A DESCRIPTION OF BLACKWELL "A" WINNING COLLIERY, ALFRETON, DERBYSHIRE IN 1933

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Abstract: This 1933 report describes the main features of a medium-scale colliery, in its mid-life, as it was in that year, including surface and underground equipment and operation, and a detailed description of the carbonisation plant and its products.

The Blackwell Colliery Company Limited are the owners of "A" and "B" Winning at Blackwell, Shirland and Alfreton, all in Derbyshire, and Sutton or Brierly Hill Colliery at Skegby, Nottinghamshire. They also own By-Product Coke Ovens at "A" Winning, producing therefrom coke, sulphate of ammonia, benzol, &c. The total number of employees is 4,477:

	Underground	Above ground
"A" Winning	1,134	206,
"B" Winning	564	163
Alfreton	742	160
Shirland	337	111
Sutton	887	173
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	3,664	813

The Collieries at "A" and "B" Winnings were commenced in 1872 and 1875 respectively, Alfreton in 1887, whilst Shirland was
purchased in 1888 and Sutton in 1899.

THE "A" WINNING COLLIERY

At " A" Winning Colliery the labour force comes from the village of Blackwell where the Company owns a large number of houses. Most are of considerable age with neither gas nor electric lighting nor modern sanitary arrangements. The Parish Council have recently erected a large number of well-built cottages close to the Colliery and in these are provided all modern conveniences. Other workers travel from South Normanton, Alfreton, Huthwaite, etc.

The shifts are 7 a.m. to 3 p.m.; 3 p.m. to 11 p.m.; and 11 p.m. to 7 a.m.. The day shift is the working shift to which is confined the winding and dressing of mineral, the afternoon is occupied with repairs and timbering and the night shift with filling. The wages are based on a rate of 3/6 per ton, the fully qualified stallman being assured of a minimum of 10/7 per shift.

Boys over the age of 16 years are enlisted for work on the surface plant. On attaining the age of 18 they enter the pit as gangers and pit bottom boys but rarely assist at the coal face until 21 years old.

The surface plant consists of a battery of eleven Lancashire boilers supplying steam to the two winding engines, fan engine, feed pumps, turbines and various items in connection with the By-Product Works. The power house was erected in 1915 as part of a scheme whereby this pit, and, subsequently, Alfreton, were electrified by the installation of mixed pressure turbines to utilise exhaust steam from their fan and winding engines.

Colliery Power Plant, published by Bellis and Morcom Limited, describes how prior to the changeover, all the prime movers and auxiliaries at these collieries were driven by steam. Ventilation was supplied by a Guibal fan 40 feet in diameter and steam was originally raised in a battery of fourteen Lancashire boilers, each 28 ft by 7 ft. 6 in. With the introduction of Messrs Bellis and Morcom's impulse turbines, in which removable brass stator blades and forged steel diaphragms are embodied, the number of boilers has been reduced to eleven and, moreover, the utilisation of the exhaust steam combined with the scheme of electrification has resulted in a reduction of 50% in the costs of power production.

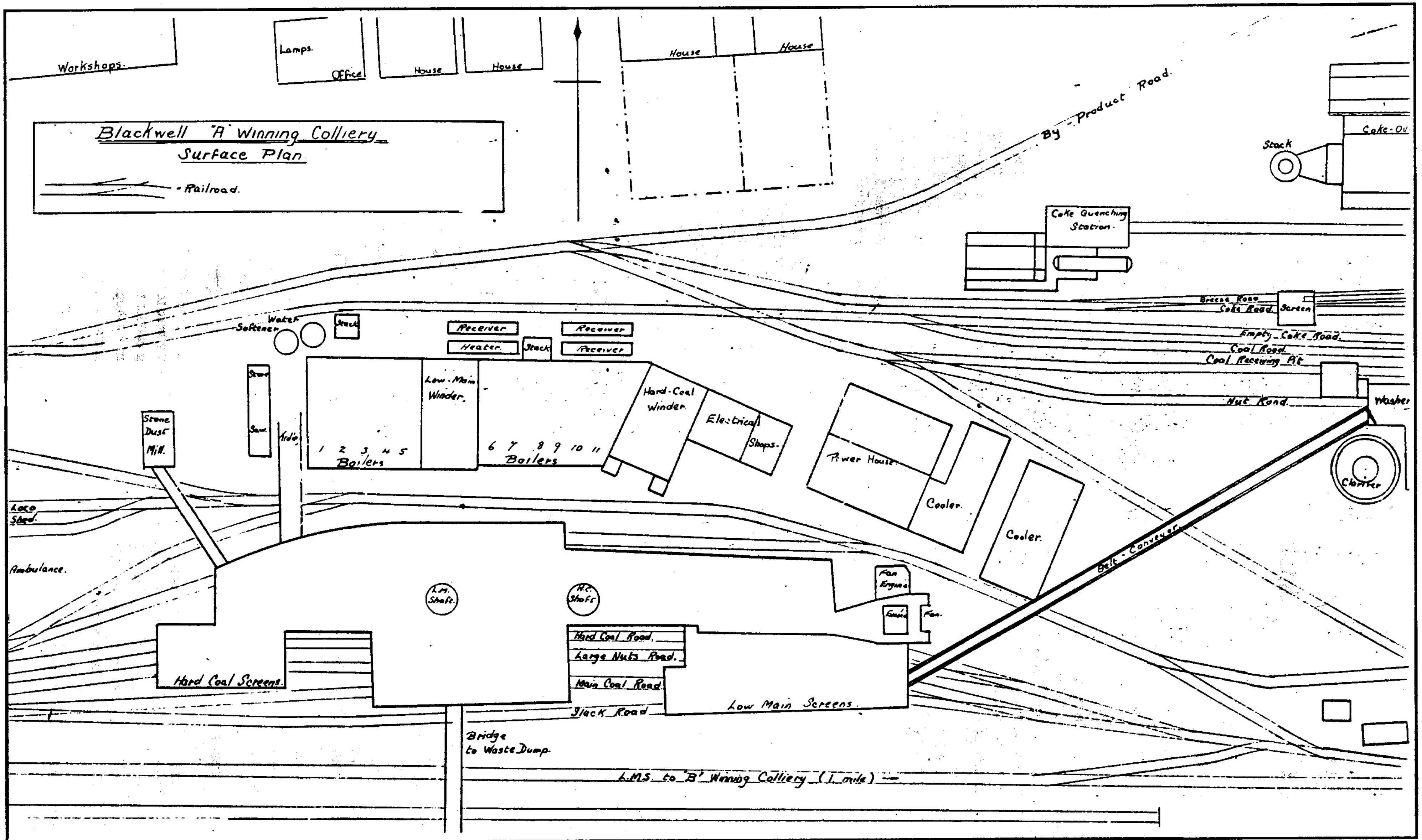
Other surface buildings include screening plants, workshops, stone dust mill, granary, lamp room, ambulance, locomotive shed, stores and offices.

The photograph (overpage) of the Colliery was taken shortly after the erection of the power house and shows the new steel headgear and new shafthouse in course of erection over the downcast shaft. A contract has recently been lodged with Plowright Bros. Ltd. of Chesterfield for the erection of a new steel headgear to replace the wooden frame which at present surmounts the Hard Coal Shaft. This work has now been commenced (May 1934) the steel frame being built around the wooden structure. When completed, the sheaves will be 15 feet higher than is their present position and, apart from moving the sheaves, the entire job will be completed without causing any disturbance to the winding on this shaft. The rate of winding in both shafts is high, an average of one wind every 43 seconds being:maintained, while a record of 95 winds per hour has been achieved in the 237 yards deep Low Main Shaft.

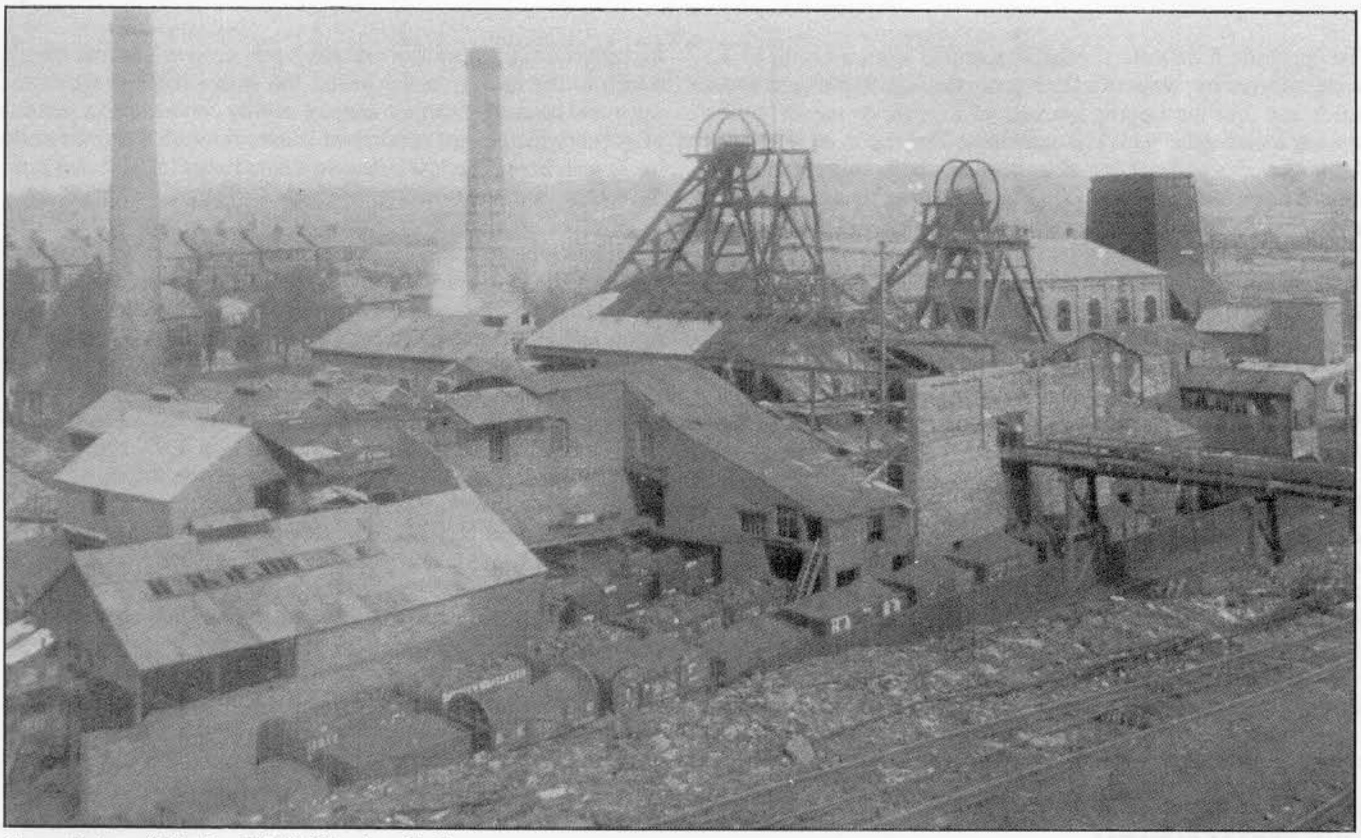
Underground, the method of winning has been by hand up until the present day. Developments are now taking place for the installation of a machine cutter in the south west of the Deep Hard Seam.

Pit ponies, in all about 150, are employed for gathering and pit-bottom work. They are well cared for and the stables are both remarkably clean and well ventilated.* The granary, which is equipped with all the latest machinery, caters for the needs of the ponies at the five pits by carefully preparing their food. This is a mixture of hay, cooked maize, oats, maize and beans which is filled into 7½ stone bags for transport to the stables.

* One deplores the embargo laid by certain buyers on coal from pits where the conditions require the employment of ponies. The following extract from the *Colliery Guardian* illustrates this attitude:- " An Infamous Appeal - The Pit Ponies Protection Society has issued a further appeal by "Distinguished Men and Women" in which all buyers of coal are urged to join the growing number of people who feel obliged, on humane grounds, to buy coal only from non-pony pits". The list is composed predominately of novelists, musicians, actresses and clergymen.



Plan of "A" Winning Colliery. Scale 1:960.



General view of Blackwell "A" Winning Colliery.

GEOLOGY

The five pits controlled by the Blackwell Company lie within an area of six by two miles, running east to west seven miles south of Chesterfield. Productive seams are confined to the Middle Coal Measures, which occupy a band seven miles wide running north and south, consisting of a number of valleys and basins, riddled with mine shafts, spoiled by colliery waste heaps and hundreds of chimneys belching forth smoke. The latter do not enourage vegetation, except out of range of the collieries and is contrasted with the much vegetated Lower Coal Measures, which, being comparatively unproductive, have been left untouched by industry for a long period.

There are thirteen seams in the Middle Coal Measures, eight are worked in this district and seven are being worked by the Blackwell Colliery Company. The Deep Soft seam outcrops at Shirland, the most westerly of the Company's pits, and is worked by means of an inclined shaft (footril). From the vertical shafts at Shirland the Low Main seam is worked. Alfreton Pit works Deep Soft, Deep Hard, and Low Main, whilst Blackwell "A" Winning turns Deep Hard and Deep Main. "B" Winning turns from Waterloo and Low Main Seams, and Sutton turns Deep Hard and Low Main.

The Blackshale seam, which in Yorkshire is known as the Silkstone, is opened at "A" Winning and is awaiting development.

At "A" Winning the Deep Hard is worked at 178 yards from the surface, its thickness in the shaft pillar being 4 ft 6 ins. The thickness in the present working places is slightly less than this. This coal contains much "bright", which, combined with the "hard" is admirably suited to domestic purposes. The bright is easily ignited, whilst the hard makes the coal durable. It burns with a long flame and for steam-making purposes it is rather smoky owing to its high volatile content. This coal stacks well, and being free from pyrites is not liable to spontaneous combustion.

The Low Main seam lies at a depth of 237 yards from the surface and is about the same thickness as the Deep Hard. The Low Main is a good gas and coking coal, providing an excellent fuel for the Company's gas ovens and by-product plant. It is also a good domestic fuel, very bright, free-burning but rather friable.

The Blackshale seam at 294 yards is similar in character to the Low Main and is considered an excellent coking coal.

The coals in the Middle Coal Measures are separated by layers of shale, though rock (sandstone) does occur in some districts in the north and east of "A" Winning (see below under roof support).

SURFACE PLANT

In order to supply steam for the two winding engines, the fan, power house, coke ovens exhauster and various pumps, eleven boilers are required. The boilers are of the Lancashire type, 30 feet in length, and are arranged in two batteries. The first battery consists of three 8 feet diameter and two 9 feet diameter boilers, while the second battery has six 8 feet diameter boilers fitted with auxiliary gas-firing apparatus.

There are three safety devices on the boilers. The dead weight safety valve blows off at 85 psi (pounds per square inch); the Hopkinson "Duad" valve blows off at 85 psi. and also for low water, the latter movement being controlled by a float; while the fusible plugs, one in the top of each tube, admit steam and water into the fire if the tubes become overheated.

The evaporative power of the boiler installation is 650 gallons/hour, 6.4 lb. of water being evaporated per pound of fuel, giving a thermal efficiency of 70%. Fuel for the boilers is brought in wagons from the screens and tipped in front of the fire holes.

Boiler washing is done at the rate of two every weekend, the time between two consecutive washings of a boiler being, therefore, about five weeks. Scaling, followed by official inspection of the boiler, is carried out every fourteen months.

To provide feed water, water is pumped from a brook to the water softener by means of a Weir pump through to the hard water inlet and into the tipping buckets of 21 gallons capacity. The tipping action of the buckets is automatic. The water, as it fills one bucket, raises a ballcock and releases a catch; the weight of water is then sufficient to cause the full bucket to tip, thus bringing the empty bucket into the filling position where it is held by the catch. When working at the maximum rate of four tips per minute the buckets can deliver 5,000 gallons per hour. It is mixed with a solution of 61 lb. of lime with 56 lb. of soda ash before being pumped to the top of the water tower, passing through the wood wool filter and, thence, by gravity to the heater. From here it is pumped direct to the boilers by means of a second Weir pump. In the heater the water is heated by contact with excess of steam from the low pressure receivers.

The hard water owes its temporary hardness to carbonates of calcium, magnesium and sodium, together with calcium hydroxide and carbon dioxide, while the sulphates and chlorides of magnesium and calcium are responsible for the permanent hardness. The carbonates of magnesium and calcium form a sludge which is run out of the bottom of the tower and deposited on the waste heap. The softened water contains the sulphate, hydroxide and chloride of sodium which are readily soluble in water. When boiler washing takes place these pass down the drain with the water.

THE STEAM SYSTEM

High pressure steam from the boilers drives the two winding engines. The Hard Coal winder is by Thornewill and Warham of Burton-on-Trent, and the Low Main is by Barclay of Kilmarnock. Both are tandem horizontal engines with 36 inch diameter cylinders, 6 feet strokes and 18 feet diameter drums. The Low Main engine has metallic packing (from the U.S.A), which has been in service for 14 years, while the asbestos packing of the Hard Coal engine lasts three months.

Both engines are fitted with safety appliances to prevent overwinding and excessive speed. In the case of overwinding or excessive speed the respective brakes are applied, and besides this, the Low Main apparatus closes the steam valve and moves the reversing lever into the neutral position. The brakes are steam brakes, the steam valve bcing operated by foot or by the overwinder.

The fan is driven by a vertical, high speed engine by J. Howden and Co. of Glasgow. It has two 24 inch diameter cylinders and 10 feet stroke, and runs at 165 r.p.m; it drives the fan direct through a spring coupling.

The fan is a double inlet "Sirocco" by Davidson of Belfast. It is 9 feet in diameter and 8 feet wide with sixtyfour 9 inch blades placed around the circumference. Air is taken in parallel to the shaft and is expelled between the blades to the evasée chimney. The purpose of the expanding chimney is to decrease the velocity energy of the air and hence, by Bernoulli's Theorem, to increase the pressure energy. The vacuum in the fan drift, measured at the point is 3 inches of water. If necessary, the direction of the air current may be reversed, i.e. the fan may be used to force air.

The fan drift, which is a large rectangular tunnel, connects the fan directly with the Hard Coal shaft. The sides of the drift are made of bricks, but the roof has a covering of corrugated iron sheets on the underside, the object of which is to present a smooth surface and hence to collect less dust. The quantity of air delivered by the fan is 300,000 to 350,000 cubic feet per minute.

Low pressure steam exhaust steam from the above-mentioned engines is taken by pipes to three low pressure receivers. When the pressure in the receivers exceeds 3 psi. a valve lifts and admits steam to the heater. In the heater the steam collects above the water and heats it by surface contact and by condensation. Excess of steam which is not condensed passes through a chimney into the atmosphere. The low pressure steam range takes steam from the receivers to the power house.

Electricity is produced in the power house. The floor of the power house is above ground level, the whole of the condensing plant being placed in the basement together with the transformers. The floor at the turbine level is of concrete, reinforced with steel girders. The plant in the power house consists of two Bellis and Morcom mixed pressure turbo generators each of 750 Kw. capacity. The generators and exciters were produced by Vickers Ltd. One mixed pressure turbo-generator of 1250 Kw. also by Bellis and Morcom, with generator and exciter supplied by the Lancashire Dynamo Co. A lighting plant of 110v.,consisting of a D.C. dynamo by J.H. Holmes of Newcastle-on-Tyne is driven by a Bellis and Morcom high-speed, self-lubricating engine of 75 B.H.P. running at 575 rpm. All the turbines run at 3000 rpm and generate alternating current, three phase, at 550v and 50 cycles per second frequency.

The mixed pressure system uses the low pressure steam to raise a valve from which it passes into the low pressure end of the turbine. If, however, there is insufficient low pressure steam the valve drops and, working through levers, opens the high pressure valve and admits steam from the boilers.

The condensing plant is by the British Westinghouse Co., and is of the multi-jet type with air and circulating pumps driven by the 75 H.P. three-phase motor. Exhaust steam from the turbine enters the top of the condenser and is there condensed by being sprayed through nozzles with water. The air pump draws air from the top of the condenser and maintains a vacuum therein of 27½ inches of mercury. The circulating pump forces the water to the top of the cooling tower whilst the difference in pressure between the atmosphere and the vacuum forces water from a pond into the condenser. Each condenser circulates about 130,000 gallons of water per hour. The temperature of the water entering the tower is 100° C. which decreases to 70°C. before it returns to the pond.

The lubricating oil is heated to a temperature of 150° C. in the bearings and is circulated through a water-jacket cooler in the basement of the house. The alternators are cooled by air, the armature acting as a fan and drawing in air through special air filters to exclude oil and dust.

The switchboard is of the "Cubicle" type by British Westinghouse Co. and is completely interlocked so that it is impossible to open the switches until the current is off. For transmission to Alfreton and Shirland Collieries two step-up transformers are used. These are made by the British Electric Transformer Co. and of 500 KV.A. to step up from 550 to 3,000 volts. During the day shift when the load is heavy the above mentioned Collieries supply themselves from their own plant, while, for the needs of this pit, the 1250 Kw. set is run. By 3 p.m., however, the load has diminished to such an extent that one of the 750 Kw. sets is sufficient for all three pits; the changeover is conducted with the aid of a Synchroscope.

WORKSHOPS

New workshops have recently been erected and the fitters', joiners', blacksmiths' and tub-repairers' shops are situated in one large building.

The fitters' shop contains one lathe with 10 foot bed, one planing machine, emery wheel, drilling machine and machine saw, all of which are driven from a 30 H.P. motor through belts and overhead shafting. A large workbench fitted with vices runs along the length of one wall and there is ample floor space for extending the plant and for dealing with large objects.

The blacksmiths' shop has four hearths blown by air supplied from an electrically driven blower, one electrically driven compressed air power hammer, anvils, tool cupboards and benches. This shop deals with such work as riveting, straightening tub wheels and axles, tempering and repairing hanging chains, overhauling King hooks, making and repairing cages, shoeing of horses, etc..

The joiners' shop contains woodwork benches on which are made "spears" for guiding cages, doors, frames for rope rollers, bars for supporting tail rope pulleys, etc.

Adjoining the joiners' shop is the tub-repairers' shop where tubs are both made and repaired.

In the electricians' shop repairs to equipment are effected, but large jobs, such as armature rewinding, are done by outside contractors. Part of this shop is walled off to form a separate room for the electric welder, and here repairs to all kinds of machinery are successfully carried out, and much constructional work is done. Current for the arc is obtained from the 110v lighting plant.

The saw mill is fitted with circular saw, hand saw, lathe and benches. The chief work done here is the pointing of props and cutting of material for construction of tubs. Sleepers, 3 feet in length, are cut here, four being obtained from a 6 foot prop. Bank bars are made by halving 4' 6" props. Lockers for tub wheels, 13 inches in length and 2 inches in diameter, are cut from ash logs. Poplar and willow wood is cut for use as brake lags on the winding engines' drums. Wood for roller frames, and for tub sides, ends and bottoms ("tram boards") is cut from larch trees, and English oak is used throughout for the construction of the tub underframes.

The mine has its own stone crushing mill, to enable it to comply with the Coal Mines Regulations, regarding the use of stonedust underground. Floor-bind from the West District in the Hard Coal seam has been found suitable for crushing and using below ground and, moreover, the winning of coal in this district is most conveniently performed by firing shots in the floor. The bind is brought to the surface in tubs and transported over a bridge to the mill.

The first stage in the production of stone-dust is the breaking-up of the bind into small pieces by means of a Blake Jaw Breaker. From the throat of the breaker, the small pieces of bind fall down a tube into a small hopper. From the bottom of the hopper the bind is transported by means of a screw feed to the top of a pipe leading to the pulverising machine. Attached to the side of this tube is an electromagnet, the purpose of which is to prevent any metal proceeding into and causing damage to the teeth of the pulverising machine.

The essential parts of the pulveriser are a fixed plate and a moving plate revolving at a speed of about 2000 rpm. The clearance between concentric rows of teeth on the plates is small, and the centrifugal force, transmitted to the bind by the revolving plate, presses the former between and against the teeth, until finally it emerges through the last row of teeth as a fine powder. The air blast accompanying the dust from the machine has the effect of a powerful fan and expels the stonedust into a large iron cylinder and thence into four large linen bags housed on the next floor, which allow the air to escape, but hold back the dust. Finally the dust falls from here, past the middle floor, into the hopper on the ground floor where it is loaded into tubs and sent down the pit.

COAL WINDING AND TREATMENT

Hard Coal Seam:- Whereas there are two decking levels at the pit bottom, there is but one banking level. When winding the top deck of the up-coming cage is banked first, the loaded tubs being pushed out and replaced by two empties. Meanwhile the pit bottom is idle. The bottom deck of the up-coming cage is then decked at the bank and simultaneous with the unloading of this one deck the cage at the Hard Coal pit bottom has both decks loaded.

The loaded tubs are pulled off the cage on to a steel plate and turned into an air-lock which has electrically operated lift-doors. The loaded tubs are pushed to the weighbridge by hand, after which they engage with the creeper track which carries them up to the rotary tippler. This is power-driven but hand-controlled using a lever and deals with one tub at a time. The empty tubs gravitate from the tippler to the air-lock whence they descend on to a steel plate ready for loading on to the cage.

Screens:- From the tippler the coal is led down a chute on to a vibrating "jigger" screen. The first set of holes are of $1\frac{3}{8}$ inches diameter, all coal passing through falls on to an endless belt conveyor which discharges into wagons, either for the boilers or for market. The holes give way to 8 inch diameter holes and these pass "cobbles" on to a plate-picking belt, wherefrom all pieces of shale and dirt are removed by hand. All coal which passes over the 8 inch holes falls down a chute on to a second picking belt. All large pieces of "bright" coal are removed by hand and stocked ready for loading as hand-picked brights. The remainder of the above 8 inch coals are classed as "hards".

Thus the market products are:-

Hard Slack	Screened through $1\frac{3}{8}$ inch round holes
Cobbles	Screened through 8 inch round holes
Screened Hards	Screened over 8 inch wide round holes
Hand-picked brights	Hand-picked off the hards belt.

Slack is sold for industrial purposes, cobbles and brights for domestic use and hards for locomotives, furnace and general utility.

Low Main Seam:- The output is classified as follows:-

Main Slack	Through $\frac{7}{8}$ inch holes (Conveyed to
washery	for Coke Ovens)
Washed Nuts	Through $1\frac{1}{4}$ inch rectangular holes
Dry Unwashed Nuts	ditto
Large Nuts	Over $1\frac{1}{4}$ through circular holes
Best Main	Over $3\frac{1}{2}$ inch
Hard Cobbles	Hand picked
Gas Coal	Over $1\frac{1}{4}$ inch
Screened House Coal	Over $1\frac{1}{4}$ inch
Colliers' Coal	Pickings from $3\frac{1}{2}$ inch screens

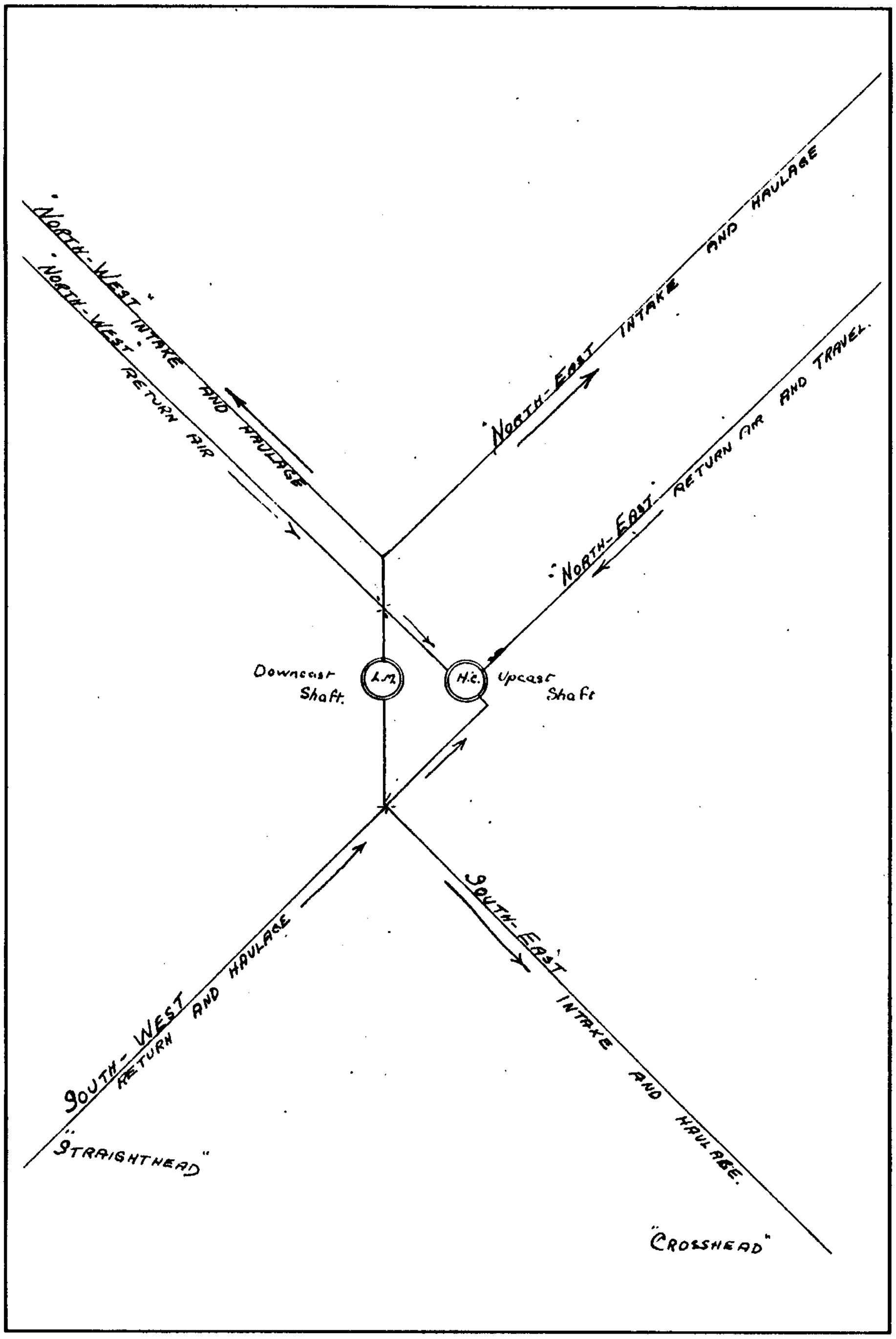
DISPOSAL OF WASTE

Ashes from the boilers and sludge from the settling ponds adjacent to the water softener are loaded into tubs and elevated to the Low Main bank by means of a trolley. From the Low Main bank an endless rope haulage system transports the tubs to the top of the waste heap which borders the colliery on the south.

UNDERGROUND WORKINGS

Scheme of Development and Method of Mining

The seams worked in the colliery are all won by the advancing longwall system. The Deep Hard (also called the "Hard Coal") seam is divided into four districts, namely, North East, South East,



Layout of the districts from the pit bottom (Hard coal shaft), showing ventilation.

South West and North West. Each district is managed by a deputy, the North West being sub-divided into two districts each with a deputy, making a total of five deputies. Both the North East and North West have separate intake and return airways, but the two southern districts are combined for purposes of ventilation. The South East road carries the intake air which travels along the coal face of both districts and returns via the South West road. The coal face at its nearest point to the pit bottom is about two miles away and in the North East this distance is two and a half miles.

A typical layout of a long-wall face is illustrated. The distance between levels is about 60 yards but varies according to local conditions. The gates are put off from the levels every 30 yards. The method of mining is by hand, no coal cutting machinery yet being employed in this pit.

Breaking Ground: To facilitate the winning of the coal and the driving of roads "permitted explosives" (having been tested by Government officials and approved by them for use in coal mines where inflammable gas has been detected) are used.

Before an explosive may be used the coal face has to be prepared by holing, either over or under the coal, as laid down in Part II of *The Explosives in Coal Mines Order*, viz:- No shot shall be fired in coal unless the coal has been holed to a depth greater than the depth of the shot hole. During holing under the coal, the face has to be supported by sprags, the distance between which must not exceed six feet.

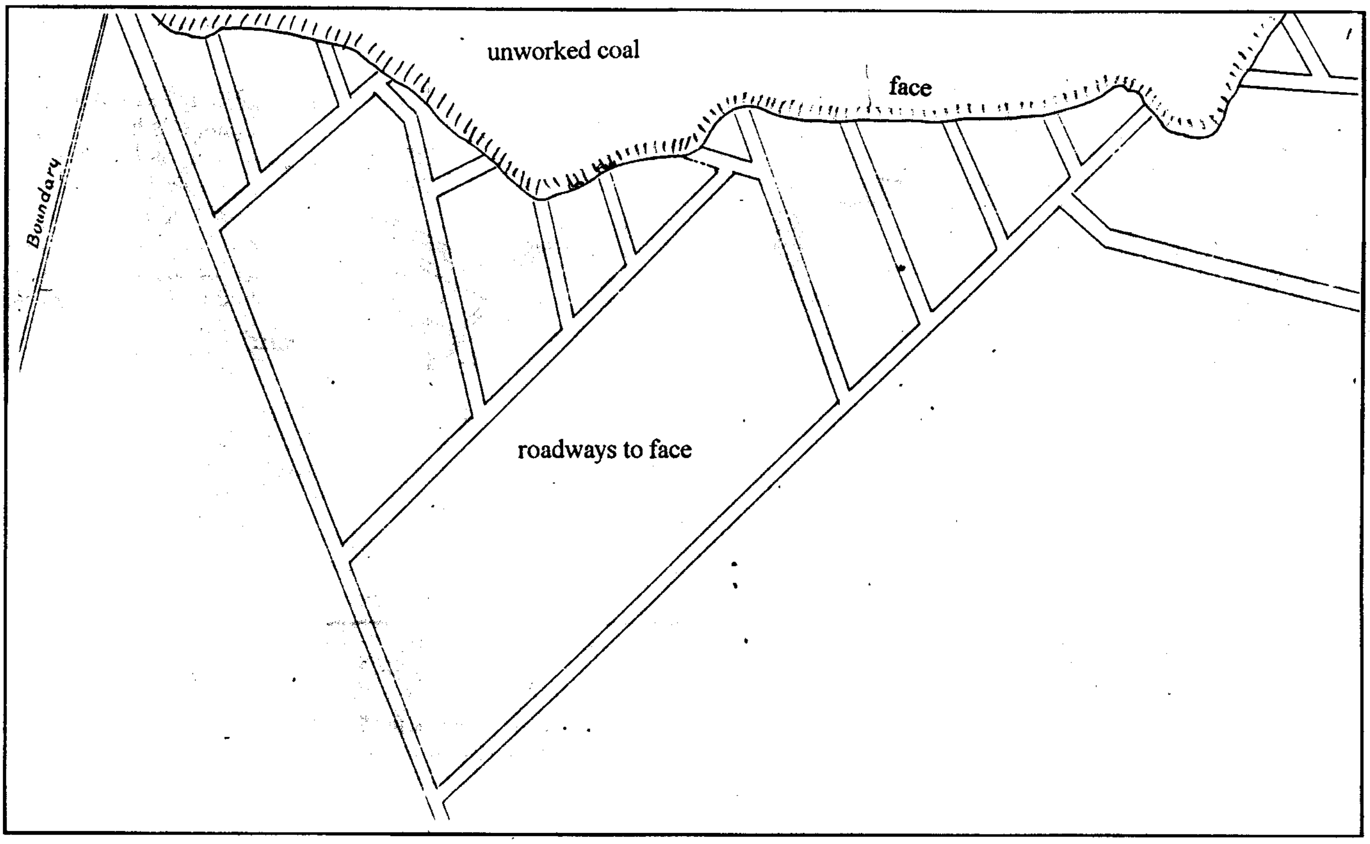
The next step is the boring of the shot hole which is done by hand with the auger drill mounted on a standard. The required depth of hole (2 to 3 feet) having been bored, the drill and standard are removed and the hole is cleaned out with a copper scraper, iron and steel scrapers being forbidden by the Act.

The cartridges are then inserted in the hole, the number thereof depending on the resistance of the coal. Usually 6 ozs (three 2 oz, cartridges) of Polar Viking are sufficient and very rarely is 8 ozs, exceeded. The detonator is inserted in the outside end of the last cartridge. The hole is then stemmed with clay or other non-inflammable material which is compressed with a wooden stemmer. The position of the shot is marked by a chalked arrow on the roof and all tools are removed into a gate or place of safety.

The deputy then satisfies himself that the place is free from gas and supervises the removal of the sprags. Stonedust is spread for a radius of five yards from the hole. The cable is connected to the leads from the detonator, passed over a bar or any suitable support to keep it clear of the floor, where it would be cut by falling coal, and paid out until the shot-firer is at a safe distance away. Firing is done by means of a magneto exploder attached to the cable.

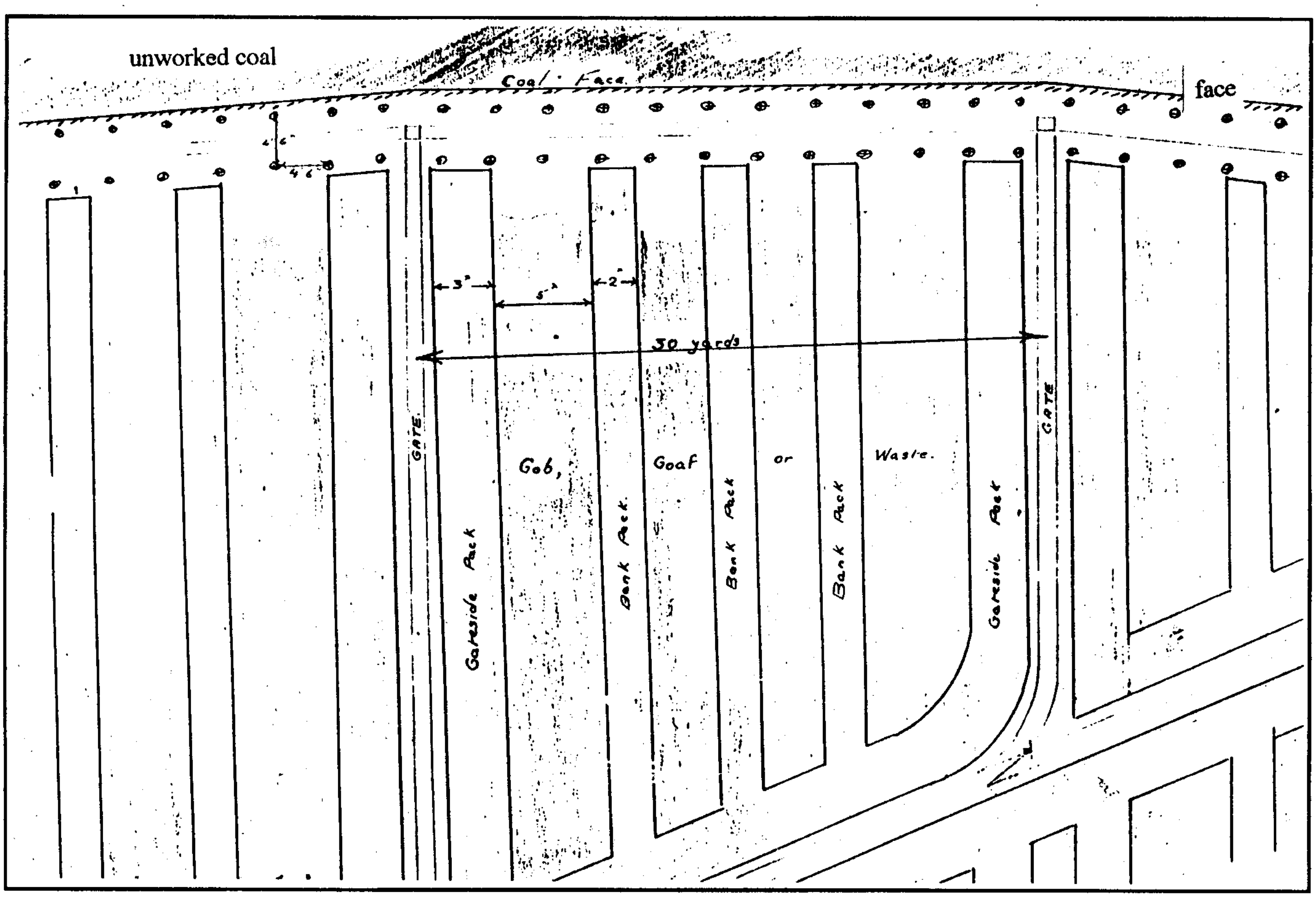
The deputy is the first to approach after the shot has been fired and, after assuring himself that no gas has been released and that the place is safe for work, he allows the men to begin clearing the broken coal from the face and loading the same into tubs.

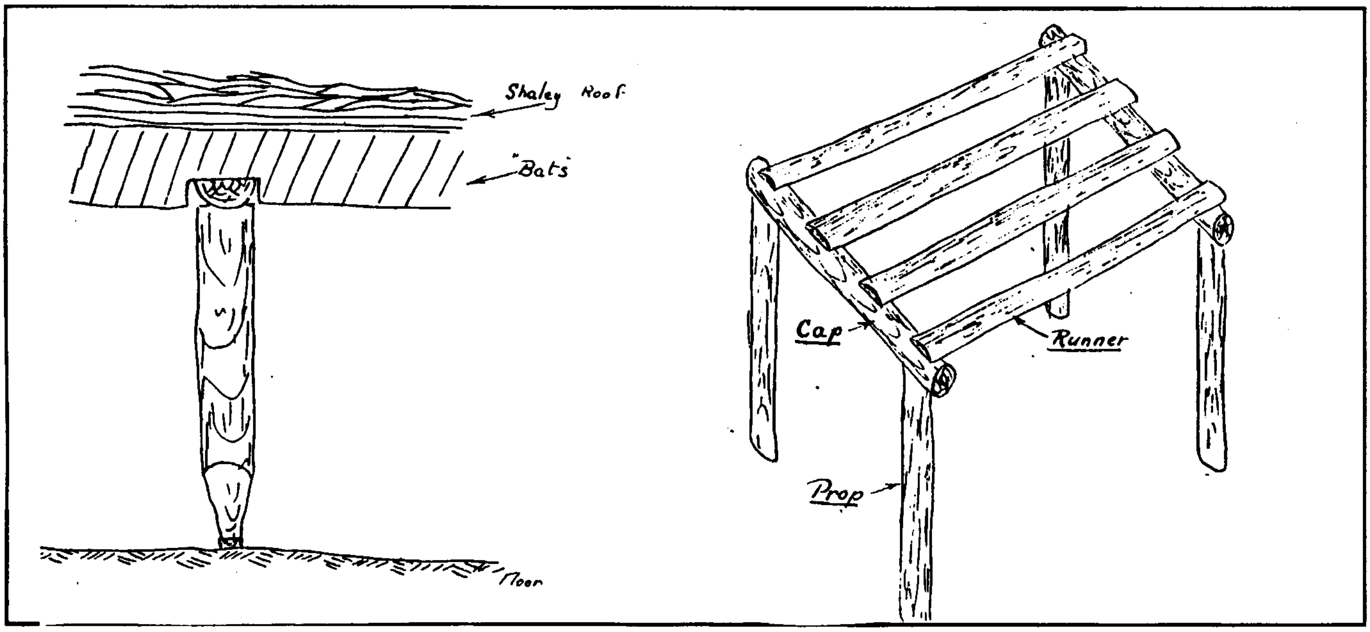
Shotfiring in coal is particularly necessary when the cleavage in the coal is at right angles to the coal face; under such conditions the coal is being worked "on end" or if the cleavage is slightly off right angles to the face the term "short 'orn" applies. When the cleavage is parallel to the face line the coal is being worked "on face" or when the cleavage is slightly inclined to the face the term "long orn" applies. In these latter conditions the winning of coal is done by inserting a crowbar in the sline. For market purposes, however, end coal is far superior to face coal on account of its regular rectangular shape, the latter tending to give thin tabular pieces. Another method of winning coal is by means of the wedge which is driven into the sline. The number of cases where this is used is small. For breaking ground other than coal, especially the gate-end ripping of the roof, explosives are used in an exactly similar manner to that in coal.



(Above) Road layout on the Short Run area in the Low Main Seam

(Below) Distances apart of gates (30 yards) and packs between the gob, goaf or waste.





(Left) Pointed prop "dented" into soft bats to increase roof height and (right) main road timbering.

Roof Support
The chief means of support is the waste pack built of the material obtained from ripping and holing. The gateside packs have a minimum width of three yards and the bank packs two yards. The maximum distance between packs is five yards. Where packing material is plentiful and the roof falls into the goaf close up to the face, more than the necessary minimum of packs may be built.

Support at the coal face is by means of props with caps placed at a maximum distance apart of 4 feet 6 inches. These face props are tapered to prevent buckling, the effect of pressure being to crush the pointed base. Where the roof of the working place is soft, or of a dangerous nature, the tops of the props are connected by bank bars 4 feet 6 inches in length made by halving a 4 feet 6 inch timber. In some stalls, for example, in the North district of the Low Main seam, the upper portion of the coal consists of inferior "bats". Often part or all of the bats is left unmined to act as an extra support for the roof. In such cases it very often happens that the effective thickness of the seam is so diminished that the tubs cannot clear the bank bars. It is customary in such cases to "dent" the bars into the bats to give tubs clearance. Where packing material is scarce and insufficient for building the packs, other methods of support have to be used. This is particularly necessary in certain parts of the Low Main seam where the roof contains few breaks and therefore take a considerable time to fill the goaf. The best means of support for such cases is the wood chock. The chock is considerably strengthened by filling with either waste wood or waste rock, the name "brattice pack" then being applied.

Very little timbering is required in the gates and levels since these have only a short life compared with the main roads. Timbering on the main roads consists of heavy upright timbers of circular section, capped with circular bars. The bars are connected by "runners" of half round section up to twelve feet in length. The space between the runners and the roof is packed tight with waste material so as to distribute pressure evenly. Wooden bars are now being replaced by H section girders of a much smaller sectional dimensions than wooden bars.

The timber used is either spruce, fir or Norwegian pine. The sizes of timbers kept in stock at the colliery are:- 2 feet; 3 feet; 3 feet 6 inches; 3 feet 9 inches; 4 feet; 4 feet 4 inches; 4 feet 6 inches, 4 feet 8 inches; 5 feet; 5 feet 6 inches; 6 feet; 6 feet 6 inches; 7 feet; 7 feet 6 inches; 8 feet; 9 feet, 10 feet and 12 feet. The diameters of the timbers are 4 inches for those up to 3 feet 9 inches in length; 5 inches for 4 feet to 4 feet 6 inches; 6 inches for 4 feet 8 inches to 6 feet; 7 inches for 6 to 8 feet; 8 inches for 9 to 10 feet and 9 inches for 12 feet.

The 4 feet, 4 feet 8 inches and 5 feet timbers are pointed for use as face props, 4 feet 6 inch timbers are halved for bank bars and four sleepers 3 feet long are cut from a 6 feet prop.

At the pit bottom where the support has to be of a permanent nature brick arching is used throughout.

Roof and Floor
There are five types of roof commonly encountered in coal measure strata, namely:- sandstone (called rock), stone bind, shale, clod and coal, all of which are found in this pit.

A sandstone roof is by far the strongest roof material in the pit and is found in the N.E. district of the Deep Hard seam and also overlying the Low Main seam. The roads are self-supporting and ragged in appearance owing to the lack of well defined bedding planes which would give a good parting. Ripping in sandstone is difficult and has to be done with shots. The picks will not face the rock and drill bits have only a short life. In spite of the fact that this roof is very strong the accident rate is relatively the highest. Breaks parallel with and just beyond the face are caused by the working. These incline steeply backwards over the goaf, but sometimes flatten-out at the bottom thus producing feather-edges. The falls which occur are mostly due to the feather-edge breaking off or to the collapse of a corner piece formed by a joint and a break.

Records of falls occuring in comparable circumstances in the five types or roof, show that for each fall under the coal or stone bind roofs there were two under sandstone, four under shale and seven under clod. The accident rate is highest under sandstone because, firstly, little indication is given that a fall is about to occur from a sandstone roof and, secondly, in this class of roof there are few minor breaks and so falls consist of large pieces of rock

Coal roofs are not well represented in "A" Winning but occur where the shales above the coal fracture at intervals causing "weights" on the face. In this pit, a coal roof is left only where it is absolutely necessary to hold up a roof of loose clod or in the Low Main Seam, where, in the North District, the "bats" can profitably be left unmined.

PIT BOTTOM LAYOUT

For the purpose of winding arrangements the pit-bottom is divided into two decks, top and bottom (see diagrams). The top deck deals with the two southern districts and the bottom deck with the two northern. Both districts using the top deck are served by the two-drum endless rope haulage engine (below). The loaded tubs from the Crosshead (S.E.) District travel outbye on the right hand side of the rails. On arriving at the sharp corner opposite the haulage inset the clip has to be removed from the rope which passes under the rails to the drum. The road, however, dips towards the pit bottom so that this corner is easily negotiated by the tubs, the effect of gravity being assisted by the pushing of a second clip at the back of the train. Before the back clip arrives at the "going under" of the rope the front is able to be clipped on again to the rope which has returned to the position between the rails. The doors of the air-lock are opened one at a time to allow the train to travel to the shaft landing, ready for running on to the cage. (The roads in the immediate vicinity of the shafts have been somewhat foreshortened in the plans).

The empties are pulled round the circuit from the far side of the cage, and are clipped on to the rope just before the air-lock, whence the rope is continuous inbye to the return wheels.

For the Straight-head (S.E.) District the endless rope passes through the top deck stables to reach the S.W. haulage road. The loads travel outbye on the right hand side of the road, using the endless rope until the latter branches off through the stables. The last section of the journey is made by a self-acting haulage system, whereby the loads gravitating to the cage-landing haul the empties up to the brake wheel. The empties are drawn from the brake-wheel to the endless rope by a pony.

The bottom deck layout is rather more complicated. The main and tail haulage serves the N.W. road only as far as the corner opposite the engine house, whence the loads are hauled to the landing by the direct haulage, the rope of which is shewn passing through the air-lock. The empties, sixteen at a time, are brought from the shaft to the N.W. road by a pony.

The N.E. district is served for the first half-mile by the endless rope "clipper" haulage, the loads being brought through the air-lock and knocked off opposite the direct haulage engine. The final marshalling on the landing is done by man power, assisted by gravity. The empties for this district are brought by the pit-bottom pony by the same route as is used for the N.W. road, the train being diverted at the parting of the ways by the engine house.

The bottom deck area contains the telephone exchange and ambulance room where a suitable supply of splints, dressings and stretchers are stored; two stables, one large and one small , and electrical switch gear in locked rooms, for the control of lighting and power.

SHAFTS AND HOISTING

Both shafts are fourteen feet in diameter and are fitted with two double deck cages, each accommodating two tubs. The cages are each guided by four conductor ropes, one at each corner. The total depth of the shafts to their bottoms is 294 yards. The Low Main seam is found at 237 yards and the Deep Hard, which we are considering, at 178 yards. The shaft lining is English tubbing for the first 50 yards, then brickwork to the bottom. The cages are of Low Moor iron, the tare being 3 to 4 tons. Winding ropes are one inch diameter Lang's lay, with hemp core surrounded by six steel strands each of nine wires around a steel core. The longest are the two used in the Low Main shaft, each 370 yards in length and weighing 37 cwts.

The Hard Coal shaft ropes are 290 yards in length. The Low Main shaft is provided with signalling apparatus at the Deep Hard Coal level for the use only of officials or in case of breakdown in the Hard Coal shaft.

The conductors in the Hard Coal shaft are kept taut by heavy weights which are suspended in the sump just below the level of the Hard Coal seam, running through the sump and anchored to the heavy timbers which form the "buntings" for the cages to rest on. Below is a winding rope which is used for inspecting this shaft from this level to the Blackshale seam. When not in use the bottom of this rope is laid in folds at the Low Main pit bottom, while the single deck cage which it carries, is supported by a girder running across the shaft. When this section of the shaft is to be inspected the top end of the rope is attached by links to chains embracing the appropriate Hard Coal cage. This cage is then raised while its fellow, counterbalanced with the loaded tubs, descends. At a height of about 60 yards above the Hard Coal level the Blackshale rope takes the weight of its cage and lifts it until the weight of the girder is just taken on its deck. The girder is then carried by three or four men on to the Low Main landing. The Blackshale cage is then free to be raised or lowered between the limits of the Deep Hard Coal sump and the Blackshale bottom. This cage is guided by wooden guides supported by beams from the shaft side.

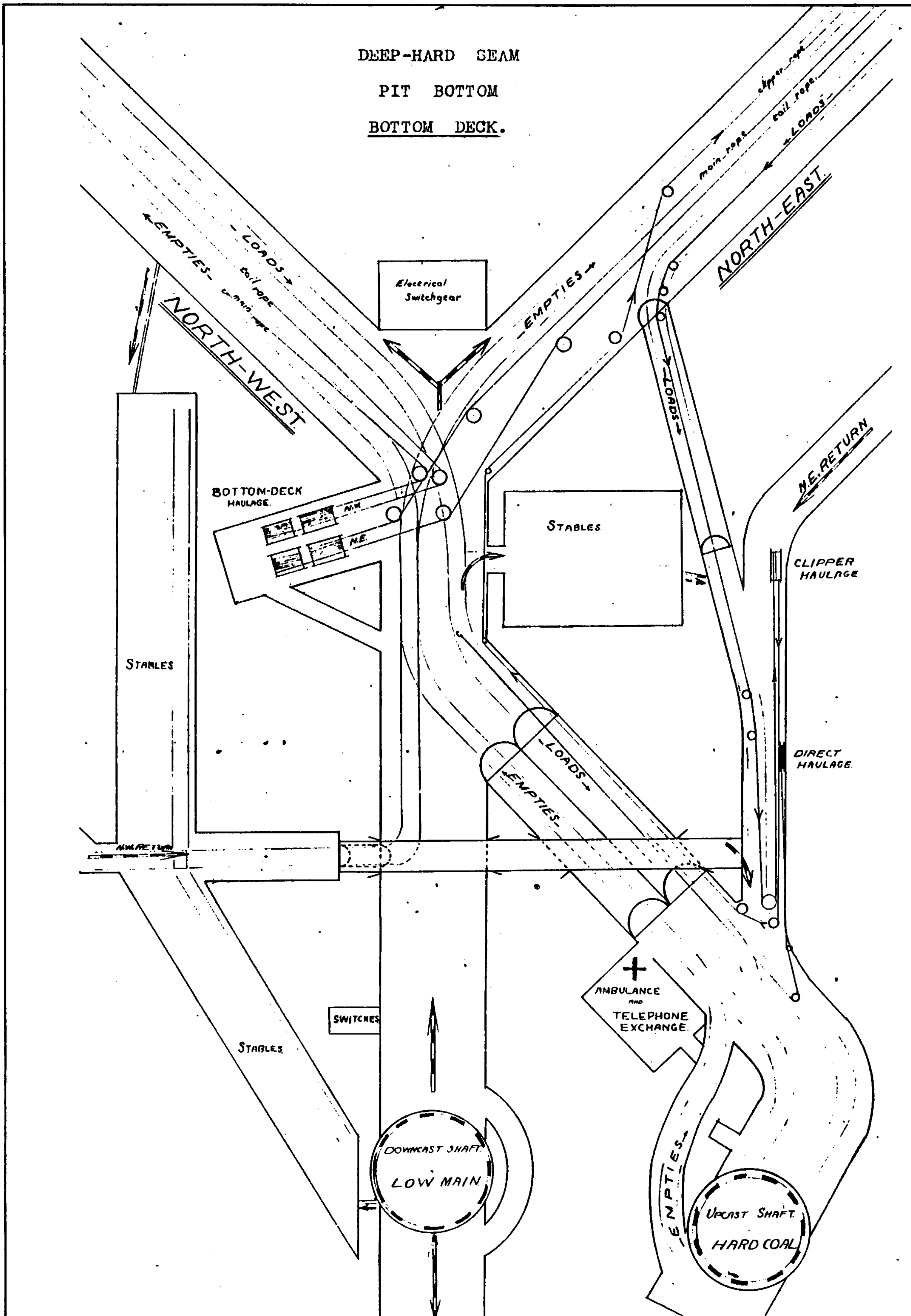
The life of a winding rope is 3½ years and recapping is done at intervals of not more than six months in accordance with the Coal Mines Act. The ropes are capped by the "lacing" method, which is briefly as follows: the rope is bound with soft wire at a point about ten feet from the end. The six strands are then unwound up to the binding and the hemp core cut away. Each strand in turn is then doubled back over the binding and laced, under the next strand, over the second and under the third. Three wires are then removed from the protruding section of each of the six strands which are then again laced under two alternate strands. Six wires are then removed from each strand leaving only the six-wired core. This also is laced under two alternate strands. The effect of decreasing the cross-section of the lacing in three stages is to form a conical end, which is necessary if efficient wedging in the cap is to be accomplished.

The wrought iron cap is brought from the blacksmith's shop at a bright red heat and is closed over the end of the rope with hammers. The final fixing of the cap is by three wrought iron ferrules which are knocked down tight on to the cap.

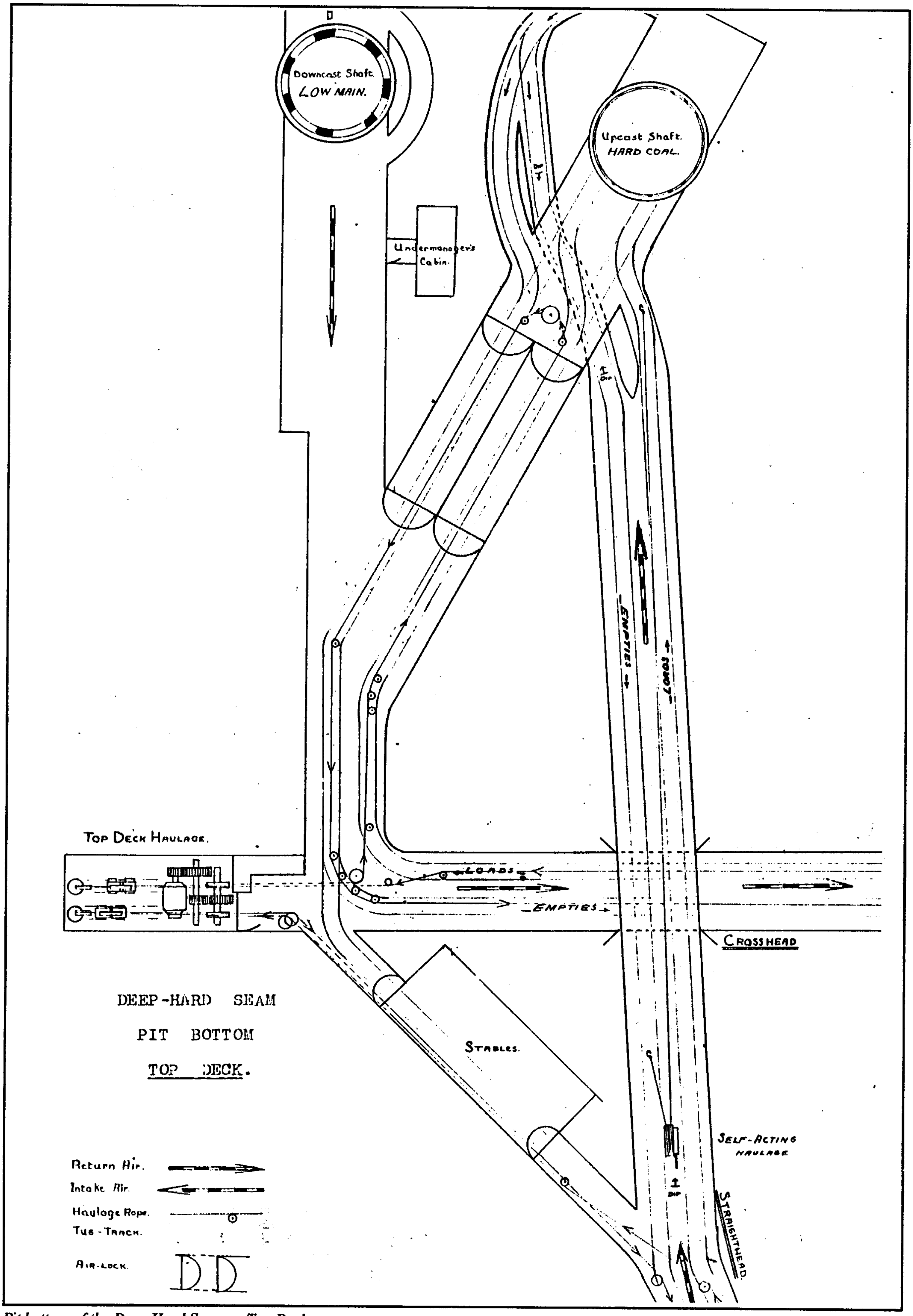
Tubs are wound four at a time and the normal rate of winding is one every 43 seconds. The winds are recorded by the onsetter by gliding washers along rods, one for each deck. At the beginning of each shift all the washers are on the left but as the shift progresses they are moved to the right, one washer signifying one wind of two tubs (one "bantle"). At the end of each hour the number of winds is chalked on a board.

When men are wound they ride on the bottom deck of the cage only, twelve men comprising one bantle. The number of men is recorded by chalk on a board. Example:- 12 + 3, chalked on the board means 12 bantles + 3 men = 144 + 3 = 147 men. The banksman also makes a record of the winds.

For coal winding, signalling is by electricity, the onsetters switch actuating a bell on the bank, a bell and one of the two indicators in the engine house. When the banksman is ready and has received the signal from the onsetter, he presses a bank switch which activates a bell and an indicator in the engine house. The winding engineman then knows that both onsetter and banksman are ready for winding. The following signals are used at all times in connection with winding in shafts:-



Pit bottom of the Deep Hard Seam - Bottom Deck.



Pit bottom of the Deep Hard Seam - Top Deck.

(a) For winding persons:-

1. When a person is about to descend, the Banksman shall signal to the Onsetter and to the Winding Engineman --- 3
Before the person enters the cage the Onsetter shall signal to the Banksman and to the Winding Engineman --- 3
When the cage at the bottom is clear and ready to ascend, the Onsetter shall signal to the Banksman and Winding Engineman --- 1
When the person is in the cage and ready to descend the Banksman shall signal to the Winding Engineman --- 2
When a person is about to ascend the Onsetter shall signal to the Banksman and to theWinding Engineman. --- 3
Before the person enters the cage the Banksman shall signal to the Onsetter --- 3
When the person is in the cage and ready to ascend, the Onsetter shall signal to the Banksman and to the Winding Engineman ---1
When the Banksman has received the signal "1" from the Onsetter he shall signal to the Winding Engineman --- 2

(b) For winding otherwise than with persons;-

To raise up	1
To stop when in motion	1
To lower down	2
To raise steadily	4
To lower steadily	5

CAGE SUSPENSION

The weight of each cage is taken by four "bull" or "hanging" chains, one connected to each corner. The tops of these chains are attached to a link, the pin of which passes through the bottom of the King's Detaching Hook. As a precaution against one or more of these chains breaking, two more chains, one for the middle of each side of the top of the cage, are also attached to the link.

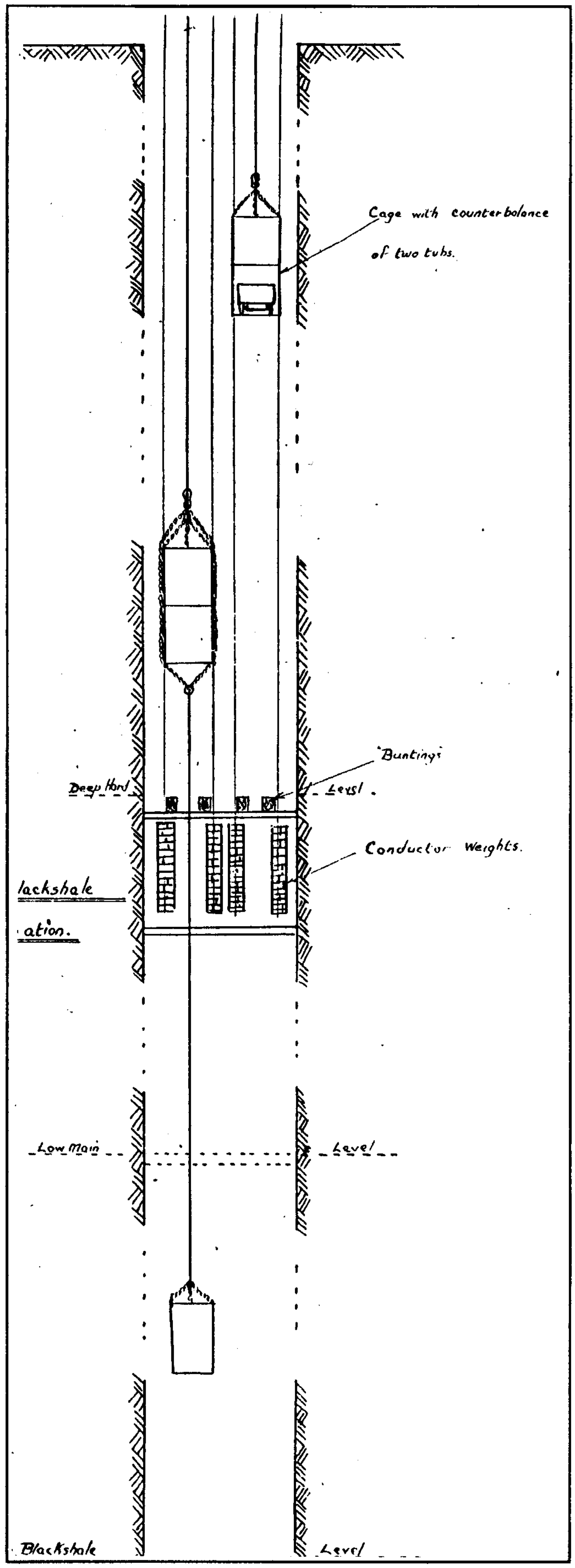
The King's hook is of the type having four points of support at an overwind. The operation of the hook is thus:- if the overwinder apparatus in the engine house fails to arrest the cage on the occasion of an overwind, the King's hook passes through the catch plate, which, pressing on its ramps, shears the copper rivet and opens the hook in the fashion of scissors, immediately releasing the link of the winding rope. The winding rope is then free to continue its journey over the head pulley. Owing to the fact that the rope is stretched slightly while the hook is opening it springs clear of the head pulley when released and descends with great violence on the engine house roof. The shock of the release is generally sufficient to render necessary the recapping of the rope. Before doing this, however, the cage is lowered to its proper place by inserting a link in the hole specially provided in the hook. When the weight of the cage is taken on the rope this link slides in specially shaped holes in the hook which causes it to close. The cage may then be lowered on to the keps at the bank.

VENTILATION

Details of the fan, and the system of ventilating the four districts have been dealt with already.

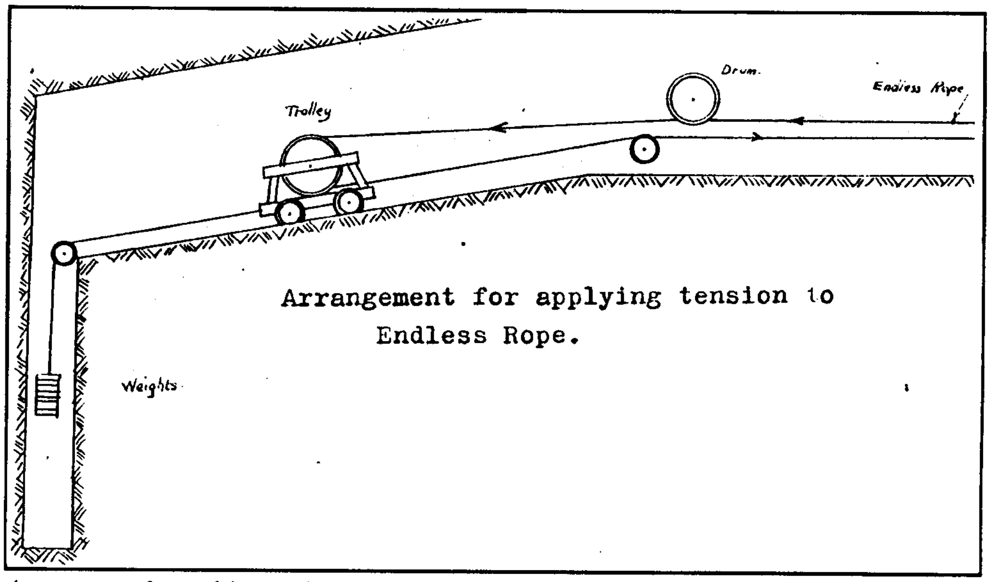
At the top deck the intake from the downcast shaft travels to the Crosshead District and returns via the Straighthead District. The air reaches the upcast shaft by means of the Straighthead road, which crosses the intake road as an overcast.

To ventilate the top deck stables a small opening exists above the doors whereby a small amount of air is circuited through to the return.



Method of winding cage for shaft examination down to the Black Shale level

At the bottom deck from the N..E. District the air travels inbye along the main haulage road, and returns direct to the upcast by way of the N.E. return. The small stables are ventilated by a pipe emerging in the N.E. return.



Arrangement for applying tension to an endless rope.

The N.W. District intake is along the main haulage road. The return enters the large stables and is thence overcast to the pit bottom, clear of the main intake and the double airlock. The bottom end of the large stables receives air by a pipe from the downcast shaft, while the top end has a pipe connected to the N.W. intake.

Measurement of Air

Anemometer readings are taken every Saturday morning in the returns, and in addition, monthly readings are taken in the intakes. About one quarter of a mile inbye the N.E. return is connected to the Low Main seam by an incline, up which a certain amount of air is drawn. Anemometer readings for the N.E. District have, therefore, to be taken beyond this point. Measurements in the N.E. intake are made at a point about 200 yards along the road, at a point where there is no means of air leakage through loose roof packing, the solid roof in this place being in contact with the horizontal timber.

The N.W. intake is recorded at a similar point on the N.W. haulage road. Return air from this district is measured in the return before it emerges into the stable.

The Crosshead intake is measured directly below the overcast where the walls and roof are solidly built and free from leakage, and the return is measured a short way along the Straighthead.

The total bottom deck intake is measured just north of the downcast shaft.

A 20% increase in volume of the return air occurs due to temperature rise during circulation around the workings.

In order to maintain the air flow around the coal face and to prevent short circuiting to the return, brattice cloths and doors are used at the entrances to certain levels and gates. Pockets in the roof are susceptible to gas accumulation; in order to remove this source of danger, "regulators" are used. These are brattice cloths running from the floor to a horizontal bar fixed at about 6 inches from the roof, the air has to pass over this obstruction and in doing so it is able to flush the pockets in the roof.

HAULAGE SYSTEMS

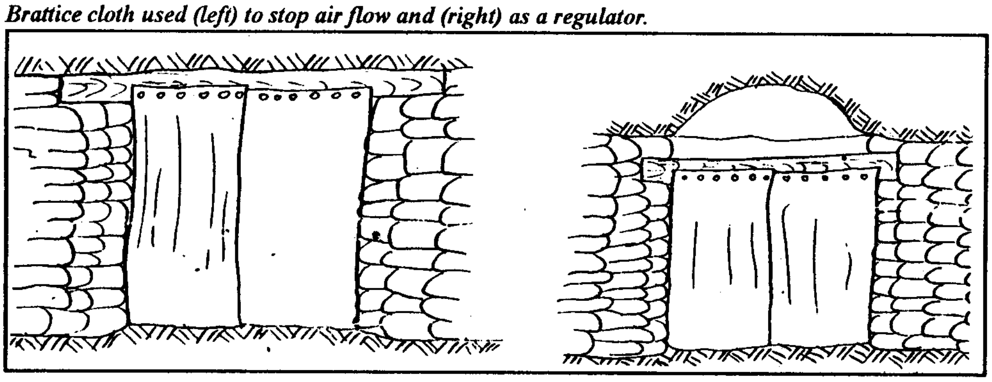
Hand haulage is is only employed at the coal face one man being able to propel a tub along the bank road to the gate end. Haulage between the stalls and the main roads is done by ponies. On horizontal roads four tubs may be "ganged" at once but, as a rule, this figure is realised only with empty tubs, the usual number of loaded tubs being two.

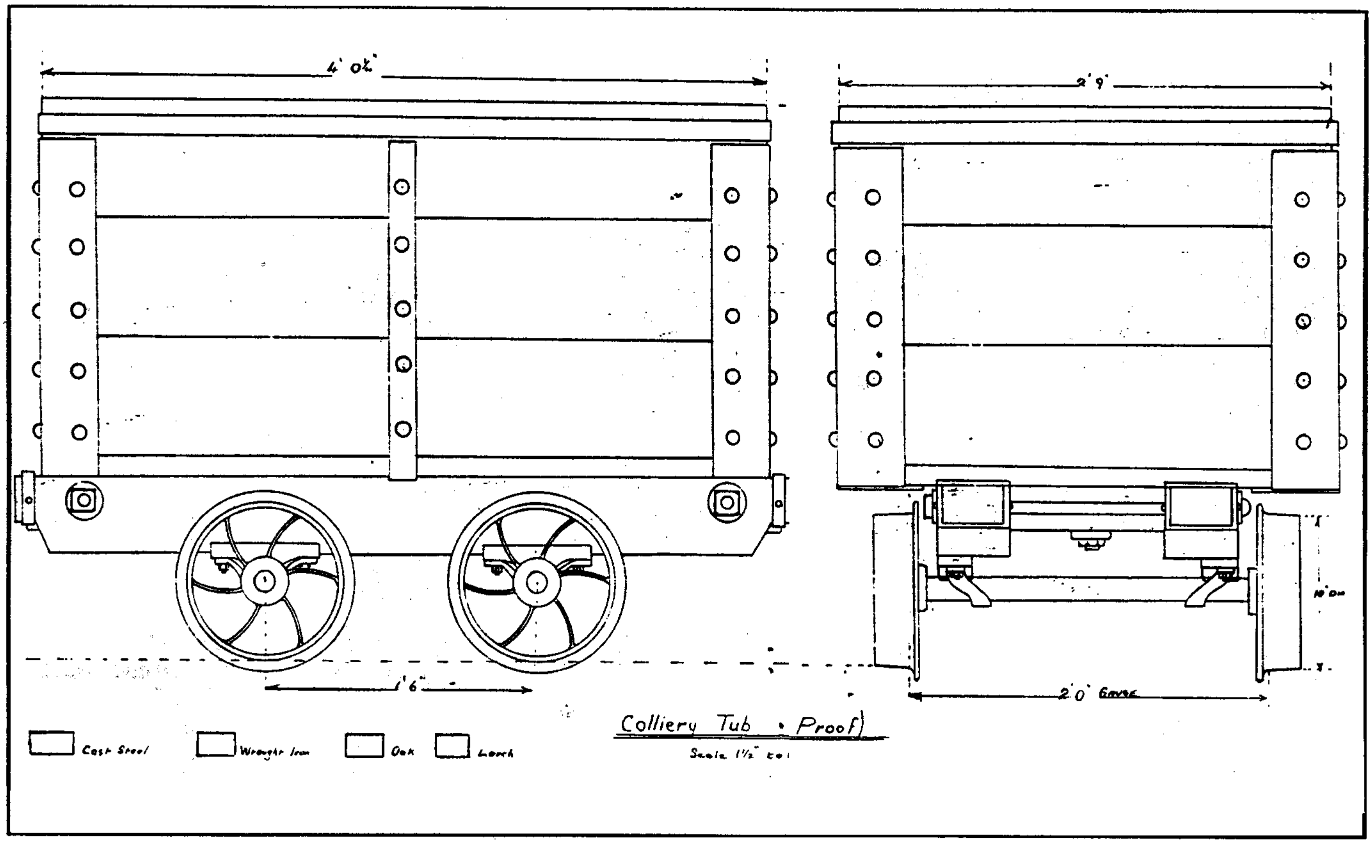
Where the main roads are to the rise, self-acting, gravity haulages ("jigs") can be employed, the empties being pulled up the incline by a rope which passes round a brake-drum at the head of the incline, and is thence attached to the rear of the loaded train. On account of friction in the tub bearings and of the rope on the ground and on the brake drum, a minimum incline of 1 in 10 is required. The inclines may have four, three or two rails, the two latter cases requiring a pass-bye where the two trains meet. The four rail system involves no points but has the disadvantage of requiring a wide road. The three rail system does not require such a wide road and has a pass-bye with no moving parts, while the two rail system saves considerable expense in road widening and upkeep and has automatic points.

On one particular three rail system employed in the N.W. of the Hard Coal Seam the road is not straight and there is thus a tendency for the downcoming train to run over the rope. This difficulty is overcome by employing a device known locally as "the patent". The patent is hung on the side of the leading loaded tub and the rope is lifted on to the pulley. By means of this device the rope is kept clear of the wheels of the descending train. When the pass-bye is reached the angle between the on-coming and the off-going sides of the rope becomes too large for the pulley to hold it, hence the rope frees itself from the pulley and passes across to the upcoming side of the road.

Various safety measures are employed on these inclines. At the top of the incline, on the empties side, a runaway switch is fixed to allow the tubs to pass up the incline but to catch the axle of a tub should the rope break or the train run away. A drag is carried by the last ascending tub to stop or derail the train in the case of a runaway. On the loaded side, until the required number of tubs have been coupled and the rope attached, the train is held by a locker or by a "jut", both being used in most cases. Between runs of the "jig", the bottom end of the rope is attached to a link which is

Brattice cloth used (left) to stop air flow and (right) as a regulator.





Dust-proof tub of the type used at "A" Winning Colliery.

secured by a chain to a stout bolt passing through a sleeper; this is a safety measure to prevent the loaded train starting before the rope has been attached to the train of empties. Lockers either of wood or steel are used in the wheels of the tubs during marshalling at the top of the incline.

Signalling

A three-wire system of electric bell signalling is employed, the circuit being so arranged that by making contact between the middle wire and one of the outside wires one or other of the electric bells is operate. The signals employed are (Regulation 98, C.M.A. 1911):-

To stop	1
To lower	2
When persons are about to travel up or down the incline	4
This signal shall be acknowledged by signalling	4

MECHANICAL HAULAGE

For short distances, as in the-bottom deck of the Hard Coal Pit Bottom, or in inclined levels where pony haulage would be too arduous or too slow, single drum direct haulages are employed. That used in the Hard Coal Pit Bottom is of 10 H.P, rope speed 1.5 m.p.h. Two similar haulages are used in the Low Main pit bottom, and two levels to the dip in the Low Main seam have their own haulages. The journey to the dip with the train of 16 empties is assisted by a pony, the drum being free-wheeled, and the friction of the rope on the ground being sufficient to check the speed of the train.

The N.E. and N.W. haulage roads are served by a 100 H.P., 4-drum engine main and tail haulage gear. The 100 H.P., 480 r.p.m. motor by Vickers Ltd., transmits the power through a 5 to 1 reduction rope drive. The drums are 7 feet in diameter. The lengths of the N.E and N.W. main ropes respectively are 3,000 yards and 1,300 yards and their haulage speed is 8 m.p.h.

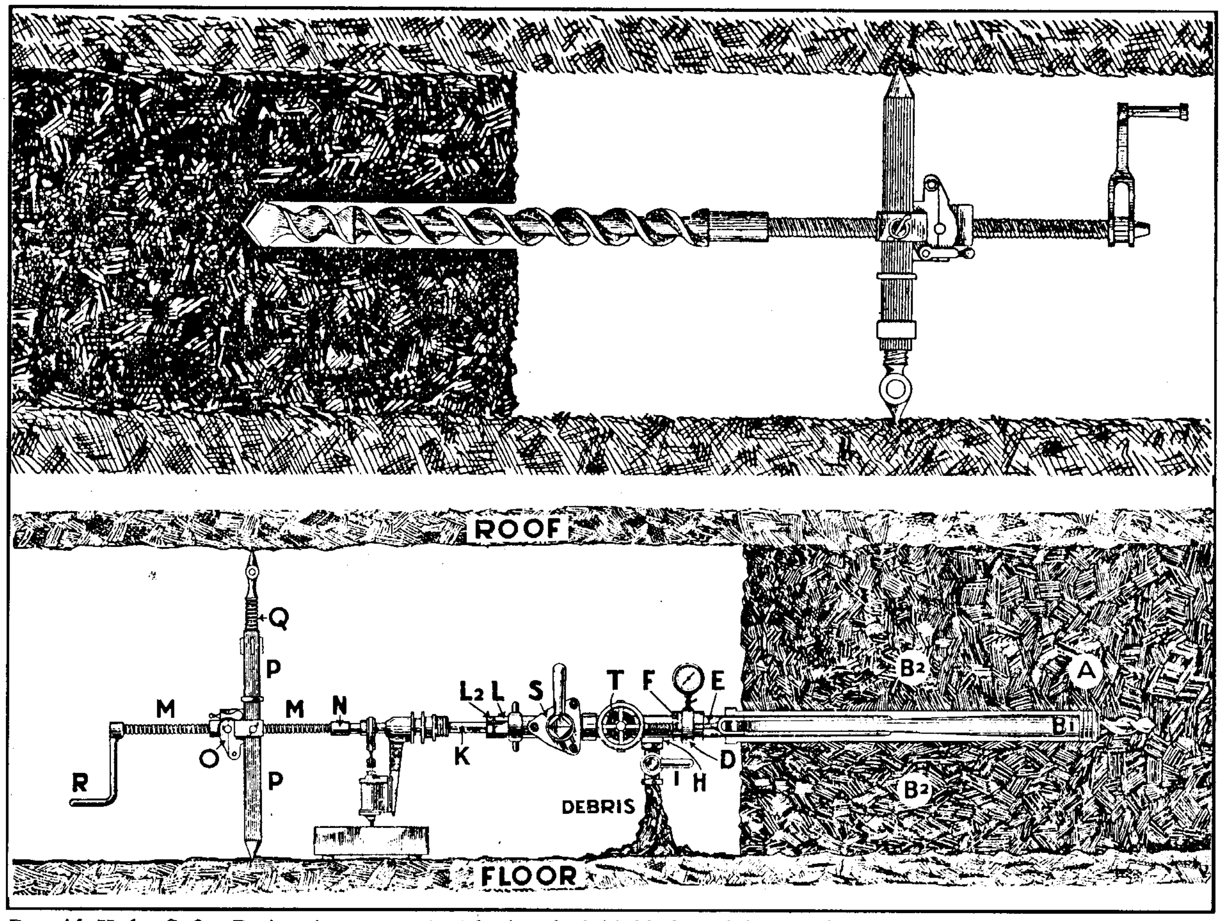
The motor is started through a liquid controller containing soda solution. The rotor is slowly short-circuited through the liquid resistance, but after being brought up to speed a switch, in parallel with the controller, is closed to give a more efficient contact. The oil-immersed Master Switch is by J.H. Holmes.

In the N.E. the main road is driven steeply to the dip from the return-wheel inbye and in order to pull the train of loads up the hill a back-rope is attached to the rear of the main and tail train. On hauling outbye the back rope pulls the load up the incline to the turn-out. The back rope is detached from the main and tail train which proceeds along to the pit bottom.

The bell signals for the main and tail haulage (Regulation 98. C.M.A, 1911):-

To stop.	1
To haul inbye.	2
To haul outbye	3
To slack-out tail-rope	4
To tighten tail-rope	5
To slack-out main-rope	6
To tighten main-rope	7
Cautioning signal toaccompany the above when persons are about to be conveyed	8

The top-deck haulage in the Deep Hard Coal uses a 60 H.P., two-drum endless rope gear with a rope speed of 2.5 m.p.h. The required tension is kept in the two endless ropes by means of tension trolleys connected by chains to heavy suspended weights. The "Clipper" Haulage in the pit bottom is a single drum endless rope gear with a rope speed of 2.75 m.p.h. The motor is 50 H.P., 920 r.p.m. by Westinghouse. This haulage is non-stop, the trains being clipped-on and knocked-off while the rope is running. "Smallman" patent haulage clips are used for attaching the trains to the endless ropes.



Burnside Hydro-Safety Boring Apparatus: (top) boring the initial hole and (bottom) boring with the watertight joint in place.

TUBS AND RAILS

The Coal Mines Act, 1911, Prevention of Coal Dust, Regulation 62, reads:- "The tubs shall be so constructed and maintained as to prevent, as far as practicable, coal dust escaping through the sides, ends or floor of the tubs."

The tubs used (see diagram) are constructed in the conpany's own workshops. The sides, ends and bottom are of thick larch wood, English oak is used for the underframe, the cast steel wheels and axles are supplied by Hadfield's and iron band and corner irons are used to strengthen the tub.

Rails are two feet gauge and sleepers are of wood three feet in length.

DRAINAGE

"A" Winning Colliery contains very little water, the greater part of which is pumped to the surface owes its presence to slight leaks in the shaft lining.

The Low Main pit bottom contains a 10 H.P., 3-throw pump by Joseph Evans and Co. of Wolverhampton, driven by a 10 H.P., 920 r.p.m. motor by the Electrical Construction Company, also of Wolverhampton.

The Hard Coal seam contains water in one place only, where a fault traversing the N.W. main haulage road causes a slight seepage. This is baled into steel tubs and transported to a portion of the old workings, into which it is allowed to drain. Removal of the water at the rate of four tubs a day balances this small influx.

Under this heading we may also include a description of the "Burnside Hydro-Safety Boring Apparatus" which the writer had the experience of using (see illustration). This apparatus has been developed by George Burnside Ltd. of Philadelphia, Co. Durham, to avoid the loss of life, such as has occurred in the past, from holing into old workings in which gas or water have accumulated under pressure.

A few of the advantages of this apparatus are;-
(a) Old mine workings can be tapped under any pressure and in perfect safety.
(b) After fluid has been tapped the boring apparatus (rods and bit) can be withdrawn and the cock closed. The fluid may then be run off from the apparatus or piped away to a convenient place.
(c) Boring can be done to the rise, horizontally or to the dip. In the former case special valve rods are used to retain the water while extra rod lengths are being added.

The longest hole yet bored by this apparatus was 702 feet and was still in the coal. The record pressure yet tapped is 335 lb./sq. inch. The special feature of the apparatus is the method of wedging the tube firmly in the hole. This is accomplished as follows:- A hole $4^1/_{16}$ inches diameter is first bored. Two plates are driven in so as to tighten a wedge against the plates to force rubber washers tightly against the coal, thus making a watertight joint.

The 2½inch boring rod is inserted and a rod is inserted through the stuffing box and screwed to the borer. To the outer end of the rod is attached the pump, the action of which is to force water through the rods for the purpose of "mucking". A feed screw is coupled to the pump by the square coupling box, and the feed block is supported by the standard. Finally the handle is attached, all being ready for boring as soon as a trough of water has been placed below the pump and the debris cock has been opened.

When two feet have been bored the short coupling is replaced by a two feet coupling box. After boring this a further two feet, another two feet rod can be inserted, between the pump and the borer, care being taken to close the water hole in the rod by the finger during the changeover. This precaution saves the necessity for using a "steady" rod instead of a feed screw until the pump has refilled the rod with water.

During an average shift 40 to 50 feet will be bored by two men. The advisability and necessity of keeping holes well ahead of the coal is of great importance in this part of the County, where many old workings exist, whose extent may not be accurately known, owing either to the absence of old plans or to their inaccuracy. This is often due to shrinkage of the paper with age.

Unlike "A" Winning, Shirland Pit contains a very large quantity of water. This is pumped to the surface and part thereof is conveyed by pipe line to Blackwell where it supplies drinking water for the ponies and reserve feed water for the boilers.

LIGHTING

The surface buildings, pit bottoms and part of the estate are illuminated at 110v by the lighting set described above.

Safety Lamps:- The Hailwood & Ackroyd type O.I.B. flame lamp is favoured at this Colliery exclusively. This lamp has a 28 mesh gauze surrounding a combustion tube. The air enters through the top glass ring, passes through the lower part of the outside gauze, thence through the gauze surrounding the combustion tube. At the bottom of the combustion tube glass the air enters the region of the flame. After combustion the gases pass up the inside of the combustion tube, through the top of the gauze and then into the atmosphere by way of the holes at the top of the bonnet. This lamp gives a very good light of about 2½ c.p., maintaining this throughout the shift.

Electric lighters and magnetic locks are used, ensuring both safety and quick lighting. Lamps are cleaned and refilled at the conclusion of every shift, and each man always uses the same lamp, for which he alone is responsible during the shift.

During the last year the firm of Hailwood and Ackroyd have introduced a new lamp known as the "Air Distribution Chamber" or A.D.C. type. This is similar to the O.I.B. but has interposed between the lamp bush and the oil vessel a special gauze air feed ring surrounded by the Hailwood Air Distribution Chamber which picks up air in whatever direction it is moving, and concentrates it in the chamber. In windy places an air valve could be turned completely off, while in hot or slow moving air it could be opened fully. This lamp gives from three to five candle power.

Three of the Company's O.I.B. lamps were converted to the A.D.C. type and found favour with the men. One difficulty arises, however, namely the excessive heat of the bonnet, which became, painful to touch. This was overcome by adding the bonnet protector as fitted to the latest type. In this the air distribution chamber has been greatly reduced in bulk and is now compact and free from the protruding valve box.

SURVEYING

The Miner's Dial is used for practically all underground work, on account of its simplicity, light weight, and speed in use. Theodolite stations are liable to movement through subsidence, unless well back from the face, hence it is inadvisable to establish these until the ground has had ample time to finish moving. Dial surveys have to be brought back to a fixed station when a high degree of accuracy is required, but for the quarterly surveys it is generally sufficient to link up with a road junction or some similar well defined point. When in use the dial is set up in a place free from iron where the needle gives a true reading. The vernier is zeroised on the needle which may then be clamped. A "fast needle" or "continuous azimuth" survey is then carried out, checks with a free needle being obtained as often as possible.

By law the movement of the face must be checked by a survey at least every three months. Where roads are maintained or progress is slow chain surveys are sufficient to record the advance of the face. The writer assisted in such a survey at Sutton Colliery on August 31st (1933). Surface triangulation is carried out by means of theodolite.

THE NEW BY-PRODUCT COKE OVEN PLANT

Coke was made originally in the beehive ovens at "A" Winning Colliery, but in 1913 a battery of Waste Heat By-Product Coke Ovens was erected. Ten years later it became necessary to extend the coking plant. After a careful survey of the merits of the different types of coke ovens, coupled with bulk tests of the coal in various types of ovens, it was decided to erect Kopper's Regenerative Taper Ovens of the latest design, and accordingly the contract for the new plant was placed in December 1924, with Kopper's Coke Oven Company Limited, of Sheffield. The results of the experimental tests showed that in order to obtain coke of the best quality it would be necessary for the coal to be compressed before charging into the ovens. The ovens were accordingly designed for carbonising the coal under compressed conditions.

The coal carbonised at Blackwell is from the Low Main seam, and has certain interesting characteristics. For a coal used for the manufacture of metallurgical coke, the content of the volatile matter is high, being between 37% and 38%, when freshly mined and dried at 105°C. As is natural with such coals the oxygen content is also high, and amounts to 10%. The coal is readily oxidisable and on this account cannot be stored for more than a week or two without serious deterioration.

A further feature of this coal which adversely influences the period of carbonisation, is that it is of a highly hygroscopic character. If the coal be exposed to the air it will be found to contain from 6% to 7% of hygroscopic moisture whilst appearing to be perfectly dry to the eye and hand. The deleterious effect of this moisture arises from the fact that however perfectly the coal is drained, whether in bunkers or in mechanical driers, 6% to 7% of hygroscopic moisture must always be added to the quantity of surface moisture notionally left in the coal. As this water cannot be removed by any known mechanical means (a temperature of 105° is necessary) it results in coal being charged into the oven containing a high percentage of moisture. The ovens have an average width of 18 inches and burn off in a period of two to three hours, as compared with a period of 37 hours in the older ovens. The capacity of the new taper ovens is 72 tons of coal (wet) per week, which compares with 41 tons in the case of the older ovens.

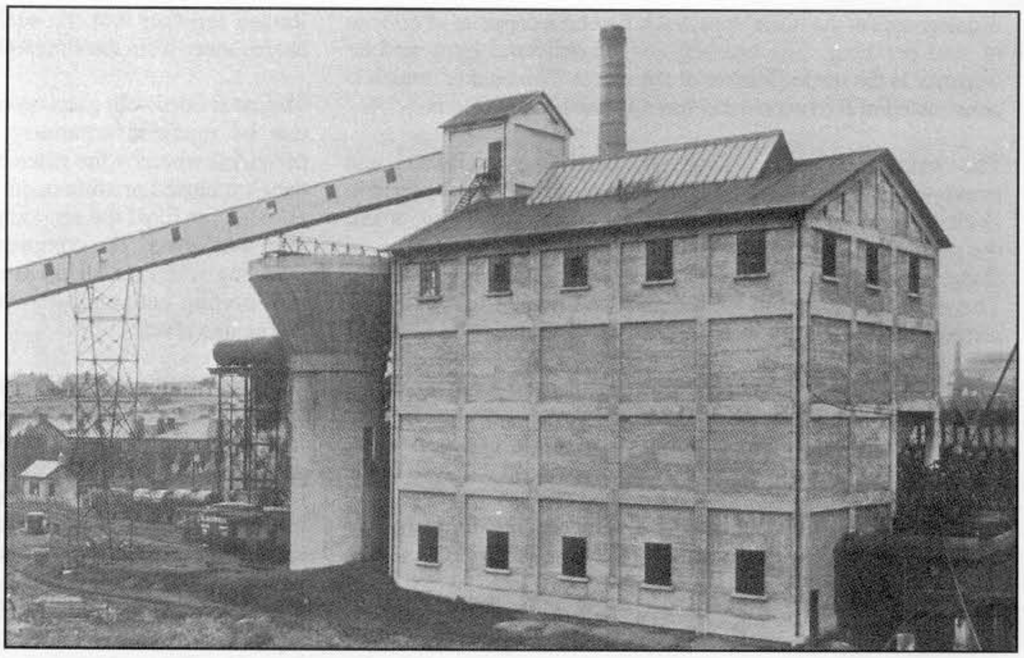
The new installation consists of a battery of 40 ovens, designed on the latest principle, together with a complete by-product plant for the recovery of tar, ammonia and crude benzol.

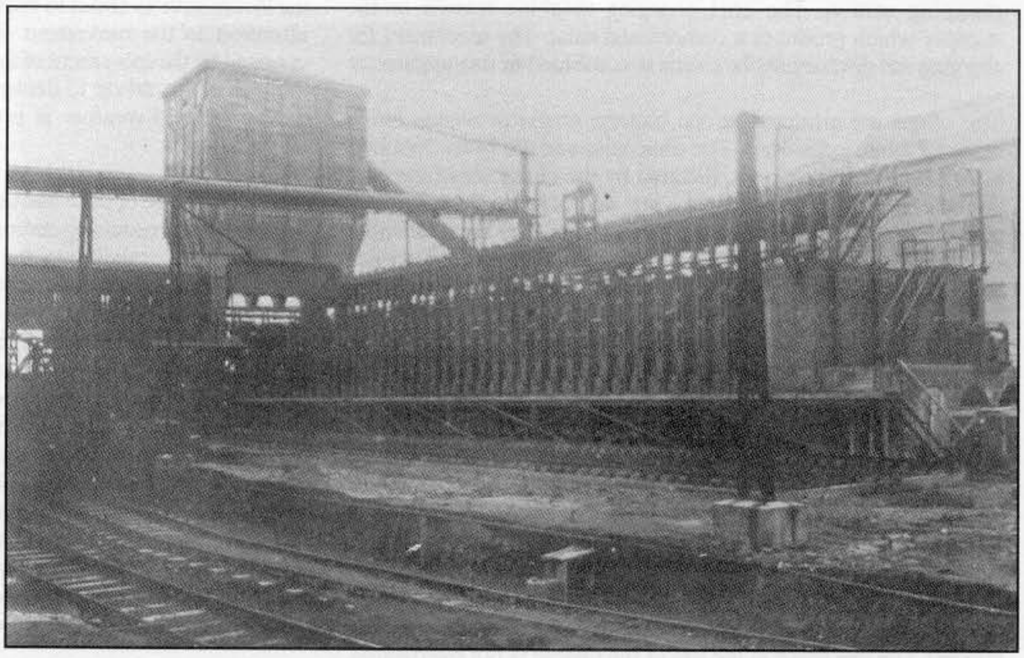
There is also a coal screening plant having a capacity of 1,200 tons of coal per shift, and a coal washer designed on the Hunter-Baum System capable of dealing with 75 tons of coal per hour.

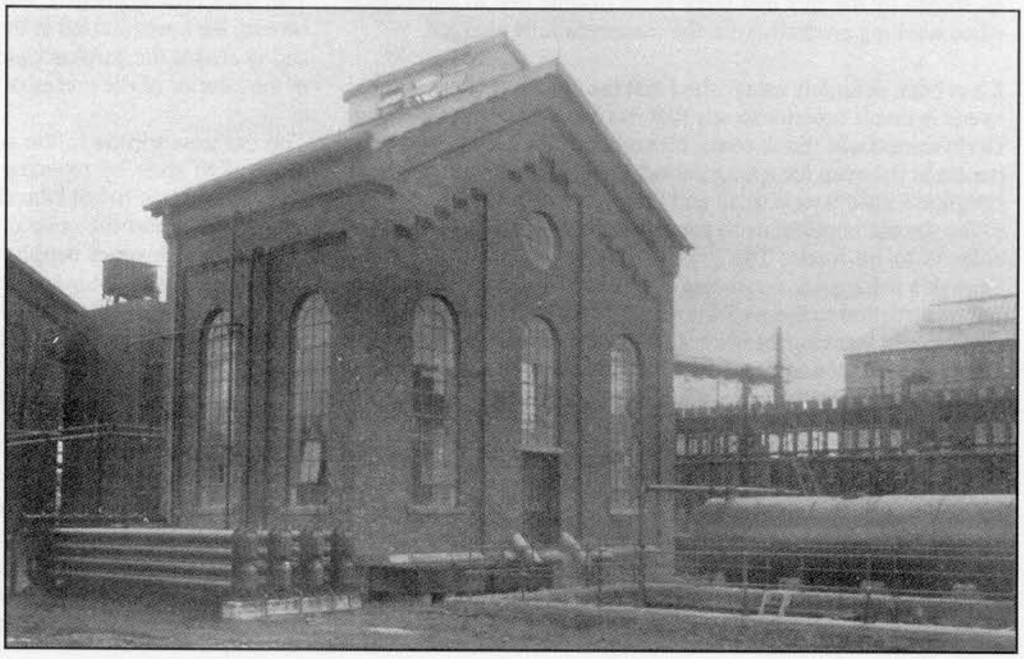
Small coal from the Low Main screens is taken by an inclined rubber conveyor, 45 feet long by 22 inches wide, to the coal washery, and is delivered into a receiving hopper of 50 tons capacity, placed on the top of the washery building. Provision is also made for washing coal brought by railway wagons from other collieries. In this case coal from the wagons is discharged into underground hoppers, whence it is elevated by a continuous bucket elevator to the main washing box. The discharge of coal from the elevated receiving hopper is regulated by means of a revolving feed table by which it is delivered to the main washer. The plant is provided with a main washer and with a second apparatus for rewashing the fine coal, both washing boxes being actuated by compressed air. The coal leaving the main washer is flushed along launders by the accompanying water to a revolving screen where it is classified into nut coal from 1½ inch to ⅞, and fine coal below ⅞ inch. The nut coal is delivered into a storage hopper, having a capacity of 150 tons.

The fine coal which has passed through the screen is conveyed in a launder by the accompanying water to a sump from which it is raised by an elevator to the fine coal washer to be subjected to a second washing. After re-washing the fine coal is conveyed to two pairs of draining screens.

On leaving the screens the coal is delivered to a pair of distributing scraper conveyors placed over the main drainage bunker situated in the washery building. This bunker is of ample size to permit of the reduction of the surface moisture to the lowest practicable figure. It is divided into 10 compartments, having a total capacity of 1,500 tons of coal. The dirt eliminated in the washing operation is conveyed into a bunker at the end of the washery building and then to the waste heap by means of an aerial ropeway. Each outlet of the compartments of the drainage bunker is furnished with a revolving feed table to regulate the discharge of the coal. The coal is delivered by these tables on to two indiarubber conveying belts, and is taken to one of two







(Top) View of coal washery.
(Middle) View of the coke ovens from the ram side.
(Bottom) Exterior of the Benzol House, with product tanks and Wolff's coolers.

disintegrators of the "Carr" type, each having a capacity of 50 tons of coal per hour. The crushed coal is delivered by a scraper conveyor to the service bunker at the ovens. The bunker, which is constructed of ferro-concrete, has a capacity of 600 tons.

The water used in the washing operation is collected and conveyed along launders to a pump sump, whence it is raised to an elevated slurry tank placed outside the washery building, where the matter in suspension settles and is drawn off in the form of sludge through a discharge opening fitted with a three-way cock. The sludge is delivered for draining on to two pairs of jigging screens, situated above the fine coal storage bunkers, where it is mixed with the fine (washed) coal.

The clarified water from the settling tank flows by gravity back to the washery. A system of drains is provided for catching all the water from the drainage bunker. This water is led to a well in the basement of the washery, from which it is raised to the clarifying tank by a centrifugal pump. The washery building and the drainage bunker are constructed of reinforced concrete with a reinforced concrete roof carried on steel principals.

The coal is taken from the bottom of the storage bunker at the ovens by means of a short scraper conveyor to a stationary stamping station. The coal charging machine travels to the stamper which produces a compressed cake. The machinery for charging and discharging the ovens is combined in one apparatus.

The ovens are arranged in one battery, ample provision being made for future extensions. The dimensions of the oven chamber, have been, to some extent, dictated by the character of the coal and the necessity for compressing and it was therefore not possible to install the latest, narrow, tall ovens. The oven chamber is 8 feet 6 inches high, 32 feet 2 inches long, by 18 inches wide and takes a charge of 9¼ tons of wet coal, the battery being capable of carbonising 130,000 tons of coal per annum. The material used in the construction is first class silica brick. A chimney, 160 feet high, with an internal diameter at the top of 6 feet 6 inches provides the necessary draught.

It isa particularly important feature of the Kopper's system that the coal is carbonised at the top and bottom of the charge simultaneously. Short coking periods can only be obtained in other systems by the aid of narrow chambers, combined with very high temperatures which lead to the decomposition of gas and tar. The ovens are insulated by non-conducting bricks at the top and ends of the battery, with the result that a great saving in heat is effected. The free space at the top of the charge is not overheated, as shown by the fact that there is no trouble due to napthalene when working normally with the chambers fully charged.

It has been definitely established that the coke produced in these ovens is much superior to any that has hitherto been made from Derbyshire coals. Such coals, if overheated by being allowed to remain in the oven for a long period after carbonisation has been completed, always yield small and fingery coke. It is consequently of the utmost importance to avoid overheating if a good class of coke is to be made. The coke is discharged from the ovens through a coke guide consisting of a metal hood similar in shape and construction to the well-known Darby quencher, but without provision for watering the coke. A further feature of the apparatus is the provision of a cast steel bottom plate fixed in such a manner as to form a floor, the top of the plate being about 1 inch below the oven floor level.

The hot coke is pushed over the floor of the guide into the coke car. This car is 36 feet long and 13 feet 8 inches wide and moves along the front of the ovens as the charge is being pushed, so that the glowing coke is spread in an even layer along the full length of the car. The car is mounted on two four-wheel bogies: the front, sides and floor are made of cast-haematite iron, and the plates so jointed together that the surface is smooth and flat. The floor slopes away from the ovens at an angle of 27°.

The car is fitted with gates operated by compressed air. Each gate can be operated separately, if desired and arrangements are provided whereby the gates become automatically locked when they are closed or wide open. The car is drawn by a locomotive, on which is fixed the air compressor for supplying the cylinders on the coke car. The compressor is entirely automatic in action, stopping when the air pressure in the cylinder reaches 100 psi. and starting automatically as soon as the pressure is reduced below this level.

The electrically powered, four-wheel coupled locomotive has a speed variation from 400 feet per minute for normal running to 40 feet per minute when loading coke on the car. Dual braking system is employed, an electrically operated device being used in ordinary circumstances, whilst there is a reserve compressed air brake which may in cases of emergency be further extended in its range to act on the wheels of the coke car in addition to the wheels of the locomotive. Provision is also made for sanding the track. The driver's cabin contains all the necessary operating gear, and is provided with current meters and pressure gauges, switches and fuses. Headlights which change colour indicate in which direction the locomotive is about to move, whilst a signalling whistle calls attention to the movement. In addition, a gong, mechanically operated by the movement of the car, eliminates any deficiency on the part of the driver to declare his intention. The comfort of the driver in cold weather is provided for by the inclusion of an electric heater.

When the charge of coke has been placed in the car it is conveyed to the central quenching station. The quenching tower comprises a hood which takes into the atmosphere the steam and gases generated during the quenching operation. As soon as the coke car is in position water from a tank 50 feet above is allowed to flow from the overhead tank through a series of pipes and sprays above the coke. The sprays are of a special design, so that there is no danger of the nozzles blocking up, and are arranged in such a manner that the whole mass of coke is subjected to the action of an almost continuous sheet of water. More efficient quenching and a lesser moisture content is obtained than with hand quenching, the quantity being about three tons of water per ton of coke. Surplus water flows into a large settling tank. Here the finest or smallest particles of breeze washed away during the quenching operations settle and the water, freed from suspended solids, is pumped back into the high level water tank.

The coke now quenched, but still steaming, is withdrawn from beneath the tower and left in the car for a short period for draining and to enable the surplus water to be evaporated by the heat still in the interior of the pieces of coke.

The car now travels to the coke wharf on to which the coke is allowed to slide by opening the car gates. The coke wharf is sufficiently large to hold the charge from six ovens. At the lower end of the wharf the coke is prevented from slipping down by finger gates. A water supply is arranged conveniently for hand quenching, if required. A conveyor, made of indiarubber belting 36 inches wide, takes the coke from the wharf to the screening station where it is discharged on to a grizzly screen, where the breeze below 1¼ inch in size is eliminated and falls into a breeze hopper, for loading into wagons as desired. The larger coke passes over the screen on to a chute whence and via a belt and chute into the wagons.

Only two men are required for the operation of the Coke Handling Plant. The driver of the electric locomotive operates the coke quenching station, and is also responsible for the discharge of the coke to the loading wharf as well as for its transference to the conveyor leading to the screens. The second man attends to the screen and to the loading of the coke into waggons.

The gases evolved during the distillation of the coal are conducted by the ascension pipes to a collecting main placed centrally above the battery which leads to the by-product plant. The heavy tar vapours condensed in this main are removed from the gas stream by a pitch trap, whilst the hot gases, now cooled to a temperature of 140°C. are further cooled to atmospheric temperature by flowing counter-current to a stream of cold water in the preliminary cooler. This leads to the condensation of the liquor and the greater portion of the tar which form layers in the 23,000 gallon separating tank and are run off from time to time into their respective 28,000 gallon storage tanks. The gases leaving the coolers still contain a small quantity of tar in the form of tar fog, which is eliminated by a tar extractor through which the gases are drawn by an exhauster. A steam supply is arranged to the tar extractors in order to keep the tar fluid in cold weather, and to clean the perforations of the drums.

The gas leaving the exhausters passes into the sulphate house. In accordance with the usual Kopper's practice, the gas is first passed through a pre-heater where its temperature is raised by means of exhaust steam to 65°C., and thence immediately enters the saturator. The pre-heaters and saturators are duplicated. The saturators (which have a diameter of 9 feet) are each capable of recovering ammonia from the whole of the gases. The liquor which is condensed from the gas in the preliminary coolers is distilled in the ammonia still situated in the sulphate house. The distillate is conducted first by steam alone to recover the free ammonia, following which the distillation is continued in the second still by the addition of milk of lime to liberate the fixed ammonia. The distillate from these stills is passed into the gas mains to the saturators, where the gas bubbles through sulphuric acid. The sulphate of ammonia produced by the reaction of the acid and the ammonia crystallizes from the bath and sinks to the bottom. It is removed by an automatic ejector on to a draining table, and after draining away the greater portion of the mother liquor, is removed from the table to a centrifugal machine. After "whizzing" to remove further quantities of liquor it is treated in a drying and neutralising plant for the production of dry, neutral sulphate of ammonia.

The residual gas having now been successively freed from tar and ammonia, passes through an acid catch-box in order to remove any entrained acid liquor that may be carried forward from the saturator, and conveyed to the benzol plant. The gas, however, is still at a temperature between 60°C and 70°C and is next passed into two secondary coolers placed in series, where the gas comes is direct contact with cold water. The cooled gas then flows in counter-current to a stream of creosote oil up two scrubbers also worked in series. The scrubbers are 60 feet in height, constructed of steel plates, and packed with timber hurdles, so placed that the oil and gas streams are perfectly distributed. The benzol is completely dissolved from the gas by the creosote oil, the rich oil flowing to a rich oil storage tank. From here the enriched oil is pumped to an overhead tank from which it flows by gravity to the distilling plant. The oil first passes through a heat exchanger where its temperature is raised by interchange of heat with the benzol vapours leaving the still. It then flows through a second heat interchanger of the plate type where it is further pre-heated by flowing in counter-current with the hot debenzolised oil leaving the base of the still. The temperature of the incoming oil is further increased to 120°C. by means of indirect steam in one of two superheaters, following which, the distillation is completed by live steam in the still. The debenzolised oil after leaving the still is partly cooled in the multitubular heat exchanger, previously mentioned, the cooling being completed in four Wolff's coolers. Here the oil passes in counter-current to a stream of cold water. The hot benzol vapours are dephlegmated and, after giving up a portion of their heat to the incoming cold oil, are condensed in a watercooled condenser. The benzol thus produced is 65% strength.

The gas leaving the benzol scrubbers has now been freed from its valuable products. A portion, amounting to about 45%, is used for heating the ovens. The remainder is passed into a gasometer of 100,000 cubic feet capacity whence it is boosted to the Derby Corporation Gas Works, a distance of approximately 11 miles. If there should be any excess above this demand the surplus gas may be used for firing the colliery boilers, six of which are fitted with gas firing apparatus.

The daily output of gas from the plant is about two and a quarter million cubic feet. From the 9½ tons of wet coal charged into the oven a net weight of about 5½ tons of coke is obtained, together with 1.1 tons of ammonium sulphate, four gallons of benzol, and 11,500 cubic feet of gas of calorific value 530 B.Th.U per cubic foot.

ACKNOWLEDGEMENTS

This account was originally written whilst I was a student at the Royal School of Mines, London, and I remain grateful to my tutors there. The variety of experience obtained and the amount of data collected at "A" Winning was entirely due to the kindness of the Management, to whom, though it was long ago, I should here like to express my appreciation for their co-operation and generosity. The editing of the report has been facilitated and permitted by courtesy of the Derbyshire Record Office and Derbyshire County Council, where it is now deposited

REFERENCES

This article is an edited version of the original report and, in particular not all illustrations could be included. The full version can be seen at the Derbyshire County Record Office. DRO/D4383/1.

Francis H. Baker,

Biographical Note: Francis Baker's father was the London sales manager for the Blackwell Company and together with his tutor Professor William A. Bone of Imperial College who was their neighbour at St Albans, influenced both his choice of the Royal School of Mines and entering the coal industry. Whilst a student at "A" Winning, Baker had the experience of men being brought out of the pit early because all the coal wagons were full, owing to lack of demand in London.

Between 1935 when he left the RSM, and 1965, his career was divided between mining and quarrying, including fourteen years as an HMI. Subsequently he switched careers and spent eight years with RoSPA, then after some 13 months studying for an Msc. at medical school in Newcastle-upon-Tyne, set up on his own as a consultant. He is now one of three associates in a health and safety consultancy.