March 18, 1958 W. N. POUNDSTONE 2,827,274

CONTINUOUS MINING MACHINE WITH ROOF CONTACTING MEANS

Filed Feb. 11, 1955 3 Sheets-Sheet 1

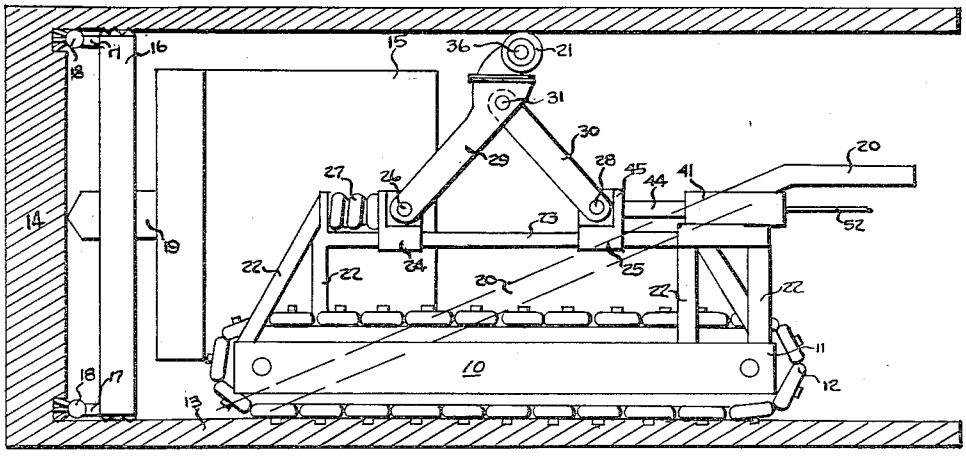


Fig. 1.

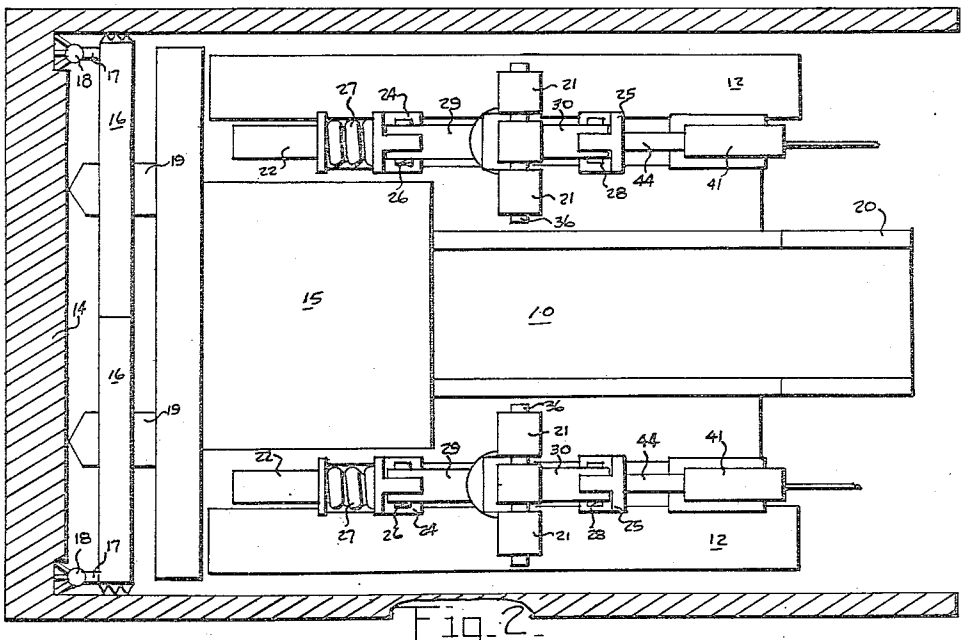


Fig. 2.

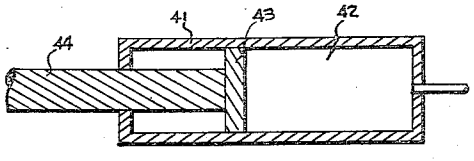


Fig. 3.

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Filed Feb. 11, 1955 3 Sheets-Sheet 2

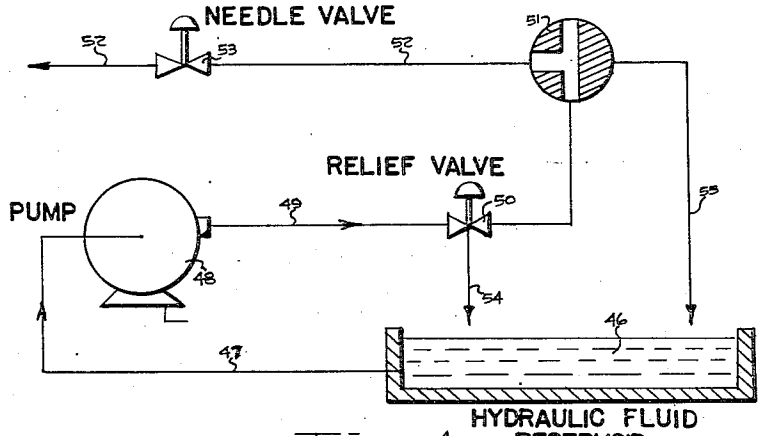


Fig. 4.

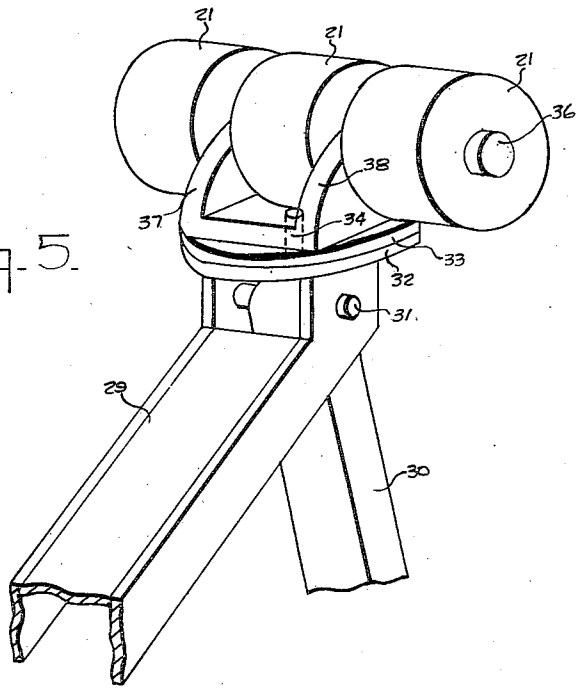


Fig. 5.

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CONTINUOUS MINING MACHINE WITH ROOF CONTACTING MEANS

Filed Feb. 11, 1955 3 Sheets-Sheet 3

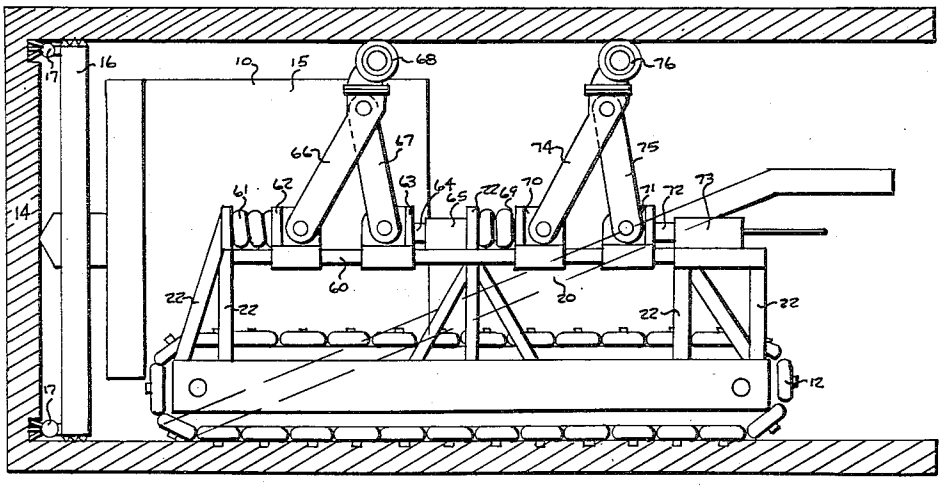


Fig. 6

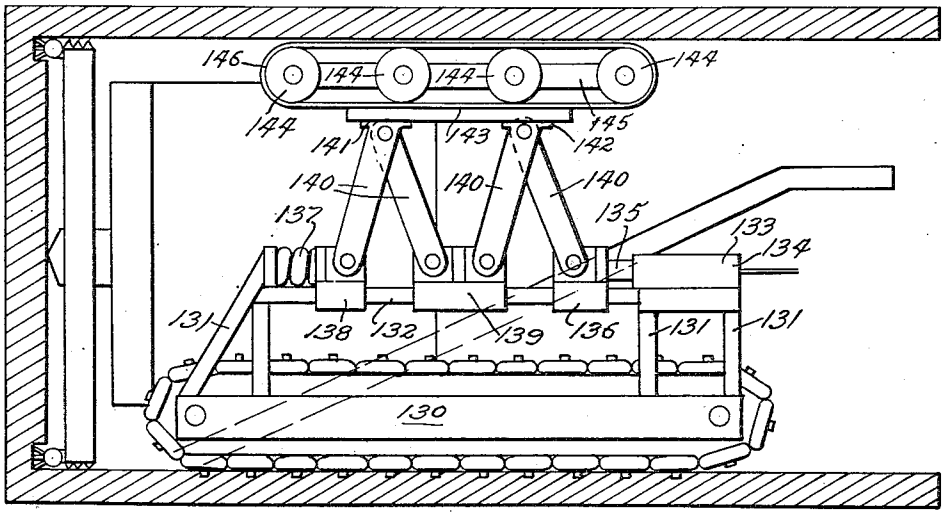


Fig. 7

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2,827,274

CONTINUOUS MINING MACHINE WITH ROOF CONTACTING MEANS

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Application February 11, 1955, Serial No. 487,529

5 Claims. (Cl. 262—7)

The present invention relates to an improved continuous mining machine. More particularly, it relates to coal mining machines which are adapted to cut, gather and remove minable material.

A great variety of continuous coal mining machines have been proposed; many types are commercially available. Despite their apparent advantages, i. e., both the cutting and removing operations are performed by one machine, these continuous mining machines have been slow in gaining acceptance in the industry.

Existing machines are quite expensive, quite heavy and cumbersome. Their expense can be justified only if high coal production rates can be realized.

A typical continuous mining machine comprises a frame, mounted upon endless treads, and a heavy cutting head at the forward end of the frame for cutting into a seam of coal in advance of the machine. A conveyer is provided from the forward end of the machine extending backward to discharge dislodged coal into shuttle cars or belt conveyer trains. Continuous loading devices are provided at the forward end of the machine to move the dislodged coal toward the machine conveyer.

One major deficiency of existing continuous mining machines is the limited traction which can be developed. Existing machines depend upon their weight alone to develop traction. To increase available traction, weight has been added as ballast to existing machines in the form of added structural members and metal weights. While this additional ballast increases the traction, the added weight of the modified machine produces problems in maneuvering the machine through underground mine passageways. Moreover the added weight increases the cost of the machine. The current trends in continuous mining contemplate the use of the mining machine itself to pull flexible and extensible conveyer systems attached directly to the mining machine. These trends require added traction for pulling which will of course reduce the traction available for the actual coal cutting operation. With existing machines operating at the maximum limit of the traction which can be developed, there is no additional traction available for this increased towing demand without sacrificing the cutting rate of the machine. Moreover, regardless of the towing demand, there is no additional traction available for increasing the cutting rates of the machine.

Even with added ballast in existing mining machines, the motors operating the cutter head seldom attain their maximum torque since the machine only rarely can develop sufficient thrust to call upon the maximum output from the cutter head motors. If additional traction were available in the mining machine, the thrust of the machine tending to drive the cutting device against the coal seam would be increased, and increased capacity motors could be installed for operating the cutting heads, thereby increasing the output of the machine.

Some existing machines have been modified by the

installation of larger grousers on the endless treads which are used to move the frame of the machine. While these deeper grousers do increase the traction in certain conditions, the amount of increased traction from this source is limited and they have the disadvantage of creating a bad bottom condition resulting from their digging action on the floor of the mine.

The power which can be applied to the cutting head in existing continuous mining machines is limited by the forward thrust which can be developed through the endless treads. If an attempt is made to increase the advance thrust by increasing the speed of the endless treads, the treads will increase in speed until they begin to slip on the bottom, digging holes and ruts in the mine floor. At the moment slippage occurs, the thrust of the machine decreases sharply.

Stability and rigidity of the cutting head in existing mining machines is maintained solely through the weight of the machine itself. As the cutter bits encounter a hard pocket in the mining face, the entire machine rises up in reaction; only the weight of the machine resists the sudden application of increased resistance to the movement of the cutter bits. One reason that cutter bit breakage has been excessive in existing continuous mining machines is this lack of rigidity in the cutting head. The individual bits are free to bounce from a hard area of a seam instead of being held firmly against it. Reduced cutter bit wear and breakage would be experienced if the cutter bits could be held firmly in contact with the coal face at all times, thereby approximating machine shop lathe operation.

In the present invention I have provided means for obtaining increased traction in existing mining machines without adding weight as ballast to the machine and without increasing the size of the grousers on the endless treads. My improved mining machine develops sufficient traction and accompanying increased advance thrust to permit installation of larger cutting head motors and realize their greater cutting capacity. The increased stability of the machine with respect to the mining face reduces wear and breakage of cutter bits.

To accomplish my desirable results, I have installed roof-contacting members to existing types of continuous mining machines. These roof-contacting members exert a force against the roof of the mine passageway, thereby increasing the normal force of the machine downwardly upon the endless treads. The increased normal force increases the traction which can be developed by the machine and yet permits construction of the machine without excessive weight so that its maneuverability throughout the mine, when not actually in coal cutting production, is strikingly improved. Moreover the roof-contacting members firmly position the machine within the passageway and provide the stability required to minimize cutter bit breakage by holding the cutter bits rigidly in position regardless of the nature of the coal seam.

In addition my invention permits location of the center of gravity of the mining machine more nearly toward the center of the machine frame to offset the inherent forward displacement of the center of gravity of continuous mining machines resulting from the substantial weight of the forward cutter head.

For a clearer understanding of the present invention, its objects and advantages, reference should be had to the following description and acompanying drawings in which:

Figure 1 is a schematic side elevation view of a mining machine adapted to practice the present invention;

Figure 2 is a schematic plan view of the mining machine shown in Figure 1;

Figure 3 is an enlarged cross sectional illustration of

the hydraulic piston and cylinder employed in the preferred embodiment of the invention;

Figure 4 is a schematic view of the preferred hydraulic system;

Figure 5 is a perspective illustration of the preferred roof-engaging structure;

Figure 6 is a schematic side elevation view of a mining machine illustrating an alternate embodiment of the present invention; and

Figure 7 is a side elevation of a continuous mining machine illustrating still another embodiment of the roof-engaging elements of the present invention.

The preferred embodiment of the present invention will be described in connection with Figures 1, 2, 3, 4 and 5. Figure 1 represents generally a typical continuous mining machine in side elevation under operating conditions. The machine, designated by the numeral **10**, comprises a frame **11** mounted upon endless treads **12** which are driven by motor power (not shown), usually hydraulic. The endless treads **12** engage the floor **13** of a mine passageway directly before a coal face **14**. A cutting head motor and frame **15** is mounted on the forward portion of the machine frame **11** to support and drive a cutter bar **16** having a rotary cutting motion. The cutter bar **16** is provided with cutter bit holders **17** which receive cutter bits **18**. When the cutter bar **16** rotates about a central horizontal shaft **19**, the cutter bits **18** engage the coal face **14**. With the endless treads **12** advancing the machine **10** against the coal seam **14**, the cutter bits **18** cut a kerf in the face **14** and coal within the kerf is dislodged by pressure from the advancing machine. The dislodged coal is gathered at the front of the machine **10** and removed rearwardly by a conveyer **20** for discharge into shuttle cars or a belt conveyer system (not shown). Although a cutter arm **16** is indicated in Figure 1, it is apparent that any form of cutter head can be employed, for example, a series of individual cutter bars, oscillating cutter blades, moving endless cutter chains, and the like.

According to my invention, I provide roof-engaging members **21** to exert an upward force against the roof of the mine passageway continuously. In the preferred embodiment the roof-engaging member **21** is a rubber-tired wheel or series of coaxial wheels, freely rotatable about an axle **36**. To support these roof-engaging elements **21**, a supporting structure **22** is mounted on the frame **11** of the machine **10**. A rail **23** is mounted in a generally horizontal position above the frame **11** of the mining machine **10** on the supporting structure **22**. Two sliding blocks **24** and **25** are provided which are free to slide longitudinally along the rail **23**. A spring **27**, supported between the supporting structure **22** and the forward sliding block **24**, is compressible with the advance of the block **24** along the rail **23** to resist further advance.

A pin joint journal is provided in each of the sliding blocks **24** and **25**. Pins **26** and **28** are provided to fasten upwardly extending arms **29** and **30** respectively to the blocks **24** and **25** in coplanar pivotal relation through the pin joint journals. As shown in Figure 5, the upper ends of the arms **29** and **30** are secured in coplanar pivotal relation by means of pin **31** inserted through axially aligned pin receiving openings oin the arms **29** and **30**. Fixedly mounted above the pin **31** on the upwardly extending arm **29** is a generally horizontal, circular plate **32** (see Figure 5) having a circular pin receiving opening vertically disposed at its center. A second generally horizontal, circular plate **33** rotatably rests upon the plate **32** and has a central downwardly vertically extending pin **34** which is received by the opening in the plate **32** to permit free rotation of the plate **33** about the pin **34**. Two axle bearings **37** and **38** are securely mounted on the top of plate **33** to support an axle **36** in a generally horizontal position. One or more freely rotatable wheels **21** are mounted on the axle **36** for engaging the roof of the mine passageway. Preferably the axis of the axle **36** is disposed off-center with respect to the axis of pin **34** to produce a caster action in the roof-engaging wheels **21**.

A compressive force of the wheels **21** against the roof of the mine passageway is obtained through the scissors action of the arms **29** and **30** as the sliding blocks **24** and **25** are brought together. The latter is accomplished, as shown in Figures 1, 2 and 3, by a hydraulic ram **41** which has chamber **42** for receiving hydraulic fluid under pressure and is mounted securely with respect to the frame **11** on the supporting structure **22**. A piston **43** slides within the chamber **42** to produce longitudinal motion of a piston shaft **44** parallel to the rail **23**. The piston shaft **44** at one end engages and effects movement of the sliding block **25**. When the chamber **42** is filled with hydraulic fluid under pressure from conduit **52**, the sliding block **25** is brought into proximity with the sliding block **24** to extend the wheel **21** to its maximum reach.

On the other hand, when the hydraulic fluid is withdrawn from the chamber **42**, the piston shaft **44** retracts and the sliding blocks **24** and **25** exhibit their maximum separation. In this position the wheel **21** is retracted out of contact with the roof of the mine and the mining machine **10** can be moved readily about the mine.

The preferred embodiment for hydraulic fluid introduction into the chamber **42** will be described by reference to Figure 4.

A hydraulic system suitably mounted on the mining machine **10** is provided which comprises a hydraulic fluid reservoir **46** for supplying hydraulic fluid through a hydraulic conduit **47** to a hydraulic pump **48**. The latter discharges high pressure hydraulic fluid continuously through a conduit **49**, through a relief valve **50** to a manually controlled two-position, three-way valve **51**. With the valve **51** in the position shown in Figure 4, hydraulic fluid from the pump **48** passes through the conduit **52** through a manually controlled needle adjusting valve **53** into the hydraulic chamber **42**. The normal operating pressure of the hydraulic chamber **42** can be up to about 2,000 p. s. i. or more. To prevent overloading of the pump **48**, the relief valve **50** should be adjusted to by-pass hydraulic fluid from the conduit **49** at the desired maximum working pressure of the system. The hydraulic fluid, by-passed through the valve **50**, returns to the reservoir **46** through the conduit **54**. As hydraulic fluid enters the chamber **42** (with the valve **51** in the position shown in Figure 4) the piston **43** advances causing the sliding block **25** to move along the rail **23** toward the sliding block **24**. Wheel **21** moves upwardly until it engages the roof of the mine passageway. Thereupon the pressure of the hydraulic fluid in the system increases to the desired operating value causing a force to be exerted through the wheel **21** against the roof of the mine. When the arm **30** forms an angle greater than 45° with the rail **23**, a positive mechanical advantage is obtained in the linkage so that the force exerted by the wheel **21** against the roof of the mine exceeds the force exerted against the piston **43** in the chamber **42**. When the desired operating pressure is obtained, the needle valve **53** can be closed to trap hydraulic fluid in the cylinder **42** and valve **51** can be turned to allow hydraulic fluid to by-pass into the reservoir **46** through a conduit **55**, allowing the pump **48** to operate under low pressures.

With the wheel **21** exerting an upward force against the roof of the mine, an equal reaction force acts downwardly through the arms **29** and **30** to increase the normal force of the frame **11** against the endless treads **12**. Thereupon the mining machine **10** commences cutting and removal operations in which the cutter arm **16** rotates as the endless treads **12** advance the machine into the coal seam. The wheels **21** roll along the roof of the mine as the machine advances. Any irregularities or discontinuities in the mine roof are compensated by the resiliency of the spring **27**.

In addition to increasing the traction of the mining machine **10**, the wheels **21** improve the general stability of the machine **10** by supporting it firmly between the floor and roof of the mine. Thus when a cutter bit **18** encounters an area of hard material, the machine **10** cannot rise up in reaction, but instead the cutter bits **18** are held firmly against the hard material and forced to penetrate while in contact with the hard material. Thus the cutter bits **18** do not bounce off the face of the seam, but instead individually simulate the operation of a machine shop lathe.

To retract the roof-engaging structure, the machine operator turns the valve **51** (Figure 4) to a position in which the conduits **52** and **55** are joined and are out of communication with the conduit **49**. Thereupon the needle valve **53** is opened and hydraulic pressure from the hydraulic cylinder chamber **42** is released through the conduits **52** and **55** to the fluid reservoir **46**.

As indicated in Figure 2, I prefer to use my roof-engaging elements in pairs, placed laterally of the longitudinal axis of the machine. When the roof-engaging elements are supplied in pairs as shown in Figure 2, I prefer to have an independent hydraulic source for each roof-engaging element. It is possible, of course, to operate both roof-engaging elements from a common source of pressurized hydraulic fluid.

An alternative embodiment is illustrated in Figure 6 where one pair of roof-engaging elements is mounted at the forward end of the machine **10** and a second pair of roof-engaging elements is mounted at the rear of the machine **10**. By providing a source of hydraulic fluid for the forward elements independent of the rear elements, thereby providing independent control of the forward and rear hydraulic jacks, it is possible to regulate the relative upward thrust from each roof-engaging structure. In addition to providing sensitive control over the apparent center of gravity of the machine, this feature permits the operator to steer the mining machine **10** in a vertical direction. Should the coal seam in which the mining machine **10** is operating slant downwardly, the machine can be made to follow the seam by merely releasing the upward thrust on the rear roof-engaging structure. Thereupon the forward element urges the front of the machine **10** downward. Similarly, if the coal seam ascends, the machine can be steered vertically upward by releasing the thrust of the forward roof-engaging structure, thereby permitting the rear roof-engaging structure to urge the front of the machine upward. With existing mining machines, vertical steering is a difficult and time consuming operation.

To cause existing machines to rise in line with an ascending coal seam, it is necessary to elevate jacks under the forward end of the frame. These floor jacks must be released and repositioned as the machine advances until its direction of motion follows that of the seam. To cause an existing machine to descend in line with a descending coal seam, the heavy cutter head is dropped to its bottom position and the descent is attained through the resulting unbalance of the machine. The improvement shown in Figure 6 permits the machine operator to steer it in a vertical plane by merely turning manual hydraulic valves.

The apparatus shown in Figure 6 corresponds to that of Figure 1; corresponding numerals are employed to indicate corresponding parts. A generally horizontal rail **60** is mounted above the frame **11** on the elevated supporting structure **22**. In the forward end of the machine a spring **61** is maintained between the supporting structure **22** and a sliding block **62**. A sliding block **63** on the rail **60** engages a piston rod **64** which is operated by a hydraulic cylinder **65**. Upwardly extending arms **66** and **67** are supported by pin joint journals in the blocks **62** and **63** respectively and joined in pivotal coplanar relation at their upper ends. The operation of the upwardly extending arm **66** is the same as that of the upwardly extending arm **29** described in Figure 1. A roof-engaging element **68**, corresponding to **21** of Figure 1, is provided at the top of the element **66** in the manner shown in Figure 5.

A second roof-engaging structure in the rear of the mining machine includes a spring **69** mounted between the supporting structure **22** and a sliding block **70**. Another sliding block **71** engages a piston arm **72** which is operated by a hydraulic cylinder **73** mounted on the supporting structure **22**. Upwardly extending arms **74** and **75** are mounted in pin joint journals on the blocks **70** and **71** respectively and joined in pivotal coplanar relation at their upper ends. A roof-engaging wheel **76**, corresponding to element **68**, is mounted above the upwardly extending element **74** in the manner shown in Figure 5.

Preferably the hydraulic fluid operating the cylinders **65** and **73** is subject to independent control by the machine operator through a hydraulic circuit corresponding to that shown in Figure 4. Independent control of the hydraulic cylinders **65** and **73** permits the operator to control steering of the machine in a vertical plane. In addition the independent control of the two hydraulic cylinders provides a sensitive means for regulating the apparent center of gravity of the machine **10**. By exerting greater force of the hydraulic cylinder **73**, the inherent unbalance of the machine **10**, resulting from the forward location of the heavy cutter head **15**, can be counterbalanced.

In place of wheels as the roof-engaging element, it is possible to use some form of moving endless belt (rubber sheet, metal plates, flexible metal sheet and the like) or endless treads to distribute the compressive stress against the roof of the mine over a wider area. One example of such apparatus is illustrated and described in Figure 7.

The frame **130** of a mining machine is provided with supporting structure **131** to support the roof-engaging apparatus of the mining machine. Mounted upon the supporting structure **131** in rigid relation to the frame **130** are a sliding rail **132** in a generally horizontal position and a hydraulic cylinder **133** of a hydraulic jack **134**. A piston rod **135** extending from the hydraulic jack is secured at its outermost end to a sliding block **136** which is free to slide longitudinally along the rail **132**. A mechanical spring **137** is provided at the opposite end of the rail **132** to resist motion of a sliding block **138**. A central sliding block **139** is provided, freely slidable along the rail **132**. Each of the sliding blocks **136**, **138** and **139** is pin connected to lever arms **140**. The lever arms **140** between adjacent sliding blocks are pin connected to second blocks **141** and **142** which are mounted upon and at the same time support in a generally horizontal position a rail **143**. One of the blocks **141** and **142** is rigidly mounted on the rail **143**; the other is free to slide along the rail **143**. A series of rollers having parallel axes which are generally horizontal and are perpendicular to the longitudinal axis of the mining machine is provided, journaled in a generally horizontal supporting structure **145**. The roller supporting structure **145** is parallel to and mounted in rigid relation to the rail **143**. An endless belt or endless tread **146** is provided to encircle the rollers **144** in slidable relation.

Introduction of hydraulic fluid into the hydraulic cylinder **133** causes the piston **135** to advance against the block **136**. The force exerted against the block **136** is transmitted equally in an upward direction against the sliding blocks **141** and **142**, resulting in a compressive force against the roof of the mine, distributed over the area in contact with the endless belt **146**. As indicated in Figure 7, the rollers are merely idlers whose function is to distribute the compressive stress uniformly over the area of the endless belt **146**. If desired, one or more of the rollers **144** may be equipped with driving means (not shown) to convert the tread **146** into a driving apparatus.

The present invention also is applicable to underground machines, other than mining machines, for example, tunnel boring machines and the like.

According to the provisions of the patent statutes, I have explained the principle, preferred construction, and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In an underground mobile machine having a working element at its forward end, said machine adapted to advance continuously into a working face behind said working element, the improvement comprising in combination a rigid supporting structure extending upwardly from the frame of said machine for supporting at least one generally horizontal rail extending longitudinally above said machine, a hydraulic ram mounted in fixed relation to said frame, two blocks slidably mounted upon said rail, each block having an upwardly extending strength member pivotally mounted thereon, said strength members being pivotally joined at their upper ends, rotatable roof-engaging elements having an endless surface mounted above the upper ends of said strength members, piston means associated with said ram for advancing the first block toward the second block, resilient means for resisting movement of said second block away from said first block, and means for introducing hydraulic fluid under pressure into said ram to advance said piston means.

2. In an underground mobile machine having a working element at its forward end, said machine adapted to advance continuously into a working face behind said working element, the improvement comprising in combination at least one generally horizontal rail on each side of said machine, supported above and in rigid relation to the frame of said machine, a hydraulic ram for each rail mounted in rigid relation to said frame, a first block and a second block each slidably mounted upon each rail, an upwardly extending strength member pivotally mounted upon each block, means for joining in pivotal relation the upper ends of the strength members associated with a common rail, rotatable roof-engaging elements having an endless surface mounted upon and above said strength members for engaging a mine ceiling, piston means associated with each of said rams for advancing said first blocks toward said second blocks, resilient mean for resisting movement of said second blocks away from said first blocks, and means for introducing pressurized hydraulic fluid into each of said rams to advance said piston means.

3. In an underground mobile machine having a working element at its forward end, said machine adapted to advance continuously into a working face behind said working element, the improvement comprising in combination two generally horizontal rails mounted above the frame of said machine in rigid relation thereto and laterally spaced apart from and parallel to the longitudinal axis of said machine, a forward block slidably mounted upon each of said rails, resilient means for resisting forward advance of said forward block, a central block slidably mounted upon each of said rails, a rear block slidably mounted upon each of said rails, hydraulic means mounted in rigid relation to the frame of said machine including piston means for advancing each of said rear blocks respectively toward each of central blocks, a forward pair of upwardly extending strength members pivotally joined at their upper ends and pivotally mounted respectively to those forward blocks and those central blocks associated on a common rail, a rear pair of upwardly extending strength members pivotally joined at their upper ends and pivotally mounted respectively to those central blocks and those rear blocks associated on a common rail, roof-engaging elements comprising a plurality of parallel rollers journalled in a generally horizontal plane above the upper ends of said strength members, said roof-engaging elements being mounted in fixed relation to the pivot juncture of said forward strength members and mounted in slidable relation to the pivot juncture of said rear strength members, and means for supplying pressurized fluid to said hydraulic means for advancing said piston means.

4. In an underground mobile machine having a working element at its forward end, said machine adapted to advance continuously into a working face behind said working element, the improvement comprising in combination a rigid supporting structure extending upwardly from the frame of said machine for supporting at least one generally horizontal rail extending longitudinally above said machine, at least one pair of blocks slidably mounted upon said rail, at least one pair of upwardly extending strength members pivotally mounted at their lower ends to adjacent blocks and being pivotally joined at their upper ends, rotatable roof-engaging elements having an endless surface mounted above the upper ends of said strength members, hydraulic means for advancing adjacent blocks toward each other, and resilient means operative to counteract said hydraulic means whereby the advance of adjacent blocks toward each other is resisted.

5. The apparatus of claim 4 wherein the rotatable roof-engaging elements comprise at least one wheel, being caster-mounted to the rear of the pivotally joined upper ends of the upwardly extending strength member.

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