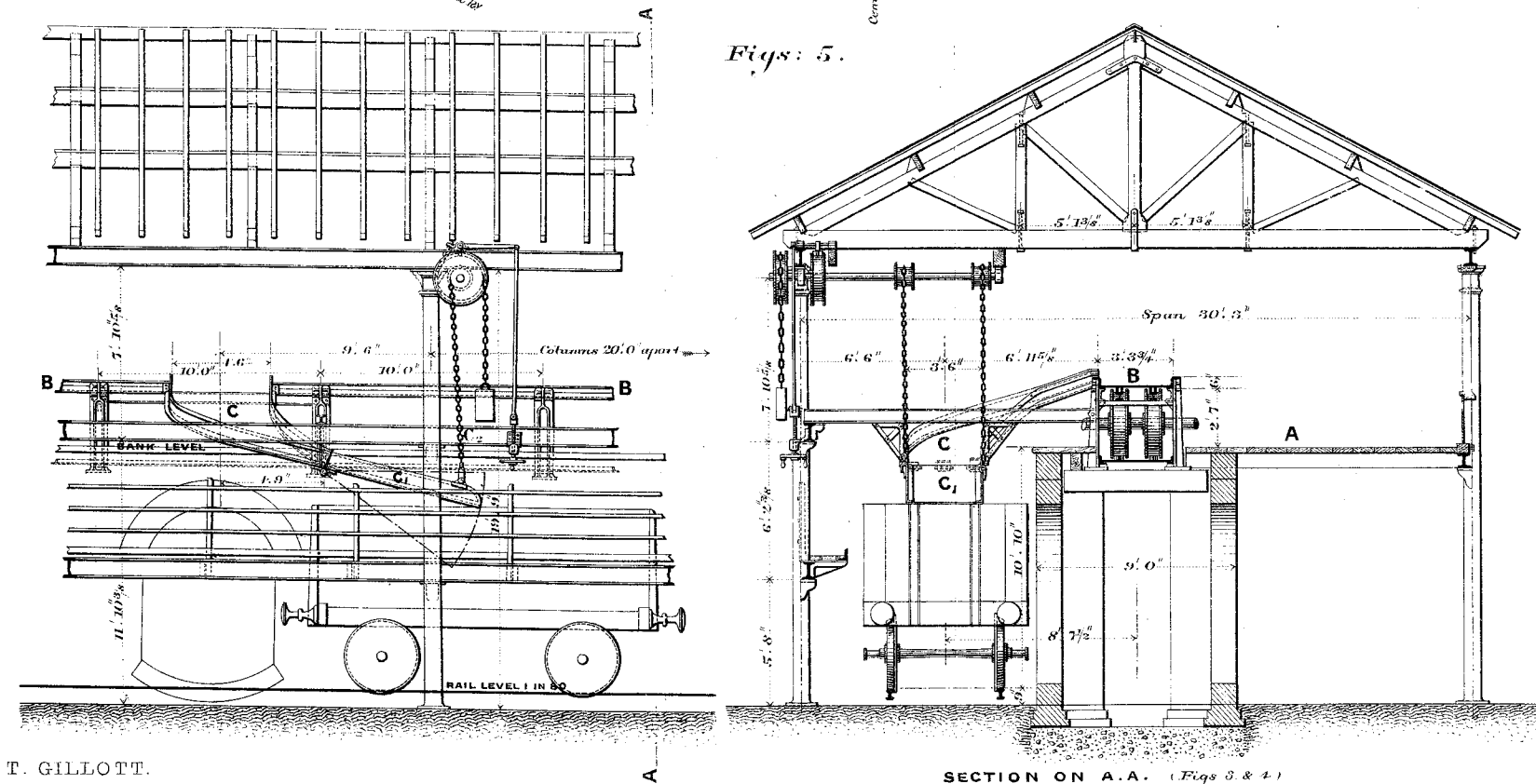
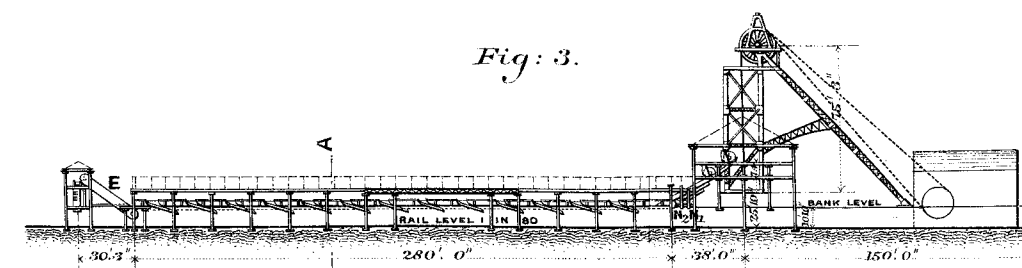
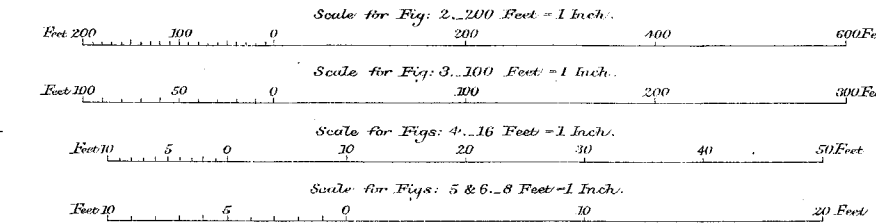
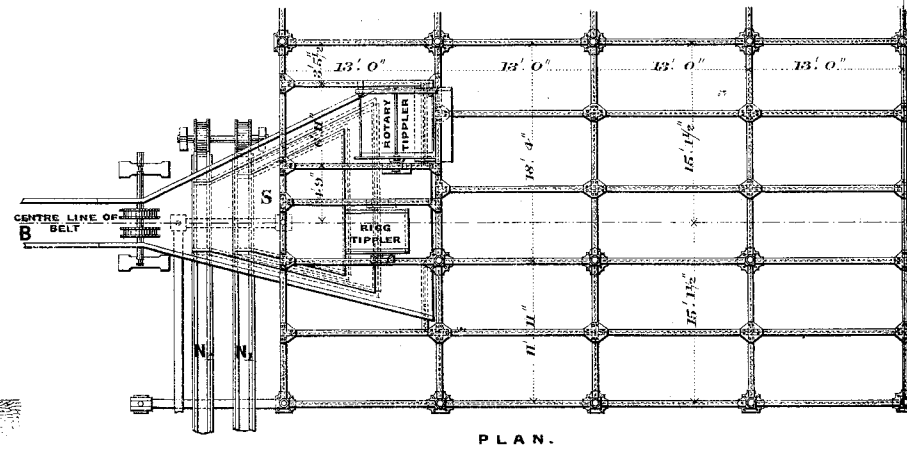
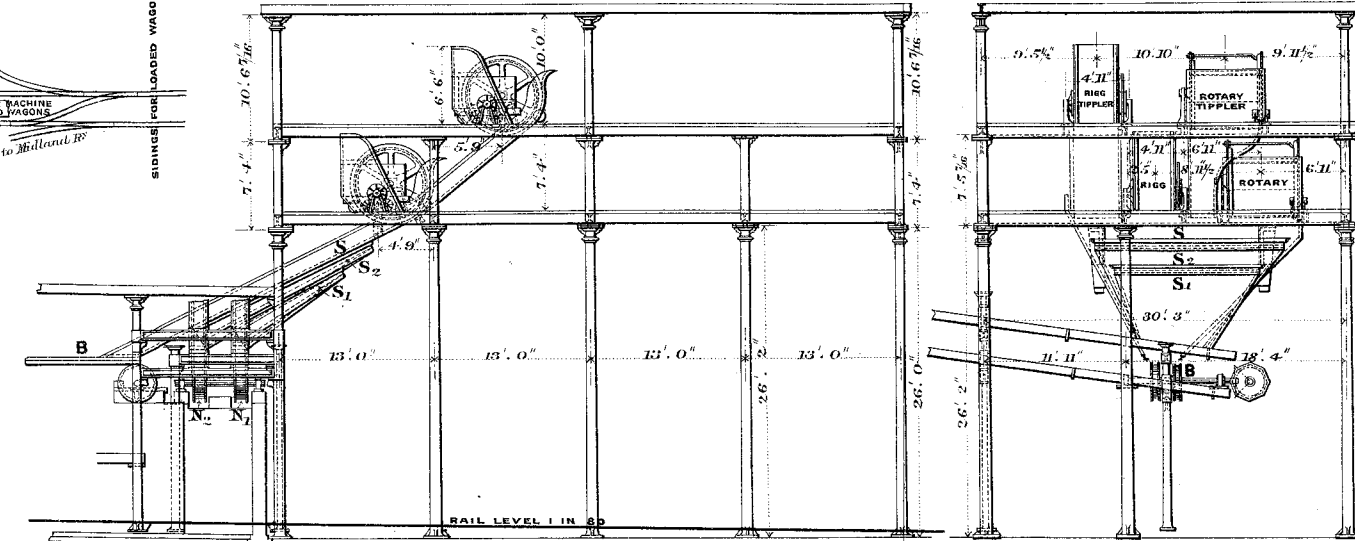


Fig: 3.



Figs: 4.



Figs: 6.

