April 24, 1956 H. C. FUNK 2,743,092

APPARATUS FOR THE CONTINUOUS UNDERGROUND MINING OF COAL

Filed Oct. 25, 1951 2 Sheets-Sheet 1

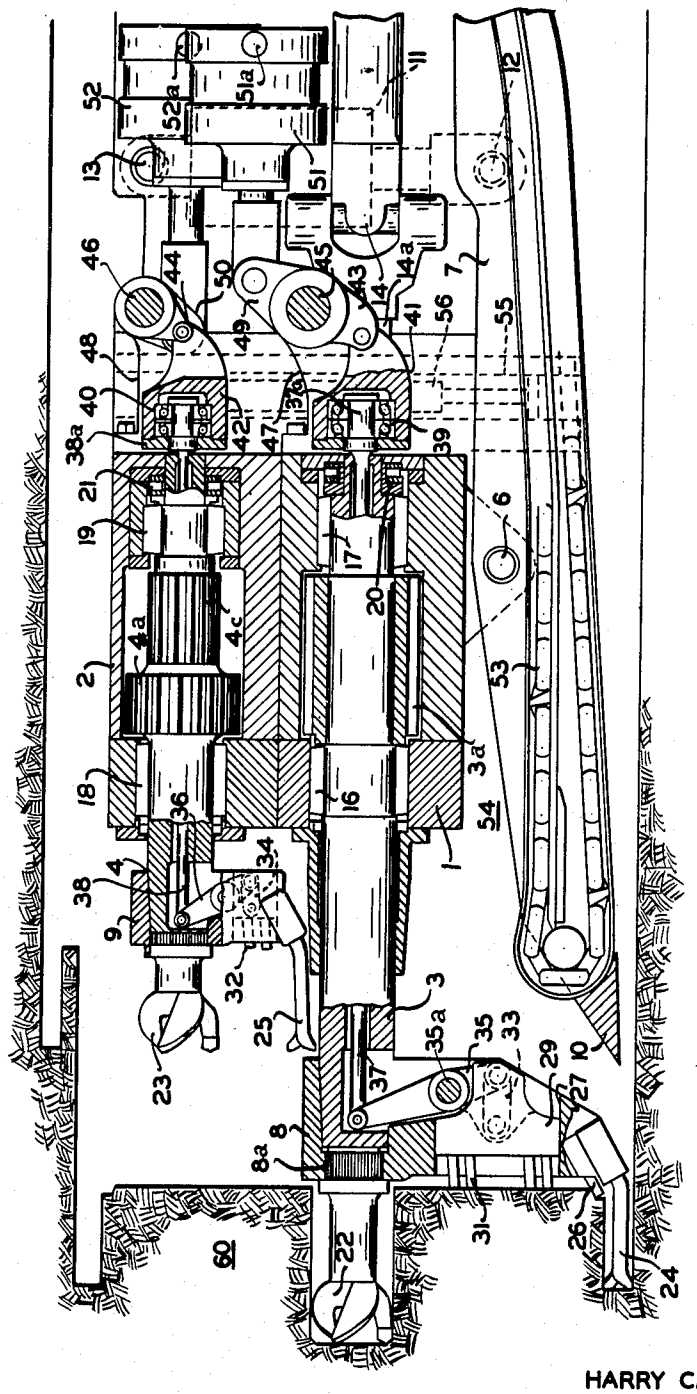


Fig. 1

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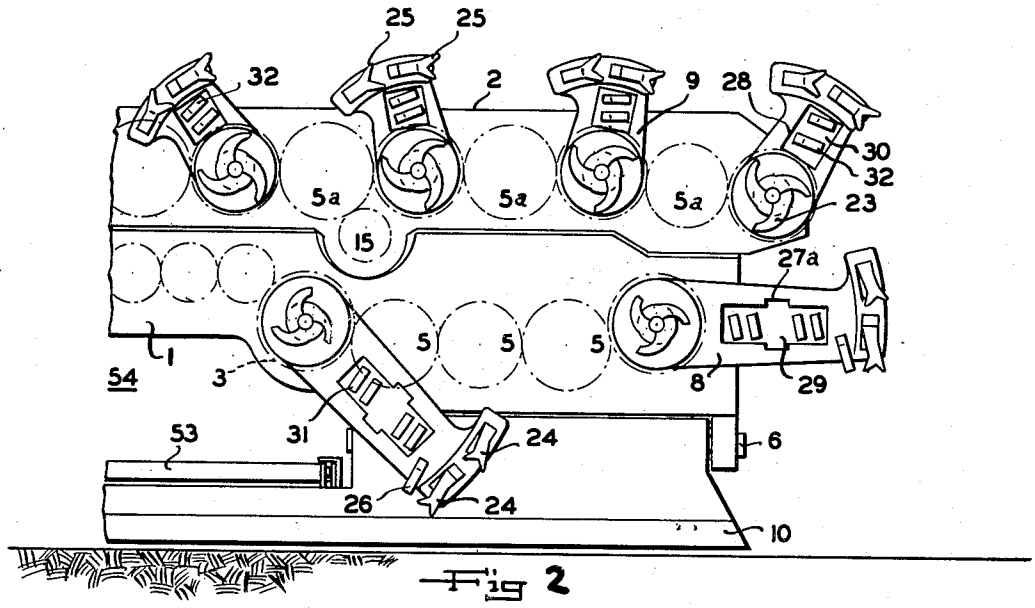


Fig 2

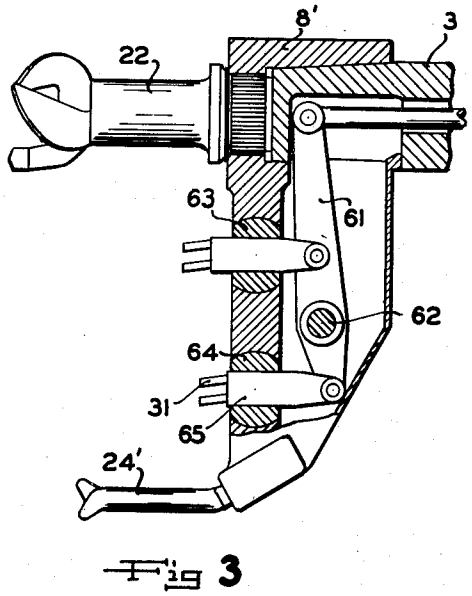


Fig 3

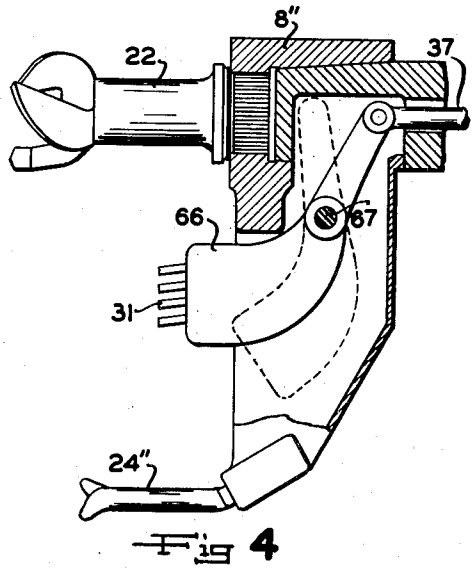


Fig 4

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APPARATUS FOR THE CONTINUOUS UNDERGROUND MINING OF COAL

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Application October 25, 1951, Serial No. 253,032

10 Claims. (Cl. 262—7)

This invention relates to continuous coal mining machinery and more particularly to an improved cutter head assembly for a self-propelled mining machine of the kind capable of advancing against an exposed face of a coal seam in underground mining operations while the cutter head operates to break out the coal of the seam and a conveyor which is built into the machine operates to discharge the mined coal through the rear of the machine. A principal objection to the performance of such machines, which are now in widespread use, is that the coal cutting or break out mechanism fractures an exceptionally high proportion of the coal mined into small or minute particles which reduces the economic value of the mined coal.

The primary object of the present invention is the provision of an improved yet practical cutter arrangement for a continuous coal mining machine of the kind generally described which is operative to substantially increase the proportion of the mined coal of egg and lump size which is delivered by the machine. This general object is accomplished, in accordance with the principles of my invention, by employing a combination type of cutter assembly wherein a continuously moving type of tool to prepare projecting segments or portions of the coal face is associated with intermittently operative pick-like tools which are forcibly and rapidly inserted in the projections thus prepared to break out a substantial portion of the coal in larger particle and lump sizes.

In accordance with the preferred embodiment of the invention this method of mining coal is accomplished most expeditiously by incorporating within a revolving trepanning tool a pick-like tool which is arranged to be driven forcibly and rapidly and in a forward longitudinal direction into the projecting annular portion of the coal face as prepared by the trepanning tool. I may, for example, provide for the forward movement of the break-out pick tools only once for each three revolutions of the trepanning cutter so that there is always available an annular projection of coal for engagement by the break-out tool or tools upon forward movement of the latter.

The above and other objects and advantages of the invention will become apparent upon consideration of the following detailed specification wherein there is disclosed the method of my invention and certain preferred embodiments of improved apparatus capable of carrying out the method of my invention.

In the drawing:

Figure 1 is a longitudinal section both of a projecting trepanned portion of a coal seam and of a preferred embodiment of apparatus constructed according to my invention and capable of trepanning the coal seam and of breaking out the resultant annular projections;

Figure 2 is a partial front elevation of the apparatus of Figure 1; and

Figures 3 and 4 are fragmentary sections through modified forms of break-out tools which may be used in the assembly of Figures 1 and 2.

Referring first to the apparatus of the invention and particularly to the embodiment illustrated in Figures 1 and 2, reference numeral 7 indicates a frame which is pivotally mounted on the main frame (not shown) of the mining machine whereby a cutting blade 10 mounted on the forward end of frame 7 as well as the cutting head assembly may be raised and lowered with respect to the main frame of the machine by actuation of cylinder 11 which is pivotally mounted on the main frame of the machine by pin 13 and which has its piston rod pivotally connected to the frame 7 by the pin 12. The cutter head assembly comprised of the housings 1 and 2 is pivotally mounted on the frame 7 by means of the pin 6. To adjust the vertical height of cut of the machine the housing 2 which mounts the upper bank of cutters is slidable vertically with respect to the housing 1, vertical guides 55 being provided to maintain the vertical alignment of the housings and a cylinder 56 which is carried by the lower housing 1 being provided to raise and lower the upper housing 2 with respect to the lower housing 1. This general structure is more or less conventional in certain types of continuous coal mining machines and is therefore not a part of the present invention and is not fully described herein. However, it should be understood that the main frame of the machine as above referred to will normally be mounted on a pair of power-driven crawler type of supports (also not shown) whereby the entire machine may advance forwardly into the coal face while the cutters to be hereinafter fully described are being operated to break out the coal which then falls on or ahead of the blade 10 and thence is loaded onto the conveyor 53 of the apparatus or transferred to the rear of the machine through clearance 54 provided underneath housing 1.

Journaled in the housing 1 is a plurality of forwardly extending but transversely spaced cutter shafts 3 which are arranged to be driven in interlocked relation through universal joint 14 and shaft 14a on which is keyed one of the idler gears 5 of the gear train contained in housing 1, it being understood that a gear 3a is keyed onto each of the shafts 3 and meshes with one of the idler gears 5. Shaft 3 is provided with a tapered outer end and a central longitudinal bore extending from adjacent the front extremity of the shaft as through the rear end of the shaft. Anti-friction bearings 16 and 17 journal shaft 3 and a thrust bearing 20 opposes rearward movement of the shaft during forward motion of the machine. Rigidly but detachably secured to the forward end of shaft 3 is a sweep carrier 8 which detachably mounts at its radial extremity a circumferentially spaced pair of trepanning tools 24 which project forwardly of the front face of the carrier 8 in order that the trepanning cut can be effected. A clearance cutting tool 26 is incorporated into the design of the apparatus so that a maximum of coal projection may be achieved while yet allowing for adequate strength to be built into the mounting of the tools 24. Carrier 8 is formed with a longitudinally disposed window 27 for the slidable reception of a tool block 29 and to guide such block in its longitudinal to and fro movement the side walls of window 27 are machined to provide ways 27a which are engaged by keys formed integrally with the block 29. Rigidly but detachably secured in the block 29 is a plurality of forwardly extending but radially spaced pick-like tools 31. These tools project a substantial distance from the front face of the block 29 so that upon forward movement of the block 29 these tools will be driven far into the projecting portion of the coal face in the manner to be hereinafter described.

For reciprocating the tool block 29 longitudinally a lever 35 is pivotally mounted within the sweep carrier 8 at 35a and is pivotally connected at its radial outer end to the block 27 by means of link 33. The inner end of lever 35 is pivotally connected to a rod 37 which is cen-

trally disposed within the bore in shaft 3 and which extends outwardly beyond the rear end of the shaft. To reciprocate the rod 37 under power I provide an actuating head 41 which is a box-like structure to receive a pair of oppositely disposed combined radial and thrust anti-friction bearings 39 which have their inner races clamped onto an enlarged portion 37*a* of the shaft 37. Head 41 is connected to a lever 43 which is rigidly mounted on a rock shaft 45 journaled in a bearing bracket 47 which is secured to and extends rearwardly from the housing 1. Also secured on the shaft 45 is a lever 49 which connects with the piston rod of a power cylinder 51 which is pivotally mounted at 51*a* on extensions of the bracket 47. It should be apparent that upon fluid pressure energization of the power cylinder 51 the break-out tools 31 may be caused to move in either a forward or a reverse direction (depending on the direction of energization of cylinder 51) while the carrier 8 and the trepanning tools 24 continue their rotation.

Detachably secured in a serrated bore 8*a* formed in the hub portion of the carrier 8 is a rotary drilling bit 22 which extends forwardly of the forward end of the tools 24 to serve as a pilot for the trepanning cutter while also providing the relief hole in the coal face whereby there is formed an annular projection on the coal face for advantageous engagement by the reciprocating bits 31.

While only one shaft 3 and its appendages have been described above it should be understood that in a machine employing a plurality of such shafts the construction of each such shaft and appendages will be identical, although the provision of the transverse rock shaft 45 enables all of the drive rods 37 to be powered from the single cylinder 51. Likewise, the construction of the cutting units journaled in the upper housing 2 is generally similar to the construction of the cutting units journaled in the housing units 1. In housing 2 shafts 4 are journaled in anti-friction bearings 18 and 19 and bear against thrust bearings 21 and secured to the forward ends of these shafts are the carriers 9 mounting trepanning tools 25 and slidable tool block 30 received in guides 28 and carrying break-out tools 32. In each unit a rotary bit 23 similar to the rotary bit 22 is mounted on the outer end of the shaft 4 and to reciprocate the tool block 30 in guides 28 I provide a lever 36 interconnected with block 30 by means of link 34 and connected with drive rod 38 which is positioned in the hollow shaft 4. Shaft 38 is arranged to be reciprocated by an actuator 42 housing a pair of opposed combined radial and thrust bearings 40, the inner races of which are clamped to an enlarged portion 38*a* of rod 38. A transversely extending rock shaft 46 journaled on bracket 48 mounts a lever 44 which is connected to actuator 42 and shaft 46 is arranged to be rocked by cylinder 52 through lever 50, the cylinder 52 being pivotally mounted on an extension of bracket 48 by means of pin 52*a*. Shafts 4 are arranged to be rotated in keyed relation by a drive pinion 15 and idler gears 5*a* which are coupled with gears 4*a* on the shafts 4.

According to the method of my invention the coal face is segregated into projecting portions of predetermined dimensions and defined peripheral edges. The dimensions intermediate the peripheral edges are such that the coal projections can be readily broken out by practical tools and equipment into an aggregate bearing a fairly large proportion of pieces greater than egg size. Thus, it is contemplated that the maximum dimension across the projecting segments or portions of the coal face will be of the order of 5 to 12 inches so that while a minimum of "slack" will be mined none of the pieces will be of such large size as to be incapable of being readily handled by conveying equipment of the mining machinery used. The forming of these projections in the coal face may be formed, of course, with the chain-type of cutters, by various types of saws and by other mechanisms, as will be understood, since it is only necessary in practical mining operations to define the projecting portions by

means of narrow slots formed in the original plane surface of the coal face. These slots should be from about 2 to about 6 inches in depth, or of such depth as the friable nature of the coal being mined may require, and since the forming of them will result in the production only of coal fines they should be of minimum volume. The apparatus described above is thought to be the type most satisfactory for carrying out my invention and in its operation it should be understood that normally the cutter shafts will be continuously driven while the mining machine bearing them will be continuously advanced at a correlated speed to give the bits 22 and 23 and the trepanning tools 24 and 25 an opportunity to advance into the coal face to form annular projections therein (designated by reference numeral 60 in the drawing). Upon such projections reaching a depth of 3 or 4 inches, for example, the break-out tools 31 and 32 are forcibly driven into the faces of the projections in a rapid manner so that the bulk of the projections is rapidly broken out by a single revolution or sweep of the cutters. Obviously if application of the break-out tools is withheld until tools 24 and 25 approach maximum penetration the break-out tool must be held in for at least a full revolution of the cutting heads. As determined by the substance to be mined, however, these break-out tools may be actuated with varying rapidity. In practical apparatus suitable automatic and adjustable control, not shown, will be employed to operate in correlation with the speed of rotation of the cutting units and the rate of advance of the assembled mining machine to rapidly dump large quantities of fluid under high pressure into the power end of the cylinders 51 and 52 at predetermined intervals.

In the embodiment of the invention shown in Figure 3 a carrier 8′ corresponding in function to the carrier 8 in Figure 1 is mounted on the shaft 3 and pivotally mounted in this carrier is a lever 61 which is pivotally mounted at 62 intermediate its ends and connected at its radially inner end with the operating rod 37 housed within shaft 3. The forward wall of carrier 8′ is formed with a pair of radially spaced and bushed apertures 63 and 64 each slidably receiving a tool block 65 which in turn mount the break-out tool bits 31. It should be noted that one of the blocks 65 is pivotally connected to the lever 61 on the rod side of pivot pin 62 while the other of the blocks 65 is pivotally connected to the lever 61 on the opposite side of pin 62. Therefore, when the rod 37 is in intermediate position the bits 31 will have maximum retraction from the point of penetration of the tools 22 and 24′ to allow the above described delineated projection to be formed. Inner and outer concentric zones of the projection may be broken out in succession in either order upon reciprocation of the drive rod 37 since it will be clear that rocking movement of the lever 61 will force first one and then the other of the tool blocks 65 forwardly.

In the embodiment of the invention shown in Figure 4 the break-out tool bits 31 are supported directly on a lever 66 which is pivotally mounted on the sweep tool carrier 8″ by means of pivot pin 67 and the lever 66 is, of course, directly connected to the driving rod 37.

It should now be apparent that I have provided an improved method and apparatus for the mining of coal and other material which accomplishes the objects initially set out above. The use of pick-like break-out tools in conjunction with cutting apparatus to continuously form projecting portions in the coal face on which the break-out tools can periodically operate provides at once a continuous mining method capable of producing a product having a much higher proportion of larger sized pieces than has heretofore been possible in continuous coal mining methods.

Having thus described the method and apparatus of my invention what I claim is new and desire to secure by Letters Patent is:

1. In a continuous coal mining machine having a support and power means to advance said support into a coal

face together with a plurality of forwardly extending and power-driven cutting tools carried by said support the improvement comprising forwardly extending hollow shafts for mounting at least a portion of said cutters, a rotary bit mounted on the forward end of each of said shafts, a radial arm mounted on each of said shafts and carried at its radial outward end a forwardly extending trepanning tool whereby upon rotation of said shafts and forward movement of said support a substantial portion of the area of the coal face within the forward projection of the machine is formed into annular projections delineated by the holes bored by said bits and the slots cut by said tools, a pick-like break-out tool carried by each of said arms and mounted thereon radially intermediate its ends for longitudinal movement into and out of the coal face, a longitudinally reciprocable rod positioned within each of said shafts and operatively connected at their forward ends with said break-out tools whereby the latter may be so moved into and out of said coal face during rotation of said arms, said rods extending outwardly of the rear ends of said shafts, and power means connected to the rear ends of said rods to reciprocate the same.

2. Apparatus according to claim 1 further characterized in that said power means comprises a fluid-pressure cylinder mounted on said support and connections between said cylinder and the rear ends of said rods comprising a collar fitting over the rear end of each of said rods, and double-thrust bearings fitted within said collars and having their inner races clamped longitudinally onto said rods.

3. Apparatus according to claim 1 further including a tool block for each of said arms for mounting said break-out tools, cooperating guide means on said arms and blocks for slidably mounting said blocks in said arms for rectilinear forward and reverse movement, a lever pivoted intermediate its end in each of said arms, the radial outward ends of the levers being pivotally connected to said blocks and the inner ends of said levers being pivotally connected to said rods.

4. Apparatus according to claim 1 further including a bellcrank lever pivotally mounted on each of said arms intermediate the ends thereof for rocking movement about axes offset and transverse to the axes of said shafts and having their outer legs extending toward the coal face, said break-out tools being rigidly carried by said outer legs, and the inner legs of said levers being pivotally connected to said rods.

5. Apparatus according to claim 1 further characterized in that each of said arms is formed with a pair of radially spaced apertures intermediate its ends, a tool carrier slidably received in each of said apertures and rigidly mounting said break-out tools on their forwardly extending ends, a lever pivotally mounted on each of said arms at a point radially intermediate said apertures but spaced longitudinally to the rear of said apertures, said carriers being pivotally connected to said levers on opposite sides of the mounting axes of said levers, and the inner ends of said levers being pivotally connected to said rods.

6. In a continuous coal mining machine having a non-rotatable support and power means to advance said support into a coal face together with a forwardly extending and power driven cutting tool carried by said support; the improvement comprising a plurality of forwardly extending rotatable shafts, an arm mounted on each of said shafts, pick-like break out tools extending from each of said arms, attachment means for securing said pick-like tools, said attachment means comprising levers pivotally connected to said arms, and driving means supplied to said levers whereby said pick-like tools are caused to reciprocate in and out of the coal face.

7. Apparatus according to claim 6 further characterized by said driving means comprising rods pivotally connected to said levers at one end, and power means supplied to said rods whereby said pick-like tools are caused to reciprocate in and out of the coal face.

8. Apparatus according to claim 6 further characterized by each arm having a window-like aperture positioned intermediate its ends for the projection of levers and said pick-like tools beyond the faces of said arms, said apertures permitting said levers to move in a rocking motion.

9. Apparatus according to claim 6 further characterized by said securing means comprising tool blocks, said tool blocks pivotally joined to said levers on both sides of the rotational axes of said levers, and power means supplied to said levers for reciprocating the same whereby part of the said pick-like tools are caused to move forwardly into the face of the coal while others of said pick-like tools are being retracted.

10. Apparatus according to claim 9 further characterized by each arm having window like apertures positioned intermediate of its ends for the projection of said tool blocks and said pick-like tools beyond the faces of said arms, said apertures permitting said tool blocks to move in rocking motion.

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