April 24, 1951 J. S. ROBBINS 2,550,202

ROCK CUTTING APPARATUS

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FIG. 1

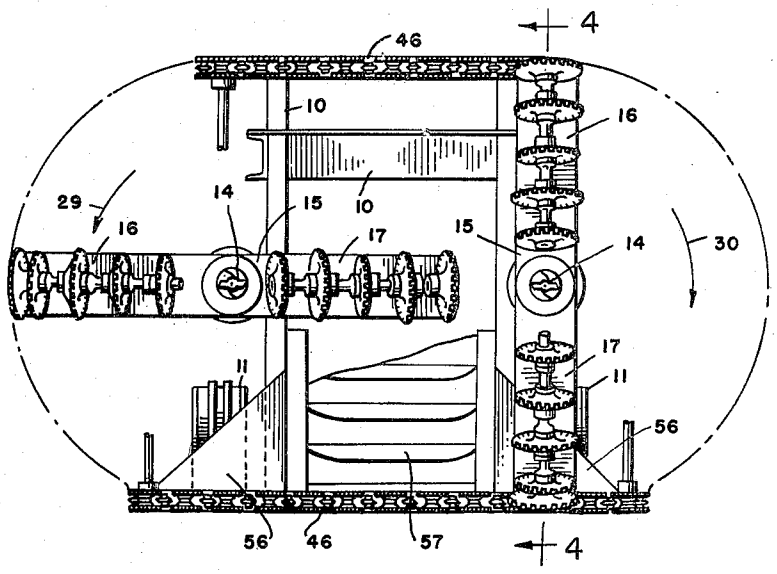
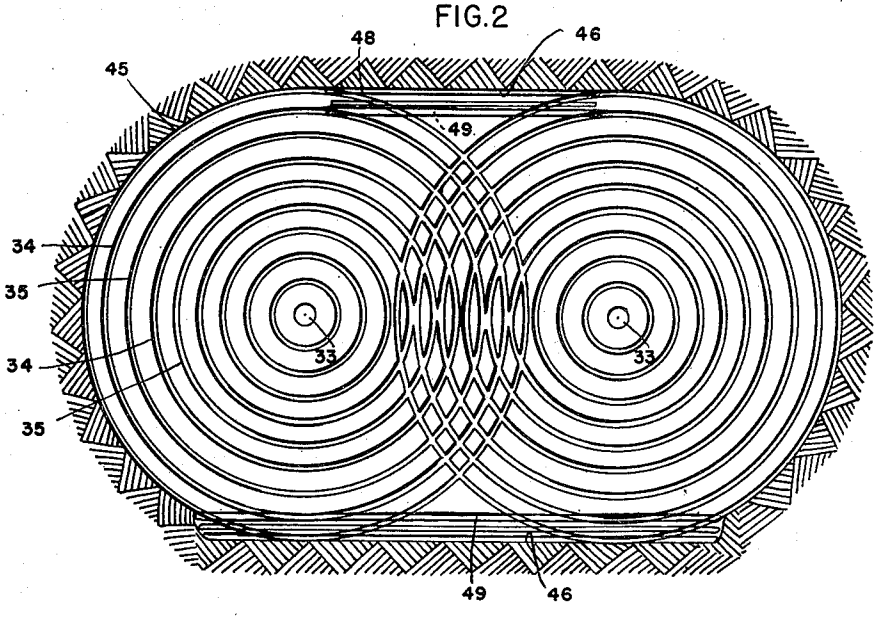


FIG. 2



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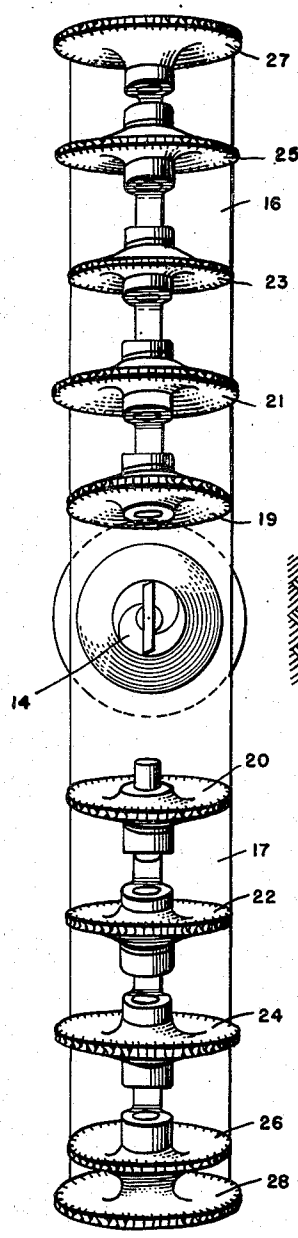


FIG. 3

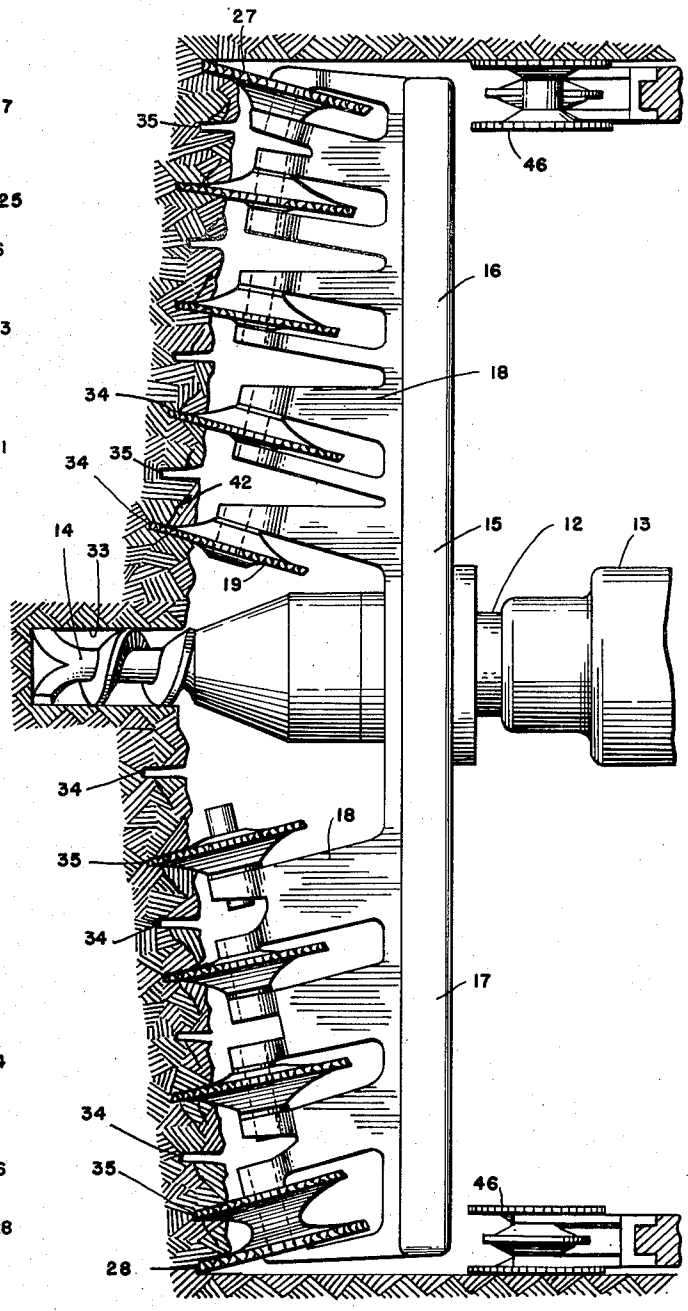


FIG. 4

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FIG. 5

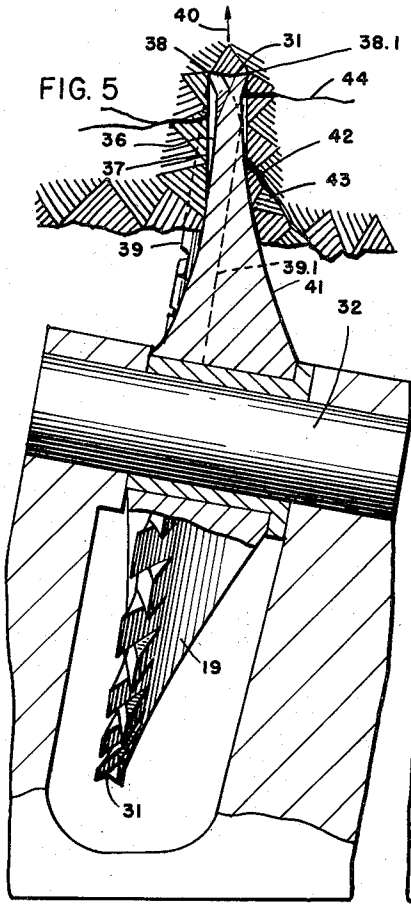


FIG. 6

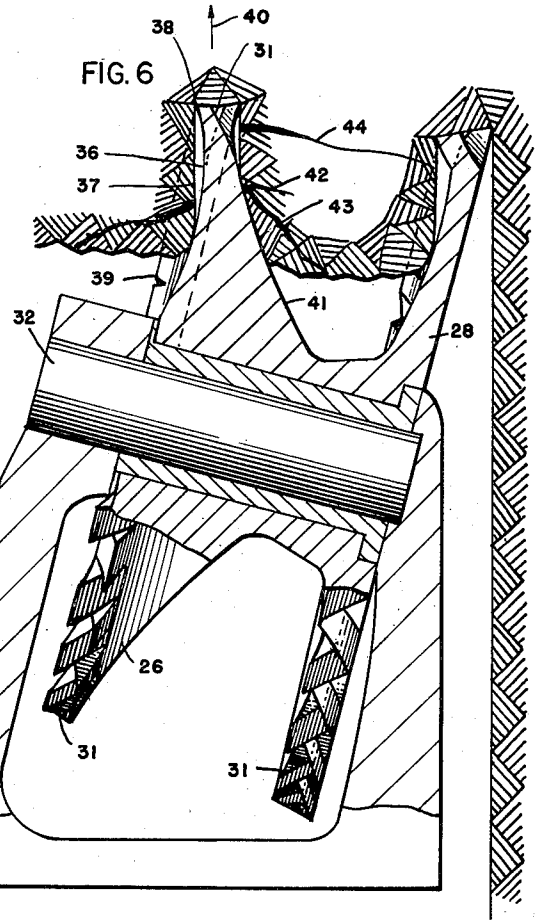


FIG. 7

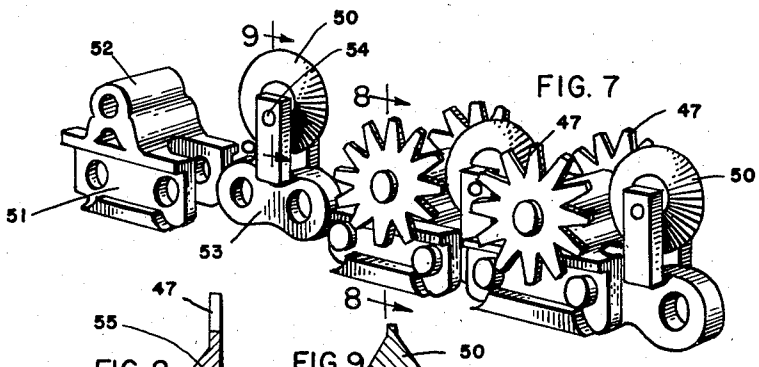


FIG. 8

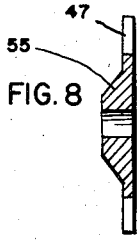


FIG. 9



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UNITED STATES PATENT OFFICE

2,550,202

ROCK CUTTING APPARATUS

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Application August 14, 1948, Serial No. 44,341

4 Claims. (Cl. 262—7)

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This invention relates to means for cutting kerfs in frangible rocks of the nature of coal and breaking down the intervening masses, and has reference more particularly to tunneling operations in veins of coal.

The main objects of the invention are to provide improved rock cutting tools designed to reduce to a minimum the wear and replacement of the kerf cutting devices, to reduce to a minimum the amount of material that is pulverized in the operation of cutting kerfs, and to provide an improved form of rock-cutting roller disk that performs both the operations of forming the kerfs and of breaking down the masses of rock that occupy the spaces between kerfs in a manner that will recover the maximum amount of commercially valuable coal.

The invention is applicable to various types of rock-cutting mechanism. In the accompanying drawings illustrative embodiments of the invention are shown as applied to a coal-tunneling apparatus of the general type shown, for example, in the McKinlay Patent No. 1,603,621 issued October 19, 1926.

Figure 1 of the drawing is a front view of a mining machine equipped with kerf-cutting devices in accordance with the present invention.

Fig. 2 is an elevation showing the general arrangement of kerfs that are cut in the rock wall at the inner end of a tunnel by a machine of the type shown in Fig. 1.

Fig. 3 is a front view of one of the rotating cutter carrier arms equipped with the improved form of cutters.

Fig. 4 is a side elevation of the same with the contour of the rock mass upon which it is operating indicated in section on the plane of the line 4—4 of Fig. 1. There is also included in this view a fragmentary sectional representation of the chain type of cutter that is used for leveling off the roof and floor surfaces of the tunnel between the paths of the rotating cutter-carrying arms.

Fig. 5 is a fragmentary detail, partly in elevation and partly in section, showing one of the cutter disks in its relation to the kerf that it cuts in the rock.

Fig. 6 is a similar detail of a modified form of the cutter roller that is employed at the outer end of the rotating carrier arms of the machine.

Fig. 7 is a perspective view of a portion of a cutter chain equipped with cutter rollers in accordance with the present invention, some of the links of the chain being shown in their assembled relation to each other and others being separated to disclose the formation of the individual chain links.

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Fig. 8 is a sectional detail of the cutter roller as employed on the chain; and

Fig. 9 is a detail of the wedge roller that is employed for splitting the ridge that is formed on the rock face between parallel kerfs that are cut by the rollers of the chain.

As represented in Fig. 1, the tunneling machine comprises a frame 10 mounted on wheels 11 so as to travel in the direction from which Fig. 1 is viewed. The power supplying equipment, which is not part of the present invention and is accordingly omitted from the drawing, is carried on the frame 10 and includes means for causing the machine to progress toward the left of Fig. 4 and for the purposes of this disclosure all such mechanism is assumed to be represented diagrammatically by the frame 10.

A pair of parallel horizontal power shafts or spindles 12, journaled in bearings 13 on the frame 10, extend outwardly from the front of the frame 10 and carry drill bits 14 at their forward ends. Each of the spindles 12 also has mounted thereon a cutter-carrying head 15 comprising oppositely extending radial arms 16 and 17 equipped with brackets 18 on which are journaled a plurality of radially spaced cutter disks designated by numerals 19 to 28, inclusive. The axes of these disks are generally radial with respect to the spindle 12 and inclined forwardly and inwardly with respect to said axis of the spindle 12.

The cutter disks on the arm 16 are staggered in their radial distances from the axis of shaft 12 with respect to those on the arm 17 so that each disk except the outermost pair will cut a kerf separate from the kerfs cut by the other disks.

The spacing between the shafts 12 is such that the arms 16 and 17 of the cutter heads can rotate freely between them and the shafts 12 are interconnected by gearing, not shown, so that when they rotate in the direction of the respective arrows 29 and 30 at the same speed, their respective arms will pass clear of each other as will be apparent from Fig. 1.

The disks 19 to 28 inclusive have appropriate tooth formations 31 at their marginal edges and are journaled so as to rotate freely about their shafts 32 as they roll on the rock face during the rotation of the carrier heads 15. This coupled with the forward progress of the machine results, with respect to each carrier head 15, in the cutting of a bore 33 by the drill bit 14 surrounded by an annular series of concentric kerfs 34 and

35, the kerfs 34 being cut by the rollers on the arm 16 and the kerfs 35 being cut by the cutter disks on the arm 17.

In order to reduce to a minimum the width of the kerfs cut by the rotating disks, the thickness of the marginal rim of each of the cutter disks is made as thin as is consistent with durability of the tooth formations thereon, and the face of the disk which is radially inward with respect to the shaft 12 is dished concavely as indicated at 36 in Figs. 5 and 6 so that the cutting edge 31 of the disk can penetrate for a considerable distance into the face of the rock without interference with the convexly curved wall at the inner side of the kerf.

As will be seen from Fig. 2, the drill bits 14 bore holes 33 in the face of the rock at the end of the tunnel and the cutters 19 to 28 cut a series of kerfs that are spaced apart in concentric relation to the bores 33; the alternate kerfs 34 and 35 respectively are cut by cutter disks on the arms 16 and 17 of each rotating cutter head 15; and the kerfs formed by one cutter head overlap those formed by the other in the space between the bores 33.

By tilting the axes of the cutter disks as shown, the paths of the cutting edges of the teeth on the rims of the cutter disks correspond very closely to the cylindrical wall curvature at the sides of the circular kerfs 34 and 35, if the diameters of the cutter disks are properly proportioned with respect to their location on the rotating carrier arms and to the angle of inclination of the axes of rotation of the disks.

To this end body faces of the cutter disks, on the side toward the center of curvature of the kerfs, as indicated at 36 in Figs. 5 and 6, are concavely dished so as to clear the convexly curved side wall 37 of the kerf throughout a considerable range of penetration of the cutter disk into the rock face before the surface 36 exerts any lateral pressure on the wall 37.

As will be seen from Figs. 5 and 6, the tooth prong, indicated by the numeral 38, in its rotation about the shaft 32 describes an arc in the plane represented by the line 39. The machine moves forward in the direction of the arrow 40 as the cutting of the kerf proceeds.

Under the combined action of the rotation of the cutting disk around the axis of the shaft 12 and the free rolling of the cutter disk around its own axis as it penetrates the rock, the resultant path of the cutting edges of the teeth 38 will conform to the surface of a cylinder concentric with the axis of the shaft 12, and the kerf that is cut by the teeth 31 will be substantially uniform in width up to the depth of penetration at which the inclined arc of travel of the rim of the cutter begins to deviate from the cylindrical wall surface of the kerf.

The face 41 of the body of the cutter disk is shaped so that after a certain amount of penetration of the rim of the disk into the rock, this face 41 will present a conical shoulder that bears wedgingly against the rib of rock that lies between the surface 41 and the next outwardly adjacent kerf so as to break down that rib of rock, as is indicated by cracks 42, 43 and 44 in Figs. 5 and 6. Similarly the face 36 of the disk also begins to exert a wedging pressure on its side of the kerf on further penetration. The side walls of the disks are highly finished so that their effect is that of a smooth gad or wedge, tending to break off large chunks of rock, as distinguished from a hammering effect of roughness that tends to chip the rock.

The outermost disks 27 and 28 travel in the same kerf 45 which defines in part the inner wall surface contour of the tunnel, as will be understood from Fig. 2 and because of space limitations these outer disks are of somewhat different form from the others.

In order to provide level floor and roof surfaces for the tunnel and cut away the triangular ridges that are defined by the paths of the cutters on the rotating carrier arms, the machine is equipped with cutter chains and bars, indicated generally by the numeral 46 and located immediately behind the cutter heads 15. These are carried by appropriately located sprockets and guide members so as to travel in endless paths defining the roof and floor of the tunnel. These chains are equipped with roller disks 47 spaced for cutting parallel kerfs 48 and 49 and with rollers 50 which travel paths midway between kerfs cut by the disks 47 so as to split and break down the rib of material that lies between the kerfs 48 and 49.

This cutter chain is made up of links 51, carrying bearings 52 for the shafts of the cutting disks 47, alternating with links 53 having bracket arms 54 on which are journaled the rollers 50. In this form of chain cutter, reliance is had upon the rollers 50 for splitting the rib of coal between the kerfs 48—49 but it will be apparent that conical body surfaces 55 on the cutting disks and corresponding to the wedging surfaces 41 of the cutting disks 19 to 28 may be provided on the cutting rollers 47 of the carrier chain, in which case the separate splitting rollers 50 might be omitted.

In operation, machines of this type are driven progressively forward toward the direction from which Fig. 1 is viewed by appropriate means, such as jacks pressing against shoulders cut in the side walls of the tunnel. The shafts 12 and drill bits 14 are rotated in opposite directions as indicated by the arrows 29 and 30; so that they will have a tendency to carry the broken-down coal toward the center line of the tunnel where it is gathered by a scoop 56 leading to a conveyor 57 which carries it toward the rear of the machine.

The drill bits 14 extend somewhat in advance of the cutting edges of the rollers 19 to 28 and serve to steady the shafts 12 and guide the forward progress of the machine. The roller disks, riding on the face of the coal or rock, roll on their axes so as to bring their peripheral teeth successively into cutting position. Each roller cuts a kerf in the face of the rock that is concentric with the shaft 12 on which its carrier arm 16 or 17 is mounted. Due to the inclination of the axis of the cutting disk and the dished form of the disk body, the cutting of the kerf is entirely performed by the portion of the rim that engages the rock at the inner end of the kerf. The side walls of the kerfs conform to true geometric cylinders having their axes in the axes of the respective shaft 12 and the inclined circular path of the cutter teeth about the axis of the cutter disk also conforms very closely to the same cylindrical surfaces within a normal range of penetration into the kerf. The dished face 36 of the cutter disk arches around that portion of the convex inner side wall of a kerf that is subtended by the circular path of the edges 38 of the cutting teeth, as will be understood from Figs. 5 and 6. This condition prevails throughout a very substantial degree of penetration of the disk into the rock face without any cutting away of the cylindrical

side walls of the kerf as the teeth enter and leave the same in their rotation around the axis of the cutter disk.

The outer corners 38 and 38.1 travel paths that are parallel in planes which are indicated in projection in Fig. 5 by the lines 39 and 39.1 but due to the cylindrical curvature of the kerf these paths conform to the cylindrical inner and outer walls of the kerf.

The size and form of each cutter disk depends upon its radial distance from the axis of rotation of its carrier arm and the depth of its desired penetration into the rock face before its wedging shoulder exerts pressure to break down the side wall of the kerf. The angular inclination of the plane of the cutting rim of the disk is selected so that the part of the rim's path about its own axis that lies within the kerf will conform substantially with hollow cylinder defined by the walls of the kerf. Theoretically, these conditions seem to call for a special design of each disk according to its location, but in practical application like disks can be employed in different locations by using differing angular dispositions for their axes without appreciable deviation from the cylindrical wall form of the kerf.

The marginal and body portions of each cutting disk are shaped for a considerable distance inward of its marginal edge so as to clear the side walls of the cylindrical kerf for a certain desired depth of penetration into the rock wall and then the faces 14 and 26 of the body of the cutter disk take on a changing conical form such as to present wedging shoulders bearing against the walls of the kerf so as to break down the material that lies between the respective kerf and the next adjacent one.

Due to the fact that there are many teeth around the periphery of the cutting disks and that in their rolling operation these teeth are subjected to much less strain than that to which the rigid teeth on the carrier arms on former machines are subjected, the cutting tools according to the present invention have a much longer life and less frequent need for replacement. These rotating teeth are also subject to much less abrasive action than are the teeth of rigid cutters.

For like reasons, this construction permits the use of thinner kerf cutting teeth, so as to cut narrower kerfs and consequently results in a substantial reduction of the amount of pulverized coal which has little commercial value.

The conical bodies 41 of the cutting disks tend to break off large lumps of coal as indicated by the fracture lines 43 and 44 in Fig. 5. Due to the staggered arrangement of the cutting disks on the opposite arms of the carrier heads, the pressure exerted by the conical shoulder of each cutting disk is directed toward an open portion of an adjacent kerf as is shown in Fig. 4.

The combined effect of the kerf cutting and fragmentation of the intervening ribs of coal enables the machine to progress continuously forward. The cutter bars with the chain cutters follow closely behind the rotary arms and serve to level off the ridges that are left at the roof and floor of the tunnel between the paths of the rotating arms.

Although but one specific embodiment of this invention is herein shown and described, it will be understood that numerous details of the structure shown may be altered or omitted without departing from the spirit of the invention as defined by the following claims.

I claim:

1. A rock cutting device, comprising a drilling spindle, means for progressing said spindle axially toward a rock face, a carrier head rotatable about the axis of said spindle, a plurality of kerf cutting disks journaled on said carrier head on axes radially disposed with respect to the axis of said spindle, but inclined toward the drilling end of said spindle, said disks being relatively spaced at different distances from the axis of said spindle for cutting concentric circular kerfs in the rock face as said spindle progresses, and each of said kerf cutting disks having a toothed marginal rim shaped to cut a kerf of substantially uniform width for a relatively large depth of its cut, having its body portion dished concavely on its face that is toward the axis of rotation of the spindle, and having its face that is away from the last-named axis bulged convexly to form a conical shoulder spaced inward from its cutting rim so as to bear wedgingly against the outer side of its kerf to break down the rock material between kerfs.

2. A rock cutting device, comprising a drilling spindle, means for progressing said spindle axially toward a rock face, a carrier head rotatable about the axis of said spindle, a plurality of kerf cutting disks journaled on said carrier head on axes radially disposed with respect to the axis of said spindle, but inclined toward the drilling end of said spindle, said disks being relatively spaced at different distances from the axis of said spindle for cutting concentric circular kerfs in the rock face as said spindle progresses, and each of said kerf cutting disks having a toothed marginal rim shaped to cut a kerf of substantially uniform width for a relatively large depth of its cut, having its body portion dished concavely on its face that is toward the axis of rotation of the spindle so as to clear, for said relatively large depth of cut, the subtended part of the convexly curved side of its kerf, and having its face that is away from the last-named axis bulged convexly to form a conical shoulder spaced inward from its cutting rim so as to bear wedgingly against the outer side of its kerf to break down the rock material between kerfs.

3. In a rock cutting device, a rolling cutter disk having a relatively thin toothed rim portion shaped for cutting a narrow kerf of substantial depth in a rock face, and having a radially wedge-shaped body tapering toward said rim, one side of said body being radially dished inward beyond the plane of said rim, and the other side of said body being radially bulged outward from the plane of said rim.

4. A rock cutter, comprising a carrier member, means for driving said carrier member in a progressing direction, means for rotating said carrier member in a plane transverse to said progressing direction, a rotary cutter disk journaled on an axis transverse to both said directions of movement of said carrier member, said cutter disk having a toothed rim portion shaped to cut a kerf of uniform width for a substantial depth into an opposed rock face without wedging pressure on the side walls of such kerf, said cutter disk having a radially wedge-shaped body tapering toward said rim, one side of said body being radially dished inward beyond the plane of said rim, and the other side of said body being radially bulged outward from the plane of said rim.

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