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MACHINERY FOR CUTTING STONE Etc.
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This invention has for its object improvements in machinery used in cutting stone, slate, and other minerals, and in forming tunnels, galleries, and roads, and is applicable (when using for such purposes) to circular rotating discs or wheels, which are formed to receive cutters or cutting teeth or tools at and near their peripheries.

Provisional wording:

According to our invention the axles on which the frames of these circular rotating cutters are carried are fixed to and are supported by arms or projections in front of the carriage employed in such a manner that the circular cutters or wheels may together with the outer ends or such arms or projected framing, penetrate into the cuts in the slate or other rock or mineral as the carriage is advanced, and the combinations or arrangements of the machinery according to this invention are such that each rotating circular cutter may, in some cases, be caused to penetrate into the slate, or other rock or mineral considerably beyond their centres of rotation.
And further, in some cases the arrangements and combinations ot the mechanism are such that the circular rotating cutters having been caused to penetrate into slate or other rock or mineral to a desired distance by the advance of the carriage and machinery may be stopped, and the cutting teeth or tools of the rotating cutters may then be set to extend the cuts at or nearly at right angles to the previous cut, so as to detach or partly to detach the parts of the rock which have been cut into by the forward cuts of the rotating circular cutters or wheels.
And further, where desired, the arrangements and combinations are such that the wheels of the carriage enter, and are guided by the grooves or cuts in the bottom or lower parts of the workings produced by some of the circular discs or wheels, and in such cases provision is made in front of the wheels fro removing the dust and broken rock from within such cuts and grooves by suitable scrapers or ploughs formed to raise the dust and broken rock out the cuts or grooves, and to deposit the same on one or other side of such grooves or cuts.
The forms of the cutting edges or teeth or tools used on the discs or wheels and the mode of fixing and adjusting them to the rotatory discs or wheels may be varied, but for stone, slate or rock it is preferred to employ a conical form, the cutting edge being formed at the base or largest diameter or each conical cutter, and the stems of these cutters are when making forward cuts fixed in suitable sockets or holders on the peripheries of the discs or wheels, but when these or other cutters or teeth or tools are to extend the original or onward cuts on each side of the discs or wheels, so as to detach or partly to detach the parts of slate or other rock which have been cut into, then the stems of the conical or other cutters or teeth or tools are to be received and fixed in suitable sockets or holders at the sides of the circular rotating discs or wheels and such cutters or teeth when applied to the sides of the rotating circular discs or wheels are arranged to be set out from such sides to a greater and a greater extent as the work proceeds.
The outer ends of the projecting frames or arms which carry the axes on which the circular rotating discs or wheels revolve are housed within the width of the peripheries of such discs or wheels by means of pinions on suitable driving shafts, the teeth of which take into and drive rings of teeth formed or applied to the discs or wheels near their peripheries; and such rings of teeth and the central portions of the discs or wheels are covered to prevent dust and grit getting to the rings of teeth, or if the rings of teeth are not covered then water may be used constantly to wash such teeth and also the cutters, teeth, or tools carried by the rotating circular discs or wheels.
In some cases when using rotating cutters as above described, in place of making a complete disc or wheel, particularly when of large diameter, we form a rotating cutter or a cross-like form, and apply the tools or cutters at the outer circumference, as above described, and the limbs of the cross are tied together by ties. When using circular cutters or wheels with cutting tools at their peripheries it is in some

cases desirable that the fixed circular axis on which such a cutter turns should be of comparatively large diameter, and that it should be supported by an arm or projecting frame affixed to the circular axis at a distance from its centre, and then to give motion to the rotating cutter by a pinion taking into a toothed ring forming part of the rotating cutter.

Final Patent wording:
Initial presentiments omitted.
This invention has for its object improvements in machinery used in cutting stone, slate, and other minerals, and in forming tunnels, galleries, and roads, and is applicable (when using for such purposes) to circular rotating discs or wheels, which are formed to receive cutters or cutting teeth or tools at and near their peripheries.

According to one part of our invention, the axles on which the circular rotating discs or wheels are carried are supported by arms or projections in front of the carriage employed in such a manner that the circular discs or wheels may, together with the outer ends of such arms or projecting framing, penetrate into the cuts in the rock or mineral as the carriage is advanced; thus the rotating circular discs or wheels may be caused to penetrate into the rock or mineral considerably beyond their centres of rotation. The outer ends of the projecting frames or arms which carry the axes on which the circular rotating discs or wheels revolve are housed within the width of the peripheries of such discs or wheels, and rotatory motion is communicated to such discs or wheels by means of pinions on suitable driving shafts, the teeth of which take into and drive rings of teeth formed or applied to the discs or wheels near their peripheries.

Fig. 1 is a plan partly in section and fig. 2 an elevation of a machine arranged as above described and intended for cutting a single tunnel by pulverising the rock which comes into its path.
A is the carriage having projecting arms A1 for supporting the axis of the cutting discs or wheels which consist of cast drums B1,B1,B2,B2 on the outside of which the tool holders are formed or fitted. The drums B1, B1 have internal rings G1, G1 either cast with them or afterwards fixed. The drums shown at B2, B2 need not be complete circles outside, but may, for convenience, be made as shown by the dotted lines in Fig. 2, and the drums B1, B1 may also have manholes in their circumference at the sides of the toothed rings, so that a person can get inside and pass through the spaces betwixt the arms to get when necessary to the front the machine. T, T are carriage rollers running on the bottoms of the road cut by the tools on the drums B2; Sx , Sxx, are top rollers bearing against the roof cut by the teeth on the drums B1. When the machine revolves, and the tools or teeth are set so as to cut downwards, then the dotted roller Sx will be used. When, however, the drum moves the opposite way, then the other roller Sxx will be used. This roller may be mounted as described in our specification dated December 20th 1865, No. 3297, see Fig. 7, or it may be mounted in any other convenient way. S, S in plan are side guide rollers; J, J is the train of gearing for giving the proper speed to the cutter; and K is either a pulley or a wheel for another pinion as the case may require. The power is by preference taken from a small turbine, as described in our former specification, or other suitable power may be applied; if a turbine is used, the water discharged from it is directed on to the cutting teeth or tools to assist in removing the debris.

P is a worm and worm wheel for driving the feed gear and feed screw P2 working in the feed nut P3; this nut is fixed to the cross anchor a in such a way that it will swivel so as not to bend the feed screw; the anchor has bolts at its end which shoot into holes cut for them in the rock, and so the anchor is secured. R is a clutch for throwing the feed screw in and out of gear.

In the arrangement shown in the drawing the cutting wheels or drums are of such a size that the whole machine is able to follow continuously in their track; this however, is not essential to the principle of the invention, so long as arms A1, A1 are housed within the periphery of the drum or drums in such a manner as to allow the drum or drums to penetrate beyond their centre of motion.

Another feature of the invention, which is also illustrated by other Figures herein-after described, is the driving the circular discs or wheels which carry the cutters by pinions gearing with teeth formed at their peripheries, as is shown. The forms of the cutting edges or teeth or tools used on the discs or wheels, and

the mode of fixing and adjusting them to the rotary discs or wheels, may be varied, but for stone, slate or rock it is preferred to employ a conical form, the cutting edge being formed at the base or largest diameter of each conical cutter, and the sockets for these cutters are fitted in grooves in the surface of the disc or wheel; such cutters with the mode of mounting them are shown in a small scale in these drawings; they are fully described in the specification of a former patent granted to George Hunter, and dated 17th day of May 1864, No. 1244. The cutters are steel bolts with conical heads forged to shape; the heads are turned to a sharp edge all round and are then hardened. The stems of the cutters enter sockets either let into or formed for them in the periphery of the drum, and bored at or nearly at a tangent to the surface.

Also, according to our Invention when employing circular rotating discs or wheels cutting endways into the rock as just described, after such rotating cutters have been caused to penetrate into the rock to a desired distance by the advance of the carriage and ther machinery carried thereby, the onward progress of the carriage and machinery may be stopped, and then other teeth on the rotating cutters may be employed in such a manner as to extend the cuts at or nearly at right angles to the previous cut, so as to detach or partly to detach the parts of the rock which have been cut into by the forward cuts of the roatating cutters or wheels.

Undercutting tools of this sort may be used in combination with a machine such as is shown at Figs. 1 and 2, and if such tools are employed the main cutting drums B1, B1 in place of cutting close up the one to the other as the machine travels forward will be made in two much narrowed cutting drums, that is to say, the portions between the points 1,1 may be omitted so as to leave a band of rock uncut between them, and then when this band projects nearly up to the axis of the cutting drums the forward motion of the machine will be stopped, and the undercutting tools applied to remove the said projecting band. Fig. 3 is a side view and fig. 4 an end view of such an undercutting tool; it consists of a slide e capable of traversing in a dovetail groove on the face of the drum B1, in a direction parallel to the axis; it is set in position by a screw b which passes through a web c formed on the drum; in this web the screw is able to turn, but by it is restrained from endway motion by a small key b1 driven through it. The screw b works into a hole with a screw thread within it formed in the slide e; d, d, are the teeth, which drop into sockets at the end of the slide. There may be any convenient number of slides on the circumference of the drum, say four or eight, and they are set so as not to interfere with the forward cut of the machine. When the forward cut has been stopped the teeth d,d are caused to project slightly from the inner sides of the drums B1, B1 and then as the drum continues to rotate they make a lateral cut at the back of the cut already made. AT each revolution the teeth d are advanced slightly by turning the screws b by hand or otherwise. Both of the drums B1 are furnished with these undercutting teeth, which continue to act until the band of rock left between the two drums B1 is detached. The slides e may be changed during the operation of others of greater length if desired. When using circular cutters or wheels with cutting tools at their peripheries, it is desirable in cases where a deep cut of comparatively small width is to be made that the circular cutter should be arranged to turn on a fixed circular axis or disc of comparatively large diameter, and that the rotating cutter should receive motion by a pinion taking into a toothed ring forming part of the rotating cutter.

Where a straight cut is required, the said fixed axis or disc should be supported by an arm or projecting frame affixed to the circular axis or disc at a distance from its centre. Figure 5 is a plan partly in section of a machine for cutting a straight or nearly straight vertical slit in horizontal or oblique lying rock; in this case the cutter is in the middle of the carriage and supported on both sides. A is the carriage or frame; A2 is the disc of large diameter, round which the ring or cutter frame B1 with the cutters D upon it revolves; the ring is driven by pinion H. The disc A2 is formed eccentrically upon a strong hollow shaft turning on bearings in the frame, and having on it the worm segment Z2, by which it can be partially turned for lowering or raising the cutter ring with its axis or central disc, as is required. Z1 is the worm; P, P are feed wheels; P2 the feed screw; and P3 the feed nut. If the machine is going down hill, a chain is made fast to the rock behind the machine, and at the other end is attached to the nut; the machine keeps to its work by its own weight, the feed nut traversing on the screw pays out the chain as is required; but on level rock the chain should be secured to the rock in front, so that the nut may pull the machine forward.

Figure 6 is an elevation of the same machine, shewing the cutter ring B1 depressed and cutting into the rock, the dotted lines show the cutter ring elevated. Figure 7 is a section through the pinion H. J,J are a train of wheels for driving this pinion and giving motion to the cutters as in the machine already described.; the ring B1 as the drawing shows is retained in a groove in the periphery of its disc or axis A2, and to admit it into its place one side of this groove is moveable and is secured by bolts; T, T are carrying wheels on which the machine runs. The cutting tools, as will be seen, are not applied to the cutter ring immediately the one behind the other, but so distributed as to clear a track exceeding the width of the cutter ring. Machines arranged in this manner can, as will be observed, produce a cut considerably exceeding in depth the radius of the circle in which the cutters travel. It is obvious that in a similar way machines can be arranged to produce two vertical cuts, one on each side of the machine; or they may be arranged to make horizontal or inclined cuts, as the circumstances of the case may require.

In all these modifications the essential feature of this part of our invention will be retained, which is the employment of a cutter ring mounted on an axis or disc of comparatively large diameter, such axis or disc being carried from the carriage or frame by an arm or arms eccentric to it, and the cutter riug being driven by a pinion gearing with teeth on the ring. The system of mounting the cutter ring on a stationary axis or disc of comparatively large diameter, and driving the said ring by a pinion gearing with teeth on the ring is also applicable to machines for making a circular or ring cut so as to partially to detach a portion of rock which is afterwards broken down by blasting or otherwise.

Figure 8 is an end view of a portion of such a machine arranged suitably for producing a double tunnel; Figure 9 is a section of the front supporting ring or frame and revolving ring. Figure 10 is a similar view with the supporting ring removed; Figure 11 is half size section of the supporting ring and revolving ring with part of the cutter. The framing of this machine consists of two supporting rings A2 at each end, and at such distances apart as to leave space fro the train of wheels J, any number of which will be used as is necessary to reduce the speed and give power; each pair of rings are fastened together sideways by the brackets A3 cast on them, and the whole four rings bound together by hollow longitudinal beams, shown in section at A4 (Figure 8) Through the hollow of these beams four shafts H1 run carrying pinions H at one end, and the bevel wheels J on the other; a set of side rollers S are also supported in these beams, and the carriage rollers T for supporting the whole machine are shewn in Figures 8 and 9. X and X1 are friction rollers for supporting the revolving rings, these rollers revolve on slightly eccentric studs, which allow of the rollers being tightened up at will; G1 shows the teeth in revolving ring; Y1 (Figures 9 and 10) are pieces screwed in front to keep the revolving ring in position and exclude the dirt. C is the cutter plate as described in the specification no 1244, 17th May 1864. This machine can be fed up to its work as shewn by the anchor A, Figure 1 or as shewn in specification 3297, December 20th 1865.