making his moves and changes quick, keeping his bits sharp, and giving the machine its fullest stroke without striking the head. Keep the hole clean, the pressure high and dry, and the machine well oiled, and every last quarter of an inch stroke, so the piston is almost "nipping" the head every blow, unless in seamy or treacherous rock.

It is frequently quite as difficult to drill a straight hole as a round one. The shape of the bit has something to do with the alignment of the hole. It is an invariable rule that the edge of the bit should never be tapered in rock of uneven or irregular formation. The marble bit is of no use, except in a material like marble, which is uniform. It is obvious that with a tapered bit passing through a flint seam or other irregularity in rock, the tendency would be to glance, and this would result in "running of the hole.

Where drill holes tend to run out of line, the bit should invariably have a straight edge, that is, at right angles to the axis of the drill steel. It makes no difference whether the drill is a + or an x bit, so far as the alignment of the hole is concerned. In some difficult places where the hole passes through soft spots or seams running diagonally across the hole, it is advisable to upset the steel for a distance of about 6 inches above the bit. In other words, the steel should be very nearly the full diameter of the bit for a distance of about 6 inches at the bottom. The purpose of this is, that the steel may be guided by the wall of the hole, thus preventing "running" until the pocket or seam has been passed. This is readily undersood when it is known that the steel used with percussive drills is usually about 1 inch diameter octagon with a bit of about 2¼ inches diameter; thus there is a space of about three-quarters of an inch between the steel and the drill hole, and should the condition of the bottom of the hole be such as to tend to thrust the bit to one side, it will gradually work the steel up against the side of the hole, and will result in a crooked hole, which will give trouble through binding and sticking. If the bar of steel were nearly equal in diameter to that of the bit, it would, as it were, force the hole to run straight. It will not do, of course, to carry so much weight of steel; hence, where trouble is met, it is best to upset the steel at the bottom.

In the ordinary course of drilling, the runner sometimes finds that his hole is going crooked, and, without waiting to get a special piece of steel, he attempts to pass through the obstruction. The first thing to do is to reduce the speed of cutting. This is done by either throttling the steam, shortening the stroke of the drill, or by dulling the bit; but whatever is done, it is necessary to "go slow" with the drilling. An effective means by which to prevent "running" is to pull out the steel and throw some iron filings, or small pieces of iron in any shape, into the hole, then put in the steel and go ahead. This not only reduces the speed of cutting, but the pieces of iron are thrust into the softer place, and thus the bit cuts through the obstruction and keeps the hole in line.

Let us assume that a cobble stone of the size of an egg or larger is encountered by the bit in the line of the hole, but a little to one side of the centre. Obviously, as the flange of the bit strikes this obstruction, it will be thrown off at a tangent and will gradually cut away the side of the hole farthest from the cobble. It is now simply necessary to drill a few inches more of the hole, without losing the line, and a few pieces of iron, or even a nut thrown in the hole, will retard the "running" until the bit cuts through the obstruction.

A drill hole will sometimes "run" in a most unexpected manner, and in rock of uniform texture. In a case of this kind, the runner should at once stop his machine and see if his bit is in good shape. Sometimes one of the flanges breaks off and serves the same purpose in throwing the steel out of line as though a "hard head" was encountered. If the broken piece is large, it will sometimes get in one corner of the hole and give considerable trouble, even after the bit has been repaired.

It is of much importance that the hole be well started, that is, it should be started straight. In stone quarries, the mouth of the hole should be preserved at about the diameter of the hole, and not cratered or broken. This can be done by starting with a light blow and a short stroke, lengthening the stroke and the force of the blow after the hole has been made a little deeper than the length of the stroke.

The machine should be oiled often, and good oil used. The driller should have a system of oiling every time a certain number of feet are drilled. This varies with the rock, but an observant driller can soon learn how often to oil. "Little and often" should be the rule.

System of "Long Wall" Used in Northern Illinois Coal Mines.

By G. S. Rice, E.M.*

The system of mining which is to be described has been developed by the special conditions of the "third vein" of the northern Illinois coal field. This "third vein" is so called because usually third from the top, but geologically it is No. 2, numbering from the bottom.

In this district the other seams are only occasionally developed, and are worked in but few places. The "third vein" is very permanent and uniform, and is workable through the large district north of the Illinois river, and its annual output is between three and four million tons. The coal is a moderately hard bituminous coal of good quality; in fact, one of the best of the Illinois coals, its actual evaporative power being eight to nine pounds of water per pound of coal under a good boiler. The thickness of the seam is from 2 feet 10 inches to 4 feet, but the greater area only varies from 3 to 3½ feet. While the "third vein" is somewhat rolling locally, the general plane is nearly horizontal, having but a slight raise toward the outcrop at the north.

The coal is underlain with sandy fire-clay, which, at times, is so sandy as to be very hard. The roof is a light drab colored shale of fine texture, called by the miners "soap stone," from its soapy touch. It is of this character for 10 or 12 feet over the coal. Above that, bands of slate are interspersed with the shale until the upper coal seams are reached about 150 feet above. The total cover above No. 2 vein varies from 100 to 500 feet in thickness in going from the eastern to the western part of the northern district. The surface is rolling prairie. The sand and gravel drift, often several hundred feet thick in the western portion, contains much water, but the shale strata, as a whole, is not fissured or broken by the long-wall working, and so the mines are quite dry, even in the case of one mine which passes underneath the Illinois river.

The only exceptions to dryness are in mines at Braceville, which is near the outcrop. There the solid covering is thin, and in a few mines of that neighborhood the roads have to be corduroyed.

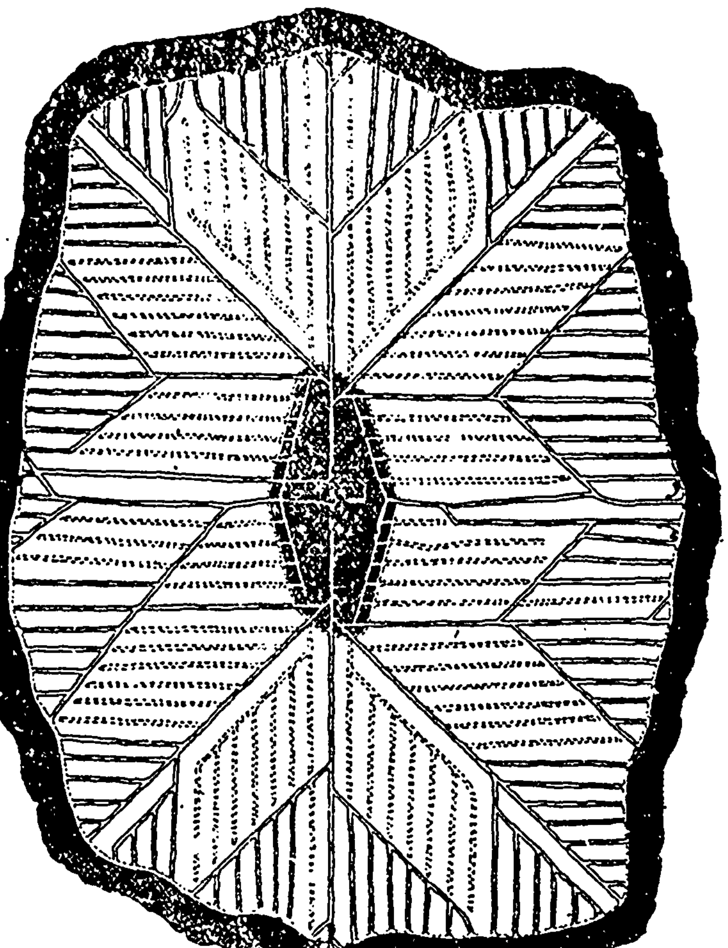
In selecting the position of a shaft, in most any part of the "third vein" district, there is usually no natural obstruction to prevent its being placed in the centre of the given tract. Besides the central hoisting shaft there must be an escape shaft, the present State law says 300 feet away. This distance may be lessened with the permission of the mine inspector. This is usually granted for the long-wall system, as it would be an unnecessary hardship to require such a great distance between the shafts, on account of the large pillar which it would necessitate.

Having selected the position of the shafts, the next point to determine in the planning of the mine is the size of the shaft pillar to be left. Of course this will depend chiefly upon the depth of the shaft, and the nature of the material gone through. The danger is in making the pillar too small, and in a number of cases there have been bad results following this mistake.

Observation of the shaft pillars of mines now open, leads to the conclusion that the strata of this district require, for a safe pillar, that its minimum diameter should be not less than the depth of the shaft. On the other hand, some advocate leaving no pillar at all, expecting that the whole shaft will sink so gradually and evenly that no danger will result; but the writer believes that the risk of racking the shaft is greater than the advantages that might be gained in more quickly opening the long-wall face. The usual plan of the district is to make the shaft pillar diamond-shaped, the "main bottoms" (termini of the main entries) occupying the long diameter. The escape is placed near the line of the short diameter; and it has been usual in the past to make it about 100 feet away from the main shaft.

After the shafts have been sunk, and connection has been made by driving headings from one to the other to establish a current of air, the "main bottoms" are pushed forward. If the diamond lies north and south, these will be the termini of the "main north" and "main south" entries. For a mine which is to have a large output, the "bottoms" are double-tracked for 250 feet on each side of the shaft, and, if practicable, are made with a down grade toward the shaft. These grades cannot always be established at once; the mine must be developed sufficiently to find how the seam is running. It may be necessary in some cases to lower the shaft if it is found that it has been sunk on the roll of a seam. At the end of the switch of the double track, the entry is narrowed to single track width, and just beyond two entries are turned off, one 45 degrees to the left, the other 45 degrees to the right, with an interval of about 40 feet between them. These form what are called "main 45 degree" entries, and run on the diagonals, so to speak, of the tract.

Fig. 1



After the latter four entries have advanced about 30 feet, from each an entry is turned off at 45 degrees to run due east or due west respectively, and these complete the main permanent entries, making ten in all. From the east and the west entries, entries are turned and directed towards each other to block out the shaft pillar. Single entries are usually used in blocking out the pillar, but there is much difficulty in airing even when boxes are used, to carry the air to the face, and if the pillar is large, it becomes very severe on the miners.

A better way with large pillars is to have double entries with "cross-cuts" between, spaced at the right intervals for room-roads, then, connections having been made all round the shaft pillar, all is ready to begin the long-wall face at once from the side of the outer block entry.

When the blocking-out entries are single, the rooms are started narrow for a certain distance, then are broadened till they meet and form a continuous face around the block. Still another plan is to use a broad entry, packing on each side of the roadway, and starting rooms off it at once. This plan was used at the Ladd mine (see Fig. 1), where the width of the entry or room was 33 feet. The method was successful, except for a difficulty in airing, in spite of the air-boxes.

The spacing adopted for the branch roads in this district is 42½ feet from centre to centre of road, measuring at right angles. This makes an even 60 feet, when measured along the 45-degree entries, from which all the room-roads are afterward turned. Although not properly "rooms," the branch roads are so called locally, and we use this term in describing them.

Two miners work in each room in "getting" coal. They first prop or "sprag" the coal-face, then undercut the coal in the fire-clay to a depth of from 16 to 20 inches;

* School of Mines Quarterly.