THE UNDERGROUND REORGANIZATION OF KINGSHILL
Nos. 1 AND 3 COLLIERS

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SYNOPSIS

This paper describes the underground reorganization at the above collieries and is complementary to the paper presented to THE MINING INSTITUTE OF SCOTLAND by Mr. W. ROWELL in April 1952.*

The problems in relation to marshalling and controlling of mine-cars at the shaft where they are wound to and from the surface, and matters relative to grading and individual unit operation are discussed.

The formation and use of a system of storage using a large bunker with spirals and fitted with a loading arrangement giving a high loading rate with minimum manpower is also outlined.

In conclusion, a review of the modifications required and the results obtained after a period of operation is given.

INTRODUCTION

The workable seams in the Kingshill No. 3 field consist of the Upper, Mid and Lower Allanton Coals. These three seams lie within relatively close proximity to each other, the distance between the Lower and Upper being usually in the region of 100 ft. while the Mid Coal lies about 70 ft. above the Low Coal, or 30 ft. below the Upper Coal. The waste of the latter seam was passed through at a depth of 126 fm. in the shaft. The approximate heights of the three seams are Upper Coal 2 ft. 9 in., Mid Coal 2 ft. 0 in., and Lower Coal 2 ft. 6 in. and these are a continuation of the Woodmuir Smithy, Jewel, and Wilsontown Main Coals of the West Lothian field.

Previous to the new sinking being made, extensive extractions of the Upper Coal had taken place and it was necessary that the new underground layout should enable the future development of the Mid and Lower Coals to take place while at the same time giving satisfactory transport for the remainder of the Upper Coal still to be extracted.

RESERVES, EXISTING WORKINGS, AND REORGANIZATION UNDERGROUND TO CONNECT WITH NEW SINKING

Reserves

The reserves in the field lie in the three following areas:

No. 1: Area to South-East of Shaft—

<table>
<thead>
<tr>
<th>Coal</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>465,000</td>
</tr>
<tr>
<td>Mid</td>
<td>1,069,000</td>
</tr>
<tr>
<td>Lower</td>
<td>1,209,000</td>
</tr>
</tbody>
</table>

Total: 2,743,000 tons

No. 2: Area to South-West (between faults)—

<table>
<thead>
<tr>
<th>Coal</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>426,000</td>
</tr>
<tr>
<td>Mid</td>
<td>462,000</td>
</tr>
<tr>
<td>Lower</td>
<td>523,000</td>
</tr>
</tbody>
</table>

Total: 1,411,000 tons

No. 3: Bowridge Area (West of 30 fm. fault)—

<table>
<thead>
<tr>
<th>Coal</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>2,318,000</td>
</tr>
<tr>
<td>Mid</td>
<td>2,033,000</td>
</tr>
<tr>
<td>Lower</td>
<td>2,800,000</td>
</tr>
</tbody>
</table>

Total: 7,151,000 tons

Total: 11,305,000 tons


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Workings and Previous System of Transport

Fig. 1 is a plan of the Kingshill field showing the existing workings in the Upper Allanton Seam in the Main South Heading district and the former loading point and roadways to No. 1 Colliery lying to the north.

Prior to the changeover approximately 700 tons were produced in this district, loaded into tubs on the Main South Heading and then transported by two under-rope endless-rope haulages to No. 1 pit-bottom. This was the maximum output which could be transported by tubs and endless-rope haulage.

Reorganization of Transport to Connect with No. 3 Shaft

The urgent need for coking-coal made it imperative that the output from this district should be increased to 1,200 tons saleable or 1,800 tons run-of-mine, per day. The problem was how to devise a simple, yet efficient, layout to satisfy the following requirements:

(1) To transfer the existing output to the new shaft without interruption of production.
(2) To give concentration of haulage and conveying.
(3) To provide suitable access to Mid and Lower Coal seams in Nos. 1 and 2 Areas and to all the seams in No. 3 Area.
(4) To provide adequate storage capacity to fully utilize winding capacity over the whole shift.

Fig. 2 shows an isometric view of the layout. The location of the shaft, which was sunk to the Upper Coal waste, was originally fixed to operate with a tub circuit but with the change to mine-cars certain modifications were necessary and the adoption of the mine-car with the automatic clip pre-determined certain aspects of the underground layout, and the clip operating lever made it necessary that the pit-bottom layout should consist basically of a back-shunt and return. The back-shunt was planned to coincide with an existing west level which would ultimately be one of the main avenues into the west side of the field—Area No. 3. The back-shunt crossed the Main South Heading and this was the only point where the new development interfered with the existing haulage arrangements.

To connect with the existing workings, a horizon mine was driven to the south of the shaft until the Low Coal was reached. Its bearing was then altered to a westerly direction to follow approximately the level course of the seam, on which course this horizon will be continued into No. 2 Area. The connexion between the new horizon mine and the existing workings was established by means of a staple-shaft to the Mid Coal at a point approximately 500 yd. from the No. 3 Shaft. A dipping mine was driven from the South Heading to connect with the top of the staple-shaft. This mine was driven as a continuation of No. 5 developing level in the Upper Coal.

There were two reasons for deciding to install a staple-shaft:

(1) To provide ample storage accommodation by means other than mine-cars.
(2) To concentrate the loading of all the output from Area No. 1 to one point.

A connexion to this point in the Mid Coal had the added advantage that development in the Mid Coal could begin immediately and was to the south of several faults. The development of this area is so planned that there will be no superimposed workings.

The thinness of the Mid Coal necessitated facilities for dealing with the debris made in the working of the seam, and a stone compartment was incorporated in the staple-shaft. A materials mine rising at 1 in 3 was driven from the inbye end of the horizon mine to No. 5 level in the Upper Coal and connected with the existing materials transport system.
DESCRIPTION OF MINE DRIVAGE AND FORMATION OF STAPLE-SHAFTS

Drifting and Equipment

On completion of the shaft-sinking and the fitting of the necessary furnishings, the labour which had been employed on the shaft-sinking was retained and the drivage of the roadways commenced. These roadways were supported by 14 ft. x 10 ft. arch girders erected at 3-ft. centres. The drifts crosscut the measures and for considerable distances the use of delay-action detonators was prohibited due to the presence of Upper Coal waste and coal bands. The nature of the strata varied from hard sandstone to soft shale and this, coupled with the changing strata sections at the face, necessitated drilling arrangements that possessed flexibility.

To meet these conditions it was decided to use percussive drilling machines mounted on airlegs, these machines to be used in conjunction with a portable drilling carriage fitted with the necessary air and water manifolds, and a drilling carriage to suit this size of drift was designed and built. This carriage gave a platform for drilling the top holes which could also be used for the storage of drilling machines, drills, etc. The carriage was portable, the main frame sitting astride the double roadway, the running wheels being hinged to the outer verticals in the frame so that when not in use these wheels could be swung clear to permit double-track operation of the tubs and also to allow the Eimco loaders to pass underneath. Before drilling, the carriage was run into the face on the two outer rails of the double roadway and on completion of drilling was withdrawn out-of-way and lifted clear of the roadway by running it up two inclined ramps. Four wheels were provided on the carriage to engage with the ramps.

The air and water manifolds were mounted on top of the platform of the carriage and the drilling machines coupled permanently to these manifolds by means of short lengths of rubber hose. The connexion from the air main to the manifold was by the same flexible air hose used to supply air to the Eimco loader, and the water from the main was supplied through a 1-in. flexible hose. This system of manifolds and machines obviated the coupling and uncoupling of hoses each time a round was being drilled.

The wood cleading of the platform was arranged duck-board style to provide adequate footing for the jacklegs. The portion of the platform nearest the face was hinged so that when not in use it could be tilted back and up to protect the machines and other equipment on the platform.

The crew consisted of 5 men and when drilling, 2 machines were mounted on the platform of the carriage and 2 on floor level. Under normal conditions the complete round of holes could be drilled in under 2 hours. Delay-action detonators were used for approximately 50 per cent. of the drivage, no difficulty being experienced with the drilling or blasting during the whole of the scheme.

The loading was effected by 2 Eimco shovels working side by side in the roadway, the controls on each machine being arranged so as to keep the operators at the sides of the drift. A portable crossing, fabricated from 35-lb. per yard rails and resting on top of the permanent track, was used for tramming between empty and full roads. This crossing was easily moved and was kept close up to the face.

The results obtained, while not up to expectations, indicated that the potencies with this equipment were there and weekly advances as high as 22 yd. were obtained, while the average was in the region of 15 yd. As already explained, a considerable stretch of the drift was in broken strata due to the close proximity of the Upper Coal waste and great care had to be exercised to keep the size of the drift to the proper dimensions.

Staple- Shaft Formation and Support

The adoption of the staple-shaft as a connexion between the old transport system and the new has already been described. Due to the limited time available, it was necessary to proceed with the making of the staple-shaft and at the same
time permit the drivage of the horizon mine inbye the staple-shaft to progress without interruption. At the point where the staple-shaft had to be driven, the roadway was widened out to enable 2½-ft. thick brick walls to be built on either side. These walls were 30 ft. long and 5 ft. 6 in. high. A scaffold consisting of 12 in. x 8-in. section wooden beams laid on top of 12 in. x 6-in. section R.S.J. was erected on top of these side walls. After the completion of the scaffold, ground was excavated to a sufficient height above the platform to enable the setting up of a diamond core drill on top of this platform and four 4-in. dia. holes at 6 in. radius were drilled vertically upwards until the Mid Coal was reached, a distance of 44 ft. These holes were placed co-axial with the centre of the spiral in the coal hopper. The drilling of these 4 holes was completed simultaneously with the completion of the drivage of the dipping mine from the South Heading to the top of the staple-shaft.

The full face of this dipping mine was stopped short of the top of the shaft, and a narrow road 5 ft. wide was driven forward to locate the position of the holes and establish limited ventilation between the horizon mine and the dipping mine from the South Heading. A pilot shaft 5 ft. in diameter was then driven up using the four 4-in. dia. holes as cut holes with a standard round using delay-action detonators. In drilling the shotholes a set of matched steels was used in conjunction with a stoper drill. Two sets of telescopic tubes, of 2 in. dia. reduced at the ends to 1 in. dia., were used as scaffolding supports for supporting the platform while raising this pilot shaft. Each set of telescopic tubes was supported at each end at the desired level in holes drilled on opposite sides of the 5-ft. shaft, about 18 in. off-centre. Being telescopic, the two sets of tubes could be placed in the short holes, extended, and then covered with cleading. This staging made the changing of long steels simple as the cleading on the platform could be moved to permit drill changing while still maintaining solid footing for the drillers.

The whole of the top of the staple-shaft was excavated and all permanent supports and walls erected before sinking of the shaft commenced. The walls supporting the top of the shaft were founded on a hard bed of sandstone about 3 ft. below the Mid Coal. As already explained, the drivage of the dipping roadway stopped short of the top of the pilot holes and a narrow road was driven forward to locate these holes. The excavation for the left- and right-hand supporting butts on this dipping roadway at the top of the shaft was then made, the butts being founded on the above-mentioned hard rock. The completion of the support of the dipping roadway was then carried out and a narrow place was driven on the opposite side of the pilot holes to make the necessary excavation for the third supporting butt. This butt was founded and erected on the same hard bed as the other two. On completion of the bricking of this butt, carrying girders were erected across the top of the pilot shaft and the excavation of the remainder of the top completed in stages. These butts are indicated "A," "B," and "C" on the plan showing the staple-shaft—Fig. 3. The supports during the excavation and until the side walls were bricked up at the top, had one end resting on the carrying joists while the other end rested on temporary supports.

When all the excavation was completed and with the roof supported on the three butts and temporary supports, three sets of special arches were placed on top of the hard bed of sandstone at 1 ft. 6-in. centres and brick filled to act as shuttering. The space behind was then filled with concrete to form a collar for the shaft. Brick walling was extended from the top of this collar to the roof, at the same time being keyed in to the existing butts.

The sinking of the shaft was then commenced by widening out the 5-ft. pilot shaft to the required diameter and steel rings, 5 in. x 3-in. section preformed to the special shape of the shaft, were set every 2 ft. to support the sides.

This phase was simplified due to the debris being disposed of down the pilot
shaft on to a scaffold at the bottom where a temporary loading chute was erected at the end of the platform from which stone could be loaded off as convenient. Limited charges were placed on the shotfiring during this operation, the limitation being especially severe in the final stages when the excavation for the main carrying frame just above the horizon mine was being carried out.

The successful completion of this stage left the shaft supported from top to bottom with temporary supports, spaced at 2-ft. centres, and the top of the shaft completely and permanently supported.

Equipment and Installation in Staple-Shaft

The main supporting frame containing the loading chutes, etc., at the foot of the shaft was of necessity heavy, this having been designed to give an adequate factor of safety with all the weight of coal resting on the structure. This structure
of two tiers consisted mainly of 14 in. x 8-in. compound girders and the whole structure was fabricated and assembled complete in the Central Workshops. The nuts on the inner side of the compound members were welded in position to facilitate re-assembly underground. After stencilling, the structure was dismantled and transported underground as required.

The scaffold at the foot of the shaft was removed with the exception of three spliced joists and the bricking up of the side walls continued to the level of the bottom structure joists of the hopper base supports. The joists in this structure were then placed in position and a new scaffold erected on these joists. Following this, the bricking was continued up to the full height and the erection of the main supporting frame completed. In the latter stage this was most exacting work as the excavation of solid strata was kept to the minimum and this resulted in the handling of the heavy joists having to be done in a very restricted space.

The brick lining of the shaft was then carried out from the bottom upwards, the rings supporting the side of the shaft being bricked into position. A neck ring was made near the foot of the shaft to key the shaft supports and lining to the surrounding strata. As the shaft lining was being bricked up, the supporting joists for the spiral were placed in position in special boxes which allowed for final adjustments. The wall dividing the coal compartment from the stone one was also bricked up during this stage.

A small electric winch placed at the top of the shaft was used for hauling material and supplies up the shaft.

On completion of the brick work the spirals were installed and the plates and loading spouts at the foot of the shaft placed in position. The supports for the spiral chute in the coal compartment were at every 2 ft. or quarter pitch, while in the stone compartment every 4 ft. or half pitch. The spiral chutes were erected from the top downwards and after lining up, the supporting joists for these were grouted into position as their erection progressed.

Following the completion of the spirals the special fourway chute was installed at the top of the staple-shaft, enabling the material from either conveyor to be fed to the coal or stone spiral as desired.

The quadrant type hopper doors operated by double-acting air cylinders 5-in. dia. by 3 ft. 3-in. stroke were then installed, together with the trimming chute, loading platform, signals, air lines, etc.

Details of Staple-Shaft

<table>
<thead>
<tr>
<th>Description</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large diameter</td>
<td>15 ft. 0 in.</td>
</tr>
<tr>
<td>Small diameter</td>
<td>6 ft. 0 in.</td>
</tr>
<tr>
<td>Length inside walls</td>
<td>20 ft. 6 in.</td>
</tr>
<tr>
<td>Diameter of spirals</td>
<td>5 ft. 0 in.</td>
</tr>
<tr>
<td>Spiral supports</td>
<td>8 in. x 6-in. R.S.J.</td>
</tr>
<tr>
<td>Pitch of coal spiral supports</td>
<td>2 ft. 0 in.</td>
</tr>
<tr>
<td>Pitch of stone spiral supports</td>
<td>4 ft. 0 in.</td>
</tr>
</tbody>
</table>

Summary of Materials and Labour

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total excavation between horizon mine and top of shaft</td>
<td>520 cu. yd.</td>
</tr>
<tr>
<td>Preparatory work (erecting side walls and platform at foot of shaft)</td>
<td>53 manshifts</td>
</tr>
<tr>
<td>Drilling pilot holes</td>
<td>100 do.</td>
</tr>
<tr>
<td>Driving pilot shaft</td>
<td>30 do.</td>
</tr>
<tr>
<td>Excavating and building collar and supports at top of shaft</td>
<td>96 do.</td>
</tr>
<tr>
<td>Sinking shaft (including setting of rings)</td>
<td>215 do.</td>
</tr>
<tr>
<td>Erecting hopper frame and roof supports at bottom of shaft</td>
<td>84 do.</td>
</tr>
<tr>
<td>Bricking shaft and setting joists for spirals</td>
<td>160 do.</td>
</tr>
<tr>
<td>Erecting spirals and assembling hopper doors, air connexions, etc.</td>
<td>120 do.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>858 manshifts</strong></td>
</tr>
</tbody>
</table>
MARSHALLING AND DECKING IN No. 3 SHAFT-BOTTOM, TRANSPORT AND LOADING

Pit-Bottom Arrangements

The system of winding and haulage adopted on the surface meant that each car travelled as an individual unit and, because of this, it was necessary to arrange grades to suit the optimum conditions and at the same time provide means for stopping the cars and locating them at certain fixed points. This whole question of marshalling and control proved more difficult with the Kingshill No. 3 car than would have been the case with the standard type mine-cars. The automatic-clip lever projected on one side of the car and in addition the car had a member on the other side projecting underneath, which was originally provided for the clipping on by means of a creeper.

After investigation, it was decided to reinforce this member and use it for stopping the car as it had the following advantages:

(1) It used an existing feature of the design.
(2) It was the only possible projection underneath the car suitable for engagement with a car stop.
(3) As the cars were only wound and hauled one at a time, this same projection could be employed for re-setting the stop.
(4) It provided a simple means for holding the car in the cage.

A stop was required to bring the car from 3 m.p.h. to rest and locate it within certain fixed limits to suit the power ramming used underground and on the surface. A special stop to comply with the foregoing conditions was designed (Fig. 4).

Briefly, the stop consists of an arm pivoted at one end and projecting upwards to engage with the creeper projection on the mine-car. This pivoted arm is raised and lowered by means of a wiper and in the lower position the car can pass over the stop. The pivot end of the arm is connected to a piston which compresses a spring. This gives a movement of 9 in. which is sufficient to bring the car smoothly to rest from normal running speeds. In front of the pivot arm there is an arm which is connected by means of a rod to the wiper. When the stop is released, this arm is drawn into the upright position and the off-going car engages this lever depressing it and resetting the stop. The stop can only pass one car at a time and before another car can pass, the mechanism needs to be again released.

On the surface, the releasing of this stop is performed by a projection from the traversing carriage which as it moves forward just previous to gripping the car, pushes back the extension lever and disengages the stop. As the car moves forward, the resetting arm in front of the stop is depressed and the stop reset.

The stops employed on the surface and underground both operate on this principle. For locating the car on the cage, a stop similar in principle to the shore-mounted stop was designed.

Cage Stop

This stop is mounted rigidly on channels and slung beneath the floor of the cage. An operating shaft attached to the wiper goes through the side of the cage
and is attached to an operating lever, which on being pulled back moves the wiper which drops the stop. The off-going car resets the stop with a resetting arm similar to that employed for the shore-mounted stop.

Decking Arrangements at No. 3 Shaft

Fig. 5 shows the decking arrangements in the pit-bottom. The locomotive delivers trains of 20 loaded cars to the pit-bottom and these cars are fed forward by means of a creeper, which is interconnected to a sequence-controlled pneumatic system operating decking rams and stops in the pit-bottom.
The sequence of operation is as follows:

"Stop "A" is released when ram "AA" charges the car. At the same time, stop "K" is released and ram "AA" forces the full car on to the cage and discharges the empty car on the opposite side. After decking, the return of the ram operates valve "G" which resets stop "A", changes points "C", releases stop "D" and starts creeper by means of cylinder "E". The creeper then moves forward 10 ft. and the mine-car which is disengaged operates treadle "F", resetting stop "D" and stopping the creeper. The mine-car then gravitates on to stop "A." The operation is repeated with ram "BB."

This whole operation is dependent on air being admitted to the system through the inline valve. This valve is actuated by the cage which, by means of a lever arrangement in the shaft, operates this mechanism in the last 6 in. of its travel and admits air to the system at the side where the cage lands.

When the cage is raised, this valve is closed and air is cut off from the system. The stop immediately in front of the cage can only be released when the cage is in position.

The marshalling creeper is provided with retarding and driving pawls and both are toggle-mounted. The electric motor on this creeper is continuous running, the one air cylinder operating the brake and the clutch to the epicyclic gearbox. The forward speed is kept low at 30 ft. per min. An inclined ramp alongside the creeper engages with the uncoupling device on the car and as the cars move forward they are uncoupled just before the car reaches the top of the creeper.

The decking platform, the feeder-creeper, pipe-lines, and all accessories were assembled complete in the Central Workshops. After test, the complete job was indexed, dismantled, transported underground, and re-assembled.

The empty cars on being discharged from the cage, gravitate to the marshalling position, where a youth couples them into sets of 20 or 22. Three compressed-air retarders controlled from an operating panel at this point are used to regulate the train as it is being assembled and when the complete train is coupled up these retarders are released, allowing the train to gravitate into the back-shunt.

**System of Transport and Loading**

All transport underground is accomplished by one 65-h.p. diesel locomotive and this is the only means of power haulage, apart from the feeder-creeper in the pit-bottom.

At the start of the haulage cycle the locomotive collects the train of 20 empty cars from the back-shunt and hauls it inbye to the staple-shaft. Here the locomotive shuts to the back of the train and pushes the whole train of cars underneath the loading chute until the car next to the locomotive is in position. The shunter then mounts the loading platform where the controls of the quadrant doors for loading the cars and signals are placed. At the commencement of loading the locomotive is close up against the loading chute and in first gear, without interruption, pulls the cars under the loading chute until all the cars are loaded. The shunter controls the opening and closing of the chute door and is able to judge the amount required to completely fill each car, the trimming arrangement ensures that the cars are properly trimmed.

This operation is very simple and most effective as there is practically no spillage between the cars and the rate of loading is very high, 20 cars being regularly loaded in 4 minutes. After the complete train is loaded, the shunter signals the driver who accelerates and proceeds outbye to the shaft-bottom. Here the locomotive fly-shunts and the first full car of the train is coupled up to the last car of the previous train. The locomotive then proceeds to the back-shunt and the above procedure is repeated.
A typical time cycle for the complete locomotive circuit is as follows:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back-shunt to Staple-Shift</td>
<td>3 min</td>
</tr>
<tr>
<td>Shunting</td>
<td>2 &quot;</td>
</tr>
<tr>
<td>Loading</td>
<td>4 &quot;</td>
</tr>
<tr>
<td>Staple-Shift to Shaft Crossing, full side</td>
<td>2 &quot;</td>
</tr>
<tr>
<td>Crossing to empty siding</td>
<td>1 &quot;</td>
</tr>
<tr>
<td><strong>Total time per cycle</strong></td>
<td><strong>12 min</strong></td>
</tr>
</tbody>
</table>

In practice the locomotive capacity exceeds the winding capacity of the shaft and this could be further extended by increasing the number of cars per train.

**Manpower**

The manpower employed to load, transport, and deck the total output from the staple-shaft is as follows:

1.—Onsetter
1.—Marshalling empties in back-shunt
1.—Locomotive Driver
1.—Shunter

**REVIEW OF OPERATIONS AFTER A PERIOD IN PRODUCTION**

**Change Over**

The mine drivage and the installation of all the equipment was completed by mid-April, 1952. Sufficient coal was ploughed off the Main South Trunk Conveyor into the new 36-in. transverse conveyor to the top of the staple-shaft to afford an opportunity to try out the new equipment and make the necessary adjustments and modifications where required. These were of a minor nature and it was then found possible to effect the complete changeover to the new scheme during the May Holiday when the colliery was idle for 2 days.

The back-shunt was completed across the Main South Heading haulage road and the driving gear of the Main Trunk Conveyor transferred up to its new position to deliver the coal on to the transverse conveyor to the top of the staple-shaft.

The total output of the district was easily handled and, after preparations were made, the output from this district has steadily increased and No. 3 Shaft is now winding to full capacity.

**Grade of Roadways**

The surface grades at No. 3 Shaft were not finally fixed, nor the concreting of the floor of the surface building carried out, until the system had been in operation for a period. The "fulls" road is running as designed, but the gradient of the "empties" road has been increased above that originally contemplated.

The following table sets out the principal grades as employed on the scheme now running:

**Surface**

<table>
<thead>
<tr>
<th>Empties: Clip-off point to traverser</th>
<th>1 in 102 (75 ft. radius turn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loads: Cage to weighs creeper</td>
<td>1 in 84 (48 ft. radius turn)</td>
</tr>
</tbody>
</table>

**Pit-Bottom**

| Empties: Cage to 1st retarer        | 1 in 147 (75 ft. radius turn) |
| 1st retarer to 2nd retarer         | 1 in 109                      |
| 2nd retarer to straight             | 1 in 103 (75 ft. radius right followed by 75 ft. radius left turn) |
| Loads: Crossing to bottom of creeper | 1 in 103 (75 ft. radius turn) |
| Creeper                             | 1 in 57 against               |
| Top of creeper to cage              | 1 in 122                      |

These grades have been found to be the most suitable, but there is quite a wide variation in the free running of the individual mine-cars. It was necessary to
change over, during the recent severe weather conditions, from the 75-h.p. to the 150-h.p. motor driving the surface endless-rope haulage.

Clipping-on of Mine-Cars

Originally the arrangements for clipping-on consisted of the rope being deflected up into the clip by means of spring-loaded roller arrangements, the car being pushed forward by a creeper which engaged the same projection as used for stopping the car. It was felt that the deflection of the rope with the spring-loaded roller to hold it into the clip as originally devised had certain disadvantages, and that it would be better to maintain the rope in a straight line and lower the car and clip on to the rope instead of deflecting the rope into the clip. The dipp ing grade on the rails to do this gave sufficient momentum to accomplish the clipping-on operation without power assistance. The Kingshill No. 3 end was modified to operate on this principle, with successful results, and the Kingshill No. 1 end has since been similarly modified.

Staple-Shaft

After the commencement of operations there was a serious collapse in the spiral of the staple-shaft, and this resulted in a large number of segments being broken. Investigation of the cause established that the elasticity of the supporting structure, when movement of a large body of coal took place, overstressed the cast segments which were attached one to another in the form of a continuous spiral. The connexions consisted of a mild steel scroll at the periphery and toe straps at the centre of the spiral. Fracture occurred above the toe straps and, following the fracture of one segment, total collapse progressed right up to the top of the spiral.

To overcome this, a new system of support was installed whereby the brackets supporting the cast segments covered a complete segment and were of much heavier construction, while there was no bolted connexion between the toes of adjacent segments as in the previous design. This has proved satisfactory and the spiral is now working without any trouble.

Loading Chute at Staple-Shaft

An automatic loading chute was designed and tried at the staple-shaft which would make the operation entirely automatic, and at the same time provide a high rate of loading. This was tried and found to operate successfully, but unfortunately did not deal satisfactorily with the occasional long prop that from time to time found its way into the hopper. The results obtained with the original loading arrangements have proved so satisfactory in operation that a change to a purely automatic chute is not contemplated meantime.

Surface decking and Surface Haulage between Nos. 2 and 3

It has been demonstrated that the electro-hydraulic traverser is very flexible in controlling and decking the mine-cars on the surface, and with a few minor modifications its application in other suitable schemes is well worthy of consideration.

The operating of the automatic clip attached to the mine-cars has given every satisfaction and there has been no case where any major mishap has occurred due to clip slip. It should be possible to install such an arrangement on haulage roads with a grade not greater than 1 in 10, either in favour or against the load, and expect trouble-free running.

CONCLUSION

Results over the past 9 months have proved that it is possible to concentrate the loading of large outputs at one point and that outputs as high as 500 to 600 tons per hour could be loaded satisfactorily into mine-cars of 2½ tons capacity with only one man.
The staple-pit equipped with spiral chutes, affords storage capacity at much less cost than with mine-cars and obviates the difficulties in marshalling and controlling a large number of loaded cars.

The output of Kingshill No. 1 Colliery prior to the reorganization was 1,500 tons per day and this has now been increased to 2,000 tons per day.

A new preparation plant is in course of erection which will wash all the coal under 8 in. and when it comes into operation a further increase in output will be possible.

Acknowledgments.—The authors desire to thank all officials and staff at Area and Sub-Area level for their co-operation and assistance in the preparation of this paper. They also wish to thank the National Coal Board for permission to publish the paper. The views expressed are those of the authors, and are not necessarily those of the Board.

The paper was illustrated by lantern slides and a sound film.

DISCUSSION

The President (Dr. Wm. Reid, Crossgates): I think we will all agree that the authors have given us a very interesting paper and we are indebted to Mr. Rowell for reading it to us.

The paper brings home to us how very out of date is some of our existing equipment. We have collieries where at the pit-bottom the empty and full tubs are turned on the plates by hand. I feel certain that if a little more ingenuity was applied—as had been applied in very great measure in this reorganization—then mechanization of many existing collieries could be effected without a tremendous amount of effort. I do say to you today that there is greater scope for ingenuity in the transport system, both in the pit-bottom and on the surface, than we ever dreamed of. We have the assistance of mechanical and electrical engineers available to help us. This paper is a first class demonstration of what can be achieved by a combination of effort by the mining, mechanical and electrical engineers.

Mr. W. F. Masterton (Edinburgh): With regard to the small pilot shaft which was driven upwards, what was the height of cut used and what method of support was used within the shaft? Was any special method of protection used in inspecting the shaft before work recommenced after blasting?

Was locomotive or endless-rop.e haulage used in the drivage of the main mine, and, if endless rope was used, what was the maximum length of hand drawing between the Eimco Loaders and the haulage terminus?

It is noted that the saleable output is stated to be 1,200 tons for 1,800 tons/day of run-of-mine coal. Is there any particular reason for this apparently small proportion of saleable output?

Mr. W. Rowell (Edinburgh): I am afraid I cannot answer all these questions as I was not present when the staple-pit was driven. On the question of saleable output the seams are thin with a friable roof, part of which falls with the coal, and most of the stone comes to the surface.

Mr. D. D. Shaw (Newmains): In answer to Mr. Masterton, regarding supports in the pilot shaft, there were no supports used in the shaft, the shaft being approximately 4 ft. in dia. in sandstone beds. The last drivage was completed from the top.

Regarding inspections, these were of the usual order and use was made of the temporary platform in making these inspections.

After each round had been blasted all the material fell into a prepared platform at the bottom of the shaft, where it was drawn off and loaded into tubs. The depth per round was approximately 6 ft. Haulage to the main mine drivage was by endless rope. Tub handling at the loader was reduced to a minimum by the use of the sliding platform. Of the five-man team employed during loading operations, two were loader operators, while one was employed in keeping material prepared for the loaders. The other two dealt with the tub handling from and to the haulage.

Mr. George Mullin (Cowdenbeath): There are only two points I would like to raise:

1. What arrangements have been made to take materials to and from the face? Since the mine-cars do not travel right into the coal face, is there some arrangement for getting the materials independently or are they transferred from the mine-cars to the tubs at a given point?

2. I was pleased to learn that the output had been increased from 1,500 to 2,000 tons per day. Can Mr. Rowell tell us what the O.M.S. was before the installation came into operation and what it is now?
Mr. Rowell: Materials are at present transferred from mine-cars to tubs at the foot of the drift mine to the Upper Seam. This is a fairly temporary arrangement because the life in the presently-worked area of the Upper Coal is quite limited.

I don't know the output per man-shift exactly, but I would say that the full benefit of the reorganization will not be felt until the preparation plant is completed.

Mr. Shaw: Mr. Mullin has raised a very important point, and one which has not been solved at present. The mine-cars from the new shaft cannot be taken into the upper horizon. To overcome this difficulty it will be necessary to provide special material car chassis which could carry two ordinary pit tubs, thereby allowing these tubs to be transferred from the mine-car horizon to the upper horizon.

Regarding the increase in output following the reorganization, the O.M.S. for the whole colliery has been increased by 3 cwt, whereas the increase for the part under reorganization would probably be twice as much.

Mr. W. C. Parker (Uddingston): We anticipate the O.M.S. will go up to nearly 28 cwt, but, as Mr. Rowell has stated, we won't get the full benefit of the project until the preparation plant is in operation.

Mr. Mullin: I thank Mr. Shaw for his explanation. The reason I asked the question is that we have a similar reorganization in operation and this was one of the weak points, the transport of the materials to and from the face, and special arrangements had to be made. It is an important point and should not be overlooked in the big schemes.

Mr. R. Nell (Joppa): Staple-shaft storage hoppers have many advantages which are worth considerable consideration in our reconstruction projects. One important item omitted from the details of the staple-shaft is the cost. It will be interesting to compare this figure, when converted to cost per ton of capacity, with a similar figure for mine-car storage. The latter is in the region of £75 per ton, which can be very expensive if large numbers of mine-cars are required for full standage. More pit-bottom accommodation and manpower is also necessary.

If a similar staple-shaft had to be driven again, would the authors repeat the drilling of four 4-in. dia. diamond boreholes as a preliminary? Do they consider that a peripheral spiral would be better than the axial spiral installed, both from the point of view of ease of support and also for subsequent operation?

The compressed-air retarders squeeze the mine-car wheels from the outside inwards, near the bottom of the flange. Has any trouble been experienced with the tapered roller bearings? I believe that the nut-cracker type, acting on both sides of the same wheel simultaneously, is better and at slow speeds it is quite effective on one rail only. A friction-lined squeezer, bearing on the side of the body near the bottom, is probably less damaging than any type of wheel squeezer.

Mr. Rowell: In comparing the cost of bunkers with storage in mine-cars, the loading arrangements can be excluded as they are common to both. The cost of the bunker was about £6,000 while the same standage in mine-cars would have cost about £12,000.

A peripheral spiral would probably cause less degradation but would be costly. One of the difficulties of the central spiral which I have noticed is that big lumps of coal appear to reach a higher velocity and get thrown off causing some breakage, whereas with the peripheral spiral the big coal would ride against the outside plate.

The standard N.C.B. mine-car is designed with retracting bars or shoes on the side of the car, but at Kingshill the mine-cars do not reach sufficient speed to require their use and the light wheel squeezer does not damage the bearings.

Mr. Shaw: In considering storage of coal in the pit as against the use of mine-cars, it should be borne in mind that, in addition to the actual capital cost involved, storing the coal in mine-cars would entail a much greater labour cost than is the case when the coal is stored in the pit.

Regarding the use of the diamond drill boreholes, this operation was so successful that we would have no hesitation in doing so again.

We suggest that the provision of these holes and the using of them to form a Burn Cut, really made the driving of this pilot shaft a very straight forward operation. No difficulty whatever was experienced in obtaining a clean pull for each round of shots.

The President: On this question of comparison between mine-cars and bunker storage, in my view there will be more breakage in the bunker than in mine-cars. It is only in certain cases that one would go to the extent of using this kind of bunkerage and then only for special qualities of coal.

Mr. Rowell: Yes, Sir, there is a lot in what you say. At Kingshill No. 3 the coal is of coking quality and breakage is not particularly important.

Mr. H. E. Dudley (Llwyn): As a visitor to your meeting it has been a privilege to have heard this very interesting paper and to have had an opportunity of seeing the actual plant in use.
It seemed to be that in using the endless ropeway between the two collieries involves having a lot of capital tied up on the surface in the form of mine-cars. Was any consideration given to tipping the coal at Kingshill, raising it a few feet and sending it to the other colliery by water flow? The water, which may be pumped from the Kingshill shaft, could be re-circulated if there is not sufficient available.

Mr. Rowell: As you say, there is a fair amount of capital involved in mine-cars on the surface. Before the Board took over we were committed to a transport system using endless-roped haulage and tubs. We did consider the various alternative methods of transport such as belt conveyors, railway, aerial ropeway, etc., and found endless rope with mine-cars the lowest in capital cost. I can’t say we investigated the hydraulic transport of coal, although I understand the possibility is now being studied, but only for sizes of coal up to about 2 mm. for horizontal transport. For coal up to 3 in. in size the volume of water required to flume it to Kingshill No. 1 would be very large and not much water is available.

Mr. G. Dott (Edinburgh): One or two matters are not clear to me. With regard to the driffling carriage and its folding wheels, on what does it rest while the wheels are being shifted? How many shots were fired in a round?

The description of running the cars into the pit-bottom is not too clear. It reads: “Here the locomotive fly-shunts and the first full car of the train is coupled up to the last car of the previous train.” I cannot see the point of this and the cars must be uncoupled somewhere before entering the cage.

I should be interested to know the total number of cars in use. To the best of my recollection there are 110 on the surface haulage. How many more are needed to keep things moving below ground?

Mr. Rowell: The carriage is equipped with wheels on the outside of the framework. When the carriage is pulled back from the face these wheels engage ramps at the roadside which lift the carriage off the track, thus allowing the brackets carrying the track wheels to be swung clear.

These ramps were shifted in periodically so that the carriage could be parked as near to the face as practicable.

Mr. Shaw: The holes per round varied between 36 and 40, while the weight of explosive used was approximately 60 lb. per round.

There are 200 mine-cars actually in use—100 on the surface haulage, and 100 underground.

Mr. Rowell: When the locomotive shunts from the full to the empty track, the train of cars is coupled to the previous train because the whole line of mine-cars is controlled onto the rams by a creeper. This positive control obviates gradients being too steep.

The cars are uncoupled on the creeper automatically.

Mr. H. R. King (Cowdenbeath): In the course of the paper Mr. Rowell was describing gradients of from 1 in 70 to 1 in 120 and, so far as I could see, these gradients were all related to tracks laid around fairly acute curves. What is the gradient of the track on the straight? My understanding is that for ball-bearing mine-cars the optimum gradient is of the order of 1 in 300 to 1 in 400.

Some years ago on the Continent I examined quite a number of staple-shafts which were in course of drivage and it was interesting to note that, wherever possible, a bore-hole was put through in advance of the staple-shaft. The staple-shafts were, however, much deeper than the one at Kingshill—in some instances up to 200 yds. It struck me at the time as remarkable that preference was given to sinking the staple-shafts downwards. The reason for this preference was that a shaft was more difficult to ventilate when driven upwards and there was also the difficulty of boring coupled with a greater dust hazard.

On the general question of transporters, I would like Mr. Rowell to express an opinion on the reconstruction of older pits. Some of us have been inclined to the view that transporters should only be introduced in conjunction with mine-cars, but it is my belief that many of our existing pits could be harnessed in the same way with a very simple transporter arrangement adapted for tubs. I feel sure we can make a very considerable and positive saving of manpower both on the surface and at the pit-bottom.

Mr. Rowell: From memory, the starting gradients on the straight were in the region of 1 in 300 and the running gradient about 1 in 400. We had therefore to make the gradients steep enough to suit the re-starting of a mine-car brought to rest. If allowed to run for any considerable distance we would have difficulty in stopping it again, so we limited the distance over which cars had to run by gravity as much as possible.

It is true that we have, so far, only incorporated transporters in major reorganizations but they could be quite simply constructed and easily installed to handle tubs.

Mr. W. Rochester (Milngavie): There are at present three men on the surface to control the coal handling system. The man who operates the traverser during coal winding
periods also acts as banksman when men are riding. A second man attends to the mine-cars and generally controls the running of the haulage from "remote-stop" and signal stations. A third man is stationed in the haulage house for direct control of the haulage in response to these signals. Equipment for complete remote-control of the haulage from the pithead is now in hand however and, before the year is out, it is expected to dispense with the services of the haulage engine-man and thus reduce the total surface complement to two.

The President: Regarding gradients for locomotive haulage and with a haulage as level as 1 in 300, I think great care must be taken to make quite sure that the water channel is big enough for that low gradient. Water must not get on to the locomotive tracks or there will be very serious trouble.

Mr. Rowell: That is quite true, Mr. President, the flatter the gradient the bigger must be the water channel.

In connexion with what Mr. King said, the automatic clip was designed for this particular job. It is the first clip of this type, so far as I am aware. It has worked remarkably well but surely, like all inventions, it can be further developed. Personally I do not see why an automatic clip cannot be developed for mine tubs, which would be fairly reasonable in cost. Such a clip could effect a very considerable saving in manpower.

Mr. Dudley: What would be the difficulties if you were compelled to use simultaneous decking arrangements?

Mr. Rowell: We have not reached a satisfactory solution in all cases but, where we have simultaneous decking at present, we are changing over at some places to individual decking and making the traversers big enough to take two mine-cars.

The President: I think it is generally agreed that simultaneous decking is rather out of date. In any new installations on the Continent it has been done away with because it requires more manpower, more car manipulation at different levels and there are difficulties of car control. The Germans, the French and, I think, the Dutch have all dispensed with simultaneous decking and use high speed single level decking arrangements.

Mr. Rowell: The difficulties in design for simultaneous decking in this instance arose underground. To get the cars on to two levels underground and bring them up again to the same level was the difficulty.

Mr. D. T. Paterson (East Wemyss): I paid a visit to Kingshill and in connexion with the spiral chute the coal seemed to lie dead. Was any consideration given to a separate installation of flaps to break the fall of the coal?

Mr. Rowell: So far as our experience goes, the coal does not lie dead on the spiral chute when it is empty or half full. Probably when you were there the bunker was nearly full—as it sometimes is—and when the coal gets up near the top, it builds up a little on the spiral chute.

That was one of the reasons which prompted Mr. Neill's query about the outside spiral because if you make a spiral steep enough to convey small coal, large coal is inclined to fly off the edges. I think it is generally agreed that a properly designed spiral chute is by far the best means of controlling coal vertically. There is less positive control with an arrangement of flaps.

Mr. Shaw: There has been no increase in the degradation since the staple-shaft came into use. The size distribution over the whole of the output has shown little change.

Mr. J. Smith (East Wemyss): In connexion with the question of wear on the spirals, has any provision been made for examination and replacement? Are there any doors in the spiral?

Mr. Rowell: The spirals are constructed of material which will resist wear, and we hope they will last for a considerable time.

Inspection can be made very easily by means of a ladder on the midwall. The spiral is right in the centre of the pit. It is an open scroll and not enclosed.

The President: I think the discussion has indicated that this paper has been very greatly appreciated and we should invite our Secretary to write to Mr. Young and Mr. Adamson to express our appreciation. At the same time we have to express our thanks to Mr. Rowell for his excellent presentation of the paper in the unavoidable absence of the authors and to Mr. Shaw and to all those who have helped with our discussion. In inviting you to show our appreciation in the customary manner we should pay tribute also to the projector operator for the screening of the film and lantern slides which were projected with perfect timing.

Discussion on the paper was then declared closed.