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THE INTRODUCTION OF POWDER

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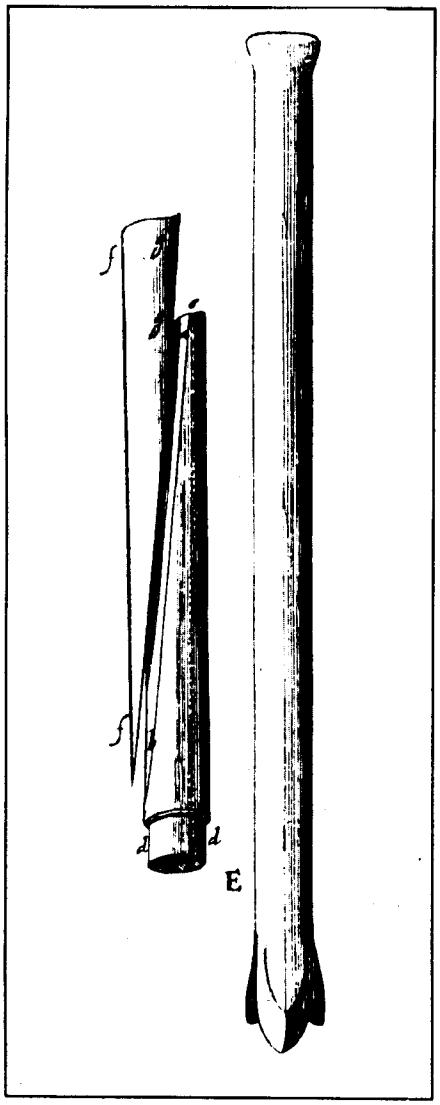
Abstract: Experiments took place in Europe from c1574 using gunpowder for mining, first at the surface as a quick way to detect concealed veins. The earliest known underground blasting dates from 1627, and the technique was widely known by the 1680s. The technique of gunpowder blasting is elaborated.

Although the military use of gunpowder as a propellant for missiles goes back to c1300, and its first attested use against fortifications in the form of "mines" to 1405, it is not until the 16th century that attempts seem to have been made to extend its application beyond warfare. The most important of these from the point of view of mining was the experimental work of Giovanni Battista Martinengo, who was active in 1572-74 in the mines of Schio, about 50 km north west of Padua. However, from a careful reading of the evidence relating to his activities it appears that his use of gunpowder to blast rock, probably in 1574, was confined to surface operations. A report of 1595 specifically states that he had not gone about his work in the normal way, with the implication that he had been wildcatting on the surface rather than working systematically, preparing his shot holes underground.



Du Son's borer (on right) and plugs (on left), from Philosphical Transactions, *1665.*

The first certain date for the use of gunpowder in underground mining as a means of driving headings is a little later. This is furnished by an official report dated February 16th, 1627 of a *public* demonstration of blasting carried out on February 8th by Caspar Weindl in the workings of the Oberbieberstollen mine at Schemnitz (Banská Stiavnica) in Slovakia. Weindl's technique travelled fast and wide. Virtually every ore mining region in Europe was familiar with the technique of 'boring and shooting' rock within 50 years.

The obvious next question is how exactly underground blasting was carried out in 1627. Nothing can be said directly about the technique Weindl used at Windschacht. It is possible, however, using the evidence furnished by the records of the Hohe Birke mine in Saxony for 1643 and 1644 and other materials bearing on the subsequent development of blasting technique, to reconstruct with some confidence the technique he used and the equipment on which he relied. It was recorded in the Hohe Birke Protocol Book in November 1643 that, Caspar Morgenstern had demonstrated boring and shooting exactly (gleichwie) as it was done in the Harz. The weekly accounts show that the bore-holes were usually about 35-40 inches deep, and that about two pounds of powder were used for each shot. There are also references to pieces of equipment it had been necessary to procure: borers, obviously, but also a Reimnadel, a Klab and a Grezer. If all this reflected the situation in the Harz in 1643, one might also have a picture of how things had been done there in 1634 when regular blasting began. This brings one quite close in time to Windschacht itself, and even closer, if Balthazar Rössler was correct in his statement that blasting reached the Harz in 1627, the very year of its invention. An obvious objection to this line of argument is that between 1627 and 1634, and 1634 and 1643, blasting technique might well have undergone development in one or both of the regions involved. Certainly techniques evolve. The more successful they are, the more they will be subject to differentiation. Diverse conditions demand diverse responses, and the resourcefulness of an ever-expanding body of practitioners will supply a perennial source of inventiveness as ways are discovered for saving on labour, in making more effective use of materials, and in finding safer ways of handling gunpowder itself.

All this can be demonstrated in considerable detail for blasting in the 17th century. It is also the case, however, that there is no evidence of substantial change having taken place anywhere before 1646. This being so, it is likely that Weindl proceeded as follows:

(i) The two-man team's first task was to make a small hole (zubrusten) with a hammer and wedge (Schlegel and Berg-Eisen) in the face to be bored. This was done in order to provide a firm key (Bohrer) so as to avoid the borer wandering off-line as it was struck.

(ii) The iron borer was square in section below the head, which latter was steeled, pointed and furnished with four flanges (see figure). In c1670, deep bore-holes (of 40 inches or over) were drilled using successively short, medium and long drills, the latter about 60 inches long and about 2½ inches thick. In order that the work should go easily and that the hole should be as round as possible, the worker holding the borer turned it a quarter turn after every hammer blow so as to allow the flanges to bite into fresh rock. The hammer (Ort-Peuschel) used was medium sized, and weighed between 10 and 15 pounds. During drilling, water was introduced into the hole if the rock was dry so as to speed up the action. The debris produced by boring (Bohrmehl, bore meal, ie. stone flour),

needed to be cleared from the hole from time to time. This was done with a tool furnished at one end with a scoop (Grezer, Cretzer, Kratzer), and at the other with a slot for a rag 'wiper' (Wischer). If the head of the boring tool broke off in the hole it was extracted with pincers (Klab, Klub, Klippe, Kluppe). Broken borers were re-welded (Schneide an Bohrer zu machen) in the smith's shop.

(iii) A quantity of loose powder would be poured into the prepared 'shot-hole' (Schiess-Loeh). Then began the work of securely blocking up the remaining space in the hole. This was done with two (shot) plugs (Schiess-Pflocke) of beech or some other hard wood about 30 inches long and 2½ inches in diameter. These had begun life as a single cylinder turned on a lathe. A hole (Spur) was then bored centrally through its length with a special tool about 3 feet long called a Pflock-Bohrer to provide space for the powder train. This done, the cylinder was sawn diagonally lengthwise to produce the cone-shaped plugs. These were driven, one at a time, into the shot-hole with a heavy sledge hammer (spike-hammer - Fimmel-Peuschel) weighing about 20-30 pounds. The plugs on their own, however, could not provide sufficient resistance to confine the blast which would have blown them bodily or in fragments out of the hole. This would have cut short the build-up of pressure in the 'powder-chamber', (Pulversack) and thus reduced the efficiency of the blast. It was necessary, therefore, to place a 6-inch square iron-plate (Schiess Bleche, Schiess-Stuck - shot plate, piece) between 1 and 2 inches thick over the mouth of the hole.

This too had a hole in its centre to align with that in the plugs. It was secured in position with 9-inch long thin steeled spikes (Fimmel) driven into the rock with the heavy hammer. The primary purpose of the shot-plate was, however, to prevent damage to the wooden props (Schiess-Spreitzen) which were wedged against it (their other ends resting in slots cut in the walls of the gallery). In all this activity the touch hole in the plugs might have become blocked. To make sure that there was a clear passage for the insertion of the powder train, an iron purging rod, 1 inch thick, (Reim-Ram-Raumnadel) was thrust through the hole in the plugs.

After firing, work could be resumed almost immediately. The report on the demonstration blast at Windschacht on February 8th, 1627, noted that the smoke had cleared after 15 minutes.

I do not have the space here to describe the development of the technique later in the century except to say that well before the 1670s and 80s were over, clay-tamping (clay-shooting - Lettenschiessen) had replaced the very elaborate procedure described above for containing the force of the ignited powder. The usual date given for tamping is 1687, when Carl Zumbe published an eight-point description of the new technique in Clausthal in November of that year. But dogmatism in such matters is never wise. Robert Boyle had already described in 1671, a very similar technique in use by English quarrymen in extracting stone for building work, most likely at Portland and most likely also as a means of accelerating the extraction of stone for the rebuilding of London after the Great Fire of 1662.

NOTES

1. For an extended account see the author's 'Gunpowder and mining in Sixteenth and Seventeenth Century Europe'. *History of Technology*, Vol 10, 1985, pp.31-66.

2. ibid, p49, but see R Boyle, *Some considerations touching the usefulness of experimental natural philosophy*. Oxford 1671, Vol. 2, pp.14-15.

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