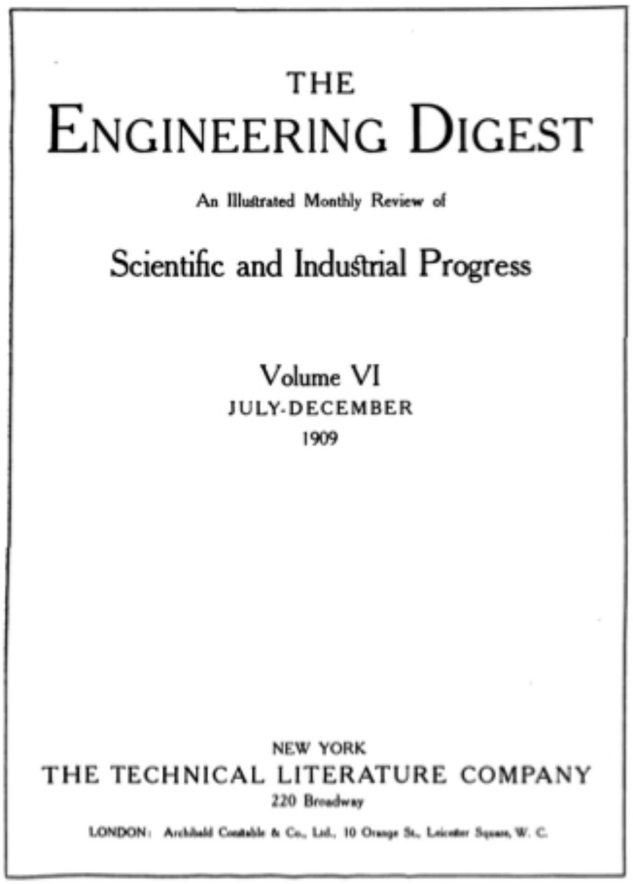
“How Mining Is Done”

Jack Purson

I ran across this article while I was looking for other information. As you can see it is dated the later half of 1909, when miners still used candlesticks. The journal appears to be some kind of “Popular Mechanics” sort of publication where people in industry write in to tell the general public about their product or process. This particular one was a simplistic summary of a more detailed article published elsewhere. I did not see much advertising in the rest of the publication but most articles did seem to be subtly hawking the latest and greatest technology. I found it interesting how the writer chose their words. Perhaps it was intended to come off sounding intelligent and sophisticated. I especially liked the use of the phrase “the mine is alive with men at work”. As an aside, I found no reference at all to environmental issues. Miners were apparently expected to become an integral team of professionals who were responsible for learning and understanding the intricate details of their mine, to ‘become one’ with the earth but yet were individually responsible for their own safety. The sketch of the underground is really nice and conveniently lacks details that show dangers. There is a brief mention about how single and double jacking are being replaced with compressed air drilling. A majority of text is devoted to drilling and blasting as if the author might believe that this is the most important part of mine development or perhaps the other parts are less interesting? It makes an interesting story and I hope you get your mind into the period as you read.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HOW MINING IS DONE

In mining the aim is to take out ore at the lowest possible cost. The work of developing new territory and of exploiting the ore bodies already discovered is carried along at the same time. The work of prospecting is the main one at the beginning and at the end of the mine's life. It is necessary, in the early days for the discovery of the ore bodies, and a property is not closed down until the work of exploration, which is done long in advance in a well-conducted mine, fails to expose new ore bodies. The entire process of this work, from the prospect to the mine, is explained in a series of articles by Mr. Etienne Ritter, published in *Mining Science* (Denver), from which the following notes have been abstracted (next page).

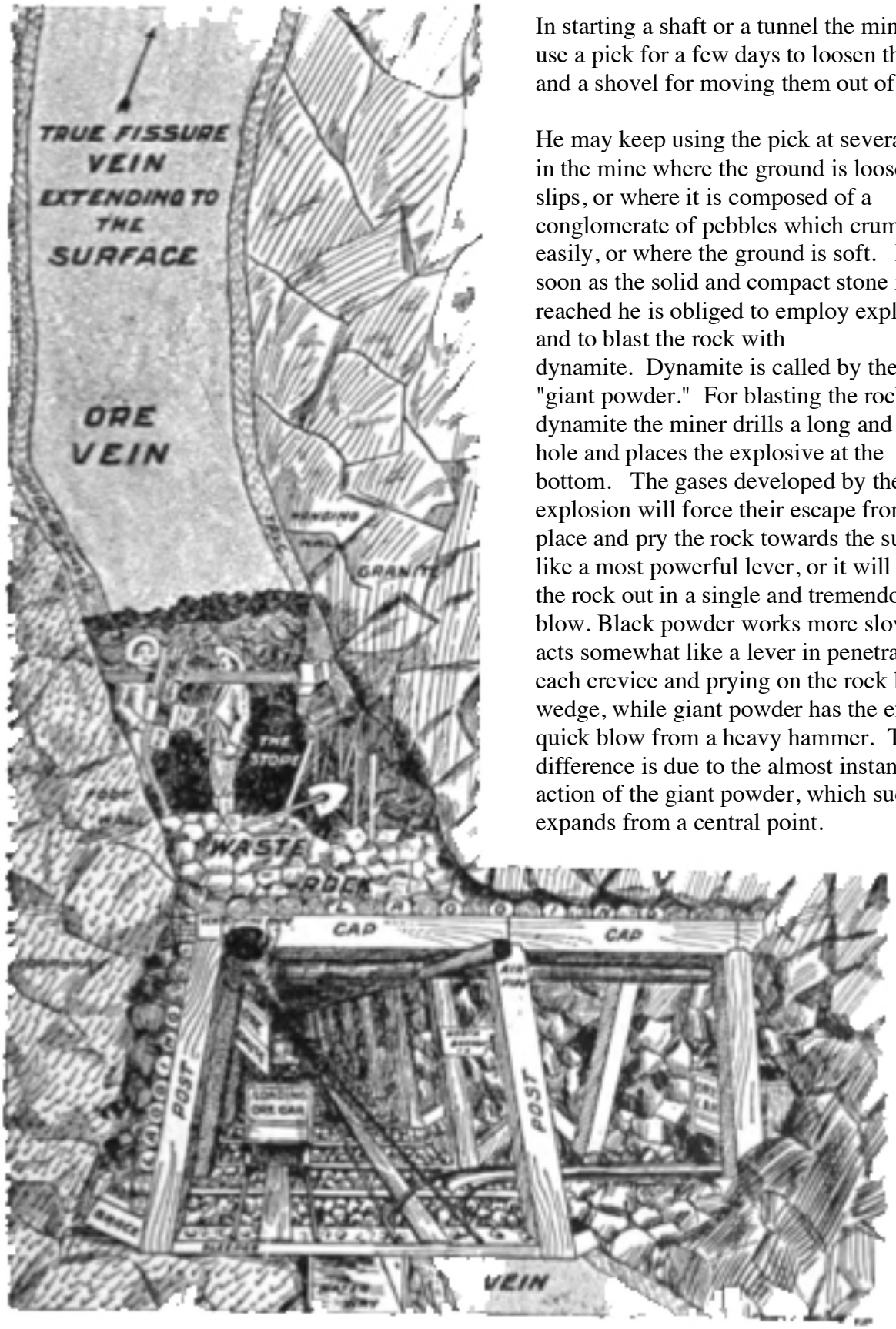
The ore bodies are reached by a main thoroughfare, which is a shaft or a tunnel. Numerous side roads branch from it, and in their turn subdivide themselves often into smaller paths leading to rooms of various sizes.

In a flat country this thoroughfare is a shaft, which may be straight or inclined but which goes down, and has for main utility to reach greater and greater depths. The side roads branching from it are the drifts or the tunnels run at regular depths, each usually one hundred feet deeper than the one above. As these side roads explore the vein on a given level they are called levels. These are the roads which lead to the rooms having no outgoing doors, such as the stopes. The stopes are the excavations in the ore. The winzes, or small auxiliary shafts sunk from some level underground, and the raises, or chimneys raised from one level to another, are the short cuts between two levels. The ore bodies lie in areas, which are cut as much as possible into blocks and squares and which are surrounded by the various roads and reached by them.

In good mining practice the ore bodies of one level are taken out, while in the one or two levels below these, the blocks of ore are divided and the roads built for every day use. Again, in the two lowest levels new productive areas are discovered, the shape and extent of the ore bodies are ascertained and the pathways that will permit the taking out of the ore in the cheapest and best way are planned and started. At the same time some roads may be driven into the country rock and fail to encounter the ore bodies which were hoped for along their course. Each morning the men with their tools, powder and a supply of candles go down the shaft. A part of the men leave at each level —the first, the second, and so on—until the last one is reached. At each level the crew divides again, a part branching off to the left and the other to the right; and, again along the drift the men separate to go to their different places in the stopes, till the mine is alive with men at work. From all the extremities the ore comes down ore chutes to bins or storerooms above the drifts. From there it is dumped into small steel cars and the ore or waste rock, as the case may be, is trammed to the shaft and hoisted to the surface.

On the surface, if the car is full of waste rock coming from some barren portion of the vein or from some road driven through the country rock, it is piled on the waste dump. The car takes another switch if it is filled with ore and is dumped into large storerooms, called ore bins. The ore lies there till it is taken later on to some mill or smelter, where the metals are extracted. When the mine is opened on the slope of a steep mountain it is much easier to use a main working tunnel instead of a shaft and branch roads, as crosscuts to the veins, drifts on the vein at the various levels, winzes and raises, are all connected with the lowest and main tunnel through which all ore taken out is finally trammed.

It seldom happens that the vein lies flat in the ground. In mines on veins dipping but slightly the main thoroughfare is a long tunnel, slightly inclined like the vein, which it follows, and called a slope. Each hundred feet, roads are pushed to left and to right from the slope. Some veins present near the surface and the ore body can be taken out by a quarry or a gigantic open cut. The mine workings are cut in the solid rock by hard and patient work and at a great expense. In following the miner from the time he enters the mine it is easy to learn how he opens the roads through the solid rock with the use of dynamite, and to recognize what are the different roads, shafts, tunnels, raises or winzes. When the ore has been reached it has to be removed. During the last fifty years great strides have been made in the art of mining which allow one to get the best results in nearly all the emergencies which may arise.



SHOWING DETAILS OF WORKINGS, TIMBERING, ETC.

In starting a shaft or a tunnel the miner can use a pick for a few days to loosen the rocks and a shovel for moving them out of the way.

He may keep using the pick at several places in the mine where the ground is loose, full of slips, or where it is composed of a conglomerate of pebbles which crumbles easily, or where the ground is soft. But as soon as the solid and compact stone is reached he is obliged to employ explosives and to blast the rock with dynamite. Dynamite is called by the miners "giant powder." For blasting the rock with dynamite the miner drills a long and narrow hole and places the explosive at the bottom. The gases developed by the explosion will force their escape from that place and pry the rock towards the surface like a most powerful lever, or it will hammer the rock out in a single and tremendous blow. Black powder works more slowly and acts somewhat like a lever in penetrating into each crevice and prying on the rock like a wedge, while giant powder has the effect of a quick blow from a heavy hammer. This difference is due to the almost instantaneous action of the giant powder, which suddenly expands from a central point.

It follows that a knowledge of how to place the holes so as to allow the powder the best show to do the maximum of work is necessary to the ordinary miner. A good blow at the right place will accomplish more than half a dozen at a wrong one. The holes for the powder are bored with a drill. The drill is a bar of steel from one to five feet long of octagonal section, so as to give a better grip for the hand than if it were round. These drills are usually seven eighths of an inch in diameter. The sharp end of the drill, called a bit, is a cutter with a sharp edge and two angular corners. In drilling a man holds the drill in one hand and turns it round and round, while at each turn he gives a blow on the head of the drill with a hammer, which he holds in his other hand.

With each blow a small, triangular piece of the rock is cut off as a piece would be cut from a cake. Then the miner turns the drills and cuts the next slice. The slice of rock falls into powder, and water is poured in holes drilled downward, so as toform mud and to prevent the holes from becoming clogged. The miner takes the mud off from time to time with a long and narrow spoon. In the holes driven upward the rock powder falls from them every time the miner turns the drill. The bit wears out and becomes rounded more or less quickly, according to the hardness of the ground. On an average the drills are sharpened each day. A drill is used in from three to five holes. The miner starts with a drill one foot long, drills in some three or four inches, then takes a drill three inches longer and keeps taking new drills each time three inches longer after he had bored a similar distance with the preceding drill. He ends with a drill six to nine inches longer than the depth of the hole.

In drilling down holes the miner has to raise the weight of the hammer at each stroke. In the upper holes his arm swings like a pendulum. The down holes are easier for the beginner to drill, but they require more muscular effort, while the upper holes require less muscular effort and a more accurate blow. The holes are drilled at an angle with the face to be blasted. The more slanting the hole is the less work the powder will have to do. A good miner will get the slant which will bring the bottom of the hole to the place where the powder will do its maximum work. If the bottom of the hole is not far enough in a part of the energy developed by the explosion will be lost. If it is too far in, the powder will not be able to break the rock and it will escape through the mouth of the hole and break off only a small amount of rock.

If the rock is soft drilling goes much quicker. But the hardness of the rock is not the only character to be considered. The worst ground to drill in is a ground of uneven hardness. Nearly everywhere in the early days, and in many places even today when the ground is quite hard, the holes are drilled by a team of two men. One man holds the drill with both hands and turns it while the other swings a double hand hammer of a weight of eight pounds and gives a full stroke.

The use of the double hand hammer is falling off more and more; it is replaced by the compressed air drill. When the corners of the bit have become rounded the drill has to be sent to the forge and sharpened again. At every mine a blacksmith is kept to sharpen the drills. To do this he puts them into the fire and heats them to a light cherry red color. Then he hammers them on the anvil into the proper shape. When the rock is hard the blacksmith makes the bit stouter, thicker and harder; when the rock is soft he makes the bit longer, thinner and sharper. In the first case the end to reach is to have a tool tough and able to stand hard work, while in the case of softer rock a sharper and longer bit will cut the rock faster. Later on, the blacksmith heats the drills again and puts them into water, in order to give the bit the steel temper. In that operation he varies the time of the cooling of the heated drill in the water so as to render the steel harder but, also, more brittle, or not so brittle and more easily worn out, according to the work for which the drills are sharpened. The hardness and other characteristics of the rock to be drilled through decide what kind of temper is the best.

It is an important thing to have a blacksmith who knows how to sharpen a drill well and to give it the right kind of temper. A good blacksmith must be able to recognize by the way the drills wear out that the miners are entering into some different ground, and he must be able to change slightly the shape and the tempering of the bits so as to meet the new conditions.

A miner who sees his drill biting well in the rock does his work better; while if his efforts are not rewarded because the drill is too soft and "does not stand," as the miners say, or if it is too brittle and breaks, he loses considerable time. The holes are drilled from eighteen inches to three feet deep in ordinary work. The hammer commonly used weighs four pounds. The miners call it a "single jack," to distinguish it from the "double jack," a hammer weighing eight pounds with a long handle. The double jack is used in team work, when one man strikes and the other turns the drill. When the miner has completed the holes he is ready to blast. The powder used is sold in boxes which contain a certain number of sticks of powder of the shape and size of an ordinary candle, with both ends fiat. There are usually thirty sticks in a ten-pound box, and as dynamite freezes at forty degrees temperature the sticks are more or less stiff. The powder is contained in strong, yellow paper, and the miner cuts it with his knife to give the stick a better chance to pack. The stick of powder is pushed into the hole and is packed carefully with a long wooden stick. The powder is introduced, cut in several pieces, and the cap and the fuse are introduced with the last piece. The fuse is a cord of gutta-percha containing in its center a column of fine gunpowder.

The miner lights the fuse and goes to some place of safety. During this time the black powder burns inside the fuse, reaches the cap, explodes it and with it the giant powder, which is transformed into gases. The gases expand so as to occupy a space twenty thousand times greater than the one in which they are enclosed. They thus develop a pressure of more than thirty tons per square inch and force the solid rock to break into fragments to give them room to escape. The rocks are streaked by numerous slips, planes of fracture, or lines of least resistance, along which the rock breaks in a few big chunks, or "breaks big," as the miners say; or it breaks into a thousand small pieces.

In every-day practice a miner seldom drills and fires only one hole at the time. He drills in the breast or in the face of the workings several holes of various lengths and inclined at different angles. He disposes them in such an order and at such places that all the explosions will work to the best advantage. The first hole not only will take a part of the block to be broken, but it will loosen a side of the piece of rock to be blasted by the second hole, and help the powder in this hole to accomplish its work.

The second hole will make easier in the same manner the work of the third one, and so on till the last one has exploded. The holes have to be fired in a carefully arranged order to give their maximum of results. With that end in view, the miner cuts the fuses of different lengths, the second two inches longer than the first and the next two inches longer again, till the last, which is the longest of all. A practiced hand can light the fuses so quickly that the difference of time in lighting them does not count.

The miner counts the explosions to make sure that all the holes have exploded. He knows then that he can safely pick the ground; that he can pry and tear down, without danger, all the pieces of rock which have been shaken by the explosions, but which are yet partially held by the solid rock.In some cases, like in the breast of a long and straight tunnel, for instance, the miner would have to walk too far before being out of danger. It has become the practice in such cases to fire all the holes at the same time from a distant and safe place by means of an electric battery.

In such wholesale firing the explosions achieve a good result on account of their "mass" by the magnitude of the forces developed. But the miners have no good means to be sure that all the holes have exploded. Many accidents are due to "miss shots," or shots which have not gone off. These are the result of numerous causes, but usually happen because the fuse burned out before reaching the cap. If the miner is not aware that a hole has not exploded he will pick the loose rock or drill again near it, and he may hammer on the dynamite and cause an explosion. In nearly every case, he will be killed or crippled for life.

When he knows that a hole has not exploded the miner goes back, after a long enough time has elapsed, to be sure that there is no more danger of an explosion. He will put a new fuse and add a fresh stick of dynamite and fire again. In nearly all cases the shot goes off the second time.When they are loading their holes, that is to say, when they charge them with dynamite, some miners deem it advisable to tamp them with a large amount of paper, or rags, or of loose dirt, so as to fill the hole nearly to its collar. That is quite unnecessary. The dynamite is transformed into gases so quickly that no gas has time to escape by the mouth of the drill hole before the result of the explosion has taken place and the rock is already broken. In the event of a "miss shot," it is very much easier and much less dangerous to slide in a new fuse with a small package of powder when the hole has nothing in it, than to dig out first a large amount of paper, of rags or of dirt.

The rock may break well or badly when it is blasted. That point is more important for getting good results and pushing the work rapidly than is the facility with which the holes are drilled. A miner will get better results in harder rock which breaks well than in a softer rock which does not "break good." In a ground which breaks badly the bottoms of the holes remain unbroken in the faces of the workings. They show that the powder did not find enough slips to help it. This ground is called "tight ground." The miner needs a great deal of experience in that kind of rock so as to concentrate the force of the explosions and get good results.

When the work consists of sinking a shaft or driving a drift, the rock which has been blasted has to be carried out of the way before new holes can be bored. In the drift, a heavy sheet of iron, followed by pans four by six inches, six or eight feet long, receives all the rock blasted. Shoveling on the smooth surface makes the work much easier. In the stopes, ore chutes are built just above the levels along the drifts and the rock broken by the shots falls into these chutes, slides down by gravity to the doors at the bottom and is dropped from there into cars and wheeled away. (End of Article)

The article oddly ends abruptly here and a new topic begins. The new article does not necessarily have anything to do with mining or explosives. The whole layout of this journal is a bit like reading news on the internet but of course, the information is months if not a year old by the time the reader sees it. There is an index by subject but the articles themselves are not grouped according to the index. I suppose we would have to live in 1909 to really understand the context of technical publication and the mentality of the reader. This provided an interesting visit to that framework and I enjoyed the trip back in time.