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Operational developments during the establishment of Secunda Collieries

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SYNOPSIS

Secunda Collieries forms part of Sasol Coal, the coal division of the Sasol Group of companies, and already produces 29 Mt of coal per annum from its four collieries: Twistdraai, Brandspruit, Bosjesspruit, and Middelbult. The successful establishment of this mining complex was achieved only through a unique team spirit in which the central services and the decentralized teams under the leadership of the mine management of each of the four mines played an important role.

The Secunda mining complex has now reached the optimization phase, during which the mining cost, productivity, safety, and quality of work become as important as production. The setting of priorities and problem solving over the long, medium, and short term are essential for improving the performance of the four collieries. Management had to adapt to the fast-changing environment during the enormously fast build-up of production. The major challenges in the environment were posed by the frequent dolerite intrusions, the extremely hard cutting conditions caused by carbonated nodules and thin sandstone intrusions in the coal seam, and excessive roof and face pressure in some areas due to semi-massive sandstone formations in the rock strata.

SAMEVATTING

Secunda-Steenkoolmyne is 'n deel van Sasol-Steenkool, die steenkoolafdeling van die Sasol-maatskappyegroep en 29 miljoen ton steenkool per jaar word reeds deur die vier myne, naamlik Twistdraai, Brandspruit, Bosjesspruit en Middelbult geproduseer. Die sukses van hierdie mynboukompleks kon slegs bereik word deur 'n unieke spangees waarin die sentrale dienste, asook die gedesentraliseerde spanne onder leiding van die bestuur van elk van die vier myne 'n belangrike rol vervul het.

Die Secunda-Mynekompleks het nou die stadium bereik waar die optimisering van bedryfskoste, produktiwiteit, veiligheid en die kwaliteit van werk netso belangrik geword het as die produksie. Prioriteitstelling en probleemoplossing oor die lang, medium en kort termyn was en is nog steeds belangrik om die myne se prestasies verder te verbeter. Die bestuur moes vinnig en korrek in 'n vinnig veranderende omgewing gedurende 'n enorme opboufase van produksie die nodige aanpassings doen. Die grootste uitdagings in die omgewingsfaktore was die hoë frekwensie van dolerietindringings, die uitermate harde snytoestande veroorsaak deur gekarboniseerde knolle en sandsteenindringings in die steenkoollaag en die buitengewone hoë druk- en frontdruktoetstande wat deur semi-massiewe sandsteenlae in die dakformasies veroorsaak is.

Introduction

Sasol is the second-largest producer of coal in South Africa. The Sasol Coal Division comprises the Sigma Colliery in Sasolburg and the four collieries that together are known as Secunda Collieries. Shaft sinking at Brandspruit Colliery, the oldest of the Secunda Collieries, started in 1975. Brandspruit is today the largest underground single-shaft coal mine in the world, and produced 823,874 kt during the calendar month of March 1985. Bosjesspruit Colliery followed about a year after Brandspruit, but the latest two mines, namely Twistdraai and Middelbult, were announced only at the end of 1979, when the decision to build Sasol Three was taken as a result of the Iranian crisis. All four mines are now fully commissioned.

The final capital cost of R20 per annual ton to get into full production is considered an achievement. The collieries' output for the last financial year was 29 Mt and met the upwardly revised production target. The highest monthly output, 2,8 Mt, was achieved during March 1985.

One of the collieries, namely Middelbult, achieved a NOSA five-star rating, and the average frequency rate of disabling injuries at the collieries improved by 50 per cent to 6, during the past year.

The personnel strength of the central complex and the four collieries amounts to 10 300 people. The central complex consists of a workshop, surface coal-handling facilities, and services, including the personnel, financial, and commercial departments in the central office. A large central training centre conducts management, apprentice, learner-miner, and operator training, while specialized artisan training is carried out at each colliery.

Development of the Complex

One of the biggest challenges was the large extent of geological disturbance experienced within the Secunda coalfield. There are two main dolerites: B4 dolerite, which is developed near the surface, and B8 dolerite, which is a later intrusion that meanders through the B4 dolerite and tends to cut through the coal seam at a non-uniform frequency of approximately once every 1,5 km.

To reduce the primary development and to ensure enough longwall panels for the seven longwall faces, the management developed the art of horizontal drilling. By variations in the speed of rotation and pressure, lengths of 1 km and more can be drilled in the pre-exploration of mining areas. Hole direction is determined accurately by the use of photographic methods. This practice has now become a normal operational activity and, on

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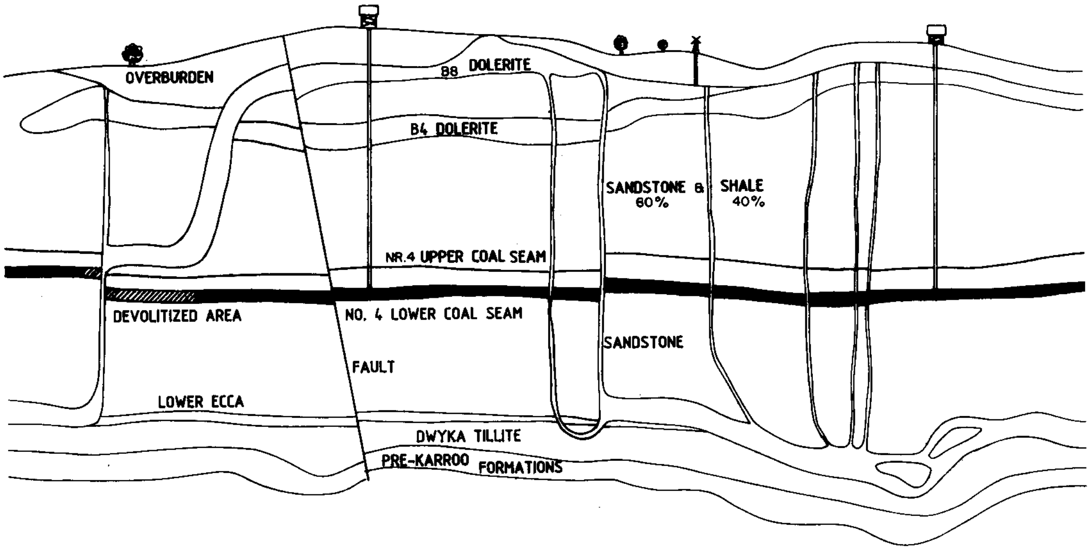

Fig. 1—Geological profile at Secunda mines

average, 9 km of horizontal in-seam drilling is done with four drills each month.

Fig. 1 shows a typical geological section through the Secunda coalfield, and Fig. 2 shows the horizontal diamond drill.

The total extraction is above average as a result of the introduction and modification of mining methods and the undermining of surface roads, power pylons, houses, surface dams, other structures, and farmland. Technology was developed, where possible in conjunction with the C S I R and the Chamber of Mines, to minimize damage to these structures.

The findings of a recent survey at the four collieries on the total extraction since the collieries started up are illustrated in Fig. 3.

It was found that an extraction of 69 per cent can be obtained, and that further improvements can be made by the reduction of the size of barrier pillars in primary development and by the partial removal of barrier pillars in both longwall and pillar-extraction sections.

Logistic System for the Control of Sub-assemblies

A macro-logistic system was designed, incorporating a sub-assembly control department in the organizational structure, to manage and control the flow of sub-assemblies, ensure quality control, and manage the repair of such components internally and externally. The responsibilities and checkpoints are defined in the flow process, which is illustrated in Fig. 4.

Productivity and In-section Mining Costs

The productivity of the longwall and continuous-miner sections were improved through modifications and adaptations to equipment and through the introduction of the methods discussed later.

A longwall face obtained 14,323 kt per 24-hour day at Twistdraai Colliery and 219,445 kg per month at Brandspruit. The continuous-miner sections also performed well, and a daily output of 8,625 kt was obtained at Twistdraai, and weekly and monthly outputs of 30,6 kt and 105,4 kt were obtained with single continuous-miner sections at Middelbult Colliery, working 17 eight-hour shifts per week.

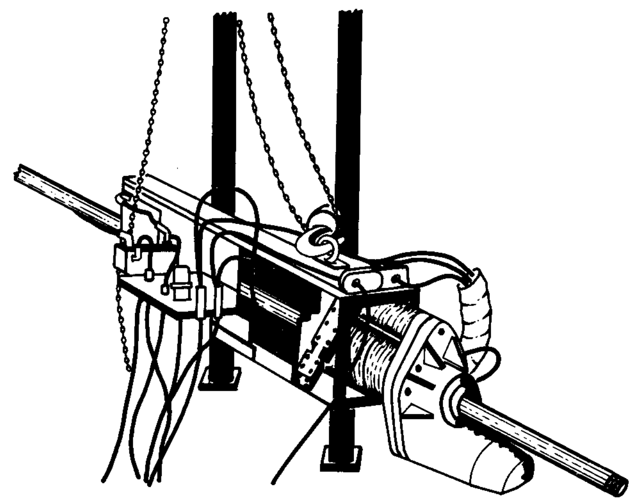

Fig. 2—A horizontal diamond drill

A comparison of the production costs in the various sections is shown in Fig. 5, in which the latest budget is reflected against the actual costs for the previous year.

It can be concluded that the production costs of the longwall unit are now being brought into line with the costs achieved by the other mining methods. If a capital depreciation cost of about 40 cents per ton is added to the longwall costs, it can be concluded that the costs of the three mining methods compare favourably. The mining environment will determine which mining method is to be applied since there are no real cost advantages of one method over the others.

Cutting Consumables

The coal-cutting costs were significantly reduced as a result of research and development on cutting drums, pick spacing, pick design, pick type, and new technology such as diamond picks. A pick laboratory for quality control was also introduced to ensure that all the picks conform to the requirements in terms of metal content and heat treatment.

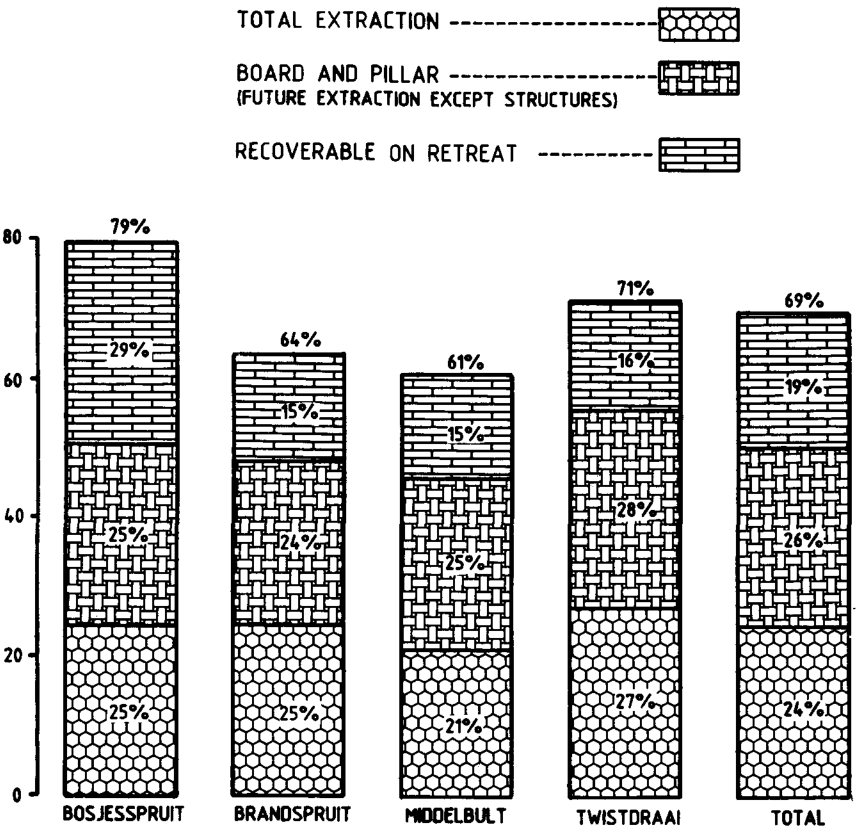

Fig. 3—Total extraction of coal at Secunda Collieries

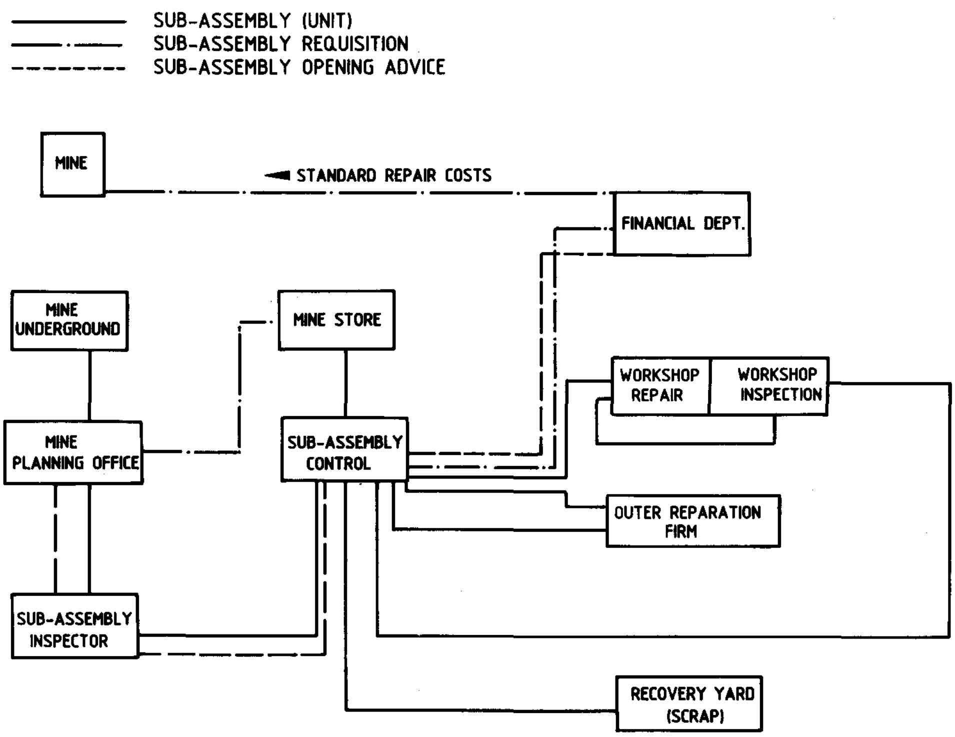

Fig. 4—Flow diagram showing sub-assemblies and documentation

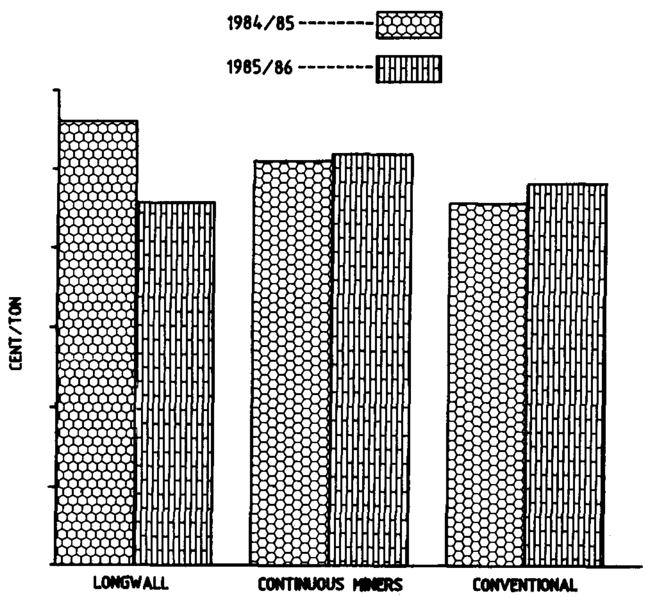

Fig. 5—Relative production costs for the longwall, continuous-miner, and conventional units

In general, it was found that, for longwall drums, radial picks in the outer ring combined with point-attack picks on the vanes gave much better results than drums with only radial picks. Consequently, a test is being carried out on drums with only point-attack picks, and the results are very promising. This does not apply at all the collieries since the cutting conditions are very different. During very hard cutting conditions, as during the startup of a new face, diamond picks gave optimal results.

Research is at present being undertaken with the Paris School of Mines on the correlation between power of cutting, machine speed, and pick configuration. There seems to be a correlation between the minimization of pick usage and, firstly, reduced drum diameter, secondly, slightly increased pick length and spacing and, thirdly, cutting power.

Availability of Conveyor Belts

The introduction of telemetric monitoring on primary and secondary conveyor belts vastly improved the availability and reliability of these belts. The systems installed carry out health monitoring and also accumulate valuable statistics that can be analysed on a daily and weekly basis in terms of conveyor availability and reasons for conveyor-belt stops.

To reduce belt tear, electronic start-up devices have been introduced to decrease conveyor-belt tension during start-up, thereby decreasing the possibility of belt tear.

Underground Transport

High-speed buses have been introduced underground, and road-building materials are handled through boreholes from the surface. Use is also being made of a containerized system for the handling of all materials.

Developments in Continuous Miner Sections

Excessive maintenance costs were experienced with the small continuous miners owing to excessive vibration in hard cutting conditions. This led to the development of a heavier continuous miner.

Transporters were developed so that the cutter heads of continuous miners could be changed as part of preventative maintenance. The completion of this operation took approximately six shifts when hoisting equipment was used. The cutter head is now transferred from the transporter in the correct position onto the continuous miner within a single shift.

Longwall Development

The productivity in longwall development was improved by the introduction of three-road development. The percentage extraction was also improved, and undulations on the surface due to uneven subsidence were reduced by the use of a crushing pillar between the previous and the present goaf areas. Fig. 6 shows the partial removal of interpanel pillars.

Continuous haulage was introduced on trial, firstly in rib pillar extraction, to prove the capacity of the system, and will later be introduced in longwall development to improve the rate of advance. Owing to the higher productivity of the longwall faces, it has become essential to improve the rate of longwall development.

Rib Pillar Extraction

Rib pillar extraction was introduced on a wide scale, and productivity and safety were improved by the introduction of a mobile breaker-line support to replace timber. Fig. 7 shows the mobile shield support as developed at Middelbult Colliery in collaboration with a manufacturer, and Fig. 8 shows the systematic support and sequence of cutting.

Conventional Pillar Extraction

Conventional pillar extraction by means of continuous miners was also introduced to further the aims of total extraction.

Developments in Longwall Sections

Shearers

A robust shearer and shearer haulage were developed in conjunction with manufacturers so that longwalling could be applied successfully in excessively hard cutting conditions as caused by the sandstone intrusions at Twistdraai Colliery.

Shields

Heavy-duty longwall shields were introduced to accommodate the effects of excessive roof pressure caused by semi-massive sandstone and dolerites above the coal seam at Bosjesspruit Colliery.

Armoured Face Conveyor

Heavy-duty closed-bottom armoured face conveyors were introduced on an economic basis to improve reliability and to reduce the costs of longwall mining. The chain size was increased from 26 to 30 mm. Friction was reduced to such an extent that only 70 per cent of the normal power consumption was needed during operation.

Longwall Faces

The introduction of the first 3,3 km longwall faces reduced voltage drops and crowding of the gate roads.

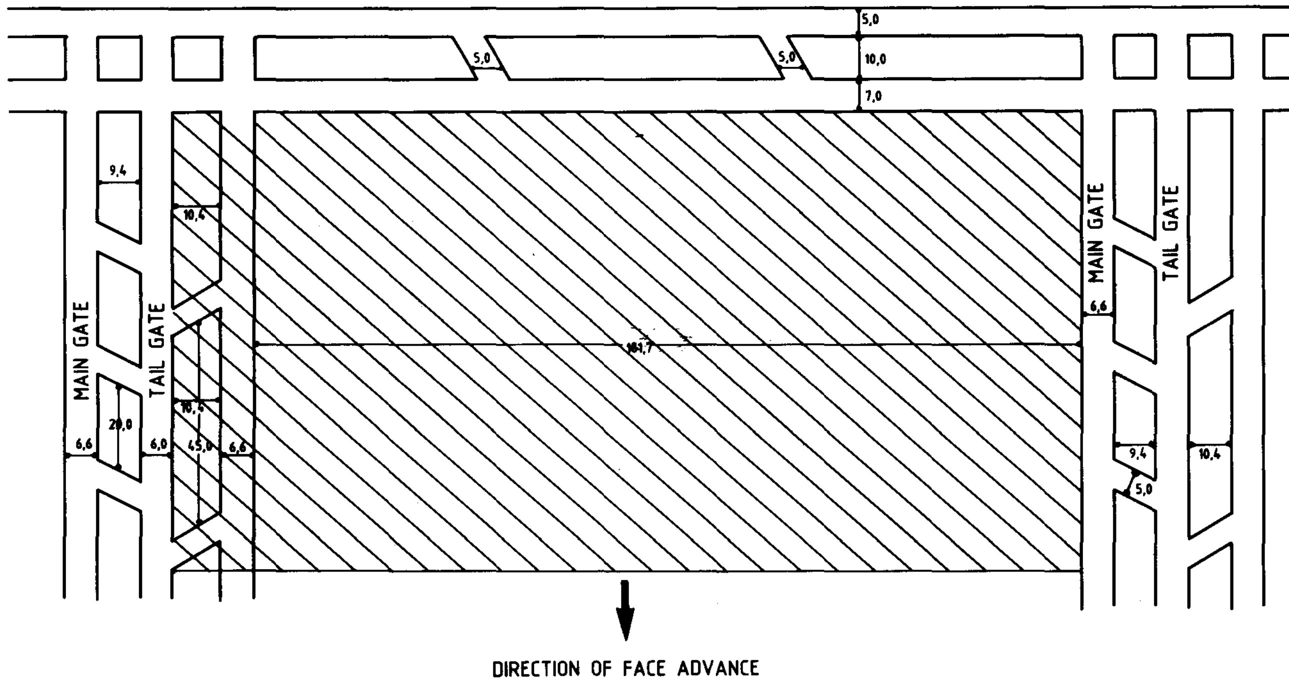

Fig. 6—Mining of an interpanel pillar at Secunda Collieries

This also eliminated the constant moving of electrical and hydraulic power packs by enabling them to be placed out of the section.

Principle of Integration

During the commissioning of the first longwalls, the principle of maximum integration of equipment was applied and led to the present side discharge, as well as the introduction of the short, simplified stage loader, which was made possible by the introduction of take-up drives in the conveyor-belt system.

Longwall Moves

The time taken to move longwalls was reduced by the use of specialized equipment to convey heavy equipment and by the selective introduction of spare equipment. In one instance, a longwall move was completed in a week, where it used to take five weeks.

Developments in Bord-and-pillar Mining

Electric, flameproof, cable-reel load–haul–dump machines were introduced to replace conventional gathering-arm loaders and shuttle cars, and have improved the productivity of these sections by 6 per cent in high-seam conditions at Middelbult Colliery. In addition, the replacement of two machines by one has reduced the artisan maintenance time required.

Future Developments Already Initiated

High-seam Breaker-line Supports

The development of a high-seam mobile breaker-line support could be a breakthrough to mine seams as thick as 6,5 m in a single pass with continuous miners and roadheaders.

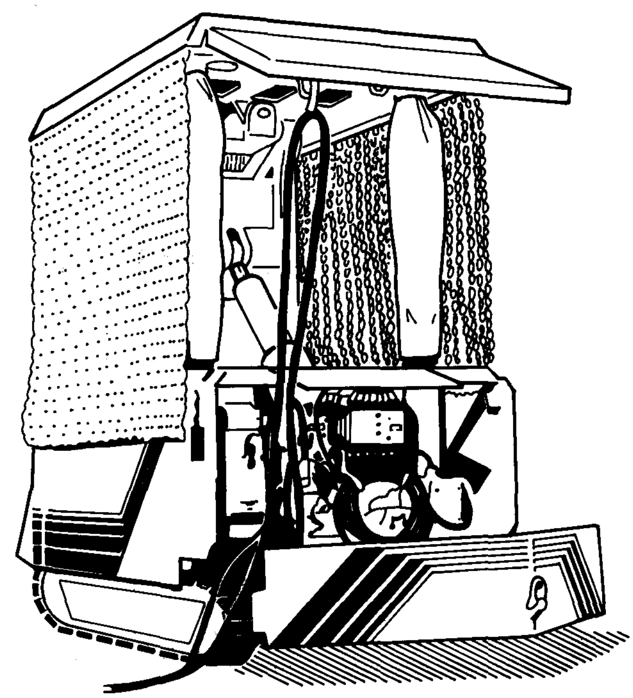

Fig. 7—Breaker-line support

New Generation Machine

Work is proceeding on the development, in collaboration with suppliers, of a high-output new-generation machine of the roadheader–continuous miner type in which weight, power, and width of drum are optimized. It seems that, with the present weight of roadheaders, power in the cutting drum could be increased to, say, 500 kW or more. The best machine could then be

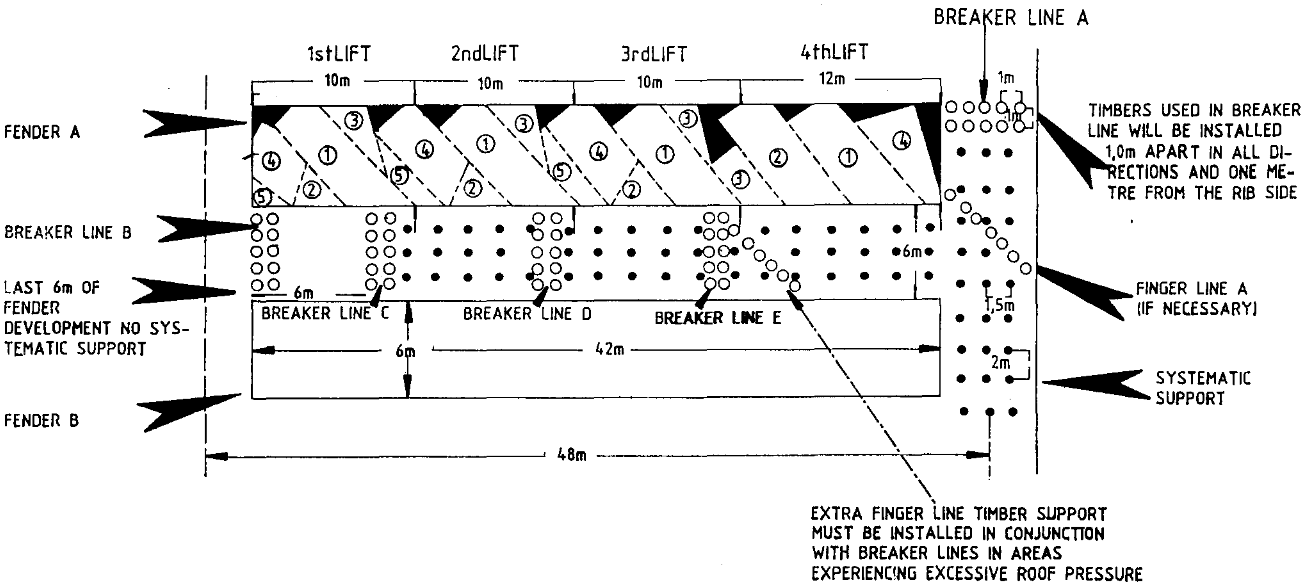

Fig. 8—Diagram showing the systematic support and sequence of the cutting used in rib pillar extraction

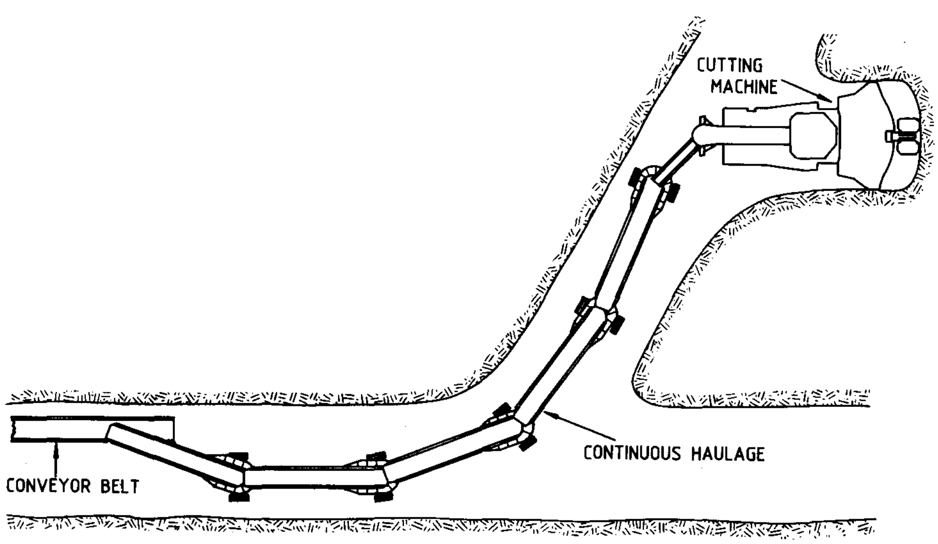

Fig. 9—Continuous haulage

developed, based on an evaluation of the strengths and weaknesses of roadheaders and continuous miners, and utilizing the strengths in one machine.

Continuous Haulage

Alternative types of continuous haulage are being developed in an effort to find the most productive and economic system and also to improve competition. An illustration of continuous haulage on wheels is given in Fig. 9.

Increased Length of Longwall Faces

The length of longwall faces is selectively being increased to 250 m and more to reduce the frequency of longwall moves and the amount of longwall development, and to improve output from the longwall faces.

Health Monitoring

Electronic health monitoring is being introduced to reduce and prevent large breakdowns of shearers, conveyor belts, and other production and service equipment.

Layout for Rib Pillar Extraction

Research and development in rock mechanics must be conducted so that the output from the rib-pillar extraction sections can be improved by increased rib lengths, with the possibility of minimizing rib development.

Water-jet Cutting and Drilling

The use of high-pressure water jets in cutting and drilling is planned for higher production output, less dust, less pick and bit consumption, less mechanical wear on machines, and a lower risk of the ignition of methane gas.

Conclusion

The innovations outlined in this paper have led to increased production, reduced costs, improved safety, and a positive management climate. The success achieved was due to a unique team spirit between the central services and the decentralized teams under the leadership of the mine management of each of the four mines making up Secunda Collieries.