

My invention relates to machinery or apparatus for sinking, tunnelling, undercutting, nicking-on-end, and other operations in connection with the excavating of coal or other minerals. By means of this invention mines can be worked with less expense and greater output than can be obtained by the methods at present in use. At the same time, the safety, confidence, and comfort of the workmen are secured, by relieving them of the most dangerous and laborious part of their duties.

My invention consists in the cutting and drilling mechanisms and their relative arrangements to the motor, and in the apparatus required with the machines to enable them (the motor and cutting and drilling mechanisms) to better carry out the various operations necessary for the excavating of coal or other minerals.

My invention is represented in the accompanying drawings, in which Fig. 1 is a plan of a coal-cutting or like machine, with most of the cutting and drilling mechanism broken away; Fig. 1<sup>a</sup> is a plan mainly in section of the cutting and drilling mechanism, which completes the view shown at Fig. 1; Fig. 2 is a side elevation partly in section, and Fig. 3 is an end-view of the same with parts removed; Fig. 4 is an end-view of parts shown at Fig. 1<sup>a</sup>, looking at the drilling-end of the cutter-bar; Fig. 5 is an internal view of the cover carrying the bearings of the reciprocating motion, worm-wheel, and shaft; Figs. 6 and 6<sup>a</sup> represent the cutter-bar drill, which is drawn in three parts for convenience in drawing; Fig. 7 is an end- or face-view of the auger or drilling-cutter; Fig. 8 is a cross-section of the cutter-bar drill, and Fig. 9 is a plan showing one form of cutter and method of fixing the same in the cutter-bar; and Fig. 10 is a face-view of the cutter separately. Other forms of cutters and methods of fixing the same are shown at Figs. 11 to 20. A modified form of cutter-bar drill is shown at Fig. 21. Fig. 22 is a plan of parts of a coal-cutting or like machine similar to that shown at Figs. 1 to 3, but slightly modified in parts; Fig. 23 is a sectional plan of parts showing the cutter-bar drill, provided with a screw-feed; Fig. 24 is a sectional plan of parts, showing the cutter-bar drill without feed-motion, and in combination with a cleaning-bar; and Fig. 25 is a sectional elevation of drilling and cutting mechanism for a tunnelling- or sinking-machine. Fig. 26 is a perspective view of my cutting-machine, showing it performing the work of undercutting; and Fig. 27 is a perspective view representing my improved cutting-machine as applied to heading or tunnelling. In all the figures like parts are indicated by similar letters of reference.

In applying my invention for undercutting, I actuate, by a motor A, constructed according to the specification of an application filed simultaneously herewith, a combined cutter-bar drill *a*, formed of forged or cast steel, or other suitable metal or alloy, and having separate or detachable chilled-steel or chilled-iron cutters *a*<sup>1</sup> fixed along its fluted or twisted periphery, and an auger-cutter *a*<sup>2</sup> at its outer end; the cutter-bar drill *a* is caused to revolve and reciprocate in a twisted or rifled sleeve *b*, having rifled grooves *b*<sup>\*</sup> for the passage of the cutters on the bar, and a key *b*<sup>1</sup> cast in it, which fits the twisted groove *a*<sup>4</sup> of the cutter-bar drill *a*; the sleeve *b* forms the boss of the wheel *b*<sup>2</sup>, by which it is rotated by a bevel-pinion *c*<sup>1</sup> fixed on the motor-shaft *c*. I preferably use double helical teeth for the wheel *b*<sup>2</sup> and pinion *c*<sup>1</sup>, but other suitable gearing may be employed; the wheel *b*<sup>2</sup> may be keyed or otherwise fixed on the sleeve *b*, instead of being cast thereon. The rear end of the cutter-bar up to the first cutter is bored out so as to give a free outlet to the cuttings when nicking-on-end or otherwise. The cutters *a*<sup>1</sup> may be fixed to the cutter-bar drill *a* according to any of the methods shown at Figs. 6 to 21.

According to the method shown at Figs. 8, 9, 10, I form a number of dovetail recesses *a*<sup>3</sup> at intervals along one edge of the twisted groove *a*<sup>4</sup>. I form the shanks *a*<sup>5</sup> of the cutters to fit the recesses *a*<sup>3</sup>, and they are retained in position by a split-pin *a*<sup>6</sup> fitting in a hole bored partly in the side of the shank *a*<sup>5</sup> and partly in the side of the dovetail recess *a*<sup>3</sup>.

According to the method shown at Figs. 11 and 12, the cutter-shank *a*<sup>5</sup> extends into a hole drilled in the cutter-bar down to a little below the bottom of the twisted groove *a*<sup>4</sup>, and in such case the upper part of the shank *a*<sup>5</sup> fits in a dovetailed or other recess *a*<sup>8</sup> formed in the upper edge of the twisted groove. In this case the cutter is held in position by a split-pin *a*<sup>6</sup> passing through an angular hole drilled through the cutter-shank *a*<sup>5</sup> and the bar *a*, and springing into a countersink. If desired, the lower end of the shank *a*<sup>5</sup> may also be formed with an eccentric stud or prolongation *a*<sup>7</sup>, to enter a corresponding hole in the cutter-bar *a* to assist in holding the cutter from rotation in its recess.

According to the method shown at Figs. 13, 14, 15, the shank *a*<sup>5</sup> of the cutter fits into a hole bored in the cutter-bar, as described with respect to Figs. 11 and 12, but it is held in position and free from rotation by a split-pin or spring-shank *a*<sup>6</sup> passing into an eccentric hole in the bar *a*, one side of the said split-shank being hooked to catch under the bottom of one side of the eccentric hole *a*<sup>8</sup>. If desired, the cutter may be formed as shown by dotted lines in Fig. 13 and full lines in Fig. 14, with a backward extension *a*<sup>9</sup> to give strength to the working part thereof.

According to the method shown at Figs. 16 and 17, the cutter *a*<sup>1</sup> has the shank *a*<sup>5</sup> fitting an angular or circular recess formed in the bar *a*; the eccentric stud or prolongation *a*<sup>7</sup> fits a corresponding hole, and it has a split pin or shank *a*<sup>6</sup> extending from its bottom end and passing through a hole formed for it in the bar *a*, as described with respect to Figs. 13, 14, 15.

The method shown at Figs. 18, 19, 20 is similar to that described with respect to Figs. 11 and 12, except that the eccentric stud or prolongation *a*<sup>7</sup> is dispensed with, and the cutter is held from rotation by the rear part of the cutter-head entering a recess in the cutter-bar, and such cutter is held in position either by an angular split-pin *a*<sup>6</sup> or by a split pin or shank *a*<sup>6</sup>, extending from the bottom of the cutter-shank and springing into a countersink, and if desired the said split-shank *a*<sup>6</sup> may be eccentric to the cutter-shank *a*<sup>5</sup>.

Fig. 21 represents a cutter-bar drill *a*, provided with two twisted grooves *a*<sup>4</sup>, and fitted with cutters *a*<sup>1</sup> of the form shown, but which may be of any of the forms previously described, so far as such are suitable to the said doubly-grooved bar. The auger-cutter *a*<sup>2</sup> is formed as shown with a