May 4, 1954 P. V. MALLOY ET AL 2,677,535

MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 1

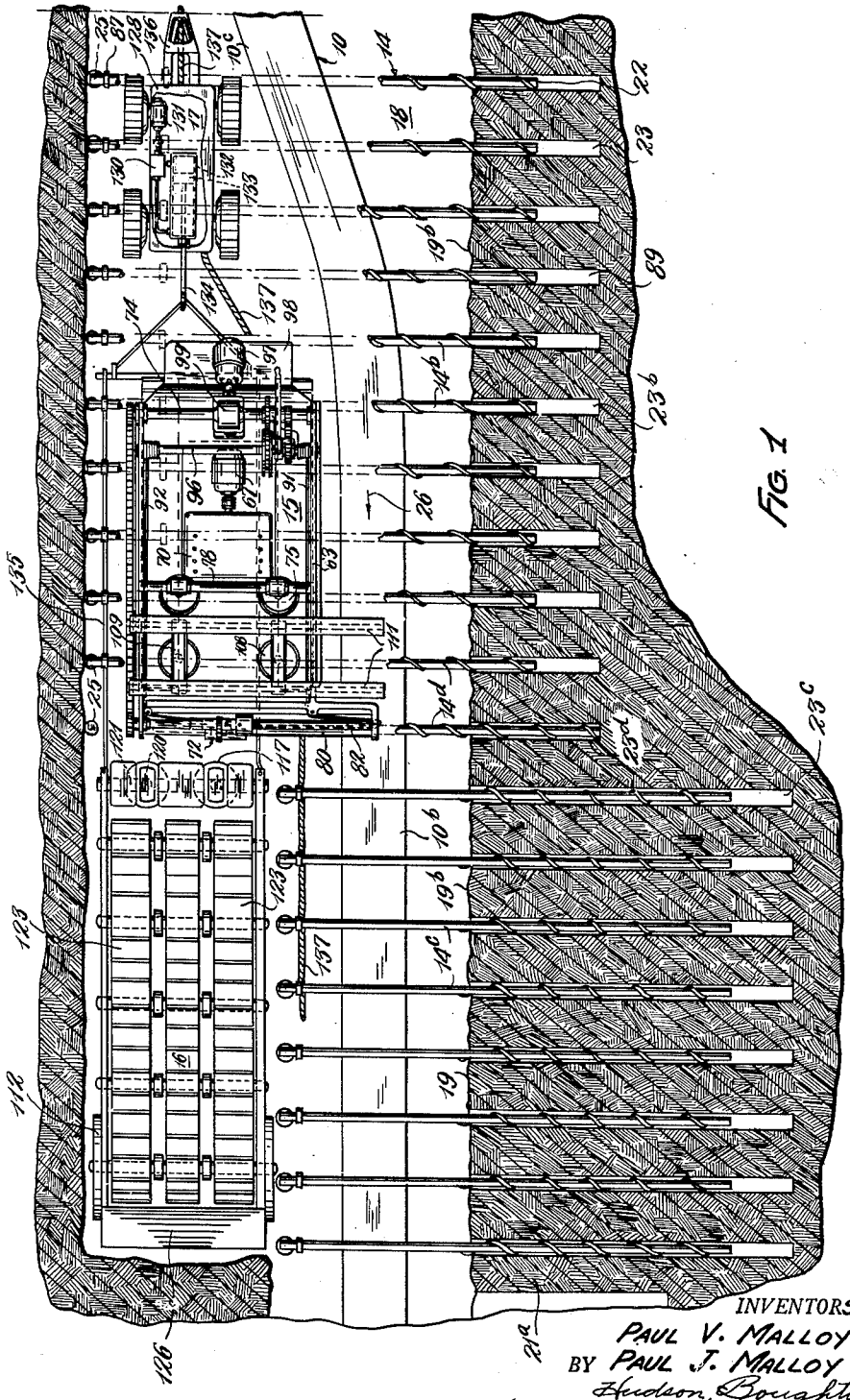


FIG. 1

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 2

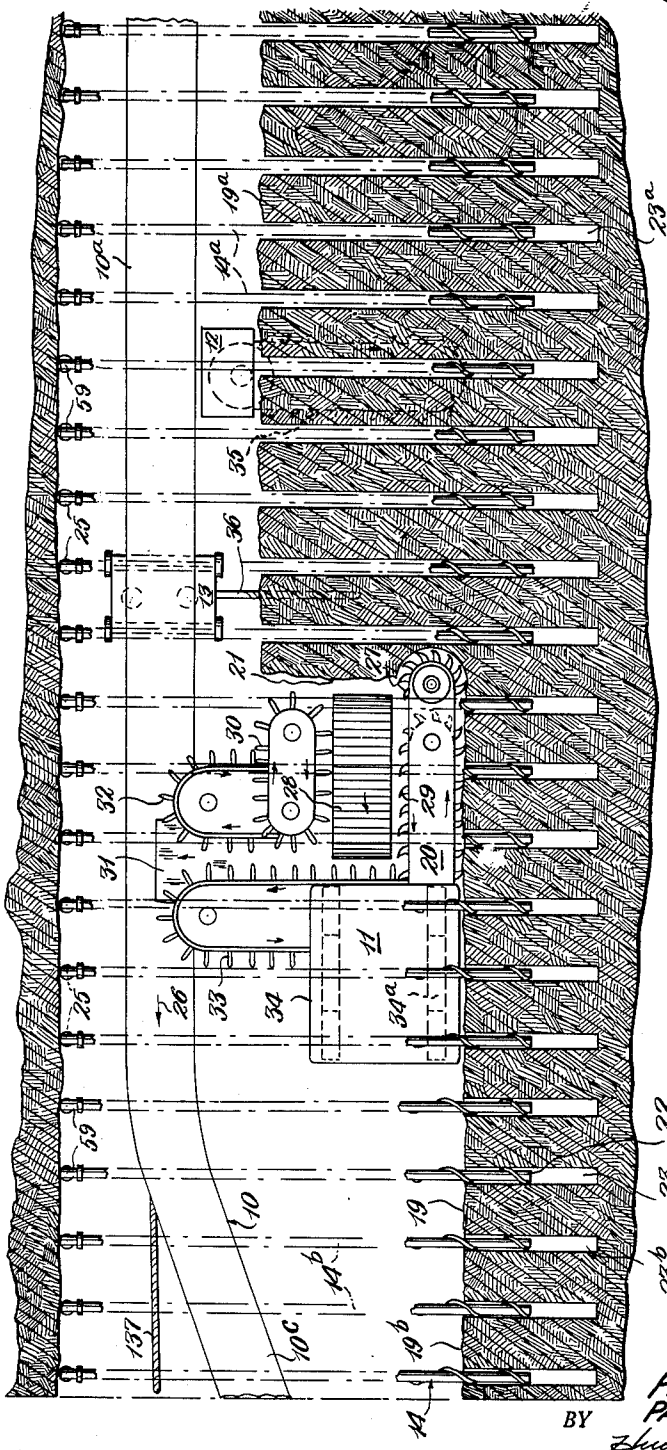


FIG. 2

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 3

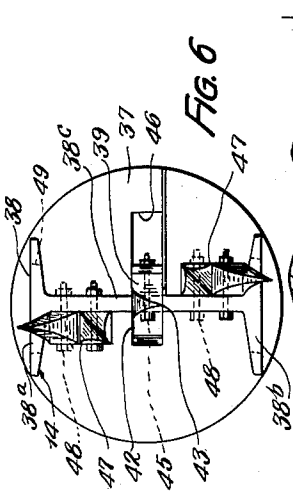


FIG. 6

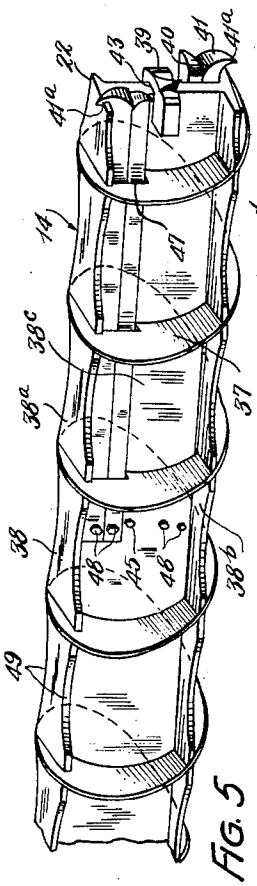


FIG. 5

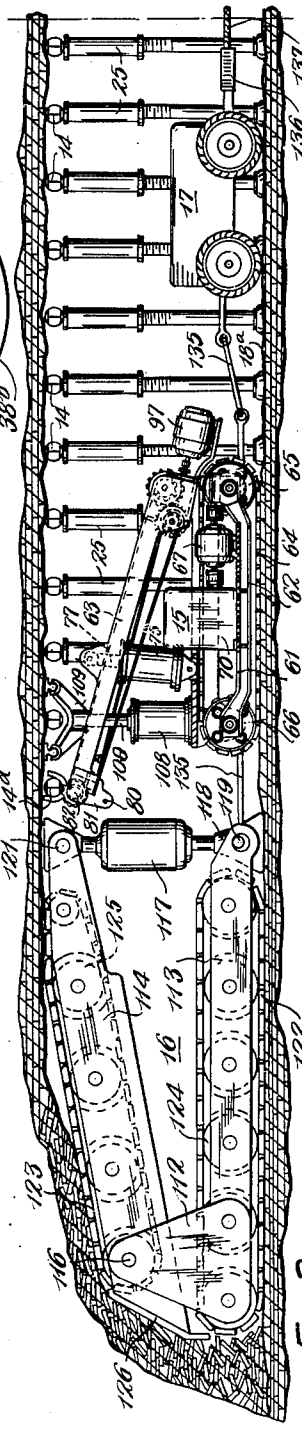


FIG. 3

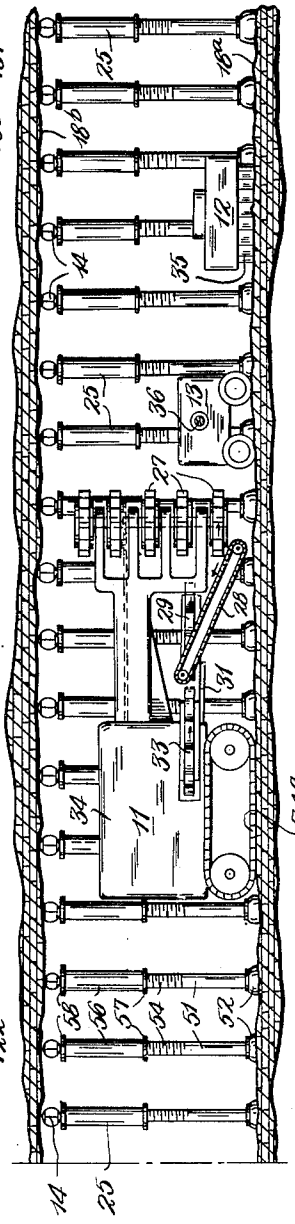


FIG. 4

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 4

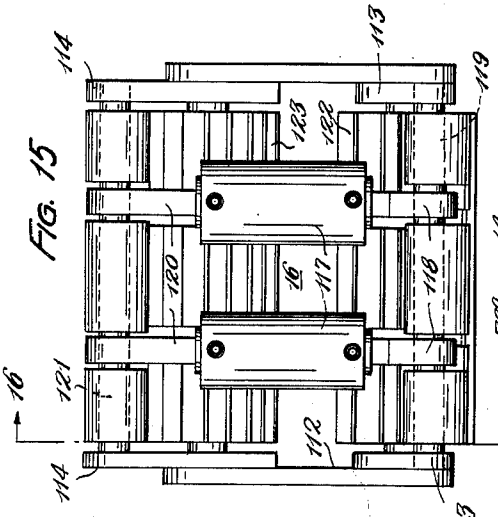


FIG. 15

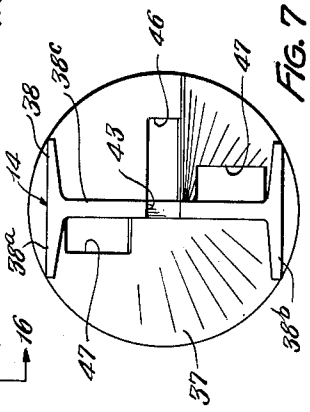


FIG. 7

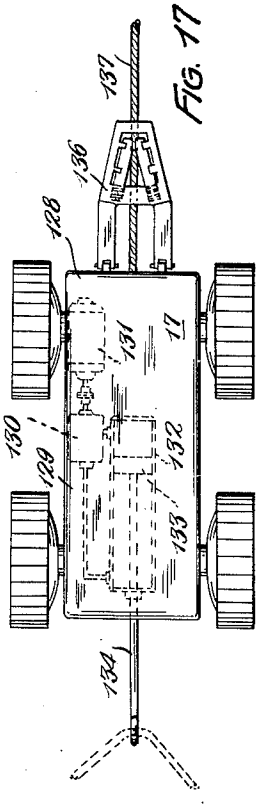


FIG. 17

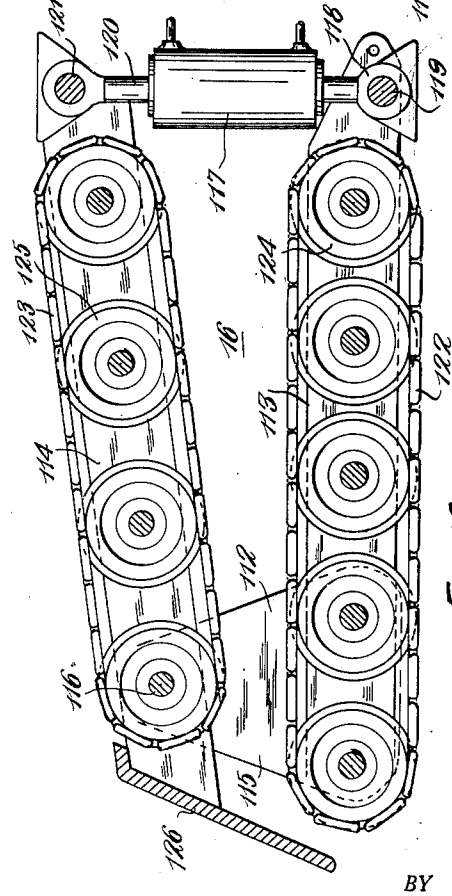


FIG. 16



FIG. 8

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 5

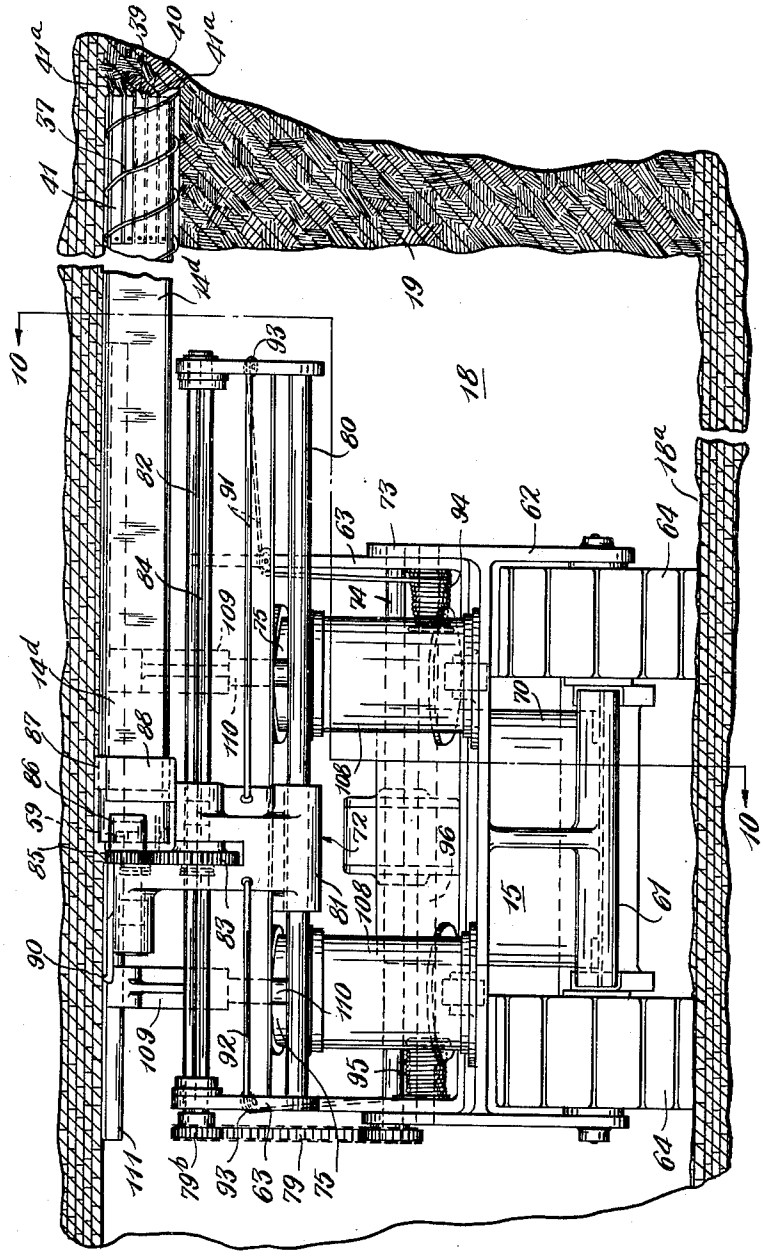


Fig. 9

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 6

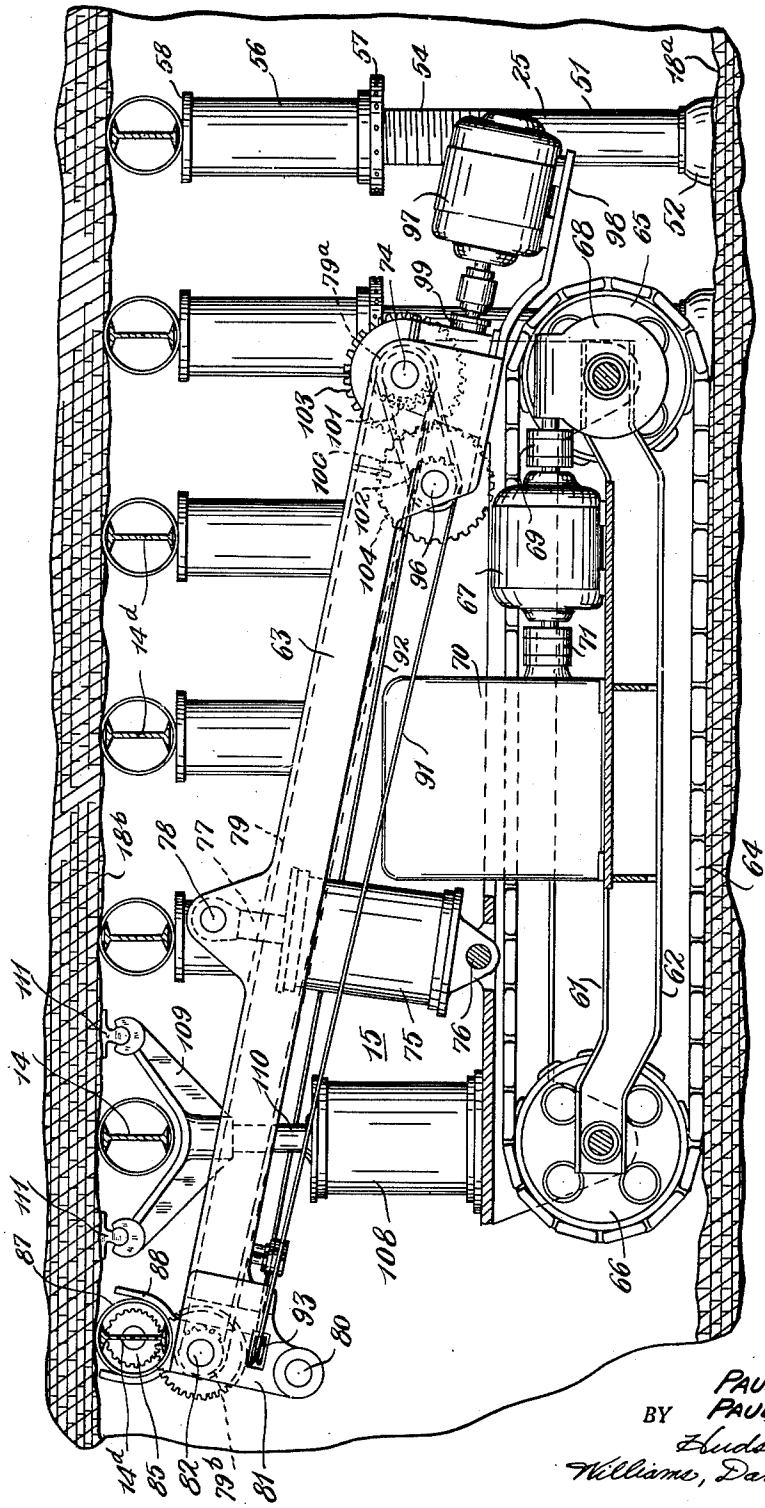


FIG. 10

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 7

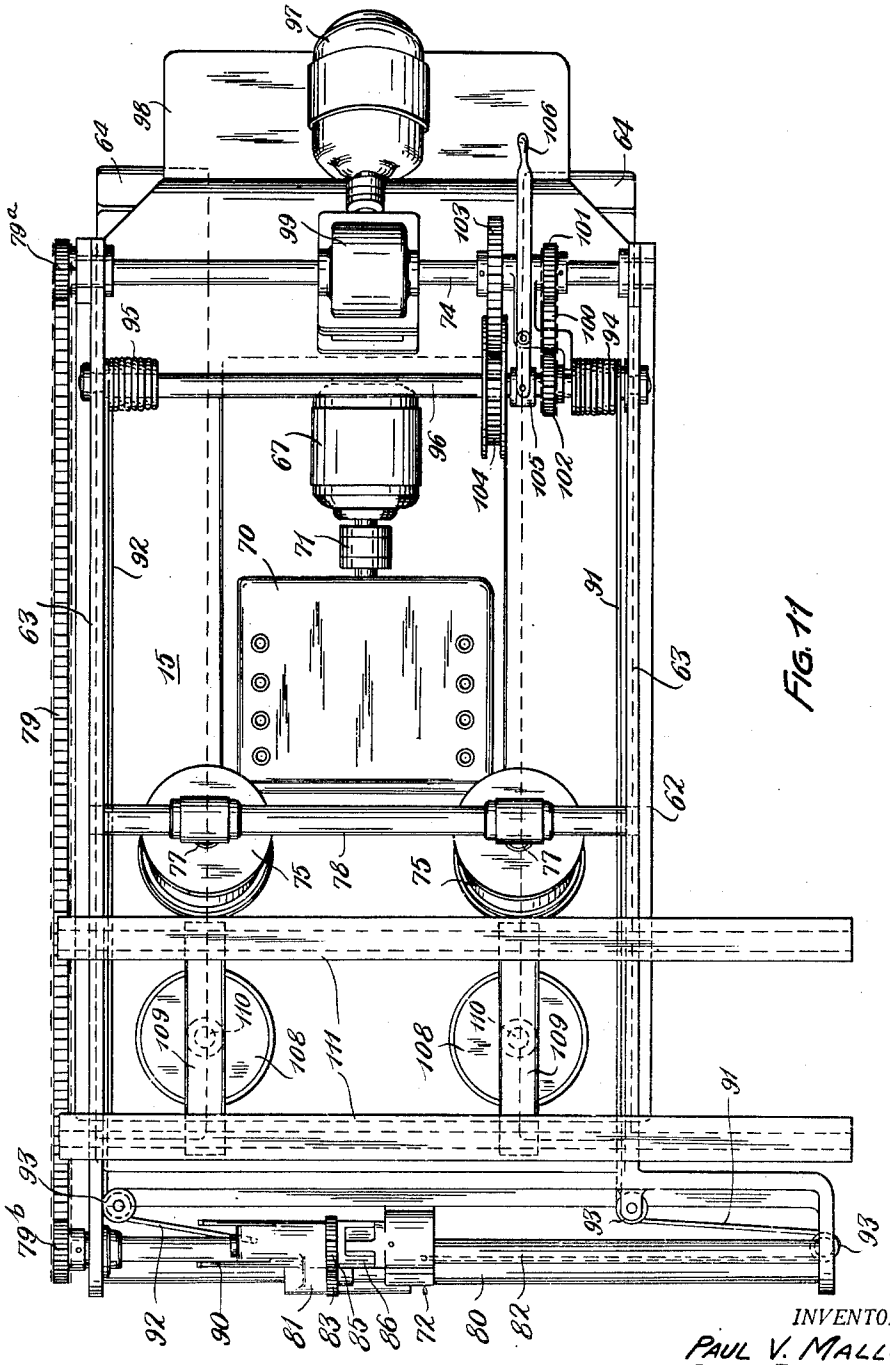


FIG. 11

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MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Filed Feb. 17, 1950 8 Sheets-Sheet 8

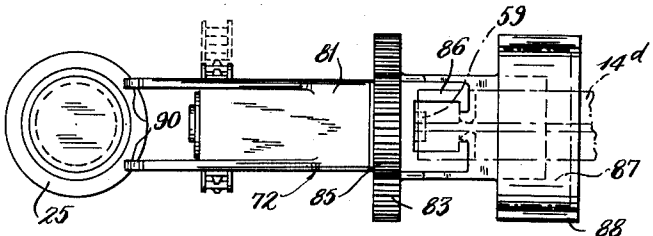


FIG. 13

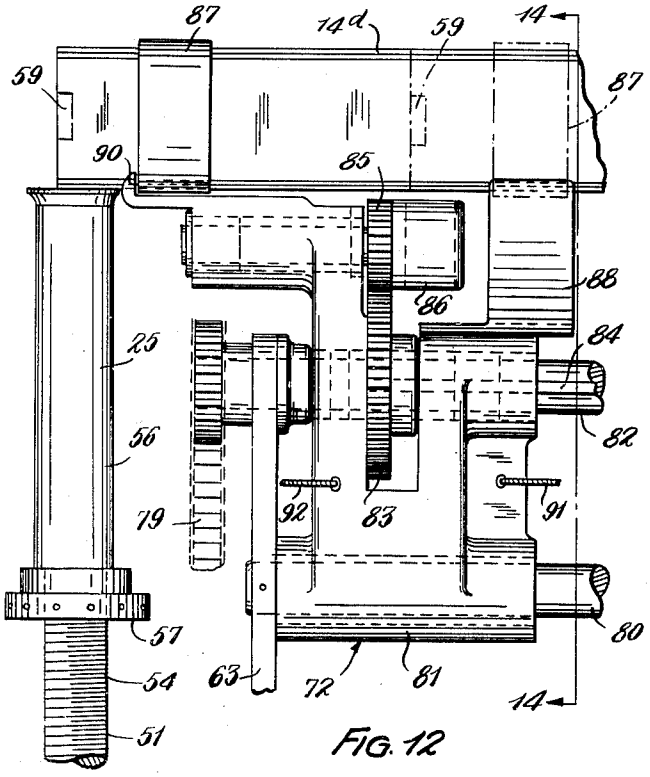


FIG. 12

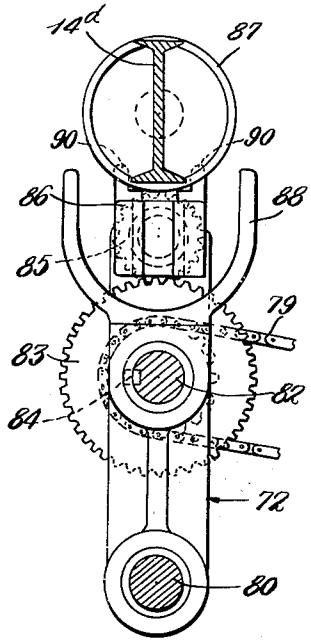


FIG. 14

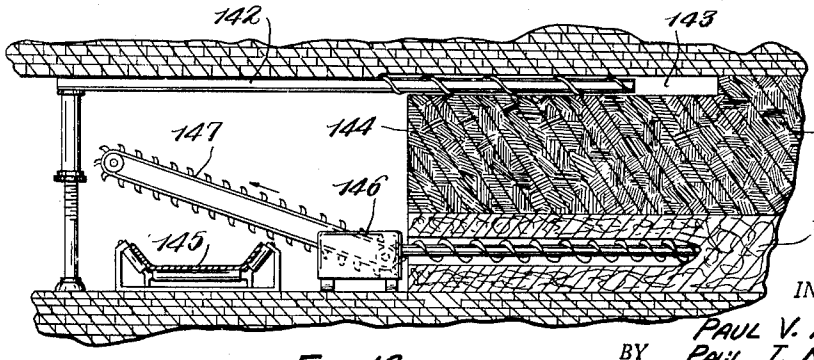


FIG. 18

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Patented May 4, 1954

2,677,535

UNITED STATES PATENT OFFICE

2,677,535

MINE ROOF SUPPORT BEAM WITH WALL DRILLING END

Paul V. Malloy and Paul J. Malloy,
Lakewood, Ohio

Application February 17, 1950, Serial No. 144,652

10 Claims. (Cl. 262—1)

1

This invention relates to the mining of coal or other materials and, as one of its objects, aims to provide novel apparatus by which such materials can be mined more safely and in a more rapid, economical and satisfactory manner than has heretofore been possible. The invention is applicable to various kinds of materials to be mined, but being especially suitable and practical for the mining of coal, it is described herein as applied to that use but without any intention of limiting the invention to that particular material.

Another object of this invention is to provide novel apparatus for mining in which roof supports of the so-called "boring beam" type are employed and form a roof-supporting canopy over a work area at which the material is being removed from a mine wall.

A further object of the present invention is to provide a novel form of roof-support beam which is adapted to be supported at one end thereof on a mine wall and which has drill means associated therewith enabling the beam to form its own support opening in the mine wall.

Still another object is to provide novel apparatus for mining in which time roof-support beams form a protective canopy over a work area adjacent a mine wall and have drilling ends supported on such wall by engagement in openings thereof and in which the drilling ends produce a deepening of said openings, while the beams remain engaged therein, for progressively advancing the canopy and maintaining the same continuously over the work area.

Yet another object is to provide a novel roof-support beam having drill means at one end thereof for forming or deepening a supporting opening in a mine wall and such beam also having conveyor means extending along the same in a direction away from the drill means for expelling the drillings from the opening.

As a further object this invention provides novel mining apparatus comprising a roof-support in the form of a boring beam adapted to form its own supporting opening in a mine wall and mechanism adapted for detachable connection with the boring beam for imparting drilling movement thereto.

It is also an object of this invention to provide a novel boring beam actuating mechanism adapted for detachable driving connection with a boring beam and including a carriage supported on the mine floor for movement of such actuating mechanism from one to another of a plurality of such boring beams.

Still another object is to provide boring beam

2

actuating mechanism having bearing means adapted for supporting engagement with a boring beam adjacent its outer end and also having means adapted to form a detachable driving connection with the boring beam.

A further object is to provide novel boring beam actuating mechanism which includes a traverse device for imparting rotary and longitudinal drilling movement to the boring beam.

As still another object this invention provides boring beam actuating mechanism which includes elevator means for moving the traverse device and bearing means into and out of cooperating engagement with the boring beam to which drilling movement is to be imparted.

The invention can be further briefly summarized as consisting in certain novel combinations and arrangements of parts hereinafter described and particularly set out in the claims hereof.

In the accompanying sheets of drawings,

Figs. 1 and 2 are complemental plan views of contiguous portions of a mine and illustrate the mining apparatus of the present invention;

Figs. 3 and 4 are complemental elevational views showing the same contiguous portions of the mine as are illustrated in Figs. 1 and 2, respectively;

Fig. 5 is a perspective view of the drilling end of a mine roof-support of the so-called boring beam type provided by this invention;

Fig. 6 is an end view of such drilling end;

Fig. 7 is a similar end view but with the drilling bits removed;

Fig. 8 is an edge view showing the central drilling bit in detached relation;

Fig. 9 is an end elevation of a boring beam actuating mechanism or operating machine, the same being shown with its bearing means and transverse device in operative engagement with one of the boring beams;

Fig. 10 is a view of the boring beam actuating mechanism showing the same partly in vertical section, the view being taken substantially as indicated by section line 10—10 of Fig. 9;

Fig. 11 is a top plan view of the boring beam actuating mechanism;

Fig. 12 is a partial end elevation of the boring beam actuating mechanism and showing the traverse device thereof on a larger scale;

Fig. 13 is a fragmentary plan view of the traverse device;

Fig. 14 is a partial vertical section taken through the traverse device substantially on section liine 14—14 of Fig. 12;

Fig. 15 is an end elevation of a roof propping

and subsidence control device forming a part of the mining apparatus of this invention;

Fig. 16 is a longitudinal vertical section taken through the roof propping and subsidence control device, as indicated by section line 16—16 of Fig. 15;

Fig. 17 is a top plan view of a towing device for imparting advance movement to the roof propping and subsidence control device; and

Fig. 18 is a vertical section taken through a mine having a thin seam of the minable material and illustrating the application of the present invention thereto.

In proceeding with a more detailed description of this improved mining apparatus, the various units of the apparatus will be first referred to in a general way and will be subsequently described herein in greater detail. These units include a main conveyor 10, a loading unit 11, a cutting unit 12 and a drilling unit 13. Additionally, the improved mining apparatus of this invention includes a plurality of spaced-apart roof supports 14 of the so-called boring beam type, a boring beam actuating machine 15, a roof propping and subsidence control unit 16 and a towing unit 17.

The various units just referred to are located in a mine chamber or tunnel 18 having a longitudinally extending upright side wall 19 formed by the coal or other material to be mined and from which wall the material is removed by a progressive mining operation. The point at which the coal is being removed from the wall 19 is referred to herein as the work area and is designated by the reference character 20 in Fig. 2. At this work area the coal is removed from the wall 19 by the loading unit 11 and is delivered by the latter onto the main conveyor 10 by which it is carried out of the mine room 18. In removing coal from the wall 19 at the work area 20, a work section 21 of approprate thickness is operated upon and the work area is advanced by the progressive removal of the work section 21 from the face of the wall 19.

The roof supports 14 constitute an important part of this invention and, as shown in Figs. 1 and 2, these supports are in the form of beams which extend outwardly from the mine wall 19 at substantially right angles thereto and are disposed in relatively closely spaced parallel relation to form a substantially continuous roof-supporting canopy over the work area 20, as well as over other portions of the mine room 18 which are adjacent to this work area. As shown in Figs. 1 and 2, the beams 14 have their inner ends 22 supported on the mine wall 19 by being engaged in openings 23 of this wall. The beams are supported at their outer ends by propping means which is here shown as being in the form of a vertically extensible column or post 25.

The openings 23 extend into the wall 19 at substantially right angles to the outer face thereof and are disposed in a longitudinal row at or adjacent the level of the mine roof 18b so that the beams will be in proper position to provide support for the roof when their ends are supported, respectively, by engagement in these openings and with the posts 25. The openings 23 are preferably located at or immediately below the level of the mine roof although they can, if desired, be located above the general level of the roof if trenches are provided in the roof to receive the beams or when irregularities in the roof extend above such general level. It should also be understood that when the beams 14 have been located in position close to the mine roof by engagement of their ends with the openings 23 and the posts 25, they can then be moved upwardly to apply supporting thrust to the roof by extension of the posts 25 and by the use of suitable shims (not shown) in the openings 23 if such shims are needed.

As already indicated above in a general way, it is an important feature of this invention that the mine roof-support beams 14 are adapted to form their own mounting openings 23 in the mine wall 19 and, for that reason, are referred to herein as boring beams. These beams and the drilling means associated therewith will be described in greater detail hereinafter. All of these boring beams are of the same construction and are adapted to be used in the same manner and in interchangeable relation with each other, but to facilitate the detailed description which is to follow, the beams are referred to as being divided into three groups comprising the beams 14a, 14b and 14c.

The beams 14a extend into the portion 19a of the mine wall which is located in advance of the loading unit 11 and in which the openings 23a are of a greater depth than the thickness of the work section 21. The beams 14a extend into the deep openings 23a for a distance such that their inner ends will extend inwardly beyond the work section 21. The roof-support beams 14b extend into openings 23b of the wall portion 19b. This portion of the mine wall represents the new face or side wall of the mine chamber 18 which is exposed after the removal of the work section 21, and the openings 23b which extend into this wall portion are the portions of these openings which remain in the mine wall after the work section has been removed.

The inner ends of the beams 14b extend into the openings 23b for only a short distance, as shown in Figs. 1 and 2, but which distance is sufficient to provide proper support for these ends of the beams on the mine walls. The roof-support beams 14c engage in relatively deep openings 23c of the mine wall portion 19b and extend into these deep openings for a greater distance than the thickness of a work section 21a. This work section 21a is similar to the work section 21 and represents the location at which the loading unit 11, or another such unit, will be put into operation for the next progressive mining operation to be performed on the wall 19.

One individual mine roof-support beam 14d is shown between the groups of beams 14b and 14c. The beam 14d represents the individual beam on which the boring beam actuating unit 15 is then operating and by which the opening 23d is being deepened from the shallow depth of the supporting openings 23b to the greater depth of the supporting openings 23c.

For the purposes of the present invention it is important to understand that the inner or drill ends 22 of the mine roof-support beams 14 always remain engaged in the openings 23 of the mine wall 19 so that these ends of the beams will always be strongly supported on undisturbed solid material of the mine wall. As the mining operation progresses, the boring beams 14 are advanced in succession into the mine wall 19 and during such advance movement the beams act as drills for forming or deepening their own mounting openings 23. By advancing the boring beams into the mine wall for a distance such that their inner ends extend inwardly beyond the thickness of the work sections 21 and 21a, these inner ends will always be solidly supported on

undisturbed portions of the mine wall and this solid support will remain after the removal of the work sections 21 and 21a from the mine wall.

Reverting now to the individual units which have been referred to only in a general way above, it should be explained that the main conveyor 10 can be a flexible conveyor of any conventional construction and can be driven by any suitable power means for moving the mined coal in the direction indicated by the arrow 26. This conveyor includes a straight portion 10a extending adjacent, and in substantially parallel relation to, the mine wall portion 19a and another straight portion 10b extending along the wall portion 19b at a location between this wall and the units 15, 16 and 17. The conveyor also includes an inclined portion 10c connecting the portions 10a and 10b and by which the conveyor portion 10b is diverted or swung in behind the loading machine 11 so as to extend adjacent, and in substantially parallel relation to, the wall portion 19b.

The loading unit can be any conventional loading apparatus by which coal can be removed from the work section 21 and delivered onto the main conveyor 10. As here shown the loading unit 11 includes a cutter 27 and a set of bottom and side conveying members 28, 29 and 30 for moving the mined coal rearwardly away from the work section 21. This loading apparatus also includes another set of bottom and side conveying members 31, 32 and 33 by which the mined coal is moved transversely of the chamber 18 and delivered onto the conveyor 10. The loading machine 11 also includes a suitable frame structure or chassis 34 mounted on tread members 34a for movement along the mine floor 18a to engage the cutter 27 with the work section 21 and suitable power devices supported on the frame structure for actuating the tread members 34a and for actuating the cutter 27 and the movable conveyor members.

The units 12 and 13 are located in advance of the loading unit 11 for operating on corresponding advance portions of the work section 21. The unit 12 comprises a conventional cutting machine having a power driven cutting member 35 for under-cutting the work section 21 of the mine wall portion 19a. The unit 13 is a conventional drilling machine having a power operating drill 36 for forming holes in the mine wall portion 19a and which holes are used in breaking down the work section 21 by explosive charges or other means.

As shown in Figs. 5 to 8 inclusive, each of the boring beams 14 comprises an elongated structural load-carrying member, preferably in the form of an I-beam 38 as here shown and which includes top and bottom flanges 38a and 38b and an upright connecting web 38c. The inner or drill end 22 of the beam 14 is provided with a plurality of drilling bits which, in this instance, include a central bit 39 and pairs of top and bottom bits. Each of these pairs consists of a bit 40 having a substantially straight cutting end and a bit 41 having a cutting end provided with a hook-like portion 41a. The boring beam 14 also includes a conveying means for expelling drillings from the opening 23 and which conveying means is here shown as being in the form of a sheet metal member or thread which extends spirally or helically around the beam and in a direction away from the drilling end 22 thereof.

As shown in Fig. 5, the above-mentioned bits are mounted on the beam 14 so as to project from the inner end 22 thereof for drilling cooperation with the mine wall 19 when rotary and axial movement is imparted to the beam. The paired bits 40 and 41 are located adjacent the top and bottom flanges 38a and 38b of the I-beam 38 and on opposite sides of the web 38c thereof so that when rotary movement is imparted to the beam in a right-hand or clockwise direction, as seen in Fig. 5, the thrust reaction of these bits during the drilling operation will be taken mainly in a lateral direction against the web 38c.

Since the inner or drilling ends 22 of the beams 14 always remain engaged in the supporting openings 23 of the mine wall 19, it is necessary to provide for the removal and replacement of these bits, from time to time, without disengagement of the beams from the supporting openings. For this purpose the bits are of such length and are so mounted on the beam 14 that the rear ends of the bits will project from the supporting opening 23b while the inner end of the beam remains sufficiently engaged in this opening.

To provide for such a dismountable connection for the central drilling bit 39 with the beam 14, this bit is provided with a substantially U-shaped or hook-like inner end portion 42 (see Fig. 8) adapted for hooked engagement over the inner end of the web 38c, as shown in Figs. 5 and 6. Shifting of this hook-shaped inner end 42 vertically along the web 38c is prevented by providing the end of this web with a notch 43 (see Fig. 7) in which the hook-like portion 42 has seating engagement. The central bit 39 also includes a stem portion 44 which extends outwardly along one face of the web 38c and is anchored to the web by a clamping bolt 45 extending through the stem adjacent its outer end.

In removing a worn bit 39 from the beam 14, the clamping bolt 45 is removed and the hook-shaped inner end 42 is disengaged from the inner end of the web 38c, whereupon this bit can be withdrawn from the opening 23 and a new or resharpened bit substituted therefor. To permit such disengagement of the hook-like inner end 42 from the web 38c and the withdrawal of the bit 39, a clearance space 46 is provided in the convolutions of the conveyor 37 and which space will permit the necessary lateral shifting of the bit 39 to disengage its hook-shaped inner end and to then be withdrawn rearwardly along the I-beam 38 through such clearance space.

The paired bits 40 and 41 are held in place adjacent the web 38c by being mounted in longitudinally aligned openings 47 of the convolutions of the spiral conveyor 37 and have the outer ends of their stems anchored on the web 38c by the clamping bolts 48. In removing the paired bits 40 and 41 from the beam 14 for replacement by similar new or resharpened bits, the bit 40 is withdrawn first through the mounting openings 47. The free withdrawal of the bit 40 is possible because the cutting means provided on the inner end of this bit does not overhang its side faces. After the bit 40 has been thus withdrawn the bit 41 can be shifted in the openings 47 in a direction to permit this bit to also be withdrawn without interference by the hook-like cutting projection 41a. In replacing the paired bits 40 and 41, the bit 41 is inserted first and shifted to the position shown in Figs. 5 and 6, after which the straight bit 40 is inserted.

The spiral conveyor 37 of the boring beam 14 can be formed by a continuous sheet metal

strip which extends around and along the I-beam 38 in the manner of a helical thread and has portions thereof cut out so that this conveyor will fit snugly around the flange and web portions of the I-beam. The sheet metal strip forming this conveyor can be welded or otherwise suitably attached to the I-beam 38 for mounting the strip thereon. The strip forming the spiral conveyor can be of suitable width so that portions of the conveyor will extend somewhat above and below the top and bottom flanges of the I-beam 38. These projecting portions will not ordinarily be required to carry the roof load because such load will be borne by drillings which become packed between the convolutions of the conveyor. During the rotary drilling movement imparted to the beam 14, the conveyor 37 propels the drillings from the mine wall 19 rearwardly along the opening 23 and ejects the same from this opening. The conveyor 37 extends along the beam 14 for a substantial portion of its length, as shown in Figs. 1 and 2, so that a portion of the conveyor will always project from the wall opening for the accomplishment of such discharge of the drillings. To facilitate the free passage of the drillings along the beam 14 under the influence of the spiral conveyor 37, the top and bottom flanges 38*a* and 38*b* of the I-beam 38 can be notched out, as indicated at 49 in Fig. 5, between each pair of adjacent convolutions of the conveyor.

As already mentioned above, the mine roof-support means 14 are adapted to be supported at their outer ends by prop means in the form of the posts 25 here shown. These posts each comprise an upright column member 51 having a foot portion 52 at the lower end thereof adapted to be supported on the mine floor 19*a* and also having a threaded portion 54 adjacent its upper end. The post 25 also includes a sleeve member 56 telescoping over the column member 51 and a rotatable nut 57 engaging the thread 54 and providing an adjustable connection between the column member and the lower end of the sleeve member. The upper end of the sleeve member 56 is provided with a cap portion 58 on which the outer end 59 of the beam 14 is adapted to rest. When the beam 14 has been advanced into one of the openings 23 of the mine wall 19 for the desired distance, the post 25 is placed under the outer end 59 of the beam and by rotation of the nut 57 the sleeve member 56 is forced upwardly, thereby lifting the beam into supporting engagement with the mine roof.

The construction and operation of the boring beam actuating unit 15 will be described next. As shown in Figs. 9, 10 and 11, the unit 15 is provided with a carriage or frame structure 61 which comprises a pair of pivotally connected lower and upper frame members 62 and 63. The lower frame member 62 is provided with tread members which, in this instance, are in the form of endless traction belts 64 so as to adapt the unit 15 for self-propelling movement along the mine floor 19*a*. The traction belts 64 extend around pairs of wheels or sprockets 65 and 66 which are rotatably mounted on the frame member 62 adjacent the ends thereof.

The sprockets 65 are operably connected with a driving motor 67 through a reduction gearing 68 and a clutch 69 to be driven by this motor for imparting advance movement to the traction belts 64. The motor 67 is also used to drive a hydraulic pressure generating unit 70 which is mounted on the carriage 61 and with which this motor is connected by a clutch 71. When the motor 67 is not being used to propel the unit 15, the clutch 69 can be disengaged and the clutch 71 can be engaged so that this same motor can then be used to drive the hydraulic pressure generating mechanism for a purpose to be explained hereinafter.

The upper frame member 63 extends in an upwardly and rearwardly inclined relation to the lower frame member 62 and constitutes a carrier or elevator means on which a traverse device 72 is mounted. As will be explained hereinafter, this traverse device forms an operative connection between the machine 15 and one of the boring beams, in this instance the boring beam 14*d*, to which a rotary and axial drilling movement is to be imparted. The lower frame member 62 is provided at the forward end thereof with a pair of upstanding arms or brackets 73 and the upper frame member 63 is pivotally mounted on a shaft 74 which extends transversely of the unit 15 and is journalled in these brackets.

The upper frame member 63 can be swung relative to the lower frame member for moving the traverse device 72 into and out of driving cooperation with the boring beam 14*d* and this is accomplished by a pair of hydraulic power cylinders 75. At their lower end these power cylinders are pivotally connected with the carriage 61 by transverse pivot pins 76. Piston rods 77 projecting from the cylinders 75 at their upper end are pivotally connected with the upper frame member 63 at an intermediate point thereof by the transverse pivot pins 78. The cylinders 75 are double-acting cylinders to which hydraulic pressure fluid can be supplied by the hydraulic pressure generating unit 70 through suitable conduits (not shown).

The traverse device 72 includes a laterally extending guide shaft 80 mounted in the upper end of the frame member or elevator 63 and a head 81 which is slidable on this guide shaft for movement back and forth across the upper end of this frame member. The traverse device also includes a rotary drive shaft 82 which is journalled in the upper end of the frame member 63 and extends in substantially parallel relation to the guide shaft 80. The head 81 has an opening through which the drive shaft 82 extends and carries a driving gear 83 whose hub is splined on the drive shaft by a longitudinally extending key 84 and is slidable on this shaft during movements of the head thereon. A second gear 85 journalled on the head 81 is in meshing engagement with the gear 83 to be driven thereby and carries a forked axial extension or yoke member 86 forming a connecting means which is releasably engageable with the outer end 59 of the beam 14*d* by being moved into straddling relation to the web 38*c* of this beam, as shown in Figs. 9 and 13. When rotary movement is imparted to the shaft 82, the gear 83 will be driven thereby to impart rotation to the second gear 85 and the connecting fork 86 carried thereby. The rotary movement thus supplied to the connecting fork 86 will be imparted to the outer end of the boring beam 14*d* when the connecting fork is in engagement with such outer end, as is shown in Fig. 9.

The rotary drive shaft 82 of the traverse device 72 is adapted to be driven from the shaft 74 and, for this purpose, a chain 79 is provided which extends around sprockets 79*a* and 79*b*. The sprocket 79*a* is mounted on the projecting end of the shaft 74 and the sprocket 79*b* is mounted

on the projecting end of the shaft 82, as shown in Figs. 9 and 11.

When drilling movement is being imparted to the boring beam 14d it is necessary to support or journal this beam at a point adjacent its outer end so that the beam will be freely rotatable with such rotation confined to the longitudinal axis of the beam. For this purpose each of the boring beams is provided with a journal member 87 in the form of a short cylindrical sleeve which is mounted on the beam so as to extend thereabout, as shown in Figs. 12 and 14. The journal member 87 can be welded or otherwise suitably connected with the beam. The supporting means for the boring beam also includes a bearing member or steady rest 88 which is carried by the head 81 of the traverse device 72. As shown in Figs. 12 and 14, the bearing member 88 can be in the form of an upwardly-opening fork member or bracket which is formed as an integral part of the head 81 or is suitably mounted thereon adjacent the connecting fork 86.

The journal member 87 is mounted on the boring beam 14d so that its spacing relative to the outer end 59 of the beam will correspond with the lateral spacing between the connecting fork 86 and the bearing fork 88, such that when the outer end of the beam is drivingly engaged by the connecting fork 86 the journal member 87 will be straddled and supportingly engaged by the bearing fork 88. Thus it will be seen that when the traverse device 72 is moved upwardly by an upward swinging movement of the frame member 63 to engage the connecting fork 86 in straddling relation to the outer end 59 of the boring beam 14d, the bearing fork 88 will at the same time be moved upwardly to straddle the journal member 87 and thereby support the outer end of the beam for rotary movement.

In the matter of establishing the above explained driving connection between the traverse device 72 and the outer end of the boring beam 14d, it should be explained that when the mounting openings 23 are formed in the mine wall 19 they are always made somewhat deeper, as shown in Figs. 1 and 2, than is needed for the supporting engagement of the beams therein. When the boring beams are in their roof-supporting position with their outer ends 59 resting on the posts 25, their inner ends 22 will be retracted somewhat from the extreme inner ends of the mounting openings 23 thus leaving an intervening space 89 therebetween. This intervening space 89 provides for an idle inward movement of the boring beam 14d when the driving connection of the traverse device 72 with the outer end of this beam is to be established.

Preparatory to the forming of this driving connection, the post 25 is slackened off by rotation of the nut 57 and the beam 14d is then moved inwardly through the extent of the idle movement afforded by the intervening space 89. This idle inward movement of the beam can be accomplished either manually or by use of the traverse device 72. At the time that this inward idle movement is to be imparted to the beam 14d, the post 25 is removed and the outer end of this beam is temporarily supported as by a manually applied propping means (not shown), or is permitted to rest on a portion of the traverse device 72.

To enable the traverse device 72 to impart such inward idle movement to the beam 14d, the head 81 of the traverse device is provided with an upstanding driving lug or pair of lugs 90 at a suitable location thereon and which lugs are adapted to be engaged with the outer edge of the journal member 87. When the lugs 90 have been thus engaged with the journal member 87, longitudinal movement is imparted to the head 81 in a right-hand direction as seen in Fig. 12, thereby shifting the beam 14d inwardly through the intervening idle space 89 to engage the drilling bits 39, 40 and 41 with the inner end of the opening 23d and at the same time moving the outer end 59 of the beam to the broken line position shown in Fig. 13. By this initial idle movement of the beam 14d, its outer end 59 and the journal member 87 will be brought into position to be engaged respectively by the connecting fork 86 and the bearing fork 88 when the head 81 is elevated by the frame member 63 to establish the above described operating connection with this beam.

For moving the head 81 along the shafts 80 and 82, the traverse device 72 is provided with cables 91 and 92 which are attached to the head and extend over suitable pulleys 93 to a pair of winding drums 94 and 95. These drums are mounted on a transverse shaft 96 which is journalled in the upper frame member 63 and extends in adjacent substantially parallel relation to the shaft 74. When the winding shaft 96 is rotated in one direction, the cable 91 will pull the head 81 toward the right, as seen in Figs. 9 and 11, to advance the boring beam 14d simultaneously with the rotary movement being imparted thereto by the connecting fork 86. During this advance movement of the head 81, the drum 95 will unwind or pay out the cable 92 at the same rate. Conversely, when the shaft 96 is rotated in the opposite direction the cable 92 will pull the head 81 toward the left, as seen in Figs. 9 and 11, to retract the same and during this movement the cable 91 will be unwound or payed out by the drum 94. To obtain the winding and unwinding functions just explained, the cable 91 passes to the winding drum 94 so as to be tangent to the upper side thereof and the cable 92 passes to the drum 95 so as to be tangent to the underside thereof.

For the purpose of imparting this back and forth movement to the head 81 of the traverse device 72 through the cables 91 and 92, a driving motor 97 is mounted on an overhanging portion 98 of the frame member 63 and is connected with the transverse shaft 74 through a reduction gearing 99. The shaft 74 is, in turn, connected with the winding shaft 96 for actuation of the latter in opposite directions and at two different winding speeds. A driving chain 100 extending around a pair of sprockets 101 and 102 of the shafts 74 and 96 provides an operating connection for driving the shaft 96 and the winding drum 94 in the proper direction and at a relatively low speed for imparting a corresponding relatively slow advance movement of the head 81 toward the right during the drilling movement being imparted to the boring beam 14d. A pair of gears 103 and 104 mounted on the shafts 74 and 96 and disposed in meshing engagement with each other form an operating connection between these shafts by which the shaft 96 and the winding drum 95 will be rotated in the opposite direction and at a relatively higher speed for imparting a more rapid return movement to the head 81.

For controlling the direction and speed of movement desired to be imparted to the head 81, a clutch member 105 is splined on the winding shaft 96 and is adapted to be shifted by a lever 106 into engagement with either the sprocket

member 102 or the gear 104. It will be understood, of course, that the sprocket 101 and the gear 103 are keyed or otherwise connected with the driving shaft 74, but that the sprocket 102 and the gear 104 rotate freely on the shaft 96 except when one or the other of these members is connected to the winding shaft by the clutch collar 105,

The boring beam operating unit 15 can also be provided with a roof propping means for supporting the mine roof 18b at one or more points adjacent to the beam 14d to which drilling movement is being imparted. For this purpose a pair of laterally spaced hydraulic pressure responsive cylinders 108 are mounted in fixed relation on the carriage 61 and a pair of correspondingly spaced forked supporting members 109 are carried by the piston rods 110. The arms of the forked members 109 extend upwardly on opposite sides of the boring beam 14 which is next adjacent to the boring beam 14d to which the drilling movement is being imparted. These forked members are provided with rockable and self-aligning pads 111 which extend transversely of the unit 15 in spaced-apart substantially parallel relation and engage the mine roof 18b on opposite sides of such next adjacent boring beam 14, as shown in Fig. 10. Hydraulic pressure fluid can be supplied to the cylinders 108 from the pressure generating unit 70 through suitable conduits (not shown).

In the functioning of the boring beam actuating unit 15 it will be understood that this unit will be advanced along the mine floor 18a from one to another of the boring beams 14 and, by imparting drilling movement to these boring beams in succession, will drill these beams into the mine wall 19 so that the boring beams 14b will thereby be shifted inwardly to the position of the boring beams 14c. After each beam has been thus drilled into the mine wall to the extent indicated in Fig. 1 for the boring beams 14c, it is supported at its outer end by replacing the post 25 thereunder and rotating the nut 57 to extend the post and lift such outer end of the beam into proper supporting engagement with the mine roof.

The roof propping and subsidence control unit 16 of Figs. 15 and 16 will be described next. This propping device 16 comprises a carriage 112 which is movable along the mine floor 18a and is formed by a pair of pivotally connected lower and upper frame members 113 and 114. The lower frame member 113 is provided at the rear end thereof with a pair of upstanding brackets 115 on which the rear end of the upper frame 114 is pivotally mounted by the transverse pivot shaft 116. The frame members 113 and 114 are connected adjacent their forward ends by a pair of hydraulic pressure fluid responsive cylinder devices 117 which serve to spread apart these frame members for causing the upper frame member to exert an upward supporting pressure against the mine roof.

The cylinder devices 117 are provided at the lower end thereof with heads 118 which are pivotally connected with the lower frame member 113 by a transverse pivot shaft 119. Piston rods 120 projecting from the opposite end of these cylinder devices are pivotally connected with the upper frame member by a transverse pivot shaft 121. The cylinder devices 117 are double-acting and are adapted to be supplied with pressure fluid from the hydraulic pressure generating unit 70 of the boring beam actuating machine 15 or from any other suitable source. The connecting means formed by the hydraulic cylinder devices 117 is of such length that the upper frame member 114 extends in a downwardly and rearwardly inclined sloping relation with respect to the lower frame member 113, as is shown in Figs. 3 and 16.

The lower and upper frame members 113 and 114 are provided respectively with movable tread members 122 and 123 which are engageable with the mine floor 18a and the mine roof 18b. The tread member 122 is here shown as being an endless belt which extends around a plurality of wheels or sprockets 124 which are rotatably mounted on the lower frame member 113. Similarly, the upper tread member 123 is an endless belt which extends around a plurality of wheels or sprockets 125 which are rotatably mounted on the upper frame member 114. With the construction just described above for the propping device 16, it will be seen that when this device is moved forward in the mine chamber 18 the downwardly and rearwardly sloping relation of the upper frame member 114 will permit the roof material to gradually subside or cave in as the propping device is advanced. During this advance movement of the propping device 16 the tread members 122 and 123 travel around their mounting wheels 124 and 125 while the contact portions of these tread members remain in engagement with the mine floor and roof respectively. The material, which is thus permitted to subside from the mine roof by the downwardly and rearwardly sloping frame member 114 and the tread member 123, is carried rearwardly by this tread member and slides down a ramp member 126 which is mounted on the carriage 112 at the rear thereof. The ramp member 126 also forms a shield for protecting the propping device from damage by the subsiding material.

The advance movement for the propping device 16 can be imparted thereto by the towing unit 17 which, as shown in Figs. 3 and 17, is a wheeled vehicle 128 which is movable along the mine floor 18a in advance of the boring beam actuating unit 15. This towing unit is provided with a body or housing 129 in which a hydraulic pressure generating device in the form of a high pressure pump 130 is located and is adapted to be driven by an electric motor 131. This towing unit also includes a cylinder 132 located in the housing 129 and to which pressure fluid is delivered by the pump 130.

A piston 133 operable in the cylinder 132 is connected with a piston rod 134 which projects rearwardly from the towing unit 17. This piston rod is connected with the propping device 16 by means of a towing bridle 135 so that movement imparted to the piston 133 toward the right, as seen in Fig. 17 while the towing unit 17 is held stationary, will transmit a strong forward pulling movement to the propping device. For maintaining the towing device 17 in a stationary position while the piston 133 is being thus actuated, the towing device is provided with a gripping means 136 which is engageable with a cable 137 extending longitudinally through the mine chamber 18. After the propping device 16 has been advanced a distance corresponding with one power stroke of the piston 133, the towing device 17 is advanced toward the right as seen in Fig. 17, in preparation for another power stroke of the piston 133. It will be understood, of course, that the remote end of the cable 137 can be suitably anchored, or can be attached to a power driving winding drum (not shown), to

permit this towing operation to be carried out as above explained. When the remote end of the cable is anchored in a fixed relation, the gripper 136 will be advanced along the cable with a step-by-step movement.

In connection with the operation of the propping device 16, it will be observed from Fig. 1 that this device is located in the mine chamber 18 immediately behind the boring beam actuating unit 15 and opposite the group of boring beams 14c which have already been advanced into the mine wall 19 by the unit 15 in preparation for the mining operation to be performed on the work section 21a. With the propping device in this location it will be seen that the roof material which is permitted to subside or cave in by the forward movement of the propping device falls into the space previously occupied by the propping device and since this space is laterally offset beyond the group of boring beams 14c, the material accumulating therein will not interfere with the progress of the mining operation.

Fig. 18 shows a mining operation in which the present invention is applied to the mining of coal which occurs in a relatively thin seam or stratum 140 lying over a layer of clay or other such material 141. In this operation, boring beams 142 of the same construction as those previously described herein are shown as extending into a row of openings 143 of the mine wall 144 for supporting the mine roof in the same manner as explained above. Fig. 18 also shows a main conveyor 145 extending longitudinally adjacent the mine wall 144 to receive the coal removed from the seam 140 after the underlying layer 141 of waste material has been removed. A drilling machine 146 is shown as operating on the underlying layer 141 to remove the same from beneath the coal seam 140. The drilling machine 146 also includes a conveyor 147 by which the waste material from the layer 141 can be discharged over the main conveyor 145 and deposited on the mine floor in an out of the way location outwardly of the main conveyor. After the underlying layer 141 has been thus removed, the coal can be readily removed from a work section of the seam 140 in the manner already explained above.

From the foregoing detailed description and the accompanying drawings it will now be readily understood that this invention provides improved apparatus for mining coal by which the mining operation can be carried out continuously as well as more safely, rapidly and satisfactorily than has heretofore been possible. It will also be seen that the use of the boring beams herein disclosed provides a substantially continuous mine roof-supporting canopy over the work area which will insure safe working conditions and will prevent damage to the mining apparatus. It will also be seen that by the use of the improved apparatus of this invention the mining operation can be carried out continuously in a progressive manner with only a relatively small number of roof-supporting beams and that these beams are used over and over again by advancing them into the mine wall as the operation progresses. Additionally, it will be seen that since the boring beams provide a continuous roof-supporting canopy over the working area, it is not necessary to leave pillars of coal in the mine for supporting the roof and, hence, the amount of coal heretofore lost in these pillars can now be safely recovered. It will also be seen that since the boring beams are advanced from one position to another and the mine roof is permitted to subside into the mined portions of the chamber 18, it is not necessary to leave beams in the mine chamber as has heretofore been necessary for supporting the mine roof and the expense represented by such abandoned beams is avoided.

In addition to the advantages already mentioned, it will be seen that the boring beams support the mine roof so as to minimize the danger of cave-ins and so as to provide a relatively narrow continuously open passage which extends for the length of the conveyor and permits free travel in both directions and a free circulation of ventilating air. By the use of this narrow passage the natural arch is used to advantage in supporting the roof material against cave-in. It will also be seen that this improved mining apparatus is adapted for mining in from an outcrop of coal and for advancing the mining operation into or around a body of coal with the main conveyor having a delivery terminal for the mined coal at the outer entrance of the mine opening. Further, it will be seen that the improved apparatus can be used to mine coal from the outer edge of a coal body or, if desired, can be made to extend through such body. Likewise, this apparatus can be used in mining coal by advancing the operation either in a straight direction into a hill containing a body of coal or by advancing the operation along a curved path extending around a hill.

Although the improved apparatus of this invention have been illustrated and described herein to a detailed extent, it will be understood, of course, that the invention is not to be regarded as being limited correspondingly in scope, but includes all changes and modifications coming within the terms of the claims hereof.

Having thus described our invention, we claim:

1. A mine roof-support beam comprising, an elongated load-bearing member adapted to be supported on a mine wall by engagement of one end thereof in a mounting opening of said wall, said member being of a generally uniform cross-sectional size for substantially its full length, and drill means carried by said member at said one end and having forwardly presented cutting portions located at a radial distance from the longitudinal axis of the beam such that said beam is adapted to form its own mounting opening directly and of beam-receiving size in said wall during a combined rotary and advance movement of said beam into the wall.

2. A mine roof-support beam comprising, an elongated load-bearing member adapted to be supported on a mine wall by engagement of one end thereof in a preformed opening of a beam-receiving transverse dimension in said wall, said member being of a generally uniform cross-sectional size for substantially its full length, drill means carried by said one end of said member and having forwardly presented cutting portions located at a radial distance from the longitudinal axis of the beam such that said drill means is effective for deepening said opening and substantially maintaining said beam-receiving transverse dimension in response to drilling force and movement transmitted through said member while the member remains engaged in said opening, and spiral conveying means connected with said member for actuation thereby and being effective for discharging drillings from said opening.

3. In coal mining apparatus, a plurality of beams disposed in spaced-apart substantially parallel relation and extending laterally outwardly in substantially normal relation to a coal wall

being worked by the progressive advance of a work area and the removal of a work section of given thickness from said wall at said work area, said wall having openings therein adjacent the mine roof of a transverse dimension to receive said beams and of a depth in excess of the thickness of said work section, said beams being supported at one end thereof on said wall by engagement in said openings and adapted to be supported at the other end by prop means such that said beams form a roof-supporting canopy over said work area, said beams extending into said openings for a greater distance than the thickness of said work section so as to remain supported on said wall after the removal of said work section therefrom, drill means carried by the forward end of said beams, said drill means having forwardly presented cutting portions located at a radial distance from the longitudinal axis of the beam such that said drill means is effective for deepening said openings and substantially maintaining the transverse beam-receiving dimension of the deepened openings by a combined rotary and advance movement of the beams while said beams remain engaged in said openings, and metal plate conveying means secured to said beams and extending spirally therealong for actuation thereby and being effective for discharging drillings from said openings.

4. A mine roof-support beam comprising, an elongated load-carrying member formed of longitudinally coextending integrally connected web and flange elements, drill bits mounted on said member to provide forwardly facing cutting elements at one end of said beam such that said cutting elements are adapted to be actuated as a drilling means by rotary and longitudinal movement transmitted thereto through the beam, said cutting elements being at a radial distance from the longitudinal axis of the beam such that an opening formed in a mine wall by said cutting elements will be of beam-receiving transverse dimension, and a conveying means carried by said member and extending spirally thereof, said conveying means being actuated by the same movement of said beam as that which actuates said drilling means.

5. A mine roof-support beam comprising, an elongated load-bearing member having longitudinal edge flanges and an intermediate longitudinal web integrally connecting said flanges, a drill bit having a stem extending along said web and cutting elements disposed so as to project from one end of said beam, said bit being adapted to be actuated as a drilling means by actuating movement transmitted thereto through the beam, and means detachably mounting said bit on said member including a substantially U-shaped portion on the bit and disposed in hooked engagement with said web.

6. In mining apparatus, a plurality of spaced-apart mine roof-support members of the boring beam type having the forward end thereof supported on a mine wall by engagement in openings extending into said wall, said members having drilling means on the forward ends thereof adapting them to deepen there own mounting openings in said wall in response to drilling movement imparted thereto, each of said support members having a first connecting portion on the rear end thereof, a carriage movable along the mine floor from one to another of said support members, connecting means on said carriage adapted for detachable connection with the rear ends of said support members in succession and comprising a second connecting portion, one of said connecting portions having a recess therein and the other of said connecting portions being engageable in said recess, said first and second connecting portions when engaged forming a driving connection between said connecting means and one of said support members for transmitting said drilling movement to the latter, and mechanism on said carriage operable to impart said drilling movement to said connecting means and the support member engaged therewith.

7. In mining apparatus, a plurality of spaced-apart mine roof-support beams supported at the forward end thereof on a mine wall by engagement in openings extending into said wall and provided with drilling means on said forward end adapting the beams to deepen their own mounting openings in said wall in response to drilling movement imparted to the beams, each of said beams comprising connected longitudinal flange and web portions, a carriage movable along the mine floor adjacent said beams, connecting means adapted for detachable engagement with said beams in succession at the rear end thereof to provide a driving connection therewith, said connecting means comprising a yoke member engageable with the web portion of said beams in straddling relation thereto, mechanism on said carriage and operable to move said connecting means into and out of said engagement with said beams, and other mechanism on said carriage for imparting said drilling movement through said connecting means to the beam engaged by the latter.

8. In mining apparatus, a plurality of spaced-apart mine roof-support beams supported at the forward end thereof on a mine wall by engagement in openings extending into said wall and provided with drilling means on said forward end adapting the beams to deepen their own mounting openings in said wall in response to drilling movement imparted to the beams, each of said beams having a first connecting portion on the rear end thereof and an annular journal portion extending therearound adjacent said rear end, a carriage movable along the mine floor adjacent said beams, connecting means adapted for detachable engagement with said beams in succession to provide a driving connection therewith and comprising a second connecting portion, one of said connecting portions having a recess therein and the other of said connecting portions being engageable in said recess, said first and second connecting portions when engaged forming a driving connection between said connecting means and one of said beams for transmitting drilling movement to the latter, bearing means engageable with said beams in succession and providing support for the same during the drilling movement thereof and comprising a forked bearing member engageable with said journal portion in straddling relation thereto from the underside thereof, mechanism on said carriage and operable to move said connecting means and said bearing means into and out of engagement with a selected one of said beams, and other mechanism on said carriage for imparting said drilling movement to said one beam through said connecting means.

9. In mining apparatus, a plurality of spaced-apart mine roof-support beams supported at the forward end thereof on a mine wall by engagement in openings extending into said wall and provided with drilling means on said forward end adapting the beams to deepen their own mounting openings in said wall in response to drilling move-

ment imparted to the beams, each of said beams comprising connected longitudinal flange and web portions, a carriage movable along the mine floor adjacent said beams, a traverse device on said carriage and including a yoke member adapted for detachable driving connection with said beams in succession at the rear end thereof by straddling engagement of said yoke member with said web portion, elevator means on said carriage and operable to move said traverse device into and out of driving connection with a selected one of said beams, and mechanism on said carriage for imparting rotary and axial drilling movement to said one beam through said yoke member.

10. In mining apparatus, a plurality of spaced-apart mine roof-support beams supported at the forward end thereof on a mine wall by engagement in openings extending into said wall and provided with drilling means at said forward end adapting the beams to deepen their own mounting openings in said wall in response to drilling movement imparted to the beams, annular journal means on said beams adjacent the rear end thereof, each of said beams comprising connected longitudinal flange and web portions, a carriage movable along the mine floor adjacent said beams, a traverse device on said carriage and including a yoke member adapted for detachable driving connection with said beams in succession at the rear end thereof by straddling engagement of said yoke member with said web portion, bearing means engageable with the journal means of said beams and providing support for a selected one of said beams during the drilling movement thereof and comprising a forked bearing member engageable with said journal portion in straddling relation thereto from the underside thereof, elevator means on said carriage and operable to move said traverse device to align said yoke member with said one beam and to bring said bearing member into supporting engagement with the journal means of said one beam, said yoke member being movable by said traverse device into said straddling relation to said web portion at the rear end of said one beam, mechanism on said carriage for imparting rotary and axial drilling movement to said one beam through said yoke member, and power actuated prop means on said carriage and including beam elements movable into supporting engagement with the mine roof in adjacent coextending relation to said one beam.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
Re. 18,491	Taber	June 14, 1932
1,052,359	McDonald	Feb. 4, 1913
1,295,320	Humphryes	Feb. 25, 1919
1,588,987	O'Toole	June 15, 1926
1,840,339	Vodoz	Jan. 12, 1932
2,090,355	Miller	Aug. 17, 1937
2,198,163	Gullick	Apr. 23, 1940
2,496,694	Brown	Feb. 7, 1950

FOREIGN PATENTS

Number	Country	Date
83,575	Austria	Apr. 11, 1921
379,975	Great Britain	Sept. 8, 1932
512,214	Germany	Nov. 10, 1930