The fixed cutter k is also formed with an inclined grooved conductor k^3, so arranged as to carry the cuttings back over the cutter-bar front journal to the rear of the machine. By this means the machine is enabled to proceed with its work without stoppage.

In applying my invention to a machine for tunnelling or sinking, a slight modification of the machine before described is necessary, and which is illustrated at Figs. 25 and 27. In this case the cutter-bar drill a, with or without its reciprocating motion (in the drawing it is shown without), is fitted to the end of a telescopic arm l, carried by the centre casting B, which is free to revolve around the end trunk A^2 of the motor in a plane at right or other angles to the motor-shaft. The cutter-bar drill a is tapered down from its driven to its working end; it is driven by shaft m and bevel gearing m^1 m^2 from the motor-shaft through the sleeve b and gearing b^2 c^1, and is fixed to the telescopic arm l, which also forms a casing for the gearing, at such an angle that the tips of the cutters are located slightly beyond the plane of the casing l of the wheel m^2 and make a cut parallel to motor-shaft c; by this means clearance is obtained between the casing l of the bevel pinion m^2 on the cutter-bar drill a and the sides of the shaft or tunnel. By the centre-piece B which carries the telescopic arm l is also carried an externally rifled tubular drill n, similar to one patented by me in England, 27th August, 1880, No. 3,474. This drill n is driven from the sleeve b by bevel gearing n^1 n^2.

The mode of operation with this machine is as follows: The machine is brought up to the face of the mineral, and the centre-drill and cutter-bar drill a set in motion. The two drills are then led into the face by the entire machine being worked forward by means of hauling and a snatch-block or connecting-rod gear, hereinbefore referred to, to the full depth required. The centre-drill n is then stopped from rotating, and the centre casting B carrying the telescopic arm l is then caused to revolve, by means of worm gearing i i^1, driven by hand or from the motor-shaft. Thus the cutter-bar drill a is caused to cut a deep circular, oval, or square groove in the face of the mineral. This groove may be made of any desired shape by fixing one or two suitable templates or cams o on the trunk A^2 of the machine, by which the length of the telescopic arm l may be varied as the centre casting B revolves, and thus enable it to cut a square, oval, rectangular, or other shaped groove. Motion is given to the telescopic arm l by studs l^1 fixed therein, and provided with rollers working in the grooved cams o. The centre-drill n being allowed to remain in at full depth serves to steady the machine.

When a complete revolution has been made by the telescopic arm l carrying the cutter-bar drill a, the drills are withdrawn from the mineral by the machine being moved backwards away from the face of the mineral, which is then broken up to the depth of the cut, the centre hole greatly facilitating this operation. When the material is removed the machine is brought up to the face of mineral again and the operation repeated.

In sinking-operations the centre piece, carrying cutter-bar drill a, centre externally rifled tubular drill n, and mechanism before described, and the motor for driving the same, are mounted in a cage similar to the one patented by me in England on the 25th March, 1869, No. 906, the mode of operation being the same as described for the preceding machine.

It will be evident that the cutting mechanism herein described may be connected with and driven by a motor of different construction to that hereinbefore referred to.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is,—

1. The improved constructions and arrangements of coal-cutting and like machinery, substantially as herein shown and described.

2. In coal-cutting and like machinery, the improved construction of cutter-bar drill, and the methods of fixing the cutters therein, substantially as herein shown and described.

3. In coal-cutting and like machinery, the combination with a suitable motor and driving-gear of a rotating and reciprocating cutter-bar drill, having cutters on its length, and an end-cutter or auger, substantially as herein shown and described.

4. In coal-cutting and like machinery, the combination with a driving-shaft of a casting carrying the cutting mechanism, and capable of being rotated around the said driving-shaft by suitable gearing, substantially as herein shown and described and for the purposes stated.

5. In coal-cutting and like machinery, the combination of a cutter-bar drill, a rifled driving-sleeve to permit of the cutter-bar drill, with its side- and end-cutters, being fed through the sleeve, and mechanism for giving endwise motion to the cutter-bar drill, substantially as herein shown and described.

6. In coal-cutting and like machinery, the combination with suitable cutter or cutters of a cleaning-bar, arranged at an acute angle therewith, and acting to clean out the *débris* from the groove cut in the coal or other mineral, substantially as herein shown and described.

7. In coal-cutting and like machinery, the combination, with suitable cutting and driving arrangements, of a fixed cutter and inclined conductor, for cutting the face and bottom of the mineral, and for lifting or conveying the *débris* backward and over the cutter-bar journal, substantially as herein shown and described.

8. In coal-cutting and like machinery, the combination of a driving-shaft, a casting capable of being rotated around said driving-shaft, a telescopic arm carried by said casting, a cutter-bar drill carried by said telescopic arm, a central cutter or drill carried by the rotatable casting, and driving mechanism for rotating the cutter-bar drill and central drill, substantially as herein shown and described.

9. In coal-cutting and like machinery, for tunnelling or sinking the combination with a telescopic arm carrying a drill or cutter, of a cam or cams acting to give a to-and-fro motion to the telescopic arm to control the shape of the groove cut in the coal or mineral, substantially as herein shown and described.

Dated the 4th day of October, 1893. FREDERICK HURD.