The Contribution of Dowty to the World of Mining

By John Whitaker, Author[1]

From the dawn of human civilisation, primitive man began seeking out food; water; clothing and shelter in order to survive and live. The needs of these first hunter gatherers were extremely simple when compared to modern day standards.

Early Mining and Safety

As the first populations expanded, along with a desire to move out of caves and to live in new locations, the need to construct weatherproof shelters developed. Tools for cutting and chopping, materials to make cooking pots and storage utensils were also needed as early farming, cookery, pottery and metal working practices developed. So began the need to mine and the utilisation of the world's mineral resources. The first record of coal mining is around 20,000 years ago, in South Africa. The Book of Job, thought to be one of the earliest books of the bible to be written, includes a vivid description of mining and primary extraction industries.

> "There is a mine for silver and a place where gold is refined. Iron is taken from the earth, and copper is smelted from ore. Mortals put an end to the darkness; they search out the farthest recesses for ore in the blackest darkness. Far from human dwellings they cut a shaft, in places untouched by human feet; far from other people they dangle and sway. The earth, from which food comes, is transformed below as by fire; lapis lazuli comes from its rocks, and its dust contains nuggets of gold. No bird of prey knows that hidden path, no falcon's eye has seen it. Proud beasts do not set foot on it, and no lion prowls there. People assault the flinty rock with their hands and lay bare the roots of the mountains. They tunnel through the rock; their eyes see all its treasures". Job 28:1-2[2]

[2]The Holy Bible, New International Version® NIV® Copyright ©1973 1978 1984 2011 by Biblica, Inc.™

Of course, mining has moved considerably on since then and throughout the world today rocks and materials such as coal, oil shale, gemstones, limestone, chalk, rock salt, potash, gravel and clay are mined and extracted in large quantities every day. A wide variety of metals and minerals are also mined including lead, zinc, nickel, copper, aluminium, manganese, tin, molybdenum, cobalt, lithium, tungsten, vanadium, cadmium, tantalum and other precious jewels and metals such as diamonds, silver, gold and platinum. Early tin mining in Cornwall, England is shown in ***Figure 1.***

Figure 1 - Early Tin Mine in Cornwall

These various rocks, minerals and elements give us the where-with-all to produce the necessities and luxuries society now takes for granted. From cars to dishwashers, mobile phones to roads, heat and light to baked bean tins, engagement rings to garden patios and so much more besides.

[1] Grandson of the first Dowty Group Chairman, A.W. Martyn, and author of the book "The Best" detailing the definitive history of H.H. Martyn. Whitaker also authored a paper recording the significant contribution made by the Dowty Group to winning the Battle of Britain during WWII.

From its beginning, mining was an extremely dangerous occupation! Dangers were many and varied and presented themselves as toxic and explosive gasses, rapidly rising water levels and roof falls and collapses, ranging from the catastrophic to single rocks being dislodged which could kill or injure a man. The way we live today surrounded by luxuries and necessities has come at a massive cost - the cost of miners' lives. The numbers that follow illustrate a fraction of that cost, and just in the United States alone.

Year	Number of Miners	Fatalities
1900	448,581	1,489
1911	728.348	2,656
1921	823,253	1,995
1931	589,705	1,463
1951	441,905	785
1985	197,045	68
2020	66,172	5

Source: https://arlweb.msha.gov/stats/centurystats/coalstats.asp

Whilst still being too high, the decreasing trend in mining deaths above is attributable to the declining number of miners employed in mines and also the knowledge gained over the years, which has led to improved safety practices underground. It's also interesting to note that the dramatic fall in accidents in 1951 was not entirely due to less miners, or better safety legislation as this came much later in the USA, than in the UK. Protective safety legislation played no part in the UK until the mid-1800s and the major revisions in mining safety legislation came with the Mines & Quarries Act introduced in 1954, followed by the Health and Safety at Work Act which was passed in 1974. Both sets of legislation then began having a positive effect on safety. However, prior to this, some actions had begun with Factory Inspectors being introduced in 1833, followed by Mine Inspectors ten years later in 1843.

Mining would also go onto to experience seismic technical changes, having used wooden pit props for hundreds of years. The methods of using picks and shovels, then transferring the coal onto 15 cwt.(0.75t) tubs on rails, pulled underground to the pit shaft by pit ponies, would eventually go. The longwall coal faces produced by these methods were initially 60 feet long (18.3m) then extended to several hundred feet long, situated between two service roads or tunnels connecting directly to the pit shafts, then to the surface usually using a cage.

Later, pneumatic picks were used to hue coal, before the introduction of coal cutting machines, which undercut coal seams by approximately 4 feet 6 inches (1.37m) and 6 inches (0.15m) in thickness allowing the coal above to be blasted out using explosives, which could then be loaded into the tubs. As the coal face progressed, the roof had to be supported every 3 feet (0.9m) for safety and access. Historically wooden pit props were used in rows along the longwall coal face at intervals of about 3-4 feet (0.9 – 1.2m) depending on the strength of the stone roof, safety and any dampness of the seam.

Figure 2 shows the method of support on a longwall face using wooden props and steel straps. As the coal face advanced, new rows of wooden props would be added and the rows furthest from the face would be manually removed, which meant the roof behind the coal face was allowed fall – all in all a dangerous business! The last deep mine in Great Britain, Kellingley Colliery, which closed in 2015, is shown in ***Figure 3.*** The layout of a longwall face is shown in ***Figure 4*** with modern powered supports, which replaced the individual hydraulic props in the 1960's.

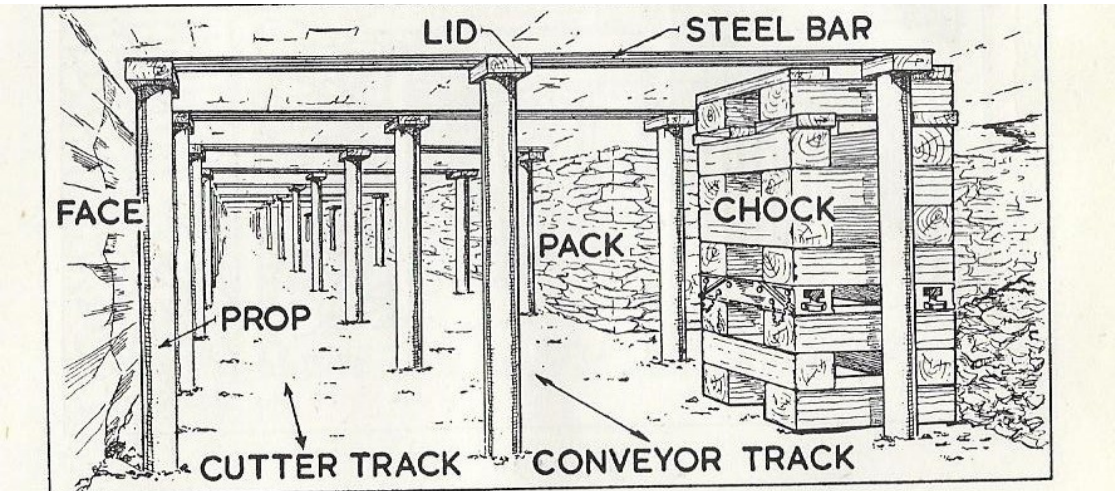


Figure 2 - Method of Support on a Longwall Face Using Props and Corrugated Steel Straps

Figure 3 - Kellingley Colliery Closed in 2015

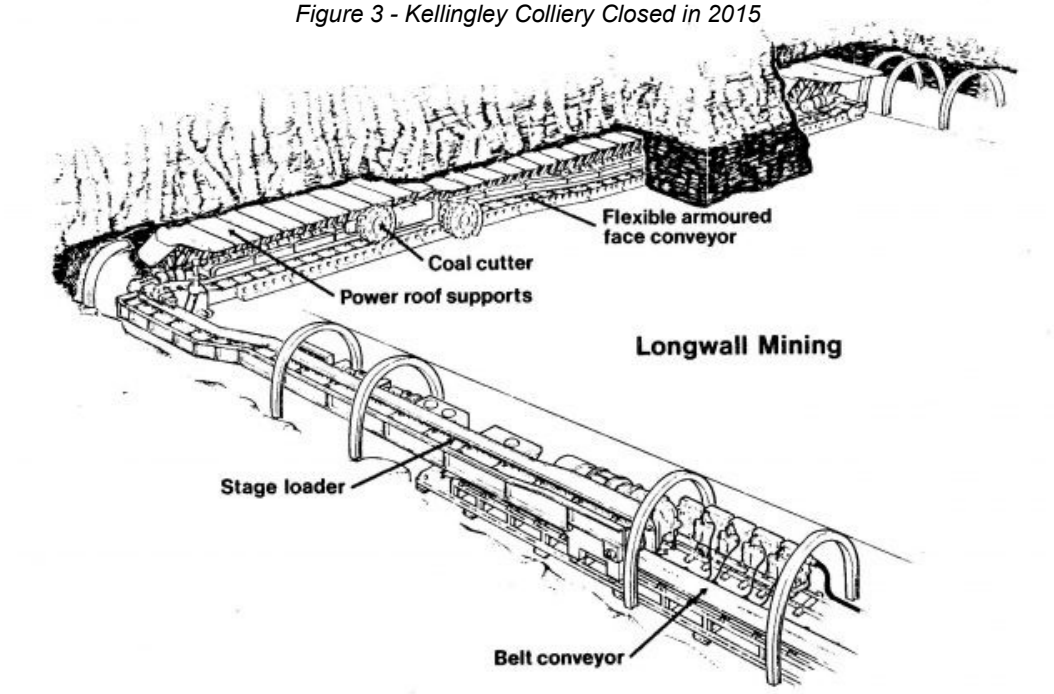


Figure 4 - Layout of a Longwall Coal Face with Modern Powered Roof Supports

Introduction of Dowty Hydraulic Props

We now turn to consider Dowty's engineering leap from 'flying in the sky' to 'burrowing underground'. Following the outbreak of World War II, Dowty was engaged in manufacturing hydraulic undercarriages for the Royal Air Force (RAF), and in turn relied on coal supplies to generate the electricity they needed to produce the undercarriage. Robert Hunt's memoirs (he later became Sir Robert Hunt and succeeded Sir George Dowty as Group Chairman) provide the background to Dowty's move into mining:

> "One of our senior employees had a close friend who was a coal mine owner in Nottingham, named Mr Lancaster. He was staying in Cheltenham for a weekend with his friend, who showed him round the company. On seeing and discussing the "Lancaster" aircraft landing gear, which had of course, hydraulic struts, he had a flash of brilliance and said, *"if only you could make those struts to descend slowly with about 10-ton end loads, we could probably use them instead of the wooden props, which have always been used in mines and are left to rot away as the coal face moves forward."* This was the most fortuitous statement ever made as far as the Dowty Company was concerned.

As an inventive engineer and prompted by this encounter, Sir George Dowty soon saw how his aircraft landing gear could with some adjustments be used to support the roof of a coal mine. So, in 1954 he formed the Dowty Mining Equipment company and began his pit prop design work. The first Dowty Standard hydraulic pit props were introduced to Hardwick Colliery, Derbyshire, where two years performance and endurance testing was undertaken. The hydraulic prop quickly became widely used and later a new design was introduced called the Dowty Duke Prop with high speed setting and withdrawal as special features. By 1957, the one millionth Dowty Pit Prop had been delivered and they were being used in mines all over the world, with the U.S. and China being particularly keen buyers. Dowty hydraulic props on the coal face supporting steel 'H' beams is shown in ***Figure 5***. Removing a Dowty prop from the waste edge behind a longwall face is illustrated in ***Figure 6***. The waste or goaf is allowed to collapse.

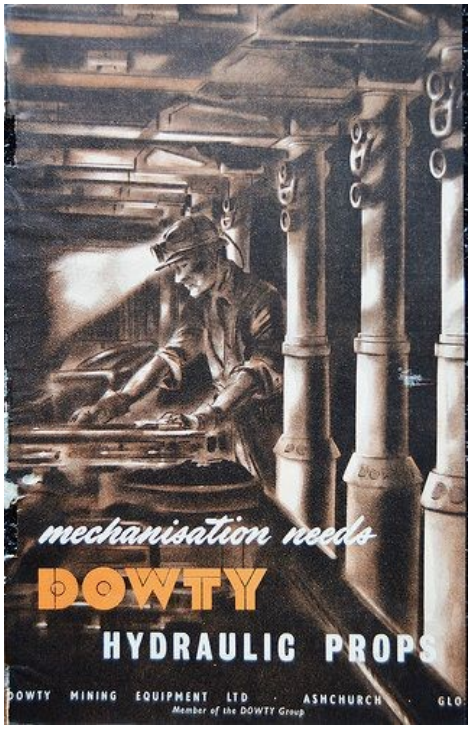


Figure 5 - Dowty Hydraulic Props

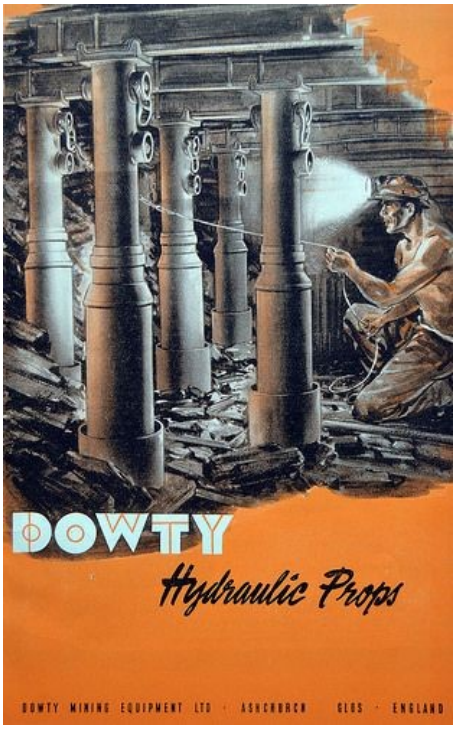


Figure 6 - Removing a Dowty Prop From the Waste Edge

After thousands of years of wooden pit props, Sir George Dowty pit props were very much the new 'kid on the block'. As with most new technology, Dowty Props were not readily accepted by miners. In fact, at one colliery the miners went on strike when they were first introduced. The problems being, Dowty props were heavier and more technical than wooden props but crucially they were also silent. For years miners had relied on the creaking sounds wooden props make, which constantly informed them of movements in the roof. Understandably, miners initially missed their trusted wooden pit props. Once the Dowty Props were better understood and trusted, miners again went on strike but this time, to have the Dowty Props reinstated after they had been removed from a mine for maintenance!

Development of Dowty Roofmaster Hydraulic Powered Supports

Following soon in the footsteps of Dowty Props, came Dowty Roofmaster Powered Supports. ***Figure 7*** shows Dowty Roofmasters supporting the roof in a 48" (1.2m) thick coal seam. The Roofmaster was a hydraulic powered roof support system housed in mobile steel boxes, which could be connected to the armoured chain face conveyor, which was mounted with a mechanical cutter-loader machine. Such mechanisation at the coal face greatly improved safety and also increased production.

Figure 7 - Dowty Roofmasters Supporting the Roof in a 48" Thin Coal Seam

Not far from the Dowty Cheltenham's headquarters in nearby Worcester, was a company already producing high quality belt and chain conveyors, called MECO (Mining Engineering Company). So, rather than "reinventing the wheel" Dowty acquired Meco and integrated its business with its own hydraulic roof props business. The Dowty Roofmaster was soon transforming coal production and, above all, miner safety at the coal face. The Meco business proved to be the perfect match Sir George Dowty envisioned it would be, bringing together on the coal face hydraulic roof props, chain conveyors and coal cutting equipment, as well as belt conveyors, which conveyed the coal to a mine entrance.

Meco were well-advanced in the development of both high quality belt and chain conveyor systems for the mining industry and were deploying the highly productive AB Meco-Moore Cutter Loader as illustrated in ***Figure 8***. This merging of products reduced, possibly by years the time it took for Dowty to widely introduce its Roofmaster powered support system into mining. It was also extremely fortuitous that Meco's owners, the Higgins family were lovely friendly people, with whom George Dowty became great friends. This friendship had a beneficial effect on both workforces, who quickly became compatible and began working cooperatively together in harmony.

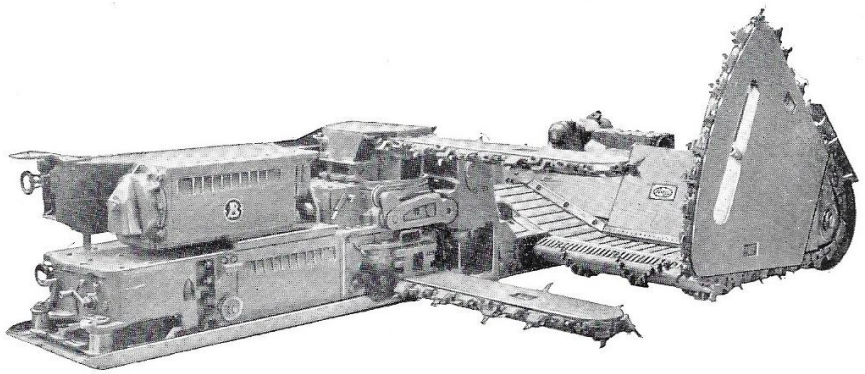


Figure 8 - A.B. Meco-Moore Cutter Loader (High Type)

Dowty brought vital qualities needed in any company wanting to be successful. This was a culture of initiative, ambitious drive, coupled with a 'can do' mentality, which probably wasn't so strong in Meco at the time. Meco soon caught on and became world leaders in all types of conveyors and cutter loaders, with Dowty being a world leader in individual hydraulic props, Dowty Roofmasters and aircraft undercarriages.

The Dowty Roofmaster made further contributions to miner safety as it provided immediate support of newly exposed sections of roof, using wide, massive roof beams, which provided great protection to the face workers, eliminated the need for 'waste edge' manual labour and reduced the exposure to obvious risks. During the 1920's, when Britain's coal industry was at its height, around 1.2 million men were employed underground. Approximately 2,000 men died every year. Today far fewer men are employed in the industry and thankfully deaths are so rare, that a single death now makes national news.

Viscount Adrian Buckmaster, who was Managing Director of Dowty Mining and also a main Dowty Board Director, is quoted as saying: “I do not remember any fatal accident associated with our longwall equipment during my time in the coal industry. In fact, accidents of any sort on the face were very rare, and were normally things like trapped fingers or toes suffered during repair work.”

Lord Shinwell the Labour Minister of Fuel and Power 1946-47 is quoted in Hansard as saying during the severe winter coal shortages and referring to the new coal face cutter loader, the A.B. Meco-Moore - “I have sleepless nights imagining what wonders this invention will bring to mining.” Understandable, as Lord Shinwell was being given a hard time over the coal shortages and the main energy source at the time.

Initially coal faces in Britain yielded around 500 tons per shift. Today productivity has risen in some cases in America to nearly 1 million tons per month!

Sir George Dowty

Minimising accidents proved to be an incentive for Sir George Dowty’s inventive genius. See ***Figure 9.*** He was also a man who valued Christian principals having been brought up in a family where his father was a minister of a nearby church. George kept a biblical quotation on his desk and at his passing, it was by his bed. Christian motivations always made him consider his fellow workers, and their safety and well-being remained in his thinking, as is evident from two of his many major engineering feats.

Figure 9 - Sir George Dowty 1901-1975

Firstly, his robust undercarriages used in most Second World War RAF bombers and fighter planes, and which were hailed by the flying men as being trustworthy and totally reliable. They certainly saved lives, particularly when landing back at base with battle weary pilots and crews, often in damaged and therefore unstable planes. The undercarriages were built to a massive margin of tolerance as well as to new engineering designs, which meant they didn’t fail under extreme and sudden loads.

Secondly the life preserving Dowty Roofmaster and Pit Props again conceived and engineered to the same high standards of invention and manufacture. Unquestionably they’ve been instrumental in ensuring death and injury is the exception rather than the norm, in mines across the world today. Just two of Sir George Dowty’s innumerable inventions, created during his lifetime.

Sir George Dowty’s company first grew through new applications for hydraulics and then by producing motorcycle forks, prime support systems, pit props and later hydraulic control systems. With other notable developments, as follows.

1950 Dowty Hydraulic Units was launched.
1952 & 1953 George Dowty elected President of the royal Aeronautical Society.
1953 Gold Medal awarded to George Dowty for outstanding design and development of aircraft equipment.
1953 launch of Dowty Fuel Systems.
1954 launch of Dowty Mining Equipment.

1955 launch of Dowty Seals.
1957 launch of Dowty Nucleonics.
1958 launch of Dowty Rotol, propeller manufacture.
Development of fuel control systems for Harrier Jump Jets and power controls for Concorde supersonic airliners.
1961 Dowty bought Boulton Paul Aircraft and began producing aircraft powered control units.
1967 elected an Honorary Fellow of the Royal Aeronautical Society.
1968 Dowty acquires Meco of Worcester

What an extraordinary man Sir George Dowty was. An outstanding British citizen, a genius inventor, engineer and businessman. His inventions continue to benefit society today and will continue to do so into the future, particularly through millions of safe airliner landings, safer mining conditions and higher productivity. Perhaps his greatest achievement is all the miners, pilots and travellers who daily return safely home to their families. What a magnificent record to have! Now it's time his nation recognised him as a giant amongst the giants!

"Cometh the moment, Cometh the Man" is certainly true of Sir George Dowty.

APPENDIX I

ALLAN WILSON C.Eng., C.MarEng., Mar.EST
NCB Lambton Engineering Works 1962-1971

Coming from three generations of miners, I had a 5-year technical apprenticeship in the National Coal Board in the Durham and Northumberland coalfields. Several of my uncles and my father were maimed at the coal face due to roof falls.

In the 1960s, the word was 'mechanisation' throughout the coal industry. I went to Seaham Colliery to do my underground training in 1963, in between my college semesters. On the coal face, there were rows of literally dozens of Dowty Props and we were taught to set a wooden prop and a Dowty prop.

The Dowty prop was much easier to set than a wooden prop, and I was told 'it had a 5-ton setting load between roof and floor, but it would 'relieve' or yield the oil pressure at 20 tons load. Two of us set our props with a 6" (0.15m) wide corrugated steel strap between them, about 3 feet (0.9m) apart. Moving away from the coal face, we used the same pump handle to pull the top ring on a prop to extract it in seconds. The 5- foot-long (1.5m) prop was easy to lift, move, and then re-use nearer the face. I was told many of the wooden props could not be reused due to splitting, bending or just not being long enough.

The advantage of the Dowty hydraulic prop was that it could be reused dozens of times for different heights between the mine roof and floor. The props came in 2, 3-, 4-, 5- and 6-foot (0.6, 0.9, 1.2, 1.5, and 1.8m) lengths, extended hydraulically and were made from coated steel tubes with a softer fibrous cap on the end, held in place by 4 rivets. The design had to be user-friendly, 'bomb proof' and resistant to corrosive water and fluids. Miners took to them immediately, as they were easier to use, and everything felt more secure with them in place.

It was obviously an attractive proposition to use Dowty props, as less miners were needed at the face, but particularly because there were fewer safety issues and accidents. A Dowty prop under severe load could be extracted from a few yards away, if necessary, and under the cover provided by other props, which made it safer.

Mechanisation of longwall coal faces rapidly changed the role of miners. The double-edged rapid coal plough, mounted on top of a coal face chain conveyor would cut coal as it was pulled along the face, in either direction. The coal then fell onto the face conveyor and in turn was fed onto a belt conveyor, sending it towards the shaft. Other coal cutting machines were also used, such as 'shearers' with either a single rotating drum with external picks or two cutting drums one at each end. The shearing machine pulled itself along a chain near the top of the coal face chain conveyor. Dowty also provided 'walking' roof supports, which enabled uninterrupted coal production – a novel solution changing the whole method of coal production. Miners called Dowty Roofmaster supports 'Daleks'!

Daleks worked as follows. A row of Daleks would be located every few feet along the longwall coal face, attached to the face conveyor with a push/pull hydraulic actuator. As the coal plough or shearer went past, the face conveyor was pushed against the coal face by the Dalek. When the coal was cut it fell onto the conveyor. The Roofmaster pushed and advanced the conveyor forward, against the freshly cut coal face.

The Roofmaster retracted the 2 or 3 vertical hydraulic rams holding the roof beam against the roof, thus freeing the Roofmaster. The horizontal ram would then retract, pulling the Roofmaster forward towards the face conveyor. It would then re-extend the 2 or 3 vertical hydraulic rams, to force the roof canopy against the roof once again. The 'Dalek' was then moved forward and reset, until the plough or shearer finished cutting and returned in the other direction.

Dowty Roofmasters came in several roof load capacities and operational specifications. They could be fully automatic as described above or set manually. A remote hydraulic power pack would power all of the Roofmasters connected together, 'daisy chain' style.

Consequently, coal production soared, and some mines produced in Britain over 1 million tons per year and 'continuous mining' had arrived. Some mines that had struggled to be profitable, suddenly became an asset! Fewer personnel were required, which therefore meant fewer casualties. However, more technical expertise was necessary to install, maintain and then extract non-operational units. The coal face had now become highly technological and Dowty played a large part in this.

APPENDIX II

BILL REID, Student Apprentice, NCB Northern (N&C Division) 1958-63
Roof Support Engineer, Huwood Limited, Yorkshire Area, 1963-1968
Founder, President & Managing Editor, Coal News, Inc. Publisher of CoalZoom.com 2004 to date

As Dowty acquired Meco in 1968, it is appropriate to briefly, mention a couple of developments that made Meco an iconic name in the coal mining industry.

Meco Chock Releases

In the years when wooden props were used to support the coal face, long before the Dowty Roofmaster was invented, wooden chocks, which were both strong and stable, were used generally built of pieces of hard-wood, usually Beech or Oak and about 2 feet (0.6m) long and 6 inches (0.15m) square, wedged tightly to the roof as shown in Figure 10. Wooden chocks measured 24 inches x 24 inches (0.6 x 0.6m) x the thickness of the seam

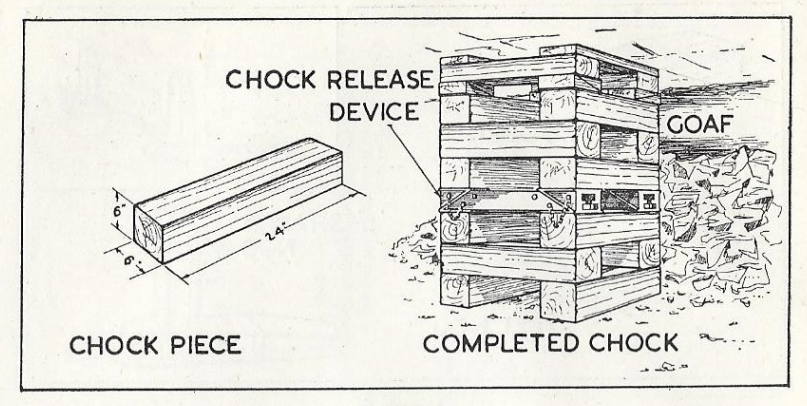


Figure 10 - Wood Chocks Provided Additional Support to the Roof

Special devices called Meco Chock Releases were incorporated in chocks so that they could easily be released when they were under pressure from the roof at the time they had to be withdrawn. Miners crouched in a safe place and using a long-handled hammer, struck the rear release trips as shown in ***Figure 11***. In the same way, the trips on the face side were released. This released the entire chock, the pieces of which were then gathered together and stored ready for future use using along-handled pick to recover the chock pieces from the unsupported area.

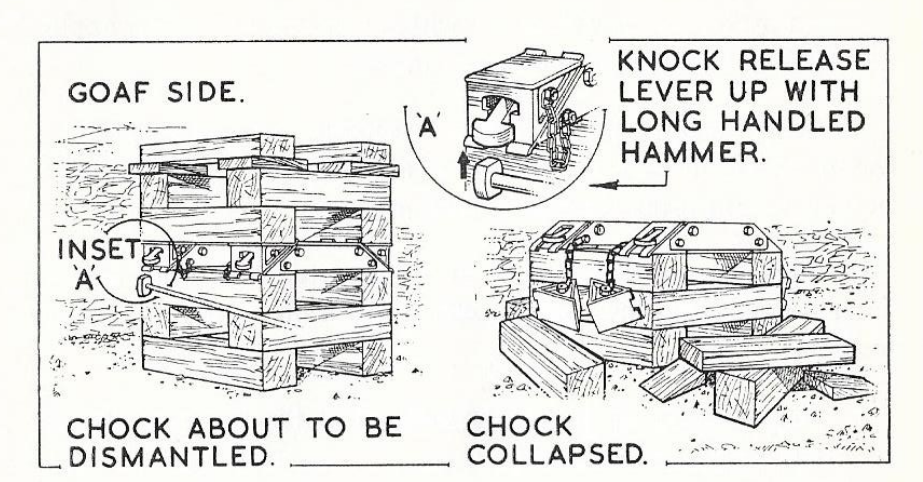


Figure 11 - Wooden Chock Being Collapsed

Meco Chock Releases, which provided greater safety to coal miners, were used for many years and became standard equipment on all longwall faces in Great Britain.

A.B. Meco-Moore Cutter Loader

The early history goes back to 1930, when the inventor, M.S. Moore and Meco started the design and production of machines for simultaneous cutting and loading on longwall faces. During the war years, the necessity arose for increasing production and in 1941 a close collaboration between Meco and Anderson Boyes of Motherwell, Scotland produced the A.B. Meco-Moore Cutter Loader as shown in ***Figure 12.***

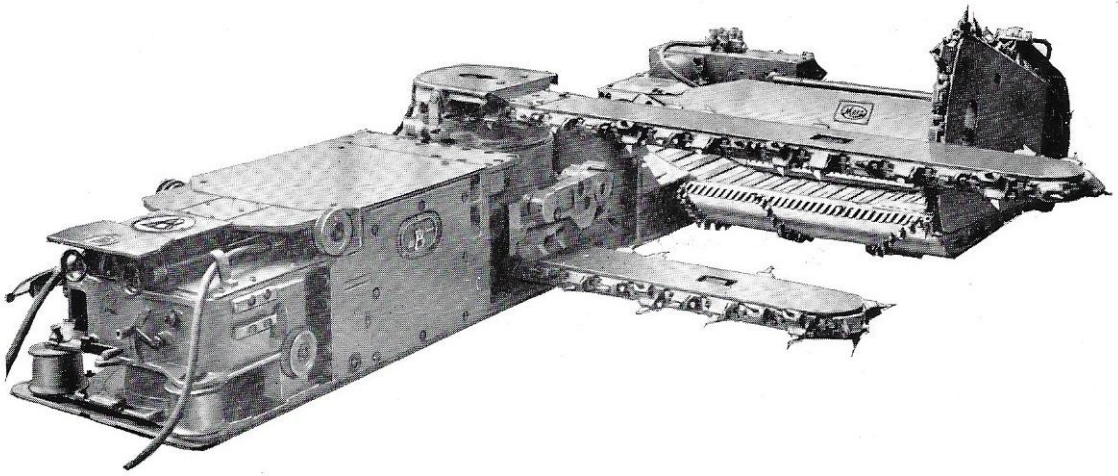


Figure 12 - A.B. Meco-Moore Cutter Loader Low Version

The machine consisted of two sections: the cutting portion and the loading portion, coupled together. The cutting portion comprised an A.B. Fifteen Special Longwall Coalcutter with undercutting and overcutting jibs, and with an additional motor of the same type and h.p. as the Coalcutter motor mounted on top. This second motor was utilized for driving the “Meco” loader portion, and also the A.B. Shearing Jib which cut the back of the web.

The loader portion consisted of a projecting frame within which is mounted the loader conveyor, which was an endless rubber belt fitted with steel slats. The loader conveyor and gummers are driven from gearboxes fitted to the sides of the loading structure. Immediately in front of the loading structure was a loader bar, which lifted the coal after it was cut and transferred it to the loader conveyor. To provide for travel of the machine in either direction, duplicate loader gearboxes and gummers were fitted on opposite sides of the loader jib.

The total h.p. of this unit was 100 h.p (37kW) and the minimum seam height to which it was applicable was 4 feet (1.2m). The machine was fitted with double rope haulage with 5/8” (16mm) wire rope. The maximum haulage speed was 30” per minute (9.15 m/min). Cutter loaders could be equipped with a 30” (0.762m) Loading Unit providing a much freer discharge onto the face conveyor, which was usually of an armoured flexible type. The machines were also equipped with wet cutting to keep dust to a minimum.

In one early application of the machine, 324 tons of coal were produced in a shift with thirteen men actually engaged in the coal-getting. The output per manshift (OMS) was 24.9 tons per man. This compared to only 13.5 tons per man for the same operation performed by hand-filling. The machine loading rate was about 70 tons per hour. In 1942, as a result of a successful trial at Bolsover Colliery in the East Midlands Division, the National Coal Board Mechanisation Advisory Committee gave authorisation for the production of 100 machines. In 1946, there were 27 machines in use.

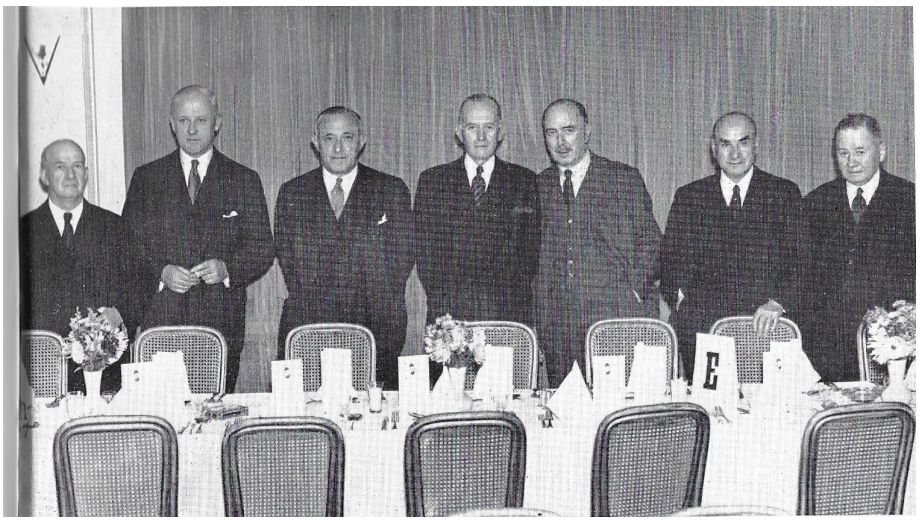


Figure 13 - Marking the Raising of the Millionth-Ton Celebration Dinner Guests L to R, Ebby Edwards, Eric Young, Emmanuel Shinwell, Mark Higgins, Lord Hyndley, Sir Charles C. Reid, J.S. Asquith

On September 26, 1946, a dinner was given at Nottingham by the Bolsover Colliery Company Limited and the Mining Engineering Company Limited, to officials and workmen of both firms to celebrate the 1,000,000th ton of coal.produced by these machines. The personalities at the top table at the dinner.are shown in ***Figure 13***. Of note, is the writer's Grandfather, Sir Charles C. Reid, Board Member for Production of the N.C.B. (second from right). By 1948, there were 42 machines in use with many more on order. During the year 1958, A.B. Meco-Moore machines produced a whopping 11,000,000 tons of coal!

Technical societies have recorded excellent production results in coalfields across the country with notable examples being at Gresford Colliery in N. Wales near Wrexham, Brookhouse Colliery in Yorkshire, and Bates Colliery in Northumberland. During the 1950's the A.B. Meco-Moore played its part in the early development of simultaneous cutting and loading in British collieries by providing greater safety and increasing production.

Dowty Hydraulic Props

After extensive trials underground, early in 1947 the East Midlands Division of the National Coal Board (NCB) decided to introduce hydraulic props at thirty collieries. These were highly successful, and soon became standard equipment on longwall faces. The Dowty Standard Hydraulic Prop had a setting load of 5 tons and a yield load of 20 tons.

Dowty Duke Prop

This was a development of the earlier design with high-speed setting and withdrawal as special features. A section of through the prop is shown in ***Figure 14***. The prop consists essentially of two steel cylinders, the inner one having a piston head extended by hydraulic pressure. The inner cylinder acts as an oil reservoir and contains all the mechanisms, the pump, release valve, relief valve, air breather, and control shaft. The control shaft is transversely mounted at the top of the inner tube operating both pumping and release mechanisms.

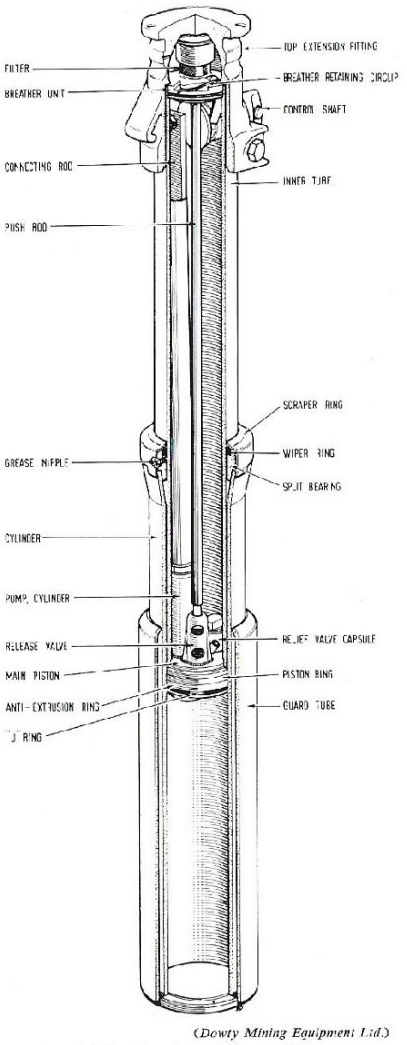


Figure 14 - Section Through Dowty Duke Prop

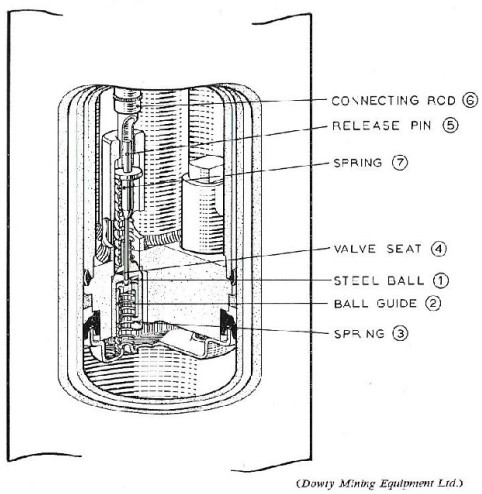


Figure 15 - Release Mechanism of Duke Prop

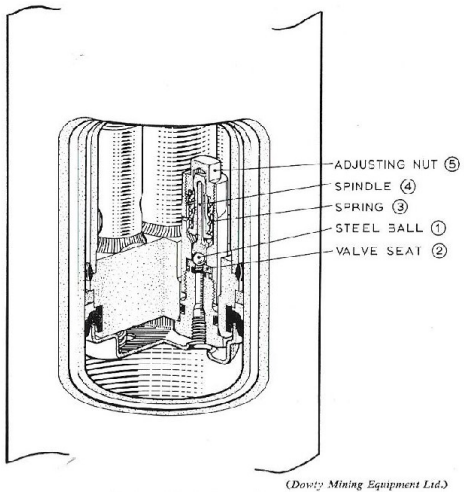


Figure 16 - Relief Valve of Duke Prop

The pump was a single-stage unit with a dual action. One full stroke of the pump extended the prop 0.2 inch (5 mm) or raises the setting load from zero to 5-7 tons. The release valve in shown in ***Figure 15*** and the relief valve is shown in ***Figure 16***. To fill the prop with oil, the extension is removed and the prop is fully closed. The breather unit is removed and the prop filled to within ½ inch (13mm) from the top with oil. By 1965, there were over 2 million hydraulic props in British mines.

Dowty Bonded Seal

Hydraulic systems have for years commonly employed O-rings. Later the Dowty bonded seal was developed. This consists of a rubber ring bonded to a metal washer as shown in ***Figure 17***. The metal mating parts are permanently static in relation to each other but the O-ring is free to deform under pressure and effect a seal in a truly automatic fashion. The Dowty bonded seal became fundamental to high pressure hydraulic systems in aviation and then in mining as well as just about everywhere else. It is simple, effective and timeless., and is yet another brilliant Dowty innovation.

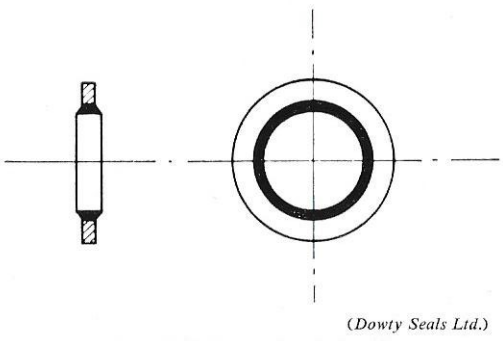


Figure 17 - Dowty Bonded Seal

Dowty Roofmaster Powered Supports

Development of the powered support began in the early 1950's with prototypes being tested at Cymtillery Colliery and Brittania Collery in South Wales. The supports were not intended at that stage to advance the conveyor but it was found that both the shearer loader and face conveyor could be advanced by pushing from the support. These tests resulted in the development of the Isleworth-Dowty support in collaboration with Dowty Mining Equipment Ltd. Further tests were carried out at Welbeck Colliery in the East Midland Division, NCB, which led to the development of the Dowty Roofmaster as shown in ***Figure 18***.

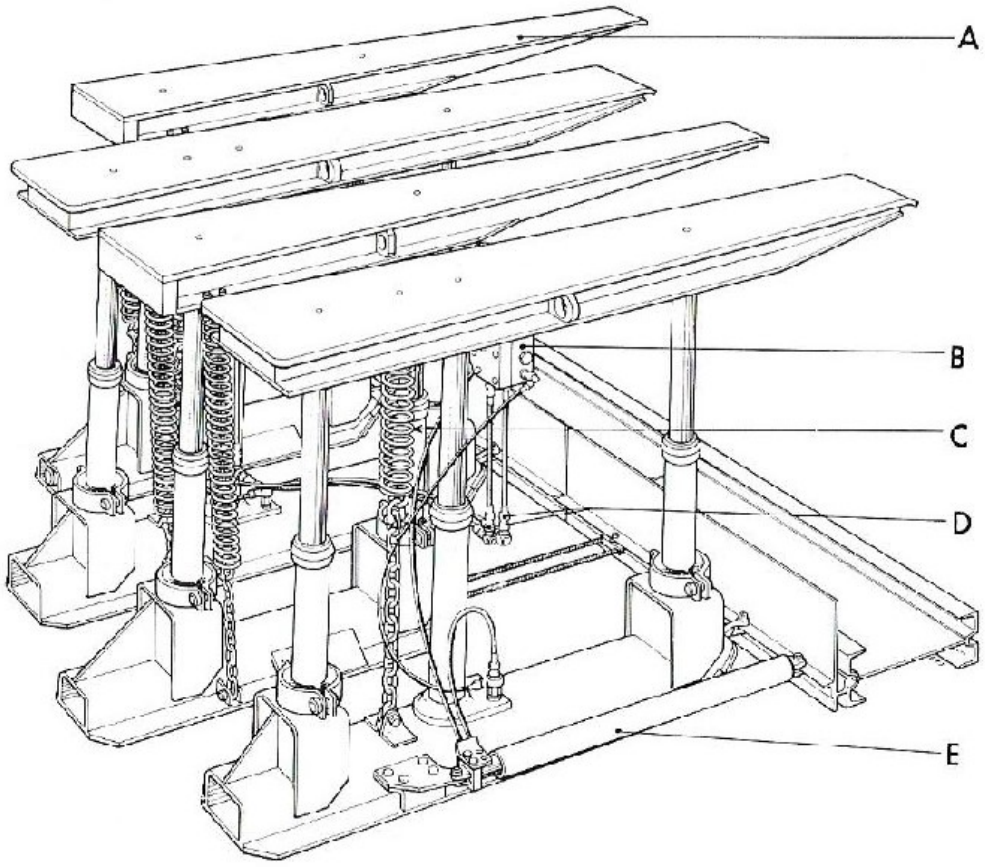
Dowty Roofmaster support units were of two types: one type incorporates two props and the other had three props and they were often used alternatively. Originally, they used mineral oil then later water and soluble oil with 95/5 solution. Each support unit comprised a box section base, which was fitted with yielding props supporting a top beam. Hydraulic power was supplied from a remote location off the coal face by a self-contained power pack, which employed a Dowty Vardel pump, adapted from the aircraft industry. The capacity of the pump was 5 gallons per minute (22 l / min) operating at 3,000 lbf/in 2 (210 bar). The power pack also included a large capacity tank, a thermo-trip, and filter.

The support units were spaced at 2 feet (0.6m), 2.5 feet (0.75m) or 3 feet (0.9m) intervals along the coal face depending on the roof and mining conditions. A jack in the base of each support was mechanically connected to the conveyor and hydraulically linked to the pressure and return lines. Control valves in the pipelines, mounted underneath the roof canopy, controlled the operation of the jacks. Fluid for prop pressurization also passed through the valves before entering the supports through hollow piston rods.

At the commencement of the "cut", all the supports were in line, with the roof beams set close to the coal face. The yield load of all supports was 25 tons. As the power loader moves along the face, the two props of each 2-leg support unit were released by selection of the prop control valve. Operation of the jack control valve closes the jacks, drawing the supports up to the conveyor. The props were then pressurized by selection of the prop control valve, to a setting load of up to 14 tons per prop. Both control valves were operated by a short removable handle by the operator. For safety, the valves were spring loaded to the neutral position.

To advance ("snake") the face conveyor over to the coalface, the PUSH position was selected at the jack control valve for each 2-leg support, extending the jack and pushing the conveyor forward. The jack was left in the PUSH position by using the lock button on the valve while the operator moved to the next unit. When the conveyor was fully advanced, the props of the 3-leg support units were released and the jacks closed, advancing the supports until they were reset in line with the 2-prop units, thus establishing a new caving line and allowing the waste roof to cave.

From the early Dowty Roofmasters to later Dowty 4-leg chock shield supports ***(Figure 19)*** and then 2-leg shields ***(Figure 20)***, Dowty had a very significant advantage in its designs of high-pressure valve technology because of its connection to the aircraft industry. In aviation, hydraulic reliability is absolutely fundamental to designs and this is precisely the case in underground mining as well. Thus, Dowty was able to lead the way in the field of hydraulic valve design and manufacture for mining roof supports.



(*Dowty Mining Equipment Ltd.*)

A 2 leg advanced unit; *B* Control valve; *C* Tension spring; *D* Self-sealing couplings; *E* Conveyor push ram

Figure 18 - Dowty Roofmaster

The use of powered supports in the mining industry was the technical advance, which made a gigantic contribution to successful coal face mechanization. The Dowty Roofmaster was a frame type support and these paved the way for development of chock-type supports, chock-shields, then the current automated modern 2-leg heavy duty shields first developed in the 1970's and used today around the world. The early Dowty Roofmaster inventors would have been certainly proud of what they had begun.

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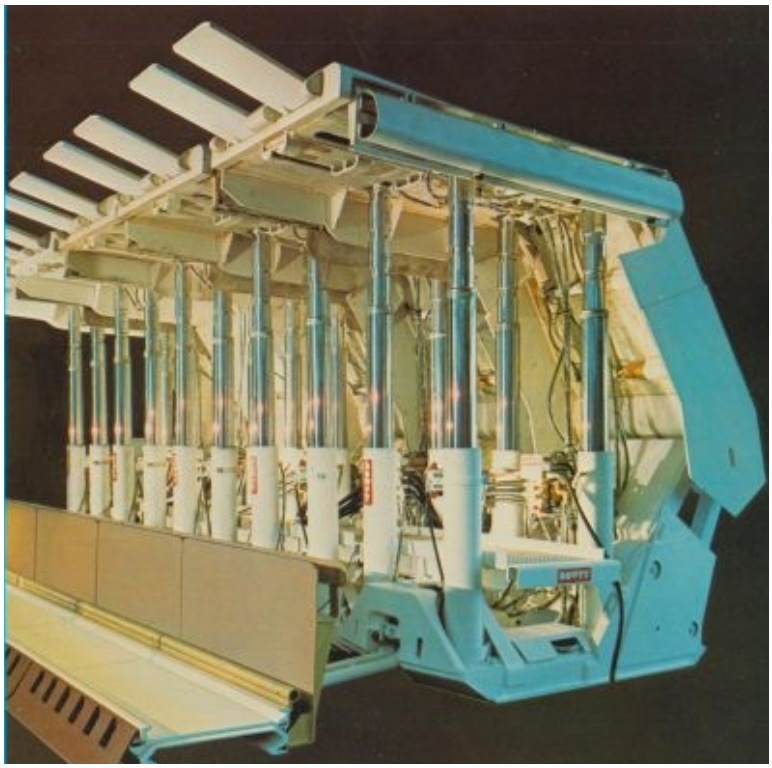

Figure 19 - Dowty 4-Leg Chock Shield Supports

Figure 20 - Dowty 2-Leg Shield Supports