

Apr. 3, 1923.

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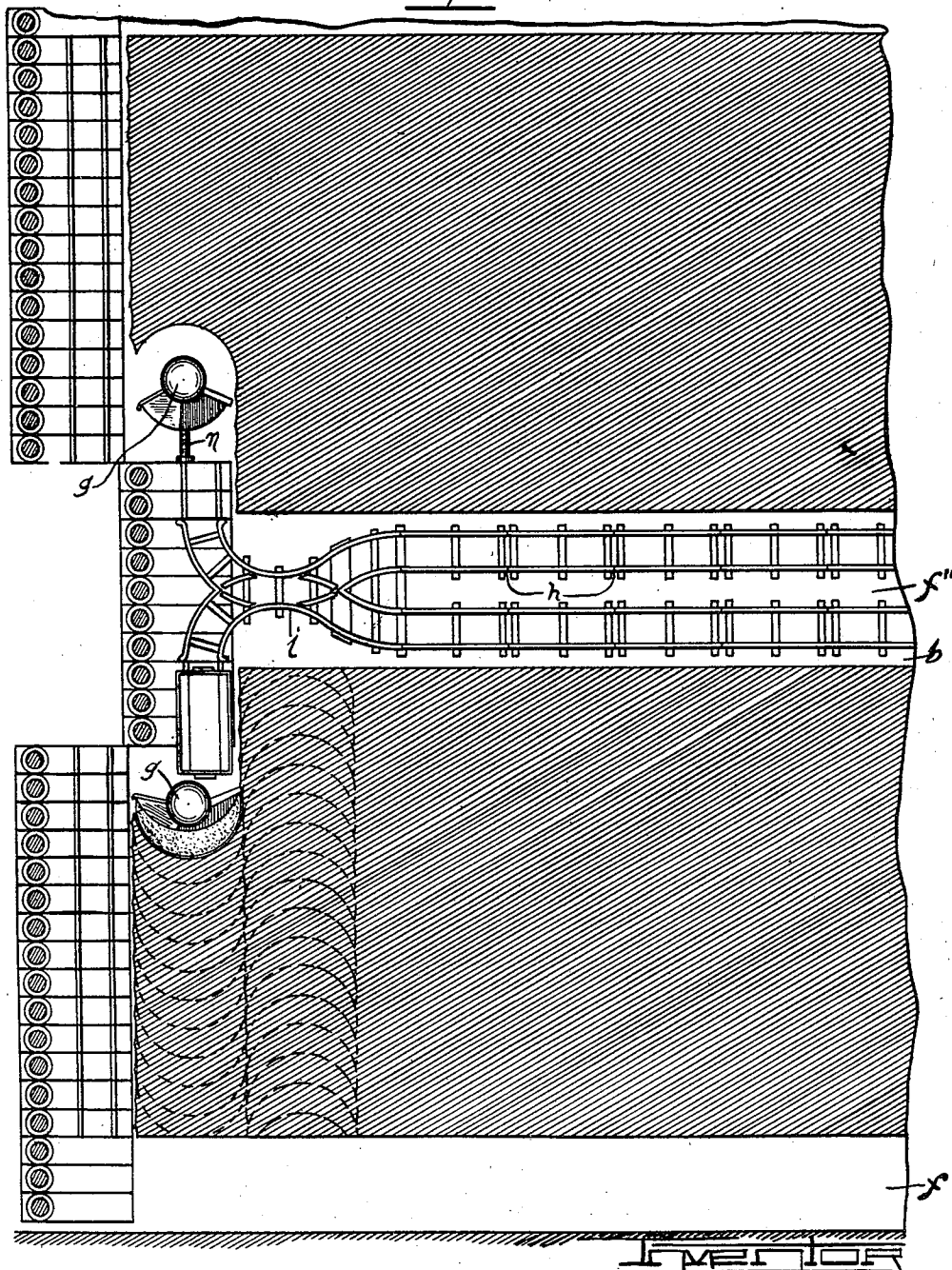
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MINE ROOF SUPPORTING METHOD AND APPARATUS

Original Filed Jan. 5, 1916

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Fig. 1



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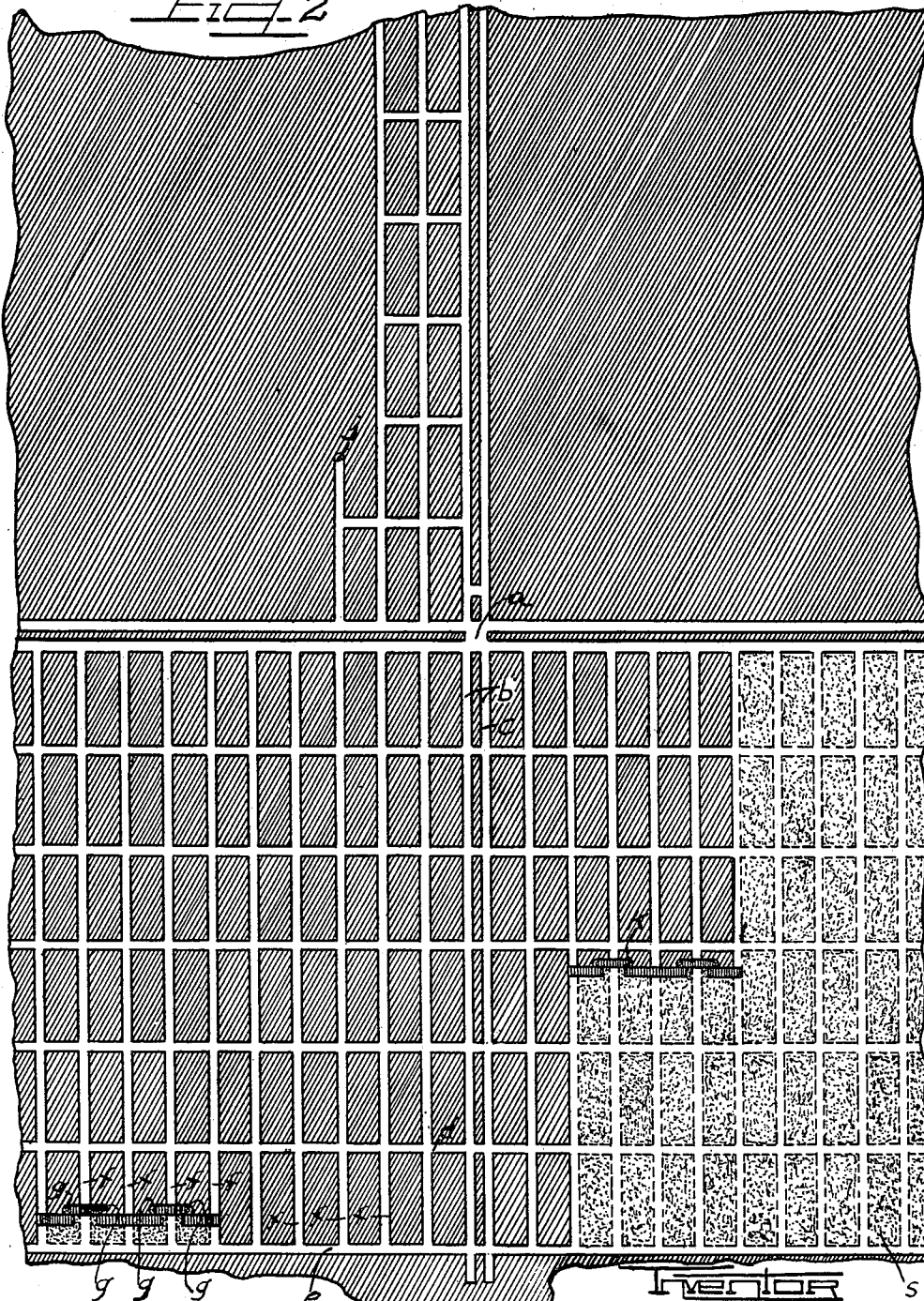
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Fig. 2



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FIG. 3

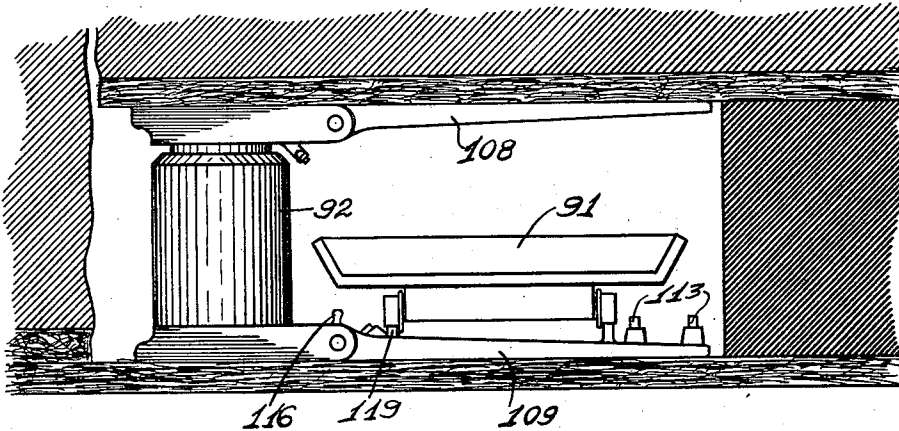
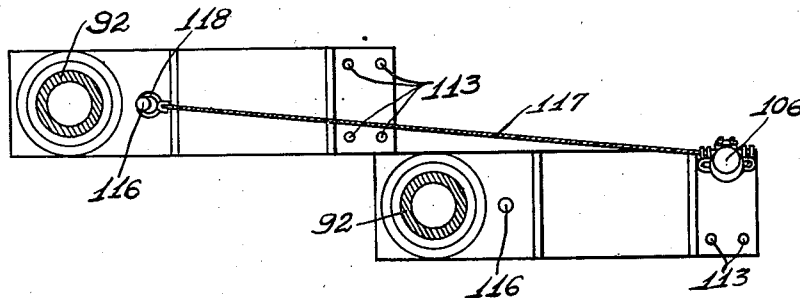


FIG. 4



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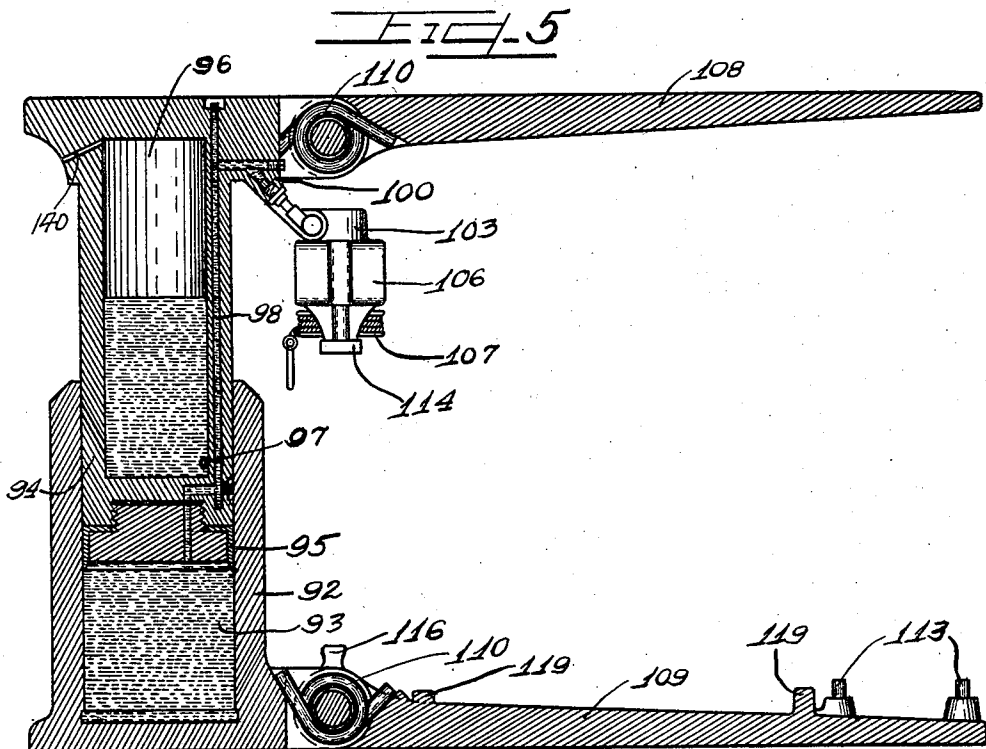
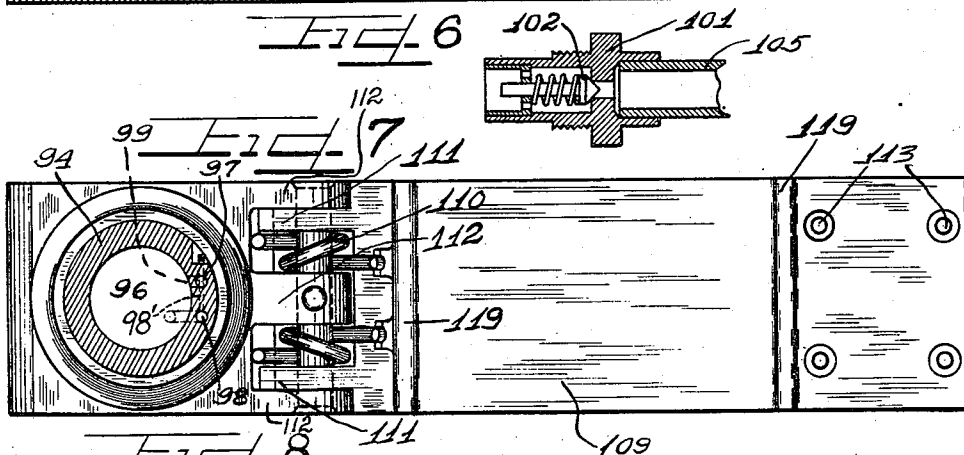
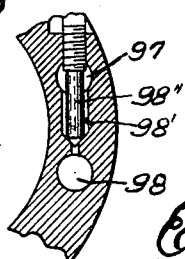
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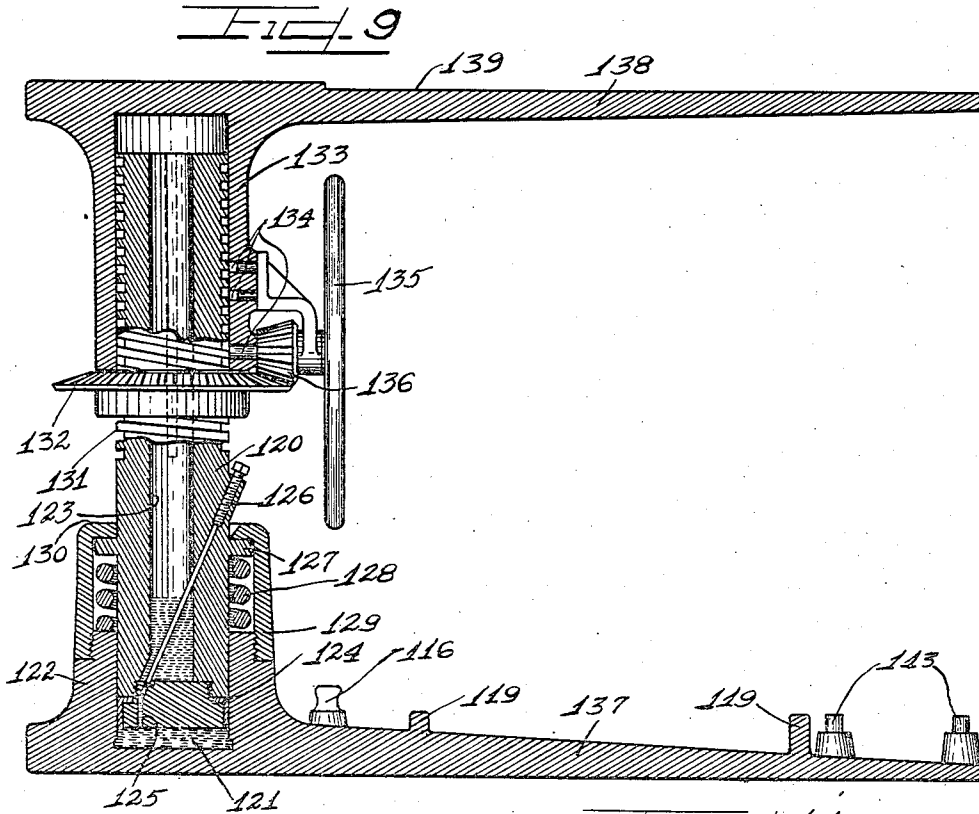
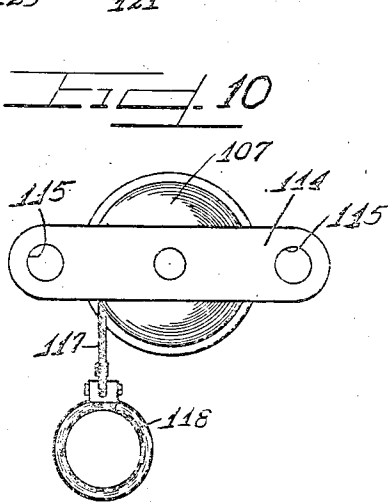
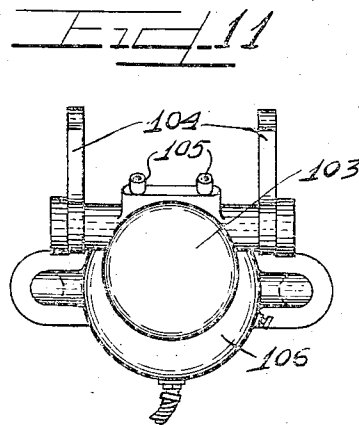
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Original Filed Jan. 5, 1916

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UNITED STATES PATENT OFFICE.

EDMUND C. MORGAN, OF NEW YORK, N. Y.

MINE-ROOF-SUPPORTING METHOD AND APPARATUS.

Original application filed January 5, 1916, Serial No. 70,341. Divided and this application filed September 9, 1922. Serial No. 587,188.

To all whom it may concern:

Be it known that I, EDMUND C. MORGAN, a citizen of United States, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Mine-Roof-Supporting Methods and Apparatus, of which the following is a specification.

This invention relates to improvements in roof-supporting mechanism for use in coal mines and has for its object the provision of mechanism of this character which shall be of novel and improved construction and operation. The invention also contemplates the new system embodying my roof-supporting mechanism.

This invention is exemplified in the combination and arrangement of parts, and the method of operation, illustrated in the accompanying drawings and described in the following specification, and it is more particularly pointed out in the appended claims.

This application is a division of my co-pending application, Serial No. 70,341, filed January 5, 1916, for machines for mining.

In the accompanying drawings—

Fig. 1 is a diagrammatic plan view of a system of mining in which the improved roof-supporting mechanism may be used;

Fig. 2 is a diagrammatic plan view of the arrangement of Fig. 1 illustrating the method of operation on a larger scale;

Fig. 3 is a transverse sectional view of a mine showing a supporting prop used in connection with this invention;

Fig. 4 is a diagrammatic sectional plan view illustrating the method of shifting the supporting props;

Fig. 5 is a vertical sectional view of one form of mine prop used in connection with this invention;

Fig. 6 is a detail view of one of the valves of the prop shown in Fig. 5;

Fig. 7 is a horizontal sectional view of the prop shown in Fig. 5;

Fig. 8 is a detail view of another valve of this prop;

Fig. 9 is a sectional view of a modified form of mine prop;

Fig. 10 is a bottom plan, and

Fig. 11 is a top plan, of a combined pump and windlass used in shifting the mine props as shown in Fig. 4.

In order to carry out the system of min-

ing for which the mining machine illustrated at *g, g* in Fig. 1 is particularly adapted, it is desirable to have an especially constructed mine support. Supports particularly adapted for this purpose are illustrated in Figs. 3, 4, and 5 to 9, inclusive. In Figs. 5 to 8 is shown a hydraulic mine support or prop especially designed for use in connection with the mining system constituting a part of this invention. This support with a hollow base member 92 in which an operating fluid 93 is confined and in which an upper telescoping plunger 94 is mounted for a vertical sliding movement. The telescoping plunger 94 is provided at its lower end with a piston 95, which makes a liquid-tight connection with the interior of the cylinder 92. The plunger 94 has an internal chamber 96 and the wall of this chamber is bored at 97 and 98 to form ducts for the passage of liquid to and from the two telescopic portions of the prop. The duct 98 extends downwardly through the piston head 95 and communicates with the chamber in the base 92. The duct 97 has an opening 99 through the wall of the plunger 94 into the chamber 96. A passage 98' connects the two ducts 98 and 97 near the lower end of the chamber 96 and a valve 98'' is provided for opening and closing this passage, as shown in Fig. 8. The two ducts 97 and 98 are continued outwardly through the lug 100 at the upper end of the prop where they are provided with nipples 101 (Fig. 6) for connection with an operating pump. The nipple connected with the duct 98 is provided with a one-way valve 102 for automatically closing the opening in the duct against outward pressure from the liquid 93 in the interior of the cylinder 92.

A detachable pump 103 (shown diagrammatically) is provided with a pair of hooks 104 by means of which it may be held in position adjacent the openings of the ducts 97, 98. The pump 103 is provided with a pair of projecting tubes 105 which make connection with the nipples 101 when the pump is in operating position. The pump is driven by a motor 106 (shown diagrammatically) to the upper surface of which it is secured, and which also drives a windlass 107 located at the base of the motor.

Extending laterally from the upper and lower portions of the prop is a pair of arms

108, 109. These arms are pivotally connected to the prop at their inner ends and are provided with heavy springs 110 for forcing them away from one another toward the roof and floor, respectively. The amount of movement of the arms 108, 109 is quite limited by reason of the inwardly projecting lugs 111, which fit over corresponding lugs 112 on the mine prop. There is a lug 111 on each side of the central lug 112 and they are spaced apart sufficiently to permit of the limited movement of the arms 108, 109, such as may be desired.

The arms 108 and 109 are in the form of plates extending laterally a distance somewhat greater than the diameter of the props themselves. The lower arm 109 is provided at its outer extremity with a plurality of upwardly projecting lugs 113, there being a pair of these lugs located adjacent each lateral edge of the arm, as shown in Fig. 7.

The motor 106 is provided, as shown in Fig. 10, with a base member 114 having openings 115 therein arranged to fit over the lugs 113 and hold the motor and windlass in position on the arm 109, as illustrated in Fig. 4.

At the inner end of the arm 109 is a boss 116 adapted to receive a ring 118 which is connected to the free end of the cable 117. It will thus be seen that the cable 117 carried by the windlass 107 is provided with a ring 118 arranged to fit over the boss 116, as shown in Fig. 4. The purpose of the windlass and the cable is to move the props relatively to one another in a way which will be clear by referring to Fig. 4.

Between the lugs 113 and the boss 116 and extending transversely of the arm 109 is a pair of upwardly projecting ribs 119 arranged to form a continuous track when a series of props are placed side by side, as illustrated in Fig. 1. A mine car 91 is adapted to travel on such tracks, as shown in Fig. 3. Such tracks formed by the rails 119 are extensions of the tracks *i* which extend to the entry between the ribs of coal which are being mined and loaded.

In Fig. 9 is shown a modified form of my mine prop in which a standard 120 is mounted for vertical movement in an opening 121 in the base member 122. The standard 120 has an internal chamber 123 and is provided with a piston head 124 fitting within the chamber 121. A passage 125 extending through the piston head 124 connects the chambers 121 and 123. The passage 125 may be opened and closed by means of a valve 126 to permit the flow of liquid from one chamber to the other. The standard 120 is provided with a flange 127 which rests upon a heavy coil spring 128 supported by the upper portion of the base 122. A cap 129 has a screw-threaded connection with the upper portion of the base 122 and an in-

wardly projecting flange 130 which bears against the upper surface of the flange 127 on the standard 120.

The upper end of the standard 120 is provided with screw threads 131 on which a bevel gear 132 is threaded. The head 133 of the mine prop telescopes over the threaded portion of the standard and is provided with openings 134 by means of which a detachable hand wheel 135 may be held in position to cause the pinion 136 to mesh with the gear 132 to rotate the gear 132 on the standard 120.

The base 122 is provided with a laterally projecting arm 137 which is similar to the arm 109 of the prop previously described, with the exception that it is made rigid with the base of the prop instead of being pivoted thereto. The head 133 is also provided with a laterally projecting arm 138 which is rigid with the head and which is provided with an offset portion 139, leaving the upper end of the head proper a little higher than the upper surface of the laterally projecting arm.

When a prop of this form is placed in position in a mine chamber, the head is forced upwardly into contact with the roof of the mine by means of the hand wheel 135. The standard 120 is prevented from settling in the base 122 by the liquid in the chamber 121, the valve 126 being closed. After a prop of this character has remained for some time in a mine chamber, the operating parts become set and difficult to move due to slight subsidence of the roof. Therefore, when it is desired to remove the prop, instead of operating the hand wheel 135 the valve 126 is opened and the weight on the head of the prop forces the standard 120 down against the resistance of the spring 128 while the liquid in the chamber 121 goes through the passage 125 into the chamber 123. As soon as the strain upon the screw threads 131 is thus released, the bevel gear 132 may be easily operated to further lower the head of the prop. As the head is lowered the spring 128 will again expand and the liquid will return to the chamber 121 after which the valve 126 may again be closed so that the prop will be in condition for a second operation.

A similar result is accomplished in connection with the prop shown in Fig. 5 by opening the valve 98'' and permitting liquid to flow through the duct 98' from the lower portion to the upper portion of the prop. When the jack shown in Fig. 5 is to be operated to a roof-propping position, the valve 98'' is in closed position so that the pump 103 when it is operated will force the liquid into the chamber 93 to lift the piston or plunger 94. When the pump stops operating the check valve 102 will hold the liquid in the chamber 93 confined and the roof jack

will be locked in anchored position between the floor and roof of the mine chamber. Now, when the valve 98'' is opened, the downward pressure of the roof and the weight of the plunger 94 and the parts mounted thereon will cause liquid to flow from chamber 93 to passage 98 into the passage 97 and thence into the chamber 96. An air vent is provided at 140 which may also serve as an overflow passageway for the liquid in the chamber 96.

The operation of the mining system for which the above described mechanism is particularly adapted may best be understood by referring to Figs. 1, 2, 3 and 4. A shaft *a* is first sunk from the surface of the earth to the level of the vein which is to be mined. The mechanism and system are especially applicable to deep mines where the roof pressure is very great, but they may be used in connection with mining coal at any depth.

From the shaft *a* entries *b* are made through the vein of coal to any desired distance from the shaft, the length of the entries depending upon the conditions of the particular field being operated. A pillar *c* is left between the entries to separate the two in order to provide for better ventilation. Such machines as those illustrated diagrammatically at *g, g* in Fig. 1 may be used in driving entries, the width of any entry being determined by the width of the cut made by the machine. As an entry is driven forward, props like those shown in Figs. 5 and 9 are placed by the side of the entry with the arms extending across the floor and roof forming a lining for both the floor and roof of the entry. The position of the props in the entry may be understood by referring to Fig. 3.

The ribs 119 on the arms 109 form a track over which cars may be run behind the mining machine as it progresses, such cars carrying away the mined material. Practically all the weight of the earth above the entry is borne by the head of the prop, the laterally extending arms 108 being merely for the purpose of preventing dropping of loose portions from the roof of the mine. The coil springs shown at 110 in Fig. 5 which force the arms 108 upwardly will permit the arms to move a sufficient amount to compensate for any unevenness in the roof of the mine chamber and prevent undue pressure on the arms.

After the entries *b* shown (Fig. 2) have been driven a sufficient distance, if it is found desirable, the props may be removed and permanent timbering and tracks substituted. From the main entries *b*, lateral entries *d* and *e* are driven to any desired distance and other entries *f* are run parallel with the main entries *b* for the purpose of facilitating the mining operation. When

this much has been accomplished, a number of machines *g* are operated in conjunction with one another to completely remove the material from the mine.

The procedure by which the material is removed will best be understood by referring to Fig. 1. The entries *f* parallel with the main entries *b* in the preferred method of operation, are only the width of a single cut made by one of the machines. They may be made of greater width, however, in order to accommodate a double track, as shown at *f''* in Fig. 1. Preferably two machines are set to operate simultaneously from alternate entries *f* and may be moved after each cut by air cylinders *n*. As the machines progress across the face of the portions of the vein between the entries, props are placed behind the machines and contiguous to one another to form tracks upon which the cars for removing the material are run. The machines will be operated back and forth across the face of the vein, each movement of the machine across the face of the vein between the entries removing a section of the vein of a width equal to that of a cut made by the machine and contiguous to the space left by the next preceding cut.

As the machines are moved along the face of the vein, the props will be successively drawn from their previous positions into positions directly behind the operating machines. This is done in a manner illustrated in Fig. 4 by means of the motor 106 and the windlass 107. As the props are drawn to their new positions, the roof of the mine from which they are removed is left unsupported and is free to fall into the space from which the coal has been removed. It should be noted that the nature of the mining machine especially adapts it to this method of operation, since the machine has no front or rear but may operate in any direction found desirable. In driving entries, the machine may work in one direction until an entry of sufficient length has been made and then it may continue to operate to drive an entry at right angles to the one already formed, without any turning of the machine whatever. In this way the machine may be turned from one direction to another in the space made by its own cut.

The track used in the entries *f* is made in sections *h* of a length equal to the cut made by one of the machines. After each section of material is removed from the face of the vein, a section *h* of the track is taken up and the switching section *i* of the track is moved to a new position in the entry to correspond to the new position of the machine. If desired, one or more machines *j* may be kept in operation driving the various entries used in connection with this

system of mining. This is not essential, however, and the entries may be driven as needed by the machines used for removing most of the material. Any number of batteries of mining machines may be operated at one time in the mine, a second battery being shown at *k* in Fig. 2. As a battery works inwardly toward the main shaft, the roof of the mine being left unsupported will fall and fill the space from which the coal has been removed, as illustrated at *s* in Fig. 2.

Since the coal is removed right up to the mine entries *b*, the roof in falling will have a tendency to break down the roof of these entries. To prevent this it may sometimes be desirable to form a kerf in the rock above and at the edge of the entry *b*. This may be done by means of a machine of well-known construction. After such a kerf has been formed the coal at the side of the entry may be removed and the earth above this coal in falling will not then draw down with it the roof of the entry, but will fall so as to preserve the entry for such further use as may be desired.

The props used in connection with the machine are of heavy construction and are especially designed for use where the pressure of the earth is very great. While the first cost of construction is greater than that of timbering, the economies effected in the operations of mining as described more than offset such cost. In fact by using these roof props in conjunction with the mining machine the cost of timbering in a mine will be greatly reduced. This is due to the fact that the mining operation is concentrated to a small area and only a comparatively small number of props is necessary in producing a given output from the mine.

The props described and shown in the accompanying drawings are used over and over again for a period covering a number of years, and thus although the first cost of the props is much more than timbering, a great saving is accomplished on the ultimate cost of roof props, and furthermore, timbering is becoming more and more expensive as the cost of timber advances. By use of the mining machines associated with the props in the method of mining herein disclosed, the entire vein of coal is removed from the mine without the necessity of leaving the pillars or timbers in the mine after the working is completed, and the dangers from insecure timbering, and mining operations extending over a large area in order to produce a required output, are practically eliminated.

Obviously those skilled in the art may make various changes in the details and arrangements of parts without departing from the spirit and scope of my invention

as defined by the claims hereto appended and I wish therefore not to be restricted to the precise construction herein disclosed.

Having thus fully disclosed an embodiment of my invention what I desire to secure by Letters Patent of the United States is:

1. The method of mining which consists in dislodging material from the face of a mine vein, forming an elongated roof support adjacent the working face by a series of individual mine props, each self-sustaining and each adapted to slide over the mine floor while retaining itself in upright position, and gradually shifting the line of roof support in accordance with the advance of mining operations.

2. The method of mining which consists of removing from the face of a mine vein sections of material crescent-shaped in plan and continuing to remove such sections along the face of the mine vein, and supporting the roof of the mine during such operation by props moved forwardly into the space formed by the removal of the succeeding crescent-shaped sections, thus effecting the removal of the material in the vein and leaving the roof unsupported after the completion of the mining operation.

3. The method of mining which consists of removing a successive series of crescent-shaped sections of material from the mine vein and supporting the roof along predetermined lines back of the space of mining operations and then gradually changing the roof support along the space through which the mining operations have been carried on.

4. The method of mining which consists of removing material from the face of a mine vein by successive contiguous parallel cuts along said face, placing power-operated extensible roof props closely adjacent each other in a comparatively long series to form a continuous line of roof support to protect the space where mining operations are proceeding on one side of said line of roof support while permitting the subsidence over the space on the other line of said roof support, and then gradually and positively shifting such series of props while remaining in upright positions to new locations while always maintaining a line of roof support to confine such subsidence to the space back of such series of roof props so that subsidence may occur during mining operations and while the series of roof props is being thus gradually shifted to a new location.

5. The process of mining which consists of removing the material from the face of a mine vein by making a plurality of successive contiguous parallel cuts along said face by a machine arranged to be advanced in any direction from a given position and operated by movements back and forth

across the face of said vein, and supporting the roof of the mine during such operation by props moved successively from the space previously occupied by each section of material removed to the space from which each succeeding section is removed.

6. The method of mining which consists of removing crescent-shaped sections of material from the face of a mine vein and forming a roof support along predetermined lines back of the space through which mining operations are carried on and then gradually shifting the support of the roof into the space previously used during the mining operations.

7. The method of mining which consists of removing the material from the face of a mine vein by successive contiguous cuts made by a machine which moves back and forth along said face, supporting the roof of the chamber formed by each cut by a plurality of props placed side by side and having laterally extending arms, and moving said props from each position into a position behind said machine as said machine advances along said face.

8. The method of mining which consists of severing material from a vein by a machine moved back and forth along the face thereof, supporting the roof of the space from which said material is removed by props advanced successively into position behind said machine as said machine is advanced, and transporting the severed material by mechanism moving in the space protected by said props.

9. The method of mining which consists of removing material from the face of a vein in successive sections by a machine moved back and forth across said face, supporting the roof of the mine by props having laterally extending arms and moved successively into position from the space formed by the removal of each section to that formed by the removal of the next section so that the space behind the machine is continuously kept open by said arms to permit removal of material therethrough.

10. The method of mining which consists of removing successive individual sections of material from the face of a mine vein, forming an elongated line of roof support by means of individual anchorages closely adjacent each other to form a series adjacent the working face, shifting the anchorages gradually toward the space from which the material has been removed, forming a covering for such space by extensions from the upper ends of the anchorages and securing the anchorages in such positions as to always form a continuous line of roof support sufficient to confine subsidence of the roof back of such line of roof support and thereby protect the space where mining operations are being carried on.

11. The method of mining which consists of removing successive individual sections of material from a mine vein, forming a continuous line of roof support by means of individual anchorages placed closely adjacent in a lone series, gradually shifting the line of roof support into the space occupied by the mining operations, and simultaneously with such shifting laying track sections supported on extensions from the lower ends of said anchorages.

12. The method of mining which consists of successively removing individual sections of material from the face of a mine vein, forming a flexible line of roof support by means of individual closely adjacent anchorages arranged in a series at a predetermined distance from the working face, gradually shifting the line of support into the space previously occupied by the mining operations while maintaining support of the roof to confine roof subsidence back of the line of support and protecting the space where mining operations are being carried on, and simultaneously with such shifting extending and shifting a roof covering between the line of support and the mine vein while also laying track sections connected to extensions from the lower ends of said anchorages.

13. The method of mining coal which consists of removing successive crescent-shaped sections of coal from the coal face, forming a line of roof support by means of individual anchorages closely adjacent in a series spaced back from such coal face, forming a roof covering by means of extensions from the upper ends of said anchorages toward the coal vein, laying a track by sections on extensions from the lower ends of said anchorages, and gradually shifting the line of roof support toward the coal vein while the mining operations proceed and simultaneously shifting the roof covering and laying the track sections by moving them toward the coal vein.

14. The method of mining which consists of removing successive individual sections of material from the face of a mine vein, forming an elongated roof support adjacent the working face of the mine vein by a series of individual mine props arranged contiguous to one another forming a covering for the space between the line of roof support and the face left by continuous mining operations, and gradually shifting the line of roof support in accordance with the advance of mining operations.

15. The method of mining which consists of removing successive sections across the face of a mine vein, supporting the roof adjacent the face being worked by a series of contiguous props arranged along said face, and moving the props successively into the space opened by the removal of each section of material, by means of a haulage device

operating between a prop already in place in the newly opened space and the prop next in order to be moved.

16. A portable mine prop comprising an upright supporting standard and an arm extending laterally from the head thereof to cooperate with similar arms on other portable mine props when placed side by side therewith to form a temporary contiguous mine roof.

17. A portable mine prop comprising an upright supporting standard and a pair of arms extending laterally from the head and base thereof respectively to cooperate with similar arms on other portable props when placed side by side therewith to form a temporary continuous roof and floor for a mine chamber.

18. A portable mine prop comprising an upright supporting standard having a head arranged to receive substantially all of the weight supported by said prop and having an offset arm extending laterally from said head to intercept material that may fall from the roof of a mine supported by said prop.

19. A mine prop comprising an upright standard having a head for receiving the weight of a mine roof and having an arm extending laterally from said head and pivotally connected thereto and provided with resilient means for holding said arm in angular relation with said standard.

20. A mine prop comprising an extensible standard having a chamber therein arranged to confine liquid to support the weight carried by said standard, a supplemental chamber connected to said first-named chamber, means for controlling the flow of liquid from one chamber to the other, and means for automatically extending said standard when the prop is in released position and the liquid is free to flow from one chamber to the other.

21. A mine prop comprising a standard having an extensible section, extending means for anchoring the prop, a hydraulic abutment between said sections, means for releasing said hydraulic abutment to permit longitudinal contraction of the prop independently of said extending means to secure release of said prop, and resilient means for extending said standard when said abutment is released and when said mine prop is released.

22. A mine prop comprising an upright supporting standard, a base, and an arm extending laterally from said base and provided with ribs arranged to form a track when a plurality of said props are placed side by side with one another.

23. In a system of mining, the combination with a series of roof-sustaining jacks located closely adjacent successively in alignment with each other, of means individual to each of said jacks for operating the same,

and mechanism for moving said jacks forwardly into a new series in alignment with each other.

24. In a system of mining, the combination with a multiplicity of independently movable roof-sustaining jacks located in series in alignment each closely adjacent the next, of means individual to each of said jacks for operating the same, and means adapted to be connected between an anchored jack and a released jack for adjusting the position of the latter in a new series in alignment arrangement of the props.

25. In a system of mining, the combination with a plurality of jacks adapted to form a line of roof support in a mine, of portable mechanism adapted to be connected between two jacks to adjust the positions of the jacks, and means for operating the jacks to anchor the same after being moved into adjusted position to form part of a new line of roof support.

26. In a system of mining, the combination with a series of jacks successively in sliding engagement with each other, of means for operating said jacks, and means for successively moving said jacks into a new series in alignment.

27. In a system of mining, the combination with a plurality of jacks adapted to be arranged in a mine to form a line of roof support, of means for operating said jacks to anchor the same to hold such line of roof support, and rope-winding mechanism comprising a rope-winding drum adapted to be mounted on one jack and a rope adapted to have its free end connected to another jack to shift the latter into a new line of roof support.

28. In a system of mining, the combination with a series of jacks substantially parallel with each other and in substantial alignment laterally, of means individual to each jack for operating the same, and means for moving the jacks one at a time into a new series in substantial parallel alignment with each other and substantially in lateral alignment.

29. In a system of mining, the combination with a plurality of jacks successively in sliding engagement with each other, of means for operating said jacks, and means for pulling a released jack to slide it along an anchored jack to a new position at the side thereof.

30. In a system of mining, the combination with a plurality of jacks in lateral alignment, of means for operating said jacks, and mechanism for pulling said jacks successively forward into new positions also in lateral alignment to each other.

31. In a system of mining, the combination with a multiplicity of jacks, of means for operating the same, and means mounted on one jack while the latter is anchored and

extending to another jack for sliding the latter to a new position.

32. In a system of mining, the combination with a plurality of jacks, of means for operating the same, a portable windlass adapted to be mounted on any of the jacks, a rope extending from such windlass to another jack, and means for operating the windlass to pull the rope and slide the jack to a new location.

33. In a system of mining, the combination with a plurality of jacks, of means for operating the same, a portable motor, a windlass connected to said motor, means for holding said motor and windlass on one of said jacks, and a rope extending from said windlass to another jack.

34. In a system of mining, the combination with a plurality of jacks, of means individual to each of said jacks for operating the same, a portable motor, a windlass connected to said motor, lugs for holding said motor and windlass on one of said jacks while the latter is in fixed position, a rope connected to one end of said windlass, and means for connecting the free end of said rope to a released jack to effect movement thereof in the operation of said motor into lateral alinement with the jack having the motor and windlass thereon.

35. In a system of mining, the combination with a series of parallel groove sustaining jacks in lateral alinement with each other, of means individual to said jacks for operating the same, forward floor extensions connected to said jacks and parallel to each other, transverse rails on each of said extensions to form a track for a mine car when said jacks and extensions are in lateral alinement with each other, and means for moving released jacks successively forward to new positions for the laying of a new track and the operation of said jacks in adjusted positions.

36. In a system of mining, the combination with a series of parallel jacks in lateral alinement with each other, of means for operating said jacks, a plurality of forward extensions one connected to each of said jacks and parallel to each other, two spaced-apart rails extending across said extensions and in alinement to form a track, a portable motor, a windlass connected to said motor, a frame for carrying said motor and windlass, means on each of said extensions to cooperate with said frame to hold the motor and windlass in fixed position on any one of said extensions, a rope wound on said windlass and having its inner end connected thereto, and means on each jack for connection to the free end of said rope to effect the successive forward movement of said rail sections and said jacks to lay a new track and adjust the jacks to new positions.

37. The combination with a series of

track sections, of means associated with each track section for anchoring it in a mine, and means for placing the track sections one after another into alinement by moving one track section in front of an anchored section to extend the track for a movement of a mine car to a position for receiving mined material.

38. The combination with a series of track sections, of a series of roof jacks one connected to each of said track sections and movable bodily therewith over a mine floor, and means connected between a track section for moving the next forward track section together with its roof jack over to a position to extend the track for movement of a mine car to a position for receiving mined material.

39. In mining apparatus, the combination of a roof-sustaining hydraulic jack, and a portable motor-operated pump detachably connected to the outside of said jack for operating the latter to roof-sustaining position.

40. In mining apparatus, the combination of a roof-sustaining hydraulic jack, and a detachable pump adapted to be hooked to the exterior of said jack for operating the latter to roof-sustaining position.

41. In mining apparatus, the combination of a roof-sustaining hydraulic jack, a detachable pump adapted to be connected to the exterior of said jack, and a check valve permitting flow of liquid into the jack from said pump and preventing return flow.

42. In a hydraulic roof jack for mines, the combination with an upright standard comprising a cylinder and a hollow plunger, of a passageway for establishing communication between said cylinder and the interior of said hollow plunger, a valve for controlling the opening and closing of said passageway, a check valve in a passageway leading from the exterior of said jack to said first-named passageway, and a pump adapted to force liquid past said check valve into said cylinder to operate the jack to roof-sustaining position, said valve when opened permitting the liquid to pass from said cylinder into said hollow plunger to effect release of the jack.

43. In a hydraulic roof jack for mines, the combination with a cylinder and a hollow plunger, of a passageway establishing communication between said cylinder and the interior of said hollow plunger, a valve at the upper end of said passageway for opening and closing the communication between the cylinder and the plunger, a pair of passageways spaced apart and extending to the exterior of the plunger, a pair of check valves one in each of said passageways extending to the exterior as aforesaid, and a pump having a pair of connections adapted to be placed in communication with said

passageways to pump liquid out of the plunger and force it into the cylinder to operate the roof jack, said first-named valve when opened permitting flow of liquid from the plunger into the cylinder to release the roof jack.

44. In a hydraulic roof jack for mines, the combination with a cylinder and a hollow plunger, of a pair of vertical spaced-apart passageways extending through the walls of the plunger one into the chamber within the plunger and the other to the chamber within the cylinder, a manually operated valve at the upper end of the plunger for opening and closing the communication between the cylinder and the plunger through said passageways, and a pump adapted to be connected to the exterior of the plunger for pumping liquid into the cylinder to operate the jack to roof-sustaining position when said valve is closed, said valve when in open position permitting flow of liquid from said cylinder to said plunger to effect release of the roof jack.

45. In a hydraulic roof jack for mines, the combination with a cylinder, of a plunger extending therein, a valve in said plunger adapted when in closed position to lock liquid in said cylinder, a roof-engaging shoe on said plunger, a pump detachably connected to the exterior of the jack for moving the shoe against the roof of the mine chamber when said liquid is locked in said cylinder, and means for opening said valve to permit the flow of liquid from said cylinder into said plunger and thereby automatically release said shoe from said roof.

46. In a hydraulic roof jack for mines, the combination with a cylinder and a plunger, of means for limiting the relative movement of said cylinder and plunger, a spring tending to move said plunger out of said cylinder, a valve for controlling the flow of liquid from said cylinder into said plunger, a roof-engaging shoe mounted on the upper end of said plunger, and means for moving said shoe upwardly to roof-engaging position.

47. In a hydraulic roof jack for mines, the combination with a cylinder, of a plunger having two vertical spaced-apart passages in the outer portion thereof, one communicating with said cylinder and the other with a chamber within said plunger, a valve for closing the communication between said cylinder and said chamber, and pumping mechanism for operating the plunger.

48. The method of mining which consists of cutting successive crescent-shaped sections of coal from the ends of adjacent pillars, forming a continuous roof support along predetermined lines adjacent the working faces, and gradually shifting such line of roof support into the space previously occupied by the mining operations.

49. The method of mining which consists of cutting successive crescent-shaped sections of coal from the rear ends of pillars having an entry between them, forming a continuous line of roof support back of the said pillars and back of said entry, and gradually shifting such line of roof support toward said entry and toward the space previously occupied by the mining operations along the rear ends of said pillars while extending tracks leading from such entry to the spaces where mining operations are being carried on.

50. In a system of mining and loading, the combination with a mining machine movable successively along the face of a mine vein to sever successive sections of material from said face, said mining machine comprising means for severing material regardless of the direction in which the mining machine is moved to a new location, a plurality of mine supports successively movable into position behind said mining machine into the space from which sections of material have been removed by said mining machine, a section of a track carried by each of said mine supports, means for moving said mine supports one at a time to new locations to effect the laying of a track for a mine car to a position adjacent said mining machine, and loading apparatus associated with said mining machine to take the severed material from the mine wall to a loading position at a mine car on said track.

51. In a system of mining and loading, the combination with a mining and loading machine, of a series of track sections, means associated with each track section for anchoring it in the mine, and means for placing the track sections one after another into alignment in the path of the mining and loading machine by moving one track section in front of an anchored section to extend the track for the movement of a mine car to a position for receiving material from said mining and loading machine.

52. In a system of mining and loading, the combination with a mining machine, of a series of track sections, a series of roof jacks, one connected to each of said track sections and movable bodily therewith over the mine floor, means connected between a track section, anchored back of the mining machine for moving the next forward track section together with its roof jack over to a position back of the mining machine to extend the track for movement of a mine car to a position adjacent the rear of said mining machine, and loading apparatus associated with said mining machine for taking the severed material from the mine wall and moving it to loading position into a mine car on said track.

53. In a system of mining and loading, the combination with a mining machine mov-

able successively along the face of a mine vein in position to sever successive sections of material from said face, a plurality of mine supports successively movable into position behind said mining machine into the space from which sections of material have been removed by said mining machine, and means between said mining machine and each of said mine supports in succession for moving said mining machine step by step to new locations in accordance with the successive movement of the mine supports into position behind the mining machine.

54. In a hydraulic roof jack for mines, the combination with a cylinder and a plunger, of means for limiting the relative movement of said cylinder and plunger, automatic means tending to move said plunger out of said cylinder, a valve for controlling the flow of liquid from said cylinder into a separate chamber, a roof-engaging shoe on the upper end of said plunger, and means for moving said shoe upwardly to roof-engaging position when said valve is closed to lock the liquid in said cylinder to form a hydraulic abutment for said plunger.

55. In a hydraulic roof jack for mines, the combination with a cylinder and a hollow plunger having a chamber therein, of means connected between said cylinder and said plunger for limiting the relative movement between the same, a spring tending to hold the plunger in such limiting position relative to said cylinder, a valve for controlling the flow of liquid from said cylinder into the chamber in said plunger, a roof-engaging shoe mounted on the upper end of said plunger, and means for moving said shoe upwardly to roof-engaging position when said valve is closed, said plunger being moved downwardly by the pressure of said roof against the action of said spring upon the opening of said valve, and said spring acting to restore the relative positions of the plunger and cylinder when said moving means is operated to fully release the roof-engaging shoe.

56. In a hydraulic roof jack for mines, the combination with a cylinder, of a plunger movable therein, an annular collar on said plunger, means comprising an annular flange mounted on said cylinder in position to be engaged by said collar for limiting the outward movement of said plunger from said cylinder, a spring between said cylinder and said collar to urge said collar against said flange, a valve for controlling the flow of liquid from said cylinder into a chamber in said plunger, a roof-engaging shoe mounted on said plunger for upward movement relatively thereto, and gearing connected between said plunger and said roof-engaging shoe for operating the latter to roof-engaging position while said valve is

closed to confine liquid in said cylinder to form a hydraulic abutment.

57. In mining apparatus, the combination of an elongated roof support comprising a multiplicity of individual roof props each adapted to be self-sustaining in upright position for movement over the mine floor into adjusted location, of means individual to said props for operating them to anchored positions to form such elongated roof support, and mechanism for moving the props to new locations when released and while in upright positions.

58. In a mining apparatus, the combination with a series of individual roof props adapted to be located closely adjacent each other to form a roof support along a predetermined line, of means individual to said props for operating them and mechanism connected between an advanced anchored prop and a released prop to shift the latter gradually to a new location along a new line of roof support while always maintaining the continuity of a line of roof support.

59. In mining apparatus, the combination with a prop, of hauling mechanism for shifting the position of said prop, a pump for operating said prop, and a motor connected to both said hauling mechanism and said pump.

60. In mining apparatus, the combination with a multiplicity of individual roof props each adapted to rest on the floor by gravity and be located between the floor and roof of a mine chamber to form a continuous comparatively long series in position to support the roof to protect the space for mining operations on one side of said series and to control the subsidence of the roof along the space on the other side of said series, and mechanism for moving said props one after another away from the space where the roof is to subside toward the space where mining operations are proceeding to maintain the series of supports along a line spaced approximately a predetermined distance from the place of mining operations.

61. In mining apparatus, the combination with a multiplicity of extensible roof props each comprising a supporting frame slidable over the floor of a mine chamber and capable of holding the prop in upright position, said extensible props being located closely adjacent each other in a comparatively long series to form a roof support to protect the space where mining operations are proceeding on one side of said line of supports and control the subsidence of the roof over the space on the other side of said line of supports, self-acting power mechanism for operating said roof props individually to secure the same in roof-propping positions between the floor and roof of the mine chamber, and mechanism for shifting each of said props individually to a new location by

sliding its frame over the floor of a mine chamber while said prop retains its upright position and is released from the roof while the remaining props are in roof-propping position.

62. In mining apparatus, the combination with a hydraulic roof jack comprising a frame adapted to slide over a mine floor and support the hydraulic roof jack in upright position, of hauling mechanism adapted to be connected to said frame to slide the same over the mine floor for shifting the position of the roof jack, a pump mounted on said roof jack in position to operate the latter to secure the same in roof-propping position between the floor and roof of a mine chamber, and a motor connected to both said hauling mechanism and said pump for operating the same.

63. In mining apparatus, the combination with a supporting frame, of a hydraulic roof jack spaced from said frame, means mounted on said frame and adapted to be connected to said roof jack to effect shifting of the latter to a position adjacent said frame, and means mounted on said frame in position to be connected to said hydraulic roof jack for operating the latter to anchor the same between the floor and roof of a mine chamber when said roof jack is adjacent said frame.

64. In a system of mining, the combination of an elongated narrow base frame rigid throughout and adapted to rest on and slide over a mine floor, of roof-supporting mechanism mounted on said base frame and comprising a roof-engaging shoe, and means for controlling the operation of said roof-supporting mechanism.

65. In a system of mining, the combination with a series of roof-sustaining jacks adapted to form a line of roof support, of means individual to each of said jacks for controlling the operation thereof, and mechanism for moving said jacks one at a time while in released position to a new location to gradually shift such line of roof support.

66. In a system of mining for controlling roof subsidence, the combination with a plurality of independently movable roof-sustaining jacks, of means individual to each of said jacks for controlling the operation thereof, and means extending from a fixed jack to a released jack for adjusting the position of the latter for establishing a line of roof support to predetermine the break line of roof subsidence.

67. In a system of mining for controlling roof subsidence, the combination with a plurality of jacks arranged to form a predetermined line of roof support, of means for operating said jacks, and mechanism for adjusting the positions of said jacks to shift such line of roof support and confine roof subsidence to one side of such line.

68. In a system of mining, the combination with a series of jacks successively in sliding engagement with each other, means for operating said jacks, and means for successively moving said jacks into a new series alinement.

69. In a system of mining, the combination with a plurality of jacks each having an elongated floor shoe and an elongated roof shoe, of means for operating said jacks, and mechanism for moving one jack into lateral alinement with another jack with said shoes in parallelism with each other.

70. In a system of mining for controlling roof subsidence, the combination with a series of jacks substantially parallel with each other and in substantial alinement laterally to form a line of roof support, of means individual to each jack for operating the same, and means for moving the jacks gradually into a new series in substantial parallel alinement with each other and substantially in lateral alinement to maintain at all times a line of roof support.

71. In a system of mining for controlling roof subsidence, the combination with a plurality of roof jacks parallel to each other to form a line of roof support, of means for operating said jacks to anchoring positions to maintain such line of roof support, and means for pulling a released jack into a new position toward forming a new line of roof support.

72. In a system of mining, the combination with a plurality of jacks in lateral alinement and adapted to form a line of roof support, of means for operating said jacks to anchor and maintain anchored nearly all of them, and mechanism for moving successively a very small percentage of the jacks into new positions for re-anchoring to form a new line of roof support.

73. In a system of mining for controlling roof subsidence, the combination with a plurality of jacks adapted to form a line of roof support, of means for operating said jacks to maintain nearly all of them always in anchored position, and means mounted on one jack and extending to another for moving the latter to a new position.

74. In a system of mining, the combination with a plurality of roof jacks, of means for operating the same to maintain a line of roof support during mining operations, a motor mounted on one of said jacks, and an actuating connection between said motor and another jack.

75. In a system of mining, the combination with a plurality of props arranged side by side to form a line of roof support, of means for operating said props to maintain nearly all of them in roof-propping position to maintain such line of roof support, and mechanism carried by the props them-

selves for changing the positions thereof a small percentage thereof at a time.

76. In a system of mining, the combination with a self-sustaining roof jack adapted to rest on and move over a mine floor, of means for operating said jack to roof-propping position, a motor mounted on said jack, and means connected to said motor and adapted to be connected to an anchorage to effect shifting of said jack to a new location when in released position and supported on the mine floor.

77. In a system of mining, the method which consists in dislodging coal from the face of a mine vein by means of a mining machine forming a line of roof support by means of self-sustaining jacks, between the space where mining operations are carried on and the space where the roof may subside, and gradually shifting such line of roof support as mining operations proceed by moving only a small percentage of the said jacks at a time while the others remain in roof-propping position.

78. In a system of mining, the method which consists in removing coal from the face of a mine vein by means of a battery of machines capable of advancing in any direction and working in unison in retreating operations, and controlling the subsidence of the roof by maintaining a line of roof support by means of self-sustaining roof jacks individually slidable over the mine floor, and gradually changing such line of roof support in accordance with mining operations by sliding only a small percentage of such roof jacks at a time to new locations while maintaining the others anchored.

79. In a system of mining, the method which consists in performing retreating operations to remove material from a mine vein, and supporting the roof of the space thus formed, by a plurality of mine supports set side by side in successive slidable engagement and shiftable to new locations to control the subsidence of the roof at the worked-out spaces.

80. In a system of mining, the method which consists in removing sections of material from a mine vein, supporting the roof adjacent the place of mining by a series of contiguous slidable upright props arranged in a series, and moving the props successively into the space opened by the removal of the material from the mine vein and thereby controlling the subsidence of the roof on that side of the series of roof prop opposite the place of mining.

81. In mining apparatus, the combination with a plurality of mine props arranged side by side parallel with the face of the mine vein, of forwardly extending arms carried by said props, transporting means adapted to be carried by said arms for movement

parallel with the face of the mine vein, and a mining machine in position to operate on such face to dislodge material from the mine vein for said transporting means.

82. In a system of mining, the combination with two mining machines adapted to be located in a mine chamber for operation on the rear ends of two spaced-apart pillars in the mine, of a series of roof jacks movable forward individually to new locations in series with each other near the mining machines but spaced therefrom, extensible tracks one between each mining machine and the series of roof jacks, such tracks being extensible to positions adjacent the operating positions of said mining machines from time to time as the mining proceeds to permit mine cars to be loaded with material in proximity to the mining machines, and a mine track between the pillars connected to the tracks extended back of the pillars.

83. In a system of mining, the combination with a mining machine, of a series of roof props each self-sustaining by being maintained upright by gravity while resting on the floor in released position and each movable forward individually to new locations in series with each other near the mining but spaced therefrom, and an extensible track between the roof props and the face of the mine vein in position to direct a mine car into proximity to said mining machine.

84. In a system of mining, the combination with a mining machine, of a series of closely adjacent roof props movable toward a mine vein individually to new locations in series with each other near the mining machine at the working face, and track sections between the roof props and the mine vein adapted to be moved toward the mine vein to extend a track between the roof props and the vein to a position in proximity to the working position of said mining machine.

85. In a system of mining and loading, the combination with a mining machine having a predetermined path of travel step by step to new mining positions, of roof-supporting mechanism, forwardly projecting mechanism connected to the lower portion of said roof-supporting mechanism, and track sections carried by said forwardly projecting mechanism to extend a track for a mine car to be moved to a loading position in proximity to said mining machine.

86. In a system of mining, the combination with a mining machine, of a series of roof supports back of said mining machine and spaced therefrom to afford a passageway approximately parallel to the face of the mine wall, and track sections carried by said roof supports and movable with the same toward the mine vein for laying a track for a mine car to be moved thereon into proximity with the mining machine.

87. In mining apparatus, the combination

with a multiplicity of power-operated extensible roof props each comprising a frame movable over the floor of a mine chamber, said extensible props being located closely adjacent each other in a comparatively long series to form a continuous line of roof support to protect the space where mining operations are proceeding on one side of said line of roof support, while permitting the subsidence of the roof over the space on the other side of said line of roof supports, of power mechanism for operating said roof props to secure the same in roof propping positions between the floor and the roof of the mine chamber, and power mechanism for gradually and positively shifting such series of props to a new location while always maintaining a line of roof support to confine such subsidence to the space back of such series of roof props so that subsidence may occur during mining operations and while the series of roof props is being thus gradually shifted to a new location.

88. In a system of mining, the combination with an anchoring jack having spaced-apart shoes adapted to engage spaced-apart abutments, and a covering plate permanently connected to one of said shoes and extending radially therefrom a sufficient distance to span the space necessary for the free movement of mine cars on tracks of the usual gauge extending at right angles to such radial plate.

89. In a system of mining, the combination with a roof jack adapted to be anchored between the floor and roof of a mine chamber and comprising a floor shoe and an extension having a width approximately equal to the width of said roof jack and permanently connected to said floor shoe in position to form a floor covering to span a space necessary for the passage of mine cars on a mine track of the usual gauge extending at right angles to such extension.

90. In a system of mining, the combination with a roof jack having a roof engaging shoe, and a permanent extension from said shoe of a length sufficient to span the space necessary for the passage of mine cars on a mine track of the usual gauge extending under such extension and transversely thereof, said permanent extension on said shoe being bodily movable with the latter into position to form a roof covering above the said space.

91. In a system of mining, the combination of a series of roof props each comprising a roof engaging shoe adapted to be brought into close proximity with each other, and elongated extensions one from each of said shoes and in parallelism with each other to form an extended roof covering adjacent the series of roof props to span the space

necessary for the passage of mine cars on a mine track of the usual gauge extending along such space transversely of such parallel extensions.

92. In a system of mining, the combination of a series of roof props each having a floor engaging shoe adapted to be brought into close proximity with each other, and elongated extensions one from each of said floor shoes and in parallel with each other to form an extended floor covering adjacent such series of roof props to span the space necessary for the passage of mine cars on a mine track laid transversely of said extensions.

93. In a system of mining, the combination with a plurality of roof jacks, of detachable portable self-contained automatic power-operated apparatus adapted to be connected between one jack and another jack for moving them relatively to each other, and means mounted on said jacks for enabling said self-contained apparatus to be attached and detached at will.

94. In a system of mining, the combination of a roof jack and a table having a width approximately equal to the width of the roof jack and connected to the latter to move bodily therewith in position to extend along the roof to intercept material that may become detached from the roof adjacent such roof jack, said table being of sufficient length to span the space necessary for the passage of mine cars on a mine track of the usual gauge laid along such space transversely of such table.

95. In a system of mining, the combination of a roof jack, of a flat bottomed plate extending radially from the bottom thereof to form a floor covering, and resilient means for urging said plate against the floor when said jack is in roof-propping position.

96. In a system of mining, the combination with a roof jack, of a flat top plate extending radially from the upper end of said jack to form a roof covering, and resilient means for urging said plate against the roof when said roof jack is in roof-propping position.

97. In a system of mining, the combination with a series of roof supports each having an elongated base adapted to engage the floor of a mine chamber over a comparatively large area, of means for connecting each roof support to the next adjacent roof support, and mechanism mounted on each roof support for shifting longitudinally the position of the next adjacent roof support by means of such connections.

In testimony whereof I have signed my name to this specification on this 7th day of September A. D. 1922.

EDMUND C. MORGAN.