USE OF RATCHET AND OTHER HAND-MACHINE DRILLS IN THE CLEVELAND MINES.

BY WILLIAM CHARLTON, Assoc.R.S.M.

Some twenty years ago, almost the whole of the Cleveland ironstone was won by the chisel-pointed hand-drill, with a swelled end to add weight to the blow, and well known to all interested in mining as the "jumper-drill."

So established had this mode of drilling become that the old practical miner of that time naturally considered it necessary for working the Cleveland stone that the holes should have the triangular shape \( \Delta \), and that it was only by his skill in drilling, with the jumper-drill, a hole with a "flat-back," or "flat-front," "flat-top," or "flat-bottom," that the stone could be successfully mined.
Experiments, however, had been made with rotary drills, which showed conclusively that a round hole could work the stone; and the millions of holes which have since been drilled by the compressed-air and electric drills, so successfully introduced by Mr. William Walker and Mr. A. L. Stevenson, are more than ample proof of their suitability.

Fig. 9.—Pendulum Drilling-machine.

Since 1880, mining by power-machines has made great progress and at the present time about one-third of the Cleveland ironstone is won by such machinery.

Until 1888, very little use had been made of the hand-machine drills. The late Mr. George Lee had tried some at the Liverton mines, and the late Mr. T. Allison, of Guisborough, had introduced a few ratchet-machines into the Belmont and Spawood mines of the Weardale Iron & Coal Company, Limited.
In 1884, owing to depression in the iron-trade, the Slapewath mines of Sir B. Samuelson & Co. were closed. It being absolutely necessary that steps should be taken to reduce the cost of winning the ironstone, on restarting the mines in 1886, a thorough and exhaustive trial of the ratchet-machine was instituted. The first machines were of crude construction, being fitted with loose brasses in the barrel and thick-edged drills; and, when drilling the hole, the machine was set against a prop fixed between the roof and the floor.

It was soon found that a great drawback to the use of the machine was the time spent in setting these props or stands. A considerable portion of the time saved in drilling the hole being spent in the preliminary setting of the props and in changing the drills. In many instances, the stone thrown down by the
previous shot would be lying where the prop should stand; and in other instances, owing to projections of the side of the working-place, the prop could not be set near enough to the side to obtain the right direction of the hole. It became necessary, therefore, to supplement the prop with a cross-bar of iron between it and the side of the place, the end of the machine resting against this bar. Old permanent-way fish-plates were found to be sufficient for this purpose. For convenience, they were pointed at one end to make the bar fit better against the stone, the other end being fastened by a nail to the prop.

![Gray-Tarhy Rotary Drilling-machine](image)

After a time, this pointed end was driven into a recess made in the stone, and it was found to fasten itself so well that when a stronger bar of iron was pointed with a chisel-end and driven into a hole made about 1 ½ inches deep, by a pick, it was sufficiently firm to stand the thrust of the machine without the aid of a prop to support the other end.

This discovery, at once, very materially increased the facilities of working, and may be said to have brought about the success which has attended the use of this mode of drilling in the Cleveland mines. It rendered unnecessary the props or stands which
were hitherto used, and made it possible to fix the machines so that the holes were drilled in the very best position for the advantageous blasting of the stone.

Figs. 1 and 2 (Plate XV.) show the pointed bar, α, of iron driven into the side of the place, and the ratchet-machine set for drilling; β is the barrel of the drill; γ, the nut-collar; δ, the screw-spindle; ε, the ratchet; and, ψ, the drill-end. The bracket or bar is chisel-pointed at θ, and is formed with a number of holes, or countersunk recesses, χ, for receiving the barrel-end, ω, of the drill.

![Hall Rotary Drilling-machine](image_url)

A remarkable development of the means employed to take advantage of the property possessed by the stone of holding fast the bar of iron driven into it is shown in Figs. 3, 4 and 5 (Plate XV.), a modification designed for use in starting or turning-away places at right angles to the winning-place. The long bar, α, is chisel-pointed at the end, γ, δ, is a short bar with holes or countersunk recesses, θ, and with a socket, ψ, capable of sliding on the bar, α, to any convenient position. Other modifications will be seen in the illustrations or photographs of the machines in working positions.
While progress was being made in the manner of setting the machines, improvements in the machine itself were not neglected. Clasps were substituted for the loose brasses in the machine shown in Fig. 1, and some time afterwards these were discarded for the improved ratchet-machines of the Hardy Patent Pick Company with the Stayner split-nut (Fig. 6, Plate XV.) for the quick withdrawal of the drills (Fig. 8).

A lighter and fish-bellied section of drill-steel was procured, which proved to be a great improvement; and, combined with these, it was found that a square-topped screw with

4 threads to the inch, instead of a Whitworth screw with 7 threads to the inch, whilst increasing the speed of the drilling by 75 per cent., scarcely, if at all, increased the labour.

To obtain the benefit of the weight of the handle and the advantage of the pulling-down stroke when the drill is advancing, which is the case with the machine in the position shown in Fig. 1 (Plate XV.), machines with left-handed screws and drills were obtained for use when the holes were to be drilled on the other side of the working-place (Fig. 8). Each pair of workmen was supplied with two machines, thus enabling them to use the machine best suited to the situation.
Many other devices of machine have been tried, such as the pendulum-machine (Fig. 9), which by an arrangement of bevel-wheels gave a cutting stroke at each stroke of the handle; the double-handled ratchet-drill (Fig. 7, Plate XV.), and others.

Passing over these, a great advancement was made by the introduction of hand rotary machines for drilling the softer stone; and Messrs. Gray & Tarbitt's machine was introduced at the South Skelton mines (Figs. 10 and 11).

![Hardy Rotary Drilling-Machine](image)

**FIG. 14.—HARDY ROTARY DRILLING-MACHINE.**

Mr. William Hall's machine is in use at Messrs. Pease & Partners', Skinningrove and Upleatham mines (Fig. 12); and Mr. C. Heslop's machine, more suited to the harder stone, is used at their Lingdale mines. Mr. John Martin, a working miner, introduced a simple, but useful rotary machine at the Skelton mine. Messrs. Blackett, Hutton & Company, the Hardy Patent Pick Company and Messrs. John Livingston & Sons have a large number of their machines in use at several of the Cleveland mines (Figs. 13, 14 and 15).

Fig. 16 shews a miner using a jumper-drill.

Among those who have given so much thought and attention to the development of drilling by ratchet and hand rotary machines
in the Cleveland mines, the names of my assistants, Mr. James Thompson and Mr. William Brooks, deserve particularly to be mentioned.

The usual practice of Cleveland hand-mining is for two miners to work together as mates, one man drilling the holes, charging and firing the shots, while the other man breaks up and fills the stone into the tubs or wagons.

Many experimental trials have been made to ascertain the relative time occupied in drilling by the jumper-drill, the ratchet, and the hand rotary machine, and in some cases very remarkable results have been obtained. Not wishing to exaggerate the value of the ratchet or hand rotary machines, the writer is keeping well within the mark in stating that two holes can be drilled with these, to one with the jumper-drill; and that, under ordinary conditions, the output per shift of the pair of men can with ease be increased fully 20 per cent.

In addition to this advantage, the diminished amount of physical labour, required in working these machines, enables men to continue mining, who would have been compelled to abandon it, if restricted to the jumper-drill; and it also allows youths,
under the direction of their fathers or other men, to engage in mining at a comparatively early age.

Table I. shows the gradual increase in the use of ratchet and other hand-machine drills in the Cleveland mines, in percentage of the total output each year.

![Fig. 16.—Miner using a Jumper-drill.](image)

**Table I.**—Percentage of the Output of the Cleveland Mines, wrought by Ratchet and other Hand-machine Drills.

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Cent.</th>
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<th>Per Cent.</th>
<th>Year</th>
<th>Per Cent.</th>
</tr>
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<tr>
<td>1886</td>
<td>0·50*</td>
<td>1890</td>
<td>2·94</td>
<td>1894</td>
<td>10·23</td>
<td>1898</td>
<td>31·59</td>
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<tr>
<td>1887</td>
<td>1·33</td>
<td>1891</td>
<td>2·79</td>
<td>1895</td>
<td>12·82</td>
<td>1899</td>
<td>33·46</td>
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<td>2·05</td>
<td>1892</td>
<td>3·99</td>
<td>1896</td>
<td>21·86</td>
<td>1900</td>
<td>40·47</td>
</tr>
<tr>
<td>1889</td>
<td>2·93</td>
<td>1893</td>
<td>5·00†</td>
<td>1897</td>
<td>28·97</td>
<td>1901</td>
<td>39·51</td>
</tr>
</tbody>
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* Commenced using ratchet-drills at the Slawson's-wath mines.
† Introduced at other mines.
‡ Large temporary decrease at one mine, owing to depression in the iron trade.
To illustrate Mr. W. Charlton's Paper on the "Use of Ratchet and other Hand-machine Drills" etc.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.—Hardy Ratchet-drill.

Fig. 7.—Hardy Double-handled Ratchet-drill.
Mr. A. L. Steavenson (Durham) said that good work appeared to have been done by the drills described by Mr. Charlton, but in his opinion there was nothing equal to an electrically-driven drill, which only required one skilled man to look after it, while unskilled men could do all the other work required in connection with taking down the ore. Electric-drills were also more economical in working than ratchet-drills—good as these latter were. Many of the members had, no doubt, seen electrically-driven drills in operation at the mines in Cleveland under his charge.

Mr. N. R. Griffith (Wrexham) said that it might not be out of place for him to mention that he was driving a drift, in metals, about 2 miles long, and he was using rotary drills worked by compressed air. In hard rocks, percussive drills were used, and in shales and metals, rotary drills were used; and they changed from one system to the other, according to the nature of the strata. If rotary drills would not bore the stone, then they used percussive drills, the drills in all cases being driven by compressed air. A percussive drill did not appear to him to be a very scientific piece of machinery, because, from the nature of its action, it was knocking itself to pieces all the time that it was working. He had not had any experience with electrically-driven rotary drills, and they might possibly have a great future before them.

Mr. W. Walker (H.M. Inspector of Mines) wrote that he had read Mr. Charlton's paper with much interest, as he well remembered the introduction of rotary drilling-machines, driven by compressed air, into the Cleveland district—at Stanghow ironstone-mines about 25 years ago. At that time, it was thought, and especially by the miners, that the circular hole would not produce such good results as the triangular one, but this prejudice was eventually overcome, and at the present time, as the author states, quite one-third of the Cleveland ironstone is got by the power-machines. For some years, even after the introduction of the rotary drilling-machine, the theory that percussive drills were best suited to the mining of Cleveland ironstone was held by many of the mine-managers, and the Eclipse and other percussive machines, driven by compressed air, were introduced into some of the mines. Eventually it was decided to try the
rotary drilling-machine, in the same mine and district as the percussive machine, for a period of three months, and the result proved so conclusively the superiority of the former, both as regards the number of holes drilled and the quantity of iron-stone got per shift, that the use of power percussive drills was discontinued, and, at the present time, the whole of the power drilling-machines, whether driven by compressed air or electricity, are rotary machines drilling circular holes.

The methods adopted to dispense with the props, which were at first set between the roof and floor, for the ratchet-machines to be set against, are ingenious and simple, and allow of the short-holes being drilled in the required position and direction; and, at the same time, one man can be drilling holes, while the other is filling away the stone brought down by previous shots.

One point is not mentioned by Mr. Charlton in his paper, and that is that the introduction of rotary drilling-machines was the means of bringing into use compressed powder in the shape used at all the mines in the Cleveland district and also, to a large extent, the use of squibs, both of which have no doubt increased the safety with which shot-firers and miners can do their work. In the old days, when loose powder and home-made straws were used, as they were with the hand jumper-drill, it would have been a physical impossibility for the shot-firers to do as much work as they do now, to say nothing of the increased safety. At first, compressed pellets were introduced, of the shape of the triangular hole produced by the jumper-drill; but it was found that if the shot-hole was the slightest out of truth the pellets stuck, and, in trying to force them in, many miners have been more or less injured. Afterwards spherical pellets were adopted, with such success that they have been used ever since, for both circular and triangular holes, although with a triangular hole great care has to be exercised, as it is very easy for, say, a "flat-fronted" hole to become "flat-backed," "flat-topped" or "flat-bottomed," or vice versa; and, if this occurs, a ledge or canch is formed, at the spot where the change takes place, in the hole, beyond which it is not possible to pass a compressed pellet without using force which is highly dangerous and a breach of the Coal-mines Regulation Act and the special rules current in the district.
Mr. W. Charlton, replying to the remarks of Mr. A. L. Steavenson, said that his object in writing the paper was, not to make comparisons between the work of the hand machine-drills and that of the power-drills (both electric and compressed air) so successfully worked in some of the Cleveland mines, but to show how jumper-drills were being superseded by hand-machines. He believed that, in many cases, the hand-machines were as economical as the power-machines, and he was strengthened in that belief by the figures recorded in Table I., showing the great increase in the tonnage wrought by hand-machines in recent years. In some mines, where a portion of the ironstone was won by jumper-drills, and the remainder by power-machines, the former have not been replaced by an extension of the use of the power-machines, but by the introduction of hand-machines.

The President (Sir Lindsay Wood, Bart.) moved a vote of thanks to Mr. William Charlton for his interesting paper.

Mr. M. Walton Brown seconded the resolution, which was cordially approved.

Mr. C. C. Leach read the following paper on "Superheated Steam at Seghill Colliery":—