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THE CANNOCK AND HUNTINGTON SINKING

N.A. Chapman

SYNOPSIS

The use of the Kind Chaudron method of shaft sinking was first applied in the coalfields of Staffordshire, at Cannock, North of Birmingham. The method was designed to sink through heavily watered strata, using boring and trepanning equipment situated at surface. This was followed by the construction and installation of a column of iron tubbing, wedged and jointed in the shaft. The writer describes the trials and tribulations encountered at this site, which it is supposed, were due to the extremely large diameter of the sinking. The sinking was suspended in 1881- *having commenced four years earlier- but eventually completed in 1901.*

GEOLOGY

A large area of the northern portion of the South Staffordshire coalfield is overlain by the Bunter Conglomerates of the Trias formation, comprising the district known as Cannock Chase and stretching northwards from the town of Cannock to the valley of the river Trent. The Lower Bunter or Variegated Sandstone group here appears to be missing and the Pebble beds rest unconformably upon the Coal Measures. Their thickness varies very considerably; – At West Cannock No.1 colliery, they were missing altogether, and at the No.2 plant they reached 80 feet in thickness; at the Fair Oak sinking they reached 300 feet; in the No.2 pit at this sinking they reached 130 feet. Nearby at the Fair Oak Tree boring, 315 feet in thickness was found.

This remarkable formation is composed of beds of gravel, sands tones containing pebbles, and conglomerates. In some instances the latter are loose and easily disintegrate; in others they are cemented to a condition of extreme hardness by carbonates of lime, iron and silica. The pebbles are chiefly yellow, brown and chocolate quartzites and siliceous limestone, with beds of trappean and felspathic detritus; in short, the Bunter Conglomerates are derived from most of the older formations from the Cambrian up to the Millstone Grit.

Two characteristics they all have in common are the rounded and elongated shape of the pebbles, and the complete lack of angularity, indicating their accumulation by strong wave or current action. As to the geographical source or sources of supply, different opinions have been expressed, varying from the North of Scotland, the local ancient rocks of the Wrekin and Malvern Hills, even to the South of England and the west of France. One of the most interesting features being the occurrence in certain localities of copper and lead ores in such quantities that, if persistent over a larger area, they might have been profitably worked. The copper ore consisting of copper carbonate and forms a portion of the cementing material of the conglomerate matrix, and the lead ore consists of galena disseminated through the gravel. The Huntington gravels are largely impregnated in this way, and being poison to vegetation, are valuable for garden walks and drives.

This formation is one of the main sources of the local water supply, several of the South Staffordshire Water Works Company pumping stations being located within a few miles of the colliery. This fact means that the mining engineer cannot reach the coal measures without dealing with the large quantities of water which the gravels contain. In the case of this sinking 360 feet of conglomerate and pebble beds were to be sunk through.

THE SINKING **Grid Ref: SJ 972129**

The period 1871-4 was one of expansion of the coal trade with output rising and more people employed. Extensive developments of existing collieries and new winnings were commenced to provide further output.

Against this background of what could be termed a "coal fever" the sinking of two shafts of the Cannock and Huntington Colliery Co. shows the lengths that a company were prepared to go in the quest for "king coal". This sinking was the first in this country to use the Kind Chaudron method which was much in vogue on the Continent for heavily watered strata. These shafts are situated on the northern edge of the Cannock Chase coalfield, beside the A34 road from Cannock to Stafford. During June of 1872 a lease was concluded between Lord Hatherton and the directors of the Cannock and Huntington Colliery Company for the purpose of locating and working coal seams believed to lie under 1,000 acres of land at Huntington, Staffordshire. The lease was to run for 52 years, without a minimum rent being payable until 1876 when it would be £1,000, the year following £2,000, then £3,500 and each subsequent year £4,500.

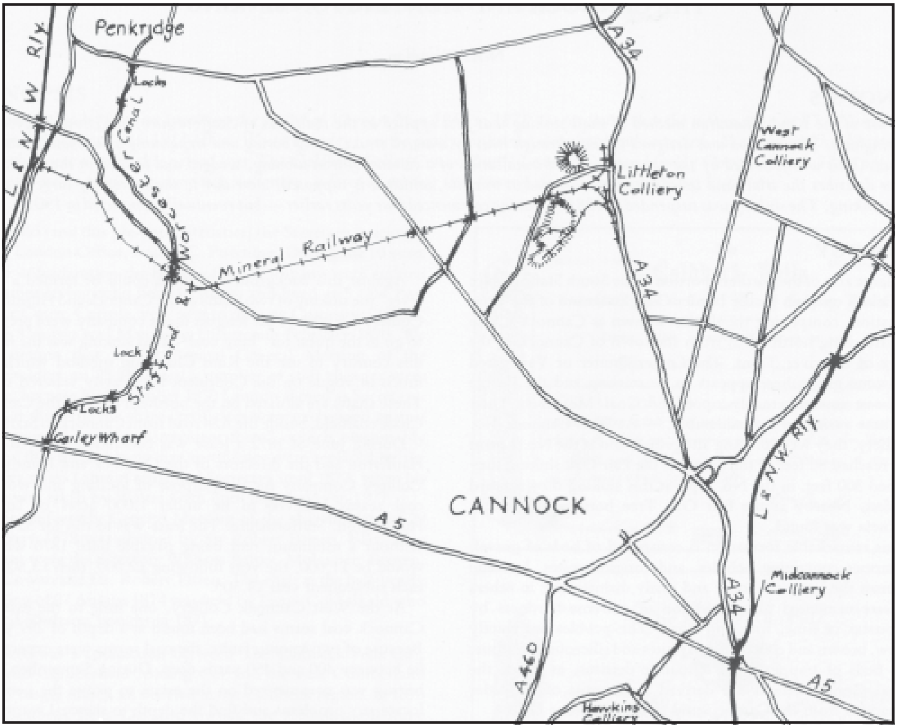
At the West Cannock Colliery, one mile to the east, the Cannock coal seams had been found at a depth of 299 yards. Because of two known faults, the coal seams were expected to lie between 400 and 450 yards deep. During September 1872, boring was commenced on the estate to prove the geology, locate any problems and ·find the depth to the coal seams. By the following April, when a prospectus for the new company was issued, the boring had reached a depth of 80 yards and indicated the presence in the pebble beds, of a considerable area of water.

The Cannock and Huntington Colliery Company was registered by May 3rd, 1873 with a capital of £100,000 divided into 5,000 shares of £20 each. The directors were:- John Avins of Birmingham, Moses Bayliss of Wolverhampton, William Butler of Wolverhampton, F.F. Clarke of Walsall, David North of Wolverhampton, John Shannon of Walsall, Stephen Thompson of Wolverhampton, with Messrs William North & Sons of Dixon's Green near Dudley as mining engineers.

It was proposed to lay a tramway 2½ miles to the Stafford and Worcester Canal and another 1½ miles to the London and North Western Railway. By these means it was intended to avoid the bottle neck of Hednesford canal basin, where 200 boats per day could be waiting to load coal from the local collieries.

The company hoped to raise at least 1,000 tons of coal per day with an expected profit of £52,000 per year. The winning of the colliery was estimated to cost between £70,000 to £80,000.

During 1875 the borings located coal at a depth of 654 feet 10 inches. At this period the directors of the company visited coal mining areas of Europe to study the methods of sinking through heavily watered strata with a view to using similar equipment at Huntington.



Sketch plan of the Cannock area, showing mineral railway, canal etc.

An agreement was concluded with M. Chaudron to sink two shafts, each of 15 feet diameter through the Pebble beds of 320 feet thick by the Kind Chaudron method. Later the same year operations were commenced with the erection of sinking plant on the proposed site of the shafts. A narrow gauge tramway from the Stafford and Worcester canal at Otherton was [35] constructed in 1877 to the sinking, and all the materials were hauled by horses over this, from the canal. A foundry and fitting shops were constructed at Huntington, where the complete rings of iron tubbing of 15 feet internal diameter by 4 feet 11 inches high, were cast, machined and fitted together. Before use, the rings were tested by hydraulic pressure, corresponding to the pressure which they would be subjected to in the shaft. To test these rings, they were placed in a wrought iron ring of larger diameter, water was introduced in the narrow annular space between the rings and the pressure applied by a force pump. After being tested, the rings were painted and left to dry. Each successive tubbing ring was of slightly thicker metal depending on its place in the shaft, varying from under an inch at the top to about 2 inches at a depth of about 300 feet.

No.1 Shaft

The boring of the pioneer shaft of 6 feet 7 inches diameter was started on January 9th, 1877 and completed to a depth of 419 feet 3 inches on October 6th of that year. The full size bore of 19 feet was started from a depth of 66 feet 9 inches to which it had previously been bored, on October 19th, 1877 and was completed to a depth of 405 feet 2 inches, on April 29th, 1879. It took a little more than twice as long to bore the large shaft, as it did to bore the small one to about the same depth.

While the boring was taking place a lining tube was placed in the shaft; this was a wrought iron tube to preserve the sides before the tubbing was put in. The diameter of this was 16 feet 6 inches and the length 22 feet 2½ inches.

As soon as the water bearing strata had been bored through, a firm seat is smoothed out below them to receive the Moss Box. (see later)

The next operation to be performed was that of tubbing the shaft. This process carried the greatest risk and was the most difficult part of the whole undertaking. The Moss Box ring was placed into the shaft and a column of tubbing rings erected with each joint being water-tight. A temporary bottom was put into the column of tubbing so that it would float on the water in the shaft. As the tubbing was being constructed a central column of pipes were positioned within the temporary bottom to permit entry of the water to act as ballast. The tubbing operation commenced on May 11th, 1879 and when 9 or 10 sections of the tubbing were in position the whole column was allowed to sink to the bottom of the shaft. One of the workmen tried to fix a pipe in the centre of the column but failed and barely reached the platform when the huge mass slowly sank in the shaft. It was believed that the Moss Box was smashed and that it would prove impossible to raise the tubbing through 135 yards of water.

It was soon evident that a serious breakage had occurred at the lower end of the column and operations were immediately started for raising the whole column of tubbing ring by ring. By October 7th, all the complete rings had been lifted and there remained still four rings, probably broken at the bottom.

From October 7th to November 23rd the time was spent in making a large number of fruitless attempts to raise the broken pieces of tubbing, the cause of the failure being the size of the [36] pieces. Eventually it was decided to break these pieces up and make their removal an easier matter. This process took nearly a year to complete and it was not until October 1880, that boring operations could again be started. It was decided to sink to a depth of 430 feet to provide a new seat for the Moss Box, the old seat having been destroyed by the breaking up of the tubbing.

On February 1st, 1881, a lining tube was again inserted in the shaft and after eight days spent cleaning out, boring was again commenced on February 15th, 1881. By March 14th the shaft was finished to a depth of 411 feet 9 inches and at this point a new seat was prepared for the Moss Box. When this was completed eighty two rings of tubbing were safely lowered into the shaft and on April 19th, 1881, all was ready for the filling in of the annular space between the back of the tubbing and the strata with concrete.

This operation was commenced on April 23rd, and finished on the 14th of May. In order to prevent the pebbles and coarse material from sinking and collecting in the bottom layers of the concrete, it was put in by means of boxes.

A pause in the sinking, of two months, was then made so that the concrete could set, then on July 14th the removal of the water was commenced. This continued until after five days a depth of 330 feet had been reached when large quantities of water issued from below the tubbing.

The boring of No.2 Shaft was commenced during January 1877, shortly after No.1 Shaft had been started and by August 11th, had reached a depth of 147 feet. The large bore was started and by September 7th had been carried down to 63 feet deep. At this point the small bore was again commenced and bored to a depth of 242 feet by October 9th. Boring resumed on October 13th and was carried down to 432 feet by January of 1878. In this way, alternatively boring the large and small pits for intervals of varying length, the shaft was finished to a depth of 438 feet during October of 1880.

On October 26th, 1880 the operation of lowering the tubbing was commenced and by December 1st, 87 rings had been lowered into the shaft.

Three days later, it was decided to put in the concrete between the back of the tubbing and the strata. This operation being completed by January 10th, 1881.

Work was stopped for seven days to permit the concrete to set, then the water was removed from the shaft by means of tanks. On January 31st. the false bottom was reached and removed and during February 4th, sinking below the Moss Box was commenced by hand. A bracket of stone was left in the course of sinking, to support the column of tubbing that was standing in the shaft. Unfortunately, at one point there lay a small fault behind this bracket, from which the only result could be that as soon as the sinking was continued below this point the bracket gave way and the water immediately rushed in, driving the men out.

So with the loss of No.1 shaft on July 19th, 1881 the operations at the Cannock Huntington sinking came to a stop. Silence descends on the project until a report of September the following year states that the company was endeavouring to raise £20,000 further capital by the issue of preference shares by December 31st, 1882. At the same time, negotiations had been opened with Lord Hatherton for better terms, considering the problems encountered and the depressed state of the coal trade at the time. These negotiations led to Lord Hatherton proposing to contribute £5,000 to the capital of the company in the event of one of the shafts being cleared of water. Also, this money would be conditional on the company being able to raise the additional £20,000 and was to be payable only on the company's success in completing the tubbing of one shaft. The directors decided to call a meeting on July 19th, 1883 to discuss Lord Hatherton's offer and to permit the shareholders to decide whether they would allow the company to go into liquidation. At this meeting the decision was taken to continue operations to raise the £20,000 and to permit the directors to conclude their negotiations with Lord Hatherton.

By agreement of August 3rd, between Lord Hatherton, Col. Littleton, Messrs North and Son, Mining Engineers, and the Cannock and Huntington Co. it was decided that if the company raised the proposed further capital by December 31st, 1883, Lord Hatherton would accept the surrender of the existing lease of the colliery. His Lordship would then grant a new lease to the company, the terms of which had already been agreed. These included a royalty on coal and slack of 6d per ton and on ironstone of 1s per ton. Surface rent up to December 25th, 1884 to be £1 10s. per acre and after that date to be £3. No minimum rent was to be payable until December 25th, 1885 when it would be £1,000. For the year to December 25th, 1886 it would be £1,500 and after that to be £2,000 per annum. Should the lease be terminated before January 1st, 1885 the sum of £3,000 would be payable. At this date the shafts were in good condition ready to be used should sufficient funds be available for the purpose.

However, sufficient funds were not available so Lord Hatherton without opposition from the company put into force his powers as lessor and distrained on the plant for the arrears of royalty due to him. On August 18th and 19th 1884 at 11 a.m. Messrs Joseph Cooksey and Son, auctioneers sold the whole of the machinery, plant and stock of the colliery, including "a large quantity of costly tools and appliances connected with the 'Kind et Chaudron' process of sinking shafts". The sale was divided into 520 lots but none is said to have realised good prices, the total produce of the auction being less than £3,000.

The Mining Journal of January 24th, 1885 sums up the story as follows, *The Cannock and Huntington Colliery Company is to be wound up. The concern was floated some years ago and was to make a fortune out of the new coal fields of Staffordshire. The capital was £100,000 all of which has been sunk and none of the shareholders have ever received a penny dividend. The undertaking was indeed an experimental one and it has failed utterly. It was here that the Belgian method of sinking through water bearing strata by means of iron tubbing was tried. The directors say that there will be no repayment of capital however trifling.*

So ends the first use of the Kind Chaudron system in this country; two shafts full of water and a lot of shareholders money lost by bad luck and mistakes. That's mining! Yet at the same time, a pair of shafts were sunk by the Kind Chaudron method at Marsden in County Durham to become the Whitburn Colliery. One of the reasons suggested at the time for this success being that the shafts were of 14 feet diameter instead of the 15 feet at Cannock. This was, at the time, the largest diameter ever proposed.

Chaudron Method of Sinking

This system of sinking was developed by M.J. Chaudron, a Belgian mining engineer. It was for use in sinking shafts through heavily watered strata. By the time of the Cannock Huntington sinking, the system had been used in Europe to sink over 40 shafts in difficult conditions. Again, at this period, a further 14 shafts were being sunk without, to this date (1876), a single failure.

The operation of sinking and tubbing was done entirely from the surface. Not a man descended the shaft until the sinking through the wet strata was completed, securely tub bed and pumped dry. During the sinking, the water remained in the shaft and helped to support the sides. In the normal method of sinking the removal of the water by pumping often caused the [37] sides to collapse. This required the support of temporary wooden shaft lining during sinking and prior to the erection of the permanent tubbing.

The Kind Chaudron Process consisted of the following stages:

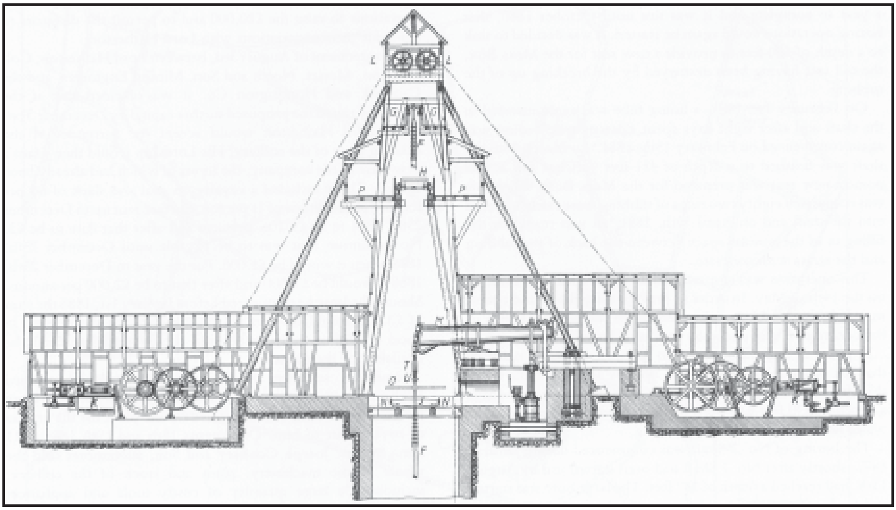


Fig. 1. *Longitudinal section of boring tower.*

A Alternatively boring a small diameter pit in advance and enlarging it with a second boring tool to the full size for the shaft.
B The preparation of the seat for the Moss-box or water tight joint on which the tubbing is placed.
C Lowering of the Moss-box with the water tight tubbing above it.
D Putting in the outside lining of concrete.
E Pumping out the shaft.
F Underpinning the Moss-box with tubbing.

Preparatory Work
This consisted of the erection of various sheds required for the particular circumstances of each sinking. In most cases a strongly framed wooden building approximately 9 or 10 metres long and of cruciform shape with a clear height of about 15 to 18 metres. Each wall would have a large opening from floor to roof apex to permit the removal and handling of the sinking tools under cover. One opening led into another wing which contained the operating steam machinery. The fourth wing provided access to the shaft used when installing the rings of tubbing.

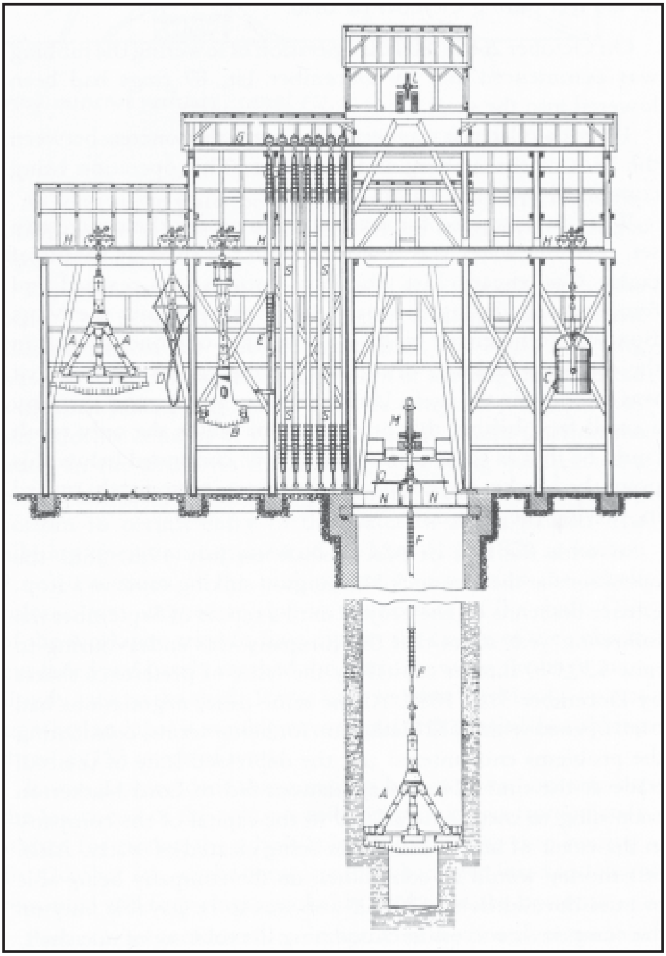


Fig. 2. *Cross section of boring tower.*

At a suitable height above the floor, strong timber beams were fixed. These supported an overhead railway system, the centre line of which was identical with a line drawn through [38] the centre of the proposed shaft and the middle of the tool house. This line of rails projected sufficiently outside the house to permit the tipping of the debris from the shaft. It also had to be constructed to provide clear access to the shaft for the long rods and tools and to allow the' rings of tubbing of the finished diameter of 15 ft for the shaft. On these rails ran a cradle or truck to carry the necessary tools, some of which could weigh 15 or 20 tons. Above the railway, a strong support of beams or girders was necessary for the pulley (L) over which passed the flat rope used for lowering and withdrawing tools from the pit shaft. Between the supports and the railway, a platform (P) was made, on which the men could stand and walk when connecting or disconnecting the rope and tools.

The tool house was usually a timber shed with the strength necessary to support the railway. One of the interesting details of this system of sinking was the tool handling methods employed within the tool-house. Every tool was hung in the roof ready for use as required. The same applied to the rods used to break up the strata.

The engine house was a timber structure built as cheaply as possible to protect the machinery from the weather. In it was placed a twin cylinder horizontal steam winding engine (K) strong enough to lift the tools and withdraw the sludger used for extracting the debris from the pit shaft. For a pit of 15 ft diameter, a pair of 20 ins x 40 ins stroke cylinders would have been used. Also, a vertical beating steam cylinder (M) with a diameter of about 36 ins x 48 ins stroke was placed in front of the winder. Above this cylinder was a horizontal wooden beam which connected to the tools used for the boring of the shaft.

This beating cylinder was entirely worked by hand. The stroke of the cylinder was limited by a strong wrought iron loop (R) attached to the end of a braced timber beam, securely fixed in the foundations of the engine-house. Between this loop and the beam, India rubber and leather packing was placed to deaden the blows and suppress noise.

Boring the Shaft

The process employed under this heading was developed by Mr Kind, a German engineer and sinker of artesian wells about 1850. It was the partnership of the two engineers which developed into the successful system later known as the Kind Chaudron.

Four men are required for this part of the operation. The first tool (B) used was called the small trepan, which in the Cannock Huntington sinking was a forging of seven to eight tons. At the widest point, it was 2 metres and bored a pioneer shaft of this diameter.

This shaft was later enlarged to 19 feet by another trepan (A) which had a weight of some 20 tons. These trepans were fitted with replaceable steel teeth or chisels on the lower surfaces, these being firmly fixed into place by keys in carefully bored holes. Each tooth weighed about 1 cwt. The large trepan was too large a forging to be produced in one piece, so it was fabricated in such a form that the principal weight was concentrated in the lower tooth-carrying area, and was connected by three strong forged pieces with the central shaft. This ended in a screw thread at the top for attachment to the boring rods.

In order to guide the trepans in their work of producing a vertical shaft, guides of the same diameter as the shaft were attached to them. The large trepan used to have a wrought iron guide piece attached in the middle of the lower end, which being placed into the smaller borehole, was intended to ensure the complete concentricity of both the borers. By experience, it was discovered that these heavy tools were guided by gravity alone and the lower guide was eventually dispensed with.

A trepan was brought by one of the small trucks to the shaft, attached to the winding rope and hoisted by the engine until its top was above the frame (N) which encircled the mouth of the shaft and supported the working platform (N). Below the threaded top of the trepan was a forged collar and a support was inserted under this to take the weight of the trepan. The winding rope was detached and would be kept out of the way. A connecting rod, also hung from the trucks (H) was brought over the trepan and screwed onto it, and the rope swivel was attached to the top of the rod. Then the winding engine lifted the trepan and rod high enough to permit the support to be removed. They were then lowered until the collar of the connecting rod was close over the frame (J) and in its turn was allowed to be supported on the rest on the support. Another boring rod could then be added. This work continued until the trepan reached the working surface at the bottom of the boring. At this point the top of the last rod was connected to the beating beam of the beating cylinder.

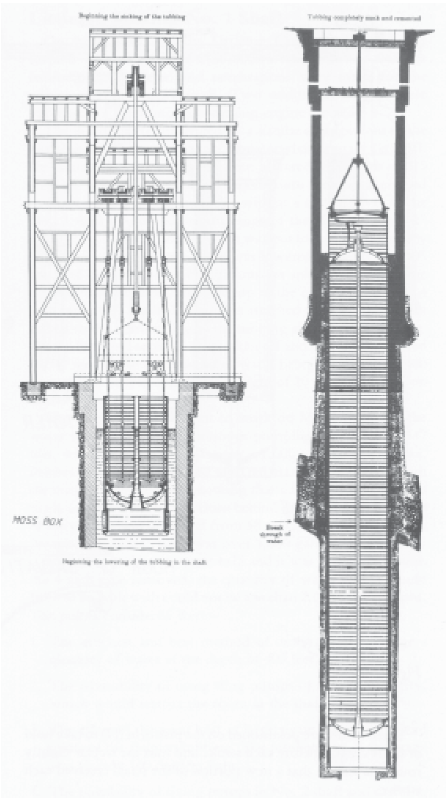


Fig.3. *Shaft boring by Kind Chaudron method.*

The plant was now ready to continue boring. An attendant at the beating cylinder admitted steam to the top of the piston and the trepan was slowly lifted to the full height of the stroke. Steam was suddenly exhausted from the cylinder and the trepan plus rods fell with great force on the base of the boring, crushing part of the strata.

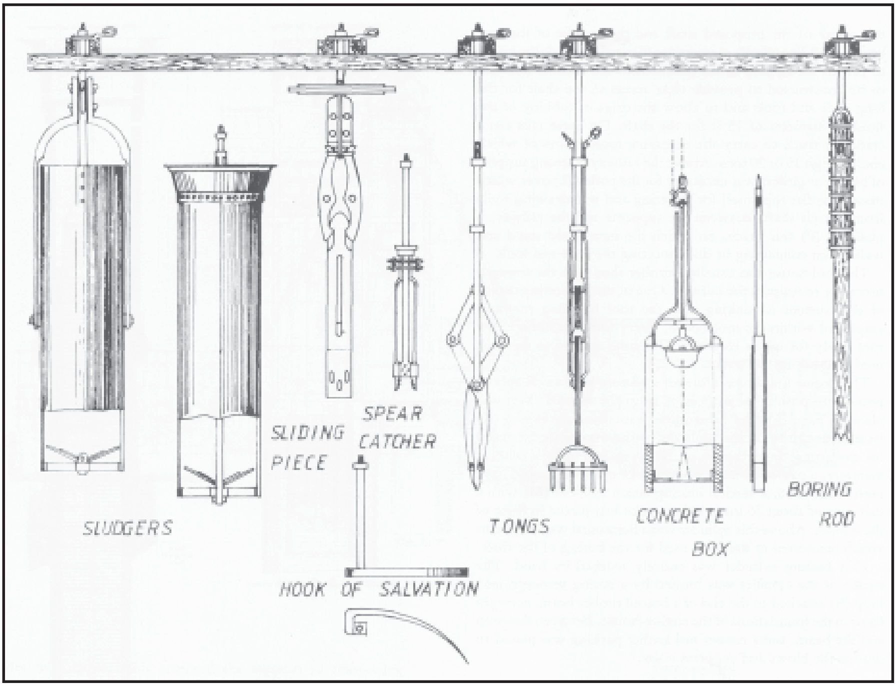


Fig. 4. *Tools.*

Three men were positioned on the platform (N) to take hold of the lever (O) before each stroke and turn the trepan slightly round its axis so that a new portion of the strata received each stroke.

As the boring proceeded and the shaft was deepened, it was necessary to lengthen the connection between the beating beam and the boring rods - this was done by turning the screw (T) which worked in the nut (U). The boring rods were wooden lengths up to 50ft long with a diameter of 6 or 7 inches. Each rod was cut from a single tree. (S) Wrought iron shoes were fitted on each end, the lower one ending in a nut while the top ended as a thread to permit them to be coupled into a continuous rod from the top to the bottom of the boring. Shorter rods were made so that the trepan was always in contact with the strata at the bottom of the boring and to be connected to the beating cylinder as the boring progressed. Some of the shorter rods were of iron, being used only at the top of the boring and replaced by a wooden rod as necessary. The wooden rods were more elastic in operation, cutting down the vibration and did not break as easily as the iron rods. When breakages occurred, leaving pieces of rod in the boring, there was a series of special recovery tools used, of which the "Hook of Salvation" was the most important. The upper rods on the beam were first removed, supported over the shaft and the boring rods were connected to the hook until it met the broken rod. On being turned round it forced the broken rod into the centre of the shaft and on being carefully drawn up, it was caught by the forged collar at the top of each rod or tool and, being locked into the hook of salvation, it could easily be withdrawn.

The connection of the lowest rod with a trepan was by a sliding piece and key, Fig. 3 and 4; the weight of the trepan could be lifted on the key, but when falling down, the boring rods did not receive the blow, but slid freely down over the sliding piece and key. As the rods were timber, their weight was partly supported by the water, thereby relieving the beating cylinder of part of the dead weight.

The first bore-hole was always kept well ahead of the larger trepan, the distance depending on local circumstances. All the debris produced by the operation of the larger trepan fell into the smaller boring and could be withdrawn by a tool called the spoon, ladle or sludger. (Figure 4) It consisted of a wrought iron riveted cylinder suspended in a wrought iron fork and of less diameter than the first boring so that it could reach the bottom. The base of the sludger consisted of two flaps which opened upwards when the tool was lowered to the bottom of the bore-hole and worked up and down a few times by the rope of the winding engine. By this means the debris produced by the boring rods could enter and fill the sludger.

When hoisting commenced, the flaps closed and the contents were brought to the surface. Sometimes, by attaching the sludger to the beating beam and operating it, the loading cycle could be completed quicker. The time taken for withdrawing the debris usually occupied about one fifth of the sinking. When the boring tools were put in or removed, the winding engine was used to pull the beating beam and its cylinder back from the edge of the shaft to leave the top clear.

When the full sludger was brought to the surface it was suspended from one of the trucks (H) running on the overhead [40] railway. It was then pushed out of the building on an extension of the railway system and when a catch on top of the sludger was released, it turned over and emptied on to the waste tip. It would have been left suspended on the railway until required again.

For the recovery of small items such as one of the teeth of the trepan, a series of grappling hooks and devices were developed. It is said that on one occasion a pocket watch accidently dropped into a boring was recovered. Most of these grapples would have found employment during the recovery of the broken tubbing at the Cannock Huntington sinking.

Having bored the shaft to the full depth and diameter, the next operation was to put in the rings of tubbing.

In the Chaudron form of tubbing, a series of complete rings of cast iron were lowered into the shaft. In other methods of sinking the tubbing consisted of sections which were bolted together as they were being fitted into place in the shaft. As the total weight of tubbing could be more than 1,000 tons dead weight, a temporary bottom was attached to a flange (Figure 3) inside the second lowest ring and made fully water tight. This made the tubbing float on the water in the shaft and as ring after ring was added to the column, all the joints were made water tight. At the same time a column of pipes was erected over a hole in the middle of the temporary bottom. By this means water was admitted to the column of tubbing by the use of taps and acted as ballast to sink the tubbing and permit other sections to be added. This operation had to be done with great care so as to keep the tubbing floating; if too much water was allowed in, the tubbing would sink. From the events at Cannock Huntington, it would appear that this is what happened in the No.1 shaft, requiring over a year's extra work to repair.

One of the problems which had to be overcome in this method of sinking was to provide a water-tight joint between base of the tubbing and the surrounding rock. To achieve such a joint, M. Chaudron developed the Moss box, of two rings of tubbing, one of slightly less diameter than the other, so that they could slide over each other, loosely suspended from the lowest flange of the tubbing and attached underneath the ring carrying the temporary bottom. It consisted of an outer ring having at its lower edge an outside flange. The space between the flanges was carefully filled with moss or a similar material, before lowering the box into the pit, the moss retained by thin thread netting. Once the tubbing was lowered on to its bed at the base of the shaft the enormous weight was allowed to compress the moss in the box and create a water tight seal to keep the water of the upper strata from the shaft.

To improve the permanent positioning and water tight capabilities of the tubbing it was then concreted into place. The space all round the tubbing and the natural rock was gradually filled up by the use of a series of boxes usually about 8 feet high by 3 feet wide and 6 to 8 inches thick with a cubic capacity of 12 feet. These boxes were of sheet iron and wood and made to fit into the circular space being filled. They were fitted with a piston so that they could be emptied as required. It appears to have been quite an art mixing the concrete, too dry and it set in the box, too wet, then it would separate into layers in the shaft. Several boxes would have been used at a time to keep the work moving. They were operated by hand winches placed on the shaft top.

After a suitable length of time to permit the concrete to set, a pump was put into the shaft and the water removed. Often the winding engine with a large water kibble would also be employed, known as "tanking". As the level subsided, the central pipe column was removed until the temporary bottom was reached. This was removed and the Moss box was further supported by the putting in a wedging crib and brickwork. At this point the Chauldron system was finished and sinking by the more usual hand method commenced.

Littleton Sinking No.1 Shaft

On June 10th 1899 the Littleton Collieries Limited was formed with a capital of £150,000 to take over the sinkings from Lord Hatherton and preparations were made for the unwatering of No.1 shaft. Two additional boilers were purchased, a pit frame and winding engine erected.

The pumps were suspended by a similar arrangement to the No.2 shaft and pumping was commenced on January 1st 1900. By January 5th the water had been lowered to a depth of 215 feet, but the amount of water flowing into the shaft increased to three times the volume dealt with at a similar level in the No.2 shaft. Two additional pumps of the Evans "Cornish" type were obtained, one of which was put to work on February 9th and by the 19th, the water was lowered to a depth of 305 feet, the quantity being 600 gallons per minute. The volume continued to increase, until the top of the central column of 4 inch pipes was reached. This was attached to the false bottom bolted to the bottom ring of the tubbing above the Moss-box. Two 5 feet long sections were taken off and the water lowered to 317 feet, when the amount of water being pumped was 600 gpm the jet of water rising to a height of 20 feet above the top of the pipe.

The fourth pump was put to work on March 15th and the water was lowered by continuous pumping to a depth of 347 feet, when the quantity was over a 1,000 gallons per minute. Rushes of water, discoloured with red mar!, now came through the central pipe-column, showing that a free passage had been made under the Moss-box from behind the tubbing. The speed of the pumps was increased from 58 to 72 strokes per minute, the quantity being raised was over 1,800 gallons per minute. Several consultations were held and it was agreed that, with the 4 inch pipe removed, the quantity of water which would have to be dealt with could not be less than 2,000 to 3,000 gpm.

The points considered were:-

1. The quickest and best method of dealing with so large a quantity of water at the depth of 400 feet.

2. The advisability of using sling pumps of a larger capacity, which would restrict the room in the shaft.

3. The effect of the great heat of large steam pipes on the lead joints of the Belgian tubbing. The temperature at this stage was already 100 degrees Fahr.

4. The possibility of fixing pumps in No.2 shaft and draining the water from No.1 shaft by means of a bore hole.

5. The boiler power required.

Finally, on May 3rd 1900, it was decided to raise the pumps in No.1 shaft out of danger, obtain larger pumps and to sink a third shaft of at least 18 feet diameter.

Littleton Sinking No.2 Shaft

During 1897, Lord Hatherton asked his mining engineers, Messrs S & J Bailey of Birmingham to report upon the state of the shafts and to consider their recovery. The report, after considering the records and reports left by the Belgian engineers, suggested that it would be possible to recover and use the shafts. At one stage the use of the Freezing process, to deal with the water, was considered.

THE CANNOCK AND HUNTINGTON SINKING

During April 1897, Mr T.H. Bailey was appointed engineer for the sinking with Mr W.J. Bates as assistant.

It was decided to attempt the recovery of No.2 shaft first, this decision being based on the following reasons:-

The dropping of the tubbing in No.1 shaft and the subsequent destruction and removal of the broken rings and the false bottom, left conditions at the shaft bottom uncertain. The water had never been cleared from the No.1 shaft, but came in when [41] it was lowered to a depth of 330 feet. In the No.2 shaft, the water had been removed and the ground prepared for a short length of segmental tubbing under the Moss Box. The records left of the rate of rise of the water in No.2 shaft pointed to an "make" of about 300 to 350 gallons per minute.

Work on the site commenced during April 1897 with the construction of temporary workshops, engine houses and boiler plant to contain 2 Lancashire boilers of 30 feet long by 8 feet diameter to work at 120 lbs psi. All the materials for this sinking was hauled by horses from the Cannock railway station, a distance of 2½ miles.

The winding engines were a pair of horizontal slide valved cylinders of 22 inches by 48 inches stroke with a steam reverser and a powerful foot brake. The drum was 10 feet diameter by 6 feet wide, fitted with oak planks. Elliot's locked coil winding ropes of $1^1/_8$ inches diameter fitted with a hopped capel and King's detaching hook were. used.

Having decided to recover the shaft by conventional means, the type of pump selection for the operation was the Evan's "Cornish" straight line differential ram pattern. The system of suspension by long links of chain to carry the weight of the pumps as they were hung in the shaft, with pipes and all their equipment was adopted. The pumps were 21 inches diameter by 24 inches stroke with displacement pumps of 10 inches by 24 inches stroke and were capable of dealing with 350 to 400 gallons per minute against a head of 600 feet with a steam pressure of 100 lbs psi. The delivery pipes of 8 inches diameter and the steam and exhaust pipes of 4 inches diameter were of steel with acme joints, carried on stand pieces on the pump. These pipes were supported between the two suspending chains by oak cross stays bolted to the links at intervals of about 30 feet, the pipes being secured to the cross stays by clip-bolts. By this means it was possible to raise and lower the pumps in the shaft as required and at the same time supply them with steam.

Over the No.2 shaft an extra strong wooden sinking headframe was placed. This carried, in addition to the pulleys for the winding and capstan ropes, a strongly made and enclosed upper platform accommodating the gear for raising and lowering the pumps. The chains, each of 8 tons weight, supporting the pumps, passed between steel girders on the surface and were each attached by shackles to screws of 4½ inches diameter and 20 feet long, having two threads per inch. The nuts supporting the screws were carried on ball bearings on the upper platform and were turned through worm and clutch gearing by vertical engines having cylinders of 7 inches diameter by 10 inches stroke. Each pair of screws was driven by a single set of engines and could be operated singly or together through the clutch gearing. By these means a load of 50 tons was raised or lowered 15 feet at a rate of 6 feet per minute. When the pumps had been raised or lowered the required distance, steel bars of a suitable section as would fit into the links of the suspending chains were inserted and rested upon the cross girders mentioned above, so that the lifting screws could be released to raise or lower the pumps as required.

Both pumps were set to work during the last week of August 1897, the level of water in both shafts being 66 feet below the surface. It came as something of a surprise for the sinkers to discover that the pumping in No.2 shaft, did not lower the water in No.1 shaft very much, although less than 126 feet apart.

Continuous pumping commenced on September 7th with the pumps working alternately, until the bottom was reached on September 28th. The ‘make’ of water had varied from 150 to 200 gallons per minute, the level of water in No.1 shaft being 69 feet from the surface. Having got the sinkers into the shaft bottom, it was found that the strata under the Moss-box was very weak and that the water was issuing from the south east side, there having been a fall of ground from a small fault behind the Moss-box. At a depth of 6 feet 9 inches below the Moss-box was an iron crib, bolted together in segments, which had been bedded on a black shale unsuitable for it. A large number of miners and carpenters tools and lamps were found on the pit bottom, left when the water broke in 16 years previously. All were in good condition and free from rust.

Sinking was commenced and taken down to a strong rock binds 51 feet below the Moss-box, a depth of 480 feet from the surface. At 42 feet below the Moss-box a cast iron crib of 1 foot 9 inches wide by 8 inches high was bedded. Upon this was placed three rings of segmental tubbing wedged in position and backed with concrete. This was allowed to stand while a further depth of 21 feet was sunk into a grey rock binds, on which an oak curb was bedded. The intervening space was bricked up to the tubbing crib. The segmental tubbing was completed up to the Moss-box and backed by 40 tons of concrete, the matching ring placed in position and the vertical joints wedged. As the wedging proceeded, the Moss-box then began to move and it became necessary to put in a second matching-piece between the top of the Moss-box and the bottom of the Chaudron tubbing. Before this could be done, 82 bolts had to be removed and the holes reamed out to take counter sunk bolts. The wedging of the tubbing joints was completed and the plug holes wedged tight from the bottom upwards except those required so that liquid concrete could be pumped behind the tubbing at 100 lbs. psi. In the second and third rings below the Moss-box, two box segments had been put in with 3 inch valves inserted to test the water pressures against the tubbing. These valves, when fitted with pressure gauges, showed by December 25th 731bs. December 27th, 90 lbs. and December 28th, 100 lbs psi. At this pressure a leakage developed in the brickwork below the tubbing and it was decided to replace the brickwork with further tubbing. A pipe was attached to one of the valves, and turned up into a tank fixed on the side of the shaft above the Moss-box, one pump raised the water from the tank and the other pump raised water from the shaft bottom. The valve was then opened and the pressure gradually reduced to 25 lbs. psi. About 6 feet of the brick lining was removed; an additional iron crib was put in on the top of an oak curb which rested on brick and concrete and two rings of tubbing with matching-piece to the curb above placed upon it. Four of the plates in the top ring had 1½ inch diameter holes tapped in them, through which concrete was forced by a pump at 200 lbs psi. After wedging this tubbing and crib, the valves were gradually closed until on February 2nd, 1898 the pressure reached 164lbs psi. This pressure caused some slight leaks in the tubbing, but after re-wedging the joints, sinking was resumed on February 7th.

The sinking and brick lining were then continued by ordinary means to a depth of 1,644 feet by February 17th, 1899. During this period the shaft passed through all the valuable coal seams of the Essington and Cannock Chase districts, the thickness of these seams exceeding 90 feet.

Littleton Sinking No.3 Shaft
In deciding the pumping plant to be provided to deal with the probable flow of water in this proposed shaft, consideration was given to the fact that the head was limited to 300 feet. Also the necessity of having units of much larger capacity. It was decided to adopt the Evans bucket or “Griff” pattern sinking pump, as this type could not only be obtained in larger capacity units, but was lighter to handle and offered considerable advantages both in first cost and in equipment.

Three of these pumps were provided, each having a steam cylinder of 24 inches by 24 inches stroke with double acting bucket pumps of 16 inches by 24 inches stroke and dealing with 900 to 1,000 gpm from a depth of 350 feet with a steam pressure of 100 lbs. psi. The steam and exhaust pipes were 5 inches diameter while the delivery pipe was of 12 inches diameter. All were of steel with acme joints, the pumps and pipes were suspended from double chains as described for the No.2 shaft. The lifting equipment consisted of wire rope blocks and a double crab steam capstan all supplied by the makers with the pumps.

Work started on the site at the end of May 1900 and by the end of July the pit frame had been constructed and the shaft was 69 feet deep. Water began to appear in the shaft at this depth, so a large Griff pump was set to work. At a depth of 81 feet a cast iron crib was bedded into the sandstone for the purpose of holding down the tubbing at a later stage of the sinking. Shaft sinking continued in the usual way for that period, with shot firing and hand filling of the sinking kibble. A temporary lining of backing deals supported by iron rings was put in until at distances varying from about 36 to 45 yards oak curbs were bedded and the brickwork lining of 9 inches thick was built up. This lining formed a back casing to the iron tubbing that was afterwards constructed.

At a depth of 192 feet, feeders of water of 800 to 1,000 gpm were encountered from a bed of hard grey sandstone with pebbles in it. Quickly two large pumps were put into action to deal with this water. Two of the original pumps were still at work in the No.1 shaft, raising 650 gpm from a depth of 300 feet. The pumping in No.3 shaft did not appreciably reduce this quantity, showing that the water had better access to the No.1 than the No.3 shaft. At this point it was decided to stop the recovery of No.1 shaft and to concentrate on No.3, sealing back the water by using segmental tubbing. A bed for a wedging crib was cut in the sandstone at a depth of 210 feet and sinking continued to a depth of 279 feet when the rock appeared to be dry. The back casing of brickwork was built up to the crib bed at 210 feet and a second crib bed cut at 279 feet to receive a cast iron wedging crib. While waiting for the arrival of the cast iron tubbing, the sinking was continued down to 360 feet deep. At a depth of 180 feet a garland curb to collect the water was built into the brickwork casing and a tank supported on timbers in the shaft, gathered this water which was pumped to the surface by one of the pumps.

By February 5th, 1901 the cast iron crib was fixed and wedged in position at a depth of 279 feet and five rings of tubbing were erected and backed with concrete. The sinking was continued down to 508 feet and the sixth ring was bedded with an additional 18 inch cast iron wedging crib to form a water-tight joint. This was carefully wedged and backed with concrete so as to provide a foundation for the tubbing up to the crib-bed at 210 feet to stand on. (86 rings in all). The tubbing was now completed up to the holding down crib, a total height of 198 feet or 96 rings of tubbing. At this point the water flowing into the shaft was constant at 1,000 gpm.

The above mentioned water tank was removed and the pumps lowered into the shaft bottom, two working alternately to their full capacity and delivering out of the shaft 1,000 gpm. The wedging and plugging of the tubbing now commenced to seal off the water and this then rose behind the tubbing. At this stage the pumps were raised in No.1 shaft to a depth of 100 feet from the surface, one pump alone then working eight hours per day and delivering to the surface 150,000 gallons.

After completing the wedging of the tubbing, the valves were closed and the pumps stopped, as the pressure behind the tubbing rose, a leakage developed in the brickwork under the two feet crib. So another ring of tubbing with a crib underneath, backed with concrete forced in at a pressure of 200 lbs. psi. was laid, this work being completed in a fortnight by June 22nd. 1901.

During the erection of the tubbing in No.3 shaft a drift had been started from the No.2 shaft at a depth of 877 feet with the intention of connecting with the No.3 shaft to provide ventilation. At the same time the No.2 shaft top was covered in and a drift constructed of brick and concrete communicating with the ventilating fan chamber.

The sinking of the No.3 shaft reached this drift on November 13, 1901 and provided a second outlet and means of ventilation. During the early months of 1902 the progress of sinking was held up by the extreme hardness of the sandstone rock of about 50 feet thick which defied the use of blasting. Having passed through this hard rock at a depth of 1,284 feet it became necessary to put in temporary linings of iron rings and backing deals. Later a shaft lining of permanent brickwork, 14 inches thick was bedded on oak curbs spaced at 36 to 90 feet apart was built.

The sinking was completed at a depth of 1,662 feet on November 22nd, 1902 having taken 2 years 5 months and included the construction of 198 feet of tubbing. The water in the pebble beds gradually regained its original level and began to flow over the top of the tubbing. In 1909 an additional length of 44 feet of tubbing was put in, the top now being only 36 feet below the surface, making the total length of tubbing 243 feet.

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