

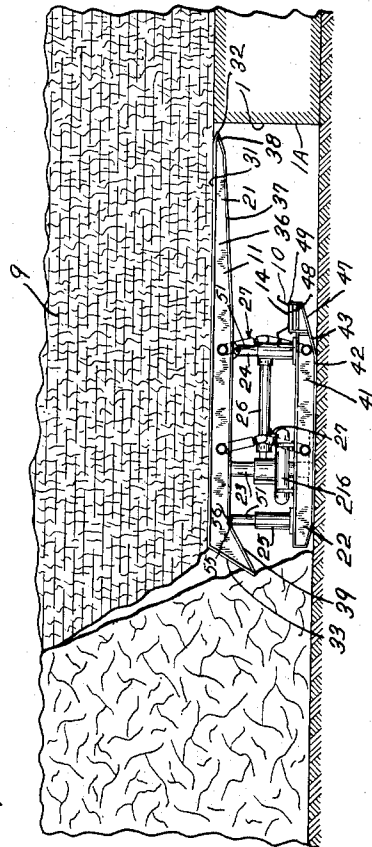
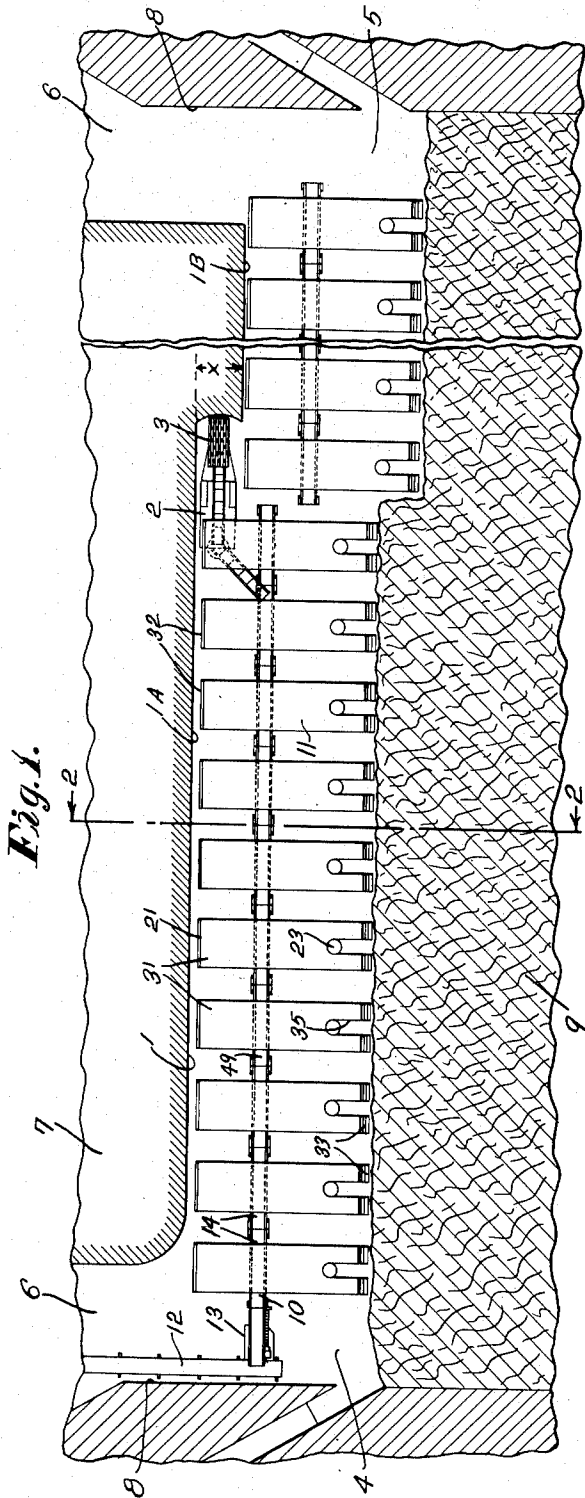
Oct. 27, 1953

J. F. JOY
WALKING JACK

2,657,028

Filed June 15, 1949

7 Sheets-Sheet 1



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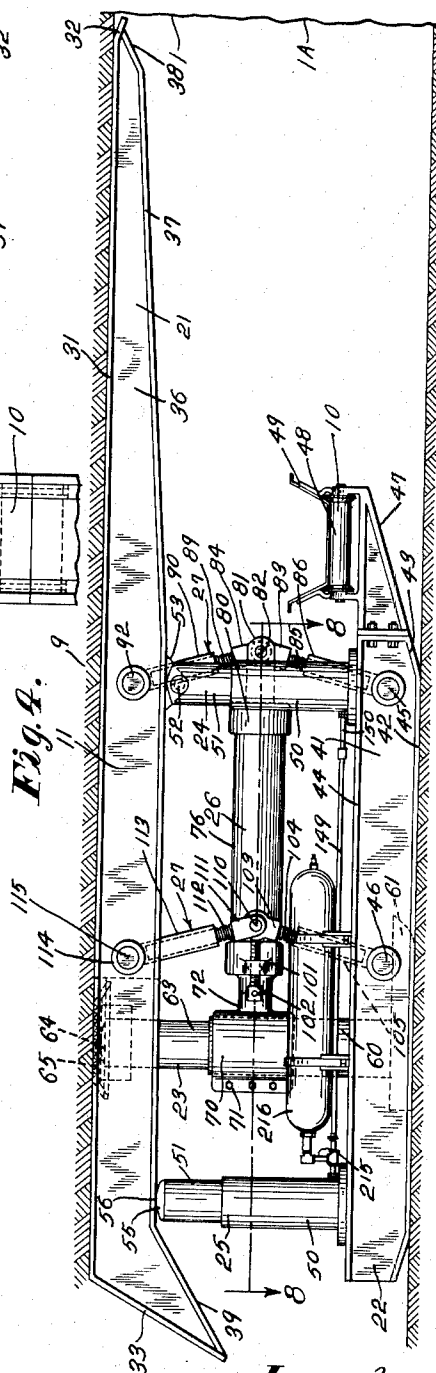
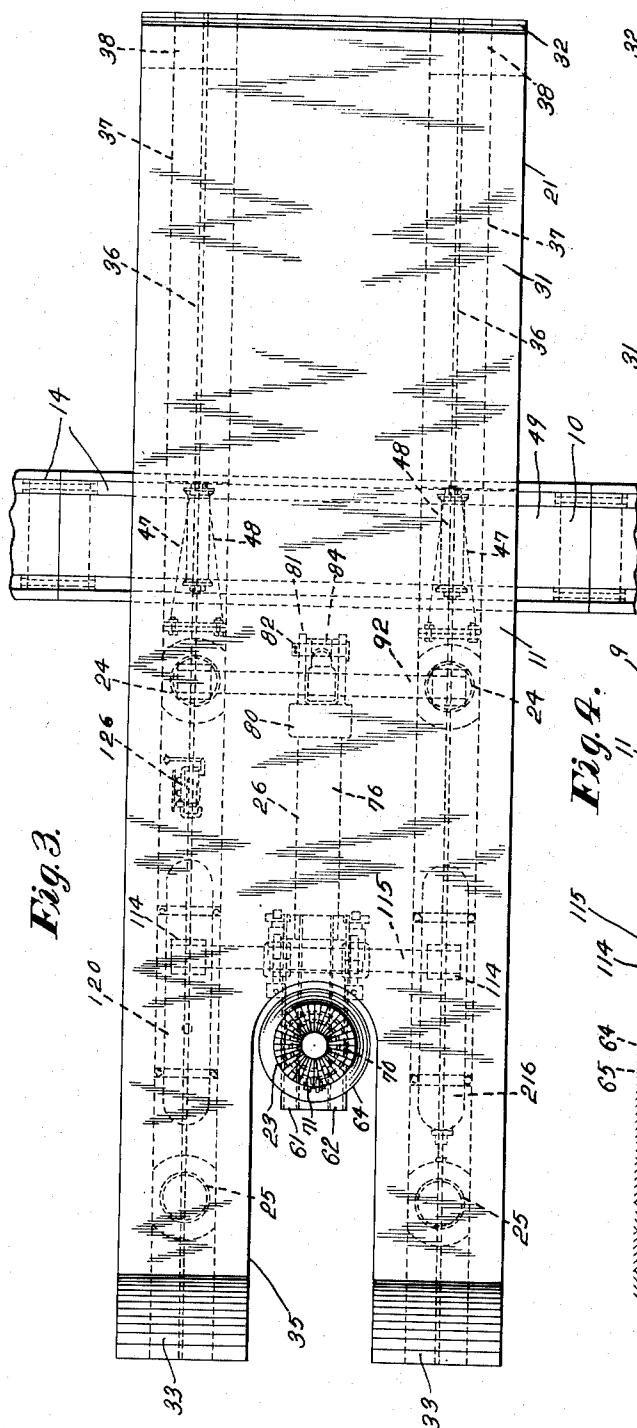
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J. F. JOY
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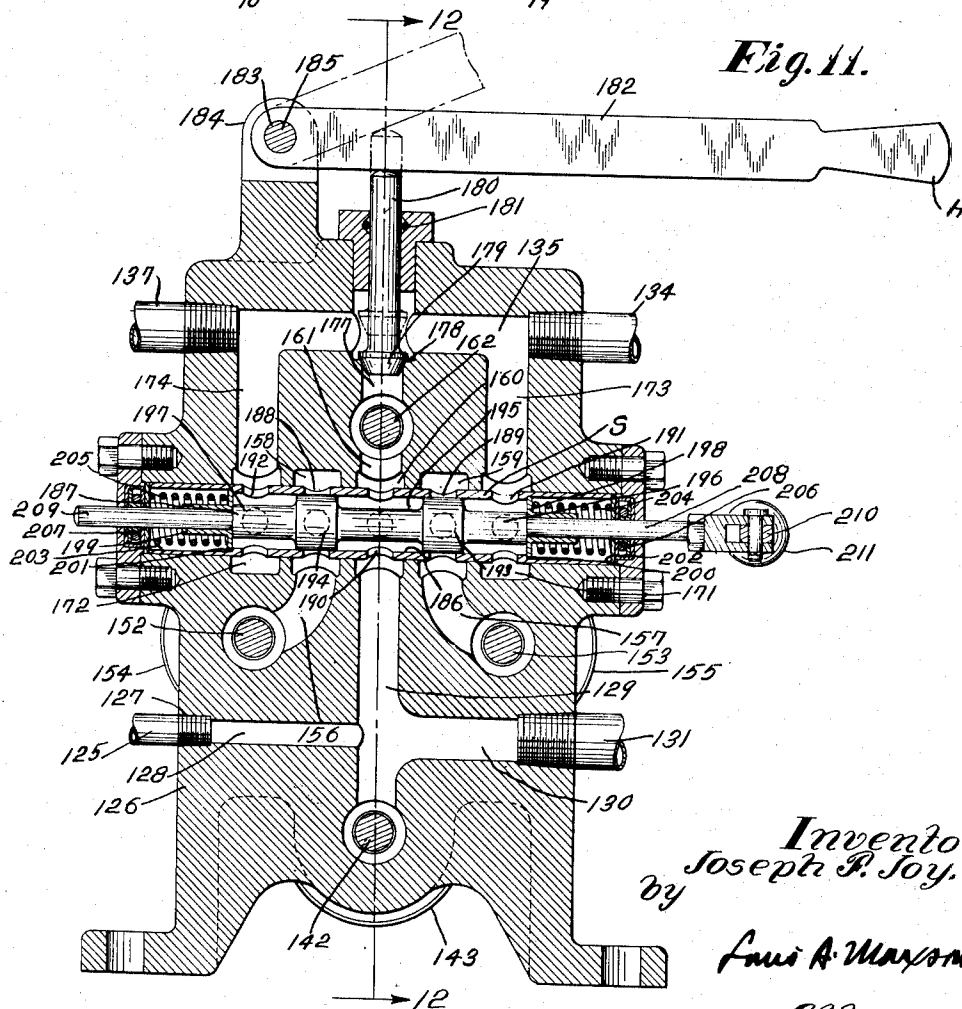


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WALKING JACK

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7 Sheets-Sheet 5



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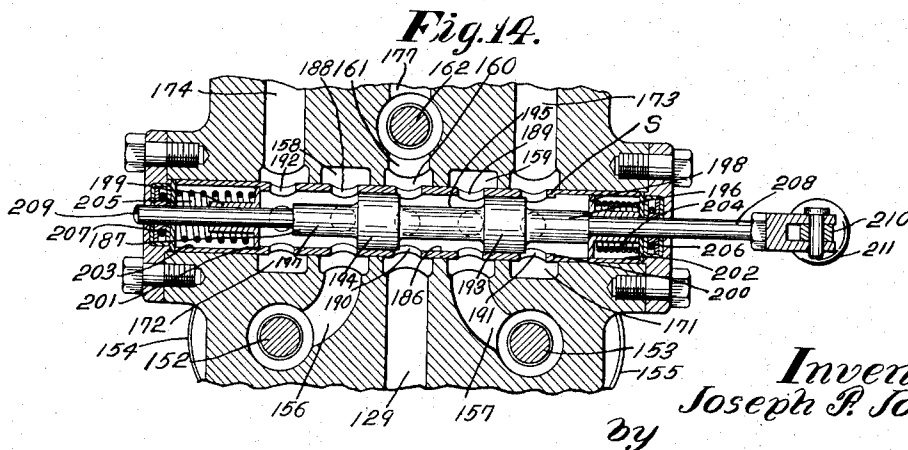
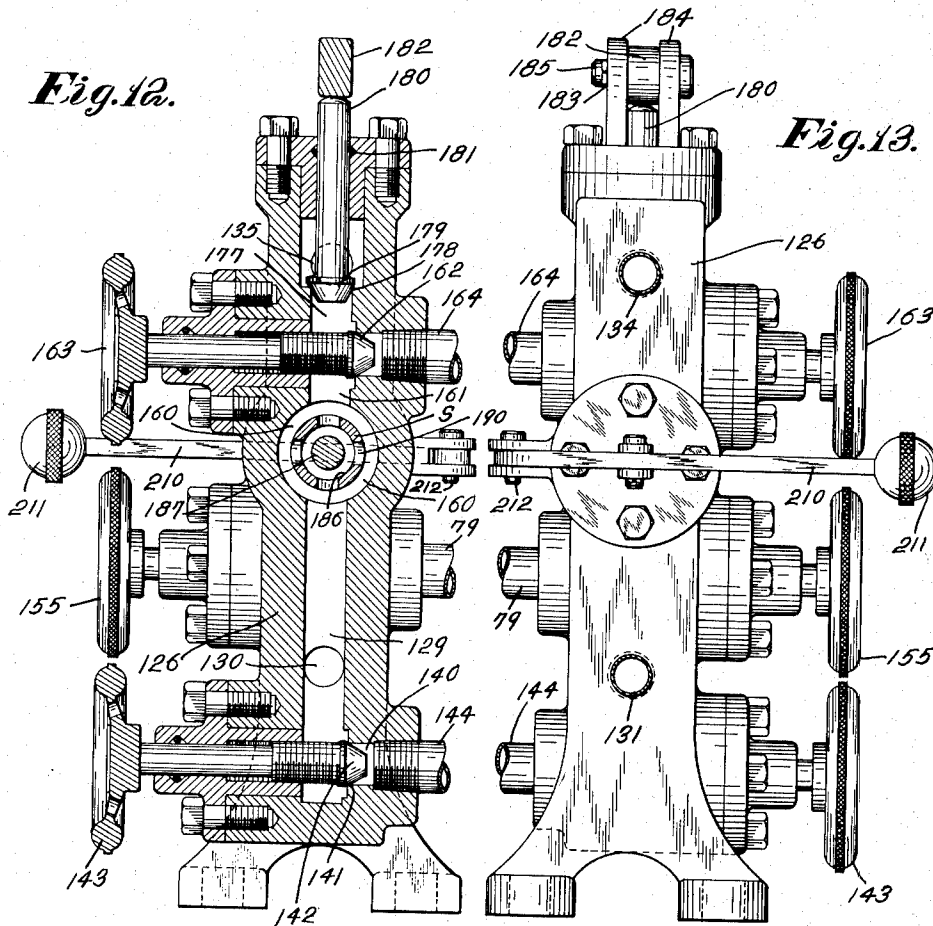
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J. F. JOY
WALKING JACK

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7 Sheets-Sheet 6



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Oct. 27, 1953

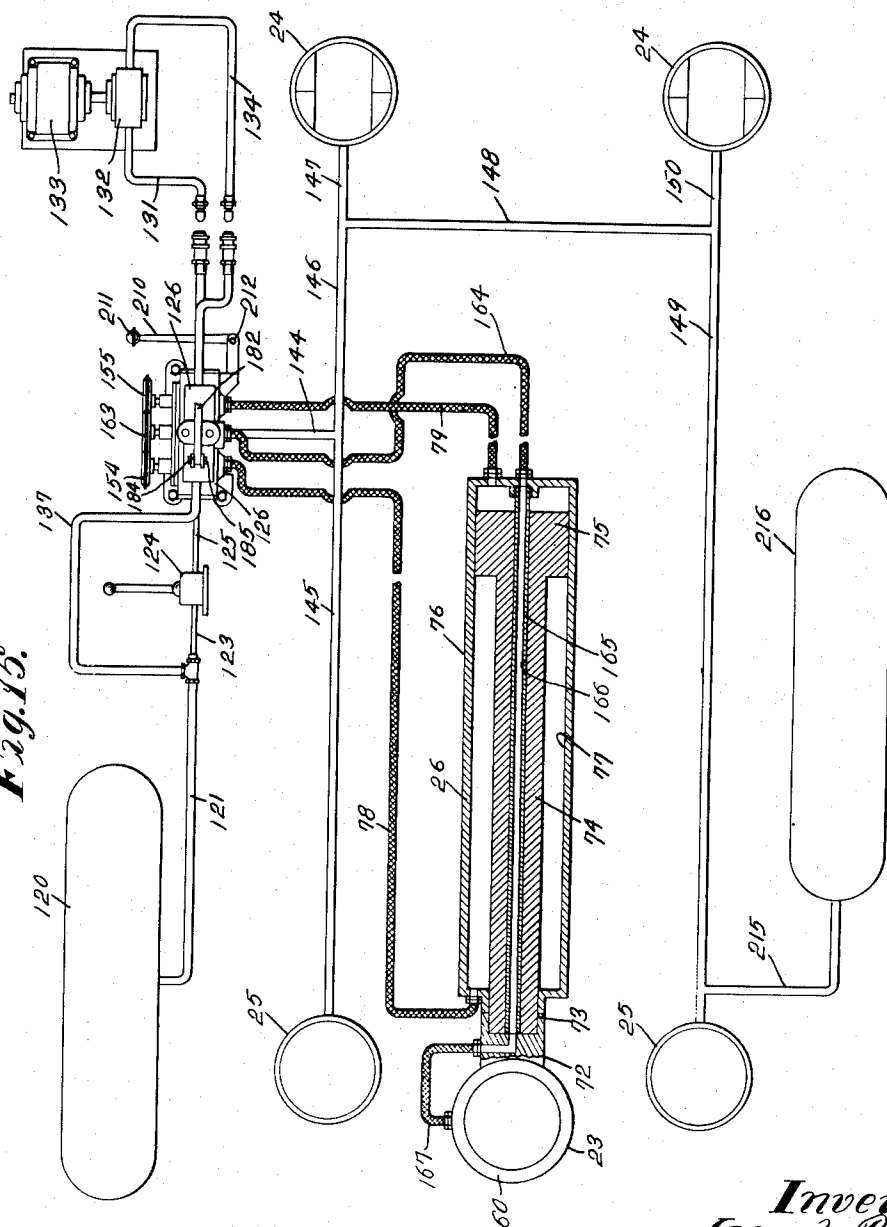
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7 Sheets-Sheet 7

Fig. 13.



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UNITED STATES PATENT OFFICE

2,657,028

WALKING JACK

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Application June 15, 1949, Serial No. 99,292

10 Claims. (Cl. 262—1)

1

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This invention relates to apparatus for mine roof control.

Roof control is one of the most troublesome and expensive items in mining. This is so because of the expense of the materials which have customarily been used and because so large a percentage of the materials employed is lost as a result of roof subsidence as the working face advances. The large amount of labor involved in building cribs, setting timbers, etc., also adds to the expense. Accordingly, if there be provided an effective rapidly adjustable means for roof control—one that is relatively secure against loss of its elements and which has a comparatively long life—it will be highly desirable, and this will be so whether or not such devices be employed with long or short faces. In this application, I shall disclose, describe and claim an improved roof control arrangement which marks a substantial improvement over prior devices of this character, in that there will be not only a roof support by devices which may yield under increased roof pressure but which shall further have the characteristic of being capable of having their pressure upon the roof diminished during repositioning without the necessity for the release of any fluid from them.

An object of my invention is to provide an improved and dependable means resisting the closing of the gap caused in the strata of the earth by the removal of certain layers thereof, such as coal seams or the like, such resistance being maintained for the full length of time to permit the effective mining of such layers. Another object is to provide an improved roof supporting structure for yieldably sustaining the pressure of the roof and adapted to have the pressure exerted between the roof and the floor diminished when adjustment or walking of the roof supporting structure is to be accomplished, this without releasing any of the fluid medium with which the roof supporting structure may have expansible chambers thereof filled. Still another object is to provide improved mechanically actuated structures for the control of mine roofs which support the roof close up to the face along the roof line, but which have the jack devices which form a part thereof spaced far enough back from the face to permit efficient operation of coal producing apparatus. Another object of my invention is to provide an improved method of mine roof control. It is a further object to provide an improved roof jack mechanism. Another object is to provide an improved roof jack mechanism which shall facilitate jack

adjustment, through a temporary reduction in the force with which the mechanism engages the mine roof, but without the dissipation of any part of the force in such a manner that in the event of a sudden subsidence of the roof there would be an inadequate—reduced—force for sustaining the roof pressure. Still a further object of my invention is to provide an improved roof jack mechanism of the hydraulic type having incorporated therein means for providing for a limited degree of yield without venting of hydraulic fluid, and in which there may be an actual reduction in the pressure exerted by the jack mechanism on the roof without a corresponding reduction in the force which the jack mechanism is constantly ready to exert at any given elevation. Yet a further object is to provide an improved roof control system having the advantages of resilient yielding through the concurrent use of a trapped body of gaseous fluid and a hydraulic fluid, together with the advantage of an over-riding control without the release of either the gaseous or hydraulic fluids. A further object of the invention is to provide an improved roof jack mechanism in which mechanical means for over-riding the forces exerted by fluid pressure providing devices is incorporated. Still another object is to provide an improved roof jack structure having incorporated therein an improved arrangement for facilitating its repositioning through a reduction in the force exerted on the roof while still maintaining available in the event of even a slight subsidence of the roof the full roof supporting pressure. Another object is to provide an improved roof jack structure having an improved roof engaging and supporting skid structure fully protecting underlying working parts. Still another object is to provide an improved jack mechanism including improved means for overcoming, without releasing, the resilient pressure exerted on the roof during roof support. Still another object is to provide an improved roof jack mechanism having a combination of toggle mechanism and pressure fluid operated mechanism arranged between upper, roof- and lower, floor-engaging elements, with improved means for enabling the toggle mechanism to overcome the fluid operated mechanism. Still a further object is to provide an improved roof jack mechanism having improved means for adapting it to different roof heights. Still another object of the invention is to provide improved means for controlling the jacks of a roof supporting mechanism permitting a limited departure from parallelism of its roof and floor

engaging elements. Other objects and advantages of the invention will hereinafter more fully appear.

In the accompanying drawings, in which for purposes of illustration I have shown one embodiment which my invention may assume in practice,

Fig. 1 is a horizontal sectional view through a mine adjacent to a longwall working face, showing illustrative embodiments of the invention from its apparatus aspect in use.

Fig. 2 is an enlarged sectional view on a vertical plane corresponding to the plane of the section line 2—2 of Fig. 1.

Fig. 3 is a further enlarged plan view of an illustrative embodiment of my improved roof jack structure.

Fig. 4 is a side elevational view of the structure of Fig. 3.

Fig. 5 is a view corresponding to Fig. 4, showing the roof supports at the conclusion of one step of advance of the floor and roof engaging support elements.

Fig. 6 is a vertical transverse section on the plane of the line 5—6 of Fig. 5, the parts being shown on a still larger scale.

Fig. 7 is a detail view, with parts broken away, showing one of the toggle mechanisms, with provision for adjustment incorporated therein.

Fig. 8 is a horizontal section on the plane of section line 8—8 of Fig. 4, parts being shown on an enlarged scale and some parts being shown in full.

Fig. 9 is a further enlarged fragmentary sectional view on the plane of the section line 9—9 of Fig. 8.

Fig. 10 is a plan view on a considerably enlarged scale of a control valve mechanism.

Fig. 11 is a vertical section through the control valve mechanism of Fig. 10, the section being taken on the plane of the line 11—11 of Fig. 10.

Fig. 12 is a vertical transverse section on the plane of the line 12—12 of Fig. 11.

Fig. 13 is an elevational view of the control valve mechanism of Fig. 10, viewed from the right-hand end thereof.

Fig. 14 is a fragmentary sectional view in the same plane as Fig. 11 showing a distributing valve forming a portion of the valve mechanism moved to a different position from the one shown in Fig. 11.

Fig. 15 is a partly diagrammatic view, with parts shown in section, illustrating the hydraulic system of the roof jack mechanism.

Referring now briefly, initially, to Fig. 1, it will be noted that a longitudinal face is indicated at 1. This includes a portion 1A which has been advanced one operation width X of a mining machine 2 beyond the portion 1B which still remains to be mined out and "advanced" to a position in line with the portion 1A. The mining machine 2 may obviously assume various forms, and as shown has suitable mechanism 3 for disintegrating the mineral, herein, coal. The face 1 has at its opposite ends spaces 4 and 5, and roadways 6 provided for ventilation and coal removal communicate with these spaces, which are really the ends of the roadways. These roadways have been driven to the limits of the area to be mined out, and are arranged between the ribs of a large unmined block of coal 7 and side walls 8. The roof is indicated at 9 as having been caved for the full width of the distance between the side walls or ribs 8. A conveyor 10 herein shown as a shaker conveyor, but which may assume various

forms, extends for the full width of the portion of the face which has been advanced, and its length is progressively increased by one section each time the face is extended by an amount equal to the distance between the center lines of the roof jack mechanism 11 which provide roof support between the face and the caved portion of the roof. The conveyor 10 discharges onto a conveyor herein shown as a belt conveyor 12 which extends out through the roadway 6. The conveyor 10 may be driven by a suitable drive mechanism 13 of conventional form and is made up of sections 14 of appropriate length, say, 8', new ones of which may be quickly attached to the ends of the conveyor line as the disintegrating apparatus progresses along the face. Roof subsidence along the face is prevented by the improved roof jack mechanisms of this application, which are herein designated 11 as above noted, and these roof jack mechanisms by their construction and spacing are adapted to hold the roof from caving, except in the manner and to the extent desired.

Now referring initially particularly to Figs. 3 and 4, it will be observed that the apparatus shown includes an upper, roof load-sustaining support element 21 and spaced parallel mine bottom engaging support elements or skids 22, an anchor jack mechanism 23, front and rear roof load-sustaining jack structures 24 and 25, herein two of each, expansible chamber means 26 for effecting repositioning of the jack structures 24 and 25 relative to the anchor jack 23 and vice versa, and means generally designated 27 for at least partially relieving the roof of the pressure of the roof support 21 as adjustment of the roof support relative to the anchor jack 23 is effected. The roof engaging structure 21 consists of a relatively wide plate structure 31 considerably longer than its width and having a short downturned end 32, to make its advance smoother, and a considerably longer, more steeply downturned end or skid-like portion 33 at its rear end. This plate structure is relatively rectangular in projection on a horizontal plane, save that there is a slot 35 formed in it at its rearward end of suitable width for the projection through it of the anchor jack 23 and of such length as to accommodate the relative movements between the anchor jack and the roof engaging member 21. The plate 31 is stiffened by laterally spaced members 36 extending for substantially the full length of the plate 31 and having secured to their lower edges plate elements 37 extending longitudinally beneath and in spaced relation to the plate 31 and connected at 38 to the downwardly directed nose 32 and at 39 to the lower end of the most steeply downwardly directed skidlike portion 33.

The lower support structure 22 includes H-beamlike members 41 as it were lying on their sides and having lower horizontal flanges 42 provided with upturned ends 43 and also provided with relatively horizontal upper flange portions 44 parallel to the portions 42. The members 41 are cross connected to each other by cross shaft portions 45 and 46, and at their front ends the members 22 each carry a forwardly projecting bracket 47, each bracket rotatably supporting a guide roller 48 for a shaker conveyor trough section 49. Rigidly secured to each of the spaced side members of the floor support base portion of the walking jack structure, adjacent the opposite ends of each of the latter, are the jack devices 24 and 25, the former arranged near the front

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end of the supports and the latter near the rear ends thereof. These jack devices include fixed cylinder elements 50 in which tubular piston elements 51 are reciprocable. Each piston element is of the trunk type, as illustrated, and the piston elements of the jack devices 24 each have a pivotal connection at 52 with a perforated ear 53 secured to the flanges 37 at points approximately midway between the ends of the roof engaging support structure 21. The rearward jacks 25 simply have suitably domed tops 55 engaging the surfaces of the flanges 37 near the downwardly inclined portions 39 thereof, as at 56. The pistons 51 are packed in any suitable manner (not shown) so as to prevent the escape of fluid around them from the bores of the cylinders 50.

The anchor jack 23 includes a vertical cylinder 60 mounted on a skid 61 shown as made up of channel irons 62 having their flanges extending longitudinally of the jack mechanism. The cylinder 60 has a piston 63 reciprocable in it. This piston is a so-called trunk type piston also, and at its top engages an enlarged roof supporting plate 64 having a serrated top 65 adapted to be pressed into non-skid relation with the mine roof. Upward movement of the piston 63 in the cylinder 60 causes the anchor jack to provide a rigid abutment against which a thrust can be exerted for the purpose of advancing the floor and roof engaging elements 22 and 21 and the several jack devices 24 and 25. On the other hand, relief of pressure from the cylinder 60 will permit the anchor jack to be moved forward readily relative to the structure which has been previously advanced with respect to it. The walking jack 26 is supported through the piston portion thereof on a clamping sleeve 70 which is secured as at 71 about the upper end of the cylinder 60. The clamping sleeve carries a socket providing lug 72, in the socket 73 of which the piston rod 74 of the walking jack piston 75 is fixedly secured. The cylinder 76 of the walking jack receives the piston 75 in its bore 77, and the cylinder 76 is reciprocable relative to the piston 75 under the action of hydraulic fluid admitted to the opposite ends of the cylinder through conduits, respectively numbered 78 and 79, conduit 78 leading to the rearward end of the cylinder 76 and the conduit 79 to its forward end. The cylinder 76 has forward and rearward heads, as best shown in Figs. 4, 5 and 8. The forward head 80 has projecting arms 81 between which a cross pin 82 extends, and the adjacent ends of toggle links 83 and 84 are connected to the pin 82. The end of link 83 is made in the form of a fork element which is connected by a screw 85 with a tubular internally threaded element 86 carrying a sleeve 87 journaled on the cross shaft or bar 45. The end of link 84 is connected by a threaded element 88 with an internally threaded tubular element 90 which is connected to a sleeve 91 which is journaled on a forward cross shaft 92 extending between the flanges 36. The rear head of the walking jack cylinder has projecting lateral ears 101 in which adjusting screws 102 are arranged. These are adapted to engage head elements 103 connected by threaded rods 104 to tubular internally threaded elements 105 which are pivotally supported on the cross shaft or bar 46. The members 103 are each connected by cross pins 110 to forked end members 111 which are connected by threaded elements 112 with internally threaded elements 113, and the two internally threaded elements 113 are connected at their upper ends by collars 114 to a cross shaft 115

extending between the flanges 36 at a point nearer the rear ends thereof. By having the cross pin 82 directly fastened to the cylinder head 80 but having adjustment of the effective length of the adjusting screws 102 a possibility, it will be appreciated that absolute parallelism of the roof engaging member 21 and of the floor engaging member 22 is not requisite, and that if the adjusting screws 102 are screwed outwardly in their supporting ears, that is, to the left in Fig. 8, there may be a somewhat greater distance between the most remote surfaces of the floor and roof engaging members at points in line with the axes of the jacks 25 than exists between points in these members in line with the axes of the jacks 24. Correspondingly, by turning the screws 102 further forwardly through their supporting ears, there may be a convergence of the top and bottom surfaces of the jack mechanism toward the rear. Normally, however, when the arms of the toggle mechanism are parallel to each other the screws 102 will be slightly out of contact with the end members 103, with the result that, as the walking jack cylinder 76 moves forwardly in a manner hereinafter described, the pressure applied by the roof jack elements 24 will be diminished somewhat before the pressure exerted by the roof jacks 25 commences to be overcome.

Before describing the system in more detail, the modification of a toggle mechanism shown in Fig. 7 may be noted. Here it will be noted that a hand wheel controlled turnbuckle 116 is arranged between the head element 103' and pivot members 117 rotatably supported by the cross shaft 46, and a hand wheel controlled turnbuckle 118 is arranged between the forked end members 111' and the collars 114' mounted on the cross shaft 115. Similar arrangements may be provided for the other rear toggle device, or for all of the toggle devices, thus providing for greater adjustability and greater relative adjustability between the elements 21 and 22.

The system for the operation of the several jacks mentioned can best be understood by reference to Figs. 8, 9 and 15, and a principal controlling valve structure forming a portion of the system is shown in the several figures numbered 10, 11, 12, 13 and 14. The fluid for the extension of the several roof jacks and of the anchor jack and for the effecting of relative extension and collapse of the walking jack is supplied from the storage tank 120 through a conduit 121. This conduit 121 communicates with a connection 123 in which a hand operated pump 124 having a built-in relief valve is provided. It will be appreciated that the hand pump 124, which is of a well-known commercial type, may be used to effect the pumping of fluid from the storage tank 120, or it could be used for pumping fluid back into the storage tank 120. The hand pump has a conduit 125 at its opposite side from the conduit 123, and this conduit enters a valve block 126 at 127, and communicates with a port 128 therein. The port 128 extends into a larger passage 129, shown in Figs. 11, 12 and 14 as extending vertically. There also communicates with the passage 129 a passage 130, this being in line with the passage 128, as illustrated, and having in communication with it a conduit 131 which constitutes a discharge connection from a motor driven pump 132 whose driving motor 133 may be mounted in any suitable position on the apparatus, as, for example, on one of the floor-engaging structures 22. This pump too will have a built-in adjustable relief valve (not shown). The suction line 134

of the pump 132 opens into a generally U-shaped passage 135 extending transversely of the valve block 126 near the top of the latter, and a conduit 137, also communicating with the cross passage 135, is connected with the tank through the conduit 121. At the lower end of the vertical passage 129, previously mentioned, there is provided a transversely extending passage 140 surrounded by a valve seat 141 on which valve seat a manually adjustable valve 142 having a controlling hand wheel 143 is adapted to seat. When the valve 142 is opened, fluid may pass freely between the passage 129 and a conduit 144 which is connected by a branch conduit 145 with one of the rear jacks 25, and through a branch conduit 146 with another conduit 147 leading to one of the front jacks 24, and through a conduit 148 and branch conduits 149 and 150 respectively, to the other of the rear jacks 25 and to the other of the front jacks 24. The conduits 78 and 79 open into the valve block 126, and are adapted, upon opening movement of valve members 152 and 153, which respectively have hand wheels 154 and 155, to communicate with passages 156 and 157 which open into annular grooves 158 and 159 which are arranged at the opposite sides of an annular groove 160 with which the passage 129 communicates and from which another passage 161 in line with the passage 129 opens out. A valve 162 having a controlling hand wheel 163 controls the communication of the passage 161 with a conduit 164, which last conduit communicates with a tube 165 extending through the cylinder 76, and a bore 166 in the piston 75 and the piston rod 74, and the bore 166 is in communication with a conduit 167 opening into the bottom of the anchor jack 23. Two other annular grooves 171 and 172 are arranged co-axially with the grooves 158, 159 and 160 and respectively at the sides more remote from the groove 160 of the grooves 159 and 158. The grooves 171 and 172 communicate respectively with the passages or arm portions 173 and 174 of the transverse passage 135. Above the passage 161 and the valve 162 there is a further extension of the passage 161, this extension being numbered 177 and being surrounded by valve seat 178 on which a valve 179 is adapted to seat. The valve 179 has a stem 180 with which an O-ring seal 181 cooperates, and has a pivoted control lever 182 having one end pivoted at 183 by means of ears 184 on the valve block 126 and a cross pin 185, and having an operating handle H at its opposite end.

The several grooves 158, 159, 160, 171 and 172 surround a perforated sleeve element S containing a valve receiving bore 186 in which a two-spool piston valve 187 is reciprocable. The valve sleeve is traversed by five circumferentially arranged sets of ports, each set arranged in one of the annular grooves. The ports of these sets are numbered:

With respect to the groove 158:188
 With respect to the groove 159:189
 With respect to the groove 160:190
 With respect to the groove 171:191, and
 With respect to the groove 172:192.

The spools 193 and 194 of the valve member are spaced by an annular groove 195 whose length is just insufficient to connect the ports 188 and 189 together, but of such length as to connect the ports 190 with the ports 188 or with the ports 189 in the oppositely disposed end positions of the valve member 187. When the valve is pushed in

one direction from the central position shown in Fig. 11, to the right in that figure, the passage 129 is connected with the passage 157 and the passage 156 is connected with the passage 174. In the oppositely disposed position of the valve 187, the passage 129 is connected with the passage 156, while the passage 157 is connected with the passage 173. The valve has enlarged end portions 196 and 197. These, in the central position of the valve, are adapted to be simultaneously contacted, or at least almost contacted, by tubular follower thimbles 198 and 199 which are spring-pressed toward shoulders 200 and 201 in enlarged bores 202 and 203 in the valve sleeve S. Springs 204 and 205 are provided to press the thimbles toward their shoulders and to center the valve 187 normally. Suitable packings 206 and 207 are arranged outside the springs to cooperate with extension stems 208 and 209 on the valve 187. The stem 208 has an operating lever 210 having a grasping portion 211 and a pivotal support at one end 212.

It will be evident that, whether fluid be supplied from the tank 120 by the hand operated pump through the passage 128 or by the motor operated pump 132 through the passage 130, the fluid so supplied will pass freely through the passage 129, the annular groove 160, the passage 161, around the stem of the valve 162, through the passage 177, past the valve 179, if this be open, through the passage 135, the connection 137 and the conduit 121 back to the tank 120. In other words, there will simply be, whenever the valve 179 is open, a circulation of fluid without the development of any substantial pressure. When the lever H is used to press the valve 179 onto the seat 178, this free return of fluid will be prevented, and a pressure will build up within the passage 129, the annular groove 160 and the passage 161 which will be determined by the setting of the relief valve associated with whichever one of the pumps 124 or 132 is the source of the pressure. Of course, separate external connections, each with a suitable relief valve, could be connected between the conduits 123 and 125 and the conduits 131 and 134. So long as all of the valves 142, 152, 153 and 162 are closed and the valve 187 is in the central position thereof shown in Fig. 11, no fluid will be delivered to any of the operating devices. If the valve 142 is opened, however, fluid will be delivered to the roof jacks 24 and 25 through the conduits 144, 145, 146, 147, 148, 149 and 150. The pressure which will be built up within these roof jacks will be determined by the relief valves mentioned, but, as shown in Fig. 8, an accumulator is arranged in communication with the conduit 149 through a conduit 215. This accumulator is of a well known construction, and includes a metallic walled chamber 216 in which there is arranged a collapsible fluid-tight bag 217 carrying a valve element 218 on the end thereof towards the point of communication of the conduit 215 with the casing 216. It will be noted in Fig. 8 that an annular valve seat 219 surrounds the passage 220 through which the conduit 215 communicates with the interior of the casing 216. The collapsible bag 217 will be pre-filled with a gaseous fluid under a considerable pressure on the order of a number of hundreds of pounds per square inch, and nitrogen may conveniently be used as this gaseous fluid. This accumulator provides for the maintenance of a yielding pressure by the hydraulic jacks 24 and 25 forcing the roof engaging plate structure 21 and the base structure 22 apart and maintaining

a desired pressure on the roof. This may be on the order of $37\frac{1}{2}$ tons per jack for a roof support 21 on the order of 20' long and 6' wide.

Reverting to the conditions when the valve 142 is open, it will be noted that fluid will be supplied to the jacks 24 and 25 if the valve 179 is closed, but will drain back out of the jacks if the valve 179 is open. Fluid may be admitted to the anchor jack 23 by opening the valve 162 and closing the valve 179. Because the accumulator 216 will have communication with the anchor jack 23 through the conduits 215, 149, 148, 146 and 144 and passages 129, groove 160, passage 161, conduit 164, tube 165 and conduits 166 and 167, the anchor jack may also exert a yielding pressure on the roof so long as the valve 142 is open. If the operator releases the handle H, however, all the fluid supplied to these jacks will commence to escape, and accordingly, the valves 142 and 162 will normally be closed when such pressure has been built up in the jacks which they respectively control, as may be desired. By opening the valves 152 and 153, it will be possible respectively to advance the anchor jack relative to the roof jacks and to advance the roof jacks and the upper and lower support devices 21 and 22 relative to the anchor jack. Ordinarily, there will be no occasion for maintaining pressure on the anchor jack except when it is desired to move the roof jacks forwardly, but if it is desired to provide the cumulative pressures of the roof jacks and the anchor jack on the mine roof, this is possible through proper control of the various valves.

When it is desired to advance the roof load sustaining support 21 and the mine bottom engaging skids 22, normally fluid will be entrapped in each of the four roof jacks and in the anchor jack. Each of the five jacks will exert a force on the order of $37\frac{1}{2}$ tons with the construction and in an apparatus of the size mentioned, or, a total of $187\frac{1}{2}$ tons. To this could be added, it may be noted in passing, a further large amount of pressure if the toggle devices which can have force exerted through them by the horizontal jack cylinder have the latter employed to tend to straighten them. It will be clear that with the four roof jacks cumulatively exerting 150 tons pressure on the mine roof, the anchor jack, with but $37\frac{1}{2}$ tons of roof pressure, would perhaps slip first, notwithstanding its special serrated roof surface engaging construction, if the action of fluid admitted between the piston 75 and the cylinder head 80 simply exerted opposite longitudinal thrusts on the anchor jack and on the skid and roof support forced apart by the roof jacks. However, the frictional resistance to sliding the skids and roof support plate is much less than that of the base and top of the anchor jack, and the mechanical advantage with the toggle connections shown is very great, and the forward thrust of the walking cylinder first greatly reduces the pressure exerted by the jacks 24 on the roof, and then, as the screws 102 engage the elements 103, also the pressure exerted by the jacks 25, and as the hydraulically applied pressures maintained by the action of the accumulator (whose presence permits any slight displacement of liquid desirable to facilitate advance of the roof support) is greatly offset by the forces transmitted through the toggles, there is an advance of the roof support as desired. It may be noted that if the roof should suddenly lower enough to tend

to collapse the roof jacks beyond the points to which the toggles might have brought them the full force of the jacks would be instantly available to sustain the roof, assuming there was not a continued admission of liquid to the walking jack in such manner as to cause the toggles to reexert their counter force. Release of the handle H would in any event instantly make the full roof supporting force available.

The general mode of operation is clear from what has already been explained, but it may be noted that as rapidly as the mining apparatus moves beyond the line of advance of a unit, the latter will be advanced until its end 32 is closely adjacent the newly formed face, and the full pressures of both the roof jacks 24 and 25 and of the anchor jack 23 may be made use of in supporting the roof. The front toggle mechanism even can be used, by admitting fluid to effect a retracting force on the cylinder of the walking jack 26, to augment the roof supporting pressure. The shaker pan section of each unit will be connected to the pan line as soon as the section has been moved into line with the previously connected and operating pan line.

The apparatus of the invention is strong, is very readily controlled, does not require a potentially dangerous relief of roof supporting pressure for its advance, and has a control system which, by the closure of the lines to the energized roof and anchor jacks, produces a condition in which the mere release of the handle H will result in an instantaneous reapplication of the full roof supporting pressure.

While there is in this application specifically disclosed one form, and a modification thereof, which the invention may assume in practice, it will be understood that these are shown for purposes of illustration and that the invention may be further modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a mine floor engaging support, a mine roof engaging frame, forwardly and rearwardly disposed jack devices yieldingly pressing said support and frame apart and causing said frame to exert a yielding supporting pressure on the roof, traction elements extending between said support and frame and connected at their opposite ends respectively to said support and frame, an abutment jack, and feeding means reacting upon said abutment jack and acting upon said traction elements at points intermediate their connections to said frame and said support for forcing said points, in the direction of feed, away from a straight line extending through the connections of said elements with said frame and support, to cause the exertion of a traction towards each other between said frame and support and of a longitudinal feeding force upon both of them.

2. In a roof control apparatus, mine floor engaging supporting means, mine roof engaging and supporting means, jack means extending between said mine floor engaging supporting means and said mine roof engaging and supporting means, said jack means including means for yieldingly pressing said first two means apart, anchor jack means engageable with the mine anchor jack means engageable with the mine floor and mine roof, walking jack means connected at one end with said anchor jack means, and an operative connection between said walking jack

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means and said mine floor engaging supporting means and said mine roof engaging and supporting means including devices connected to said first two means for causing a major component of the force exerted by said walking jack means to be transmitted to said first two means in such a direction as to subtract from the separative forces exerted by said first mentioned jack means, said operative connection including elements having their opposite ends connected for relative movement as said supporting means undergo relative movement and engaged between their ends by said walking jack means in such a direction that extension of said walking jack means tends to cause a reduction in distance between said opposite ends.

3. In a roof control apparatus, mine floor engaging supporting means, mine roof engaging and supporting means, jack means extending between said mine floor engaging supporting means and said mine roof engaging and supporting means, said jack means including means for yieldingly pressing said first two means apart, anchor jack means engageable with the mine floor and mine roof, walking jack means connected at one end with said anchor jack means, and an operative connection between said walking jack means and said mine floor engaging supporting means and said mine roof engaging and supporting means including means for causing a major component of the force exerted by said walking jack means to be transmitted to said first two means in such a direction as at least to tend to cause approach of the second to the first while said first mentioned jack means are acting to press them apart, said last recited means including toggle devices having upper and lower ends connected respectively to said mine roof engaging and supporting means and to said mine floor engaging supporting means and having their central portions pressed by said walking jack means, as the latter is extended, in a direction to effect mutual approach of their ends.

4. In a roof control apparatus, mine floor engaging supporting means, mine roof engaging and supporting means, jack means extending between said mine floor engaging supporting means and said mine roof engaging and supporting means, said jack means including forwardly and rearwardly disposed jack devices for yieldingly pressing said first two means apart, anchor jack means engageable with the mine floor and mine roof, walking jack means connected at one end with said anchor jack means, and an operative connection between said walking jack means and said first two means including forwardly and rearwardly disposed toggle devices connected with said first two means for causing a major component of the force exerted by said walking jack means to be transmitted to said first two means in a direction to cause approach of the second to the first.

5. In a roof control apparatus, mine floor engaging supporting means, mine roof engaging and supporting means, jack means, respectively adjacent the forward and rearward ends of said floor engaging means, extending between said mine floor engaging supporting means and said mine roof engaging and supporting means, said jack means including means for yieldingly pressing said first two means apart, anchor jack means engageable with the mine floor and mine roof, walking jack means connected at one end with said anchor jack means, and an operative con-

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nection between said walking jack means and said mine roof engaging and supporting means and said mine floor engaging supporting means including toggle means, respectively adjacent the forward end and adjacent the center of said floor engaging supporting means, and means for rendering said toggle means sequentially effective for causing a major component of the force exerted by said walking jack means to be transmitted to said first two means in opposition to the separative action of said first mentioned jack means.

6. In a roof control apparatus of the character wherein there is provided roof supporting means including mine floor engaging supporting means and mine roof engaging and supporting means and jack means, including a forward jack and a rearward jack at either side, yieldably forcing apart the mine floor engaging supporting means and the mine roof engaging and supporting means, and wherein there is provided an abutment jack expansible into firm contact with the floor and roof, and in which there is further provided a cylinder and piston mechanism connected at one end to said abutment jack and operatively connected at its other end with said roof engaging and supporting means and floor engaging supporting means and which is selectively operable to advance said abutment jack, or, when said abutment jack is in firm contact with the floor and roof, to advance said roof supporting means, the arrangement in which said operative connections include toggle links pivotally connected together and at their mutually opposite ends pivotally connected with said mine floor engaging supporting means and said mine roof engaging and supporting means and said cylinder and piston mechanism acts on said toggle links in a direction to decrease the included angle between said links upon extension of said cylinder and piston mechanism in the direction of feed.

7. In a roof control apparatus of the character wherein roof supporting means is provided including mine floor engaging supporting means and mine roof engaging and supporting means and four jack means yieldably forcing apart the mine floor engaging supporting means and the mine roof engaging and supporting means, and in which an abutment jack is provided which is at will expansible into firm contact with the floor and roof, and there is provided a cylinder and piston mechanism connected at one end to said abutment jack and operatively connected at its other end with said roof supporting means and which is selectively operable to advance said abutment jack, or, when said abutment jack is in firm contact with the floor and roof, to advance said roof supporting means, the provision of toggle connections pivotally connected to said mine floor engaging supporting means and to said mine roof engaging and supporting means and engaged by said cylinder and piston mechanism and transmitting longitudinal thrust to said roof supporting means and, when the thrust necessary to advance said roof supporting means exceeds a predetermined value, reducing the effective pressure which said four jack means cause to be exerted on the mine roof and floor.

8. In a roof control apparatus of the character wherein roof supporting means is provided including mine floor engaging supporting means and mine roof engaging and supporting means and jack means, which jack means yieldably force apart the mine floor and mine roof engag-

ing supporting means, and in which an abutment jack is provided which is at will expansible into firm contact with the floor and roof, and there is provided a cylinder and piston mechanism connected at one end to said abutment jack and operatively connected at its other end with said roof supporting means and which is selectively operable to advance said abutment jack, or, when said abutment jack is in firm contact with the floor and roof, to advance said roof supporting means, the provision of operative connections between said cylinder and piston mechanism and said roof supporting means which not only transmit longitudinal thrust to the latter, but are operative when the thrust necessary to advance said roof supporting means exceeds a predetermined value to reduce the effective pressure which said jack means cause to be exerted on the mine roof and floor, said operative connections including toggle mechanisms spaced apart longitudinally of said apparatus and connected between the mine floor engaging supporting means and said mine roof engaging and supporting means and each having its joint engaged by said cylinder and piston mechanism and arranged to be collapsed on the extension of the latter.

9. In a mobile roof jack mechanism for mines, a base engageable with a floor surface, a roof engaging top overlying said base, power operated devices operatively connected to said base and said top for yieldingly forcing the same apart into roof supporting relation, an anchor device engageable with extraneous means, a horizontal feeding device operatively connected to said anchor device for moving said base and top horizontally relative to the floor and roof, and an operative connection between said feeding device and said base and top including means for causing a major component of the force exerted by said feeding device to be transmitted to said base and top in a direction to reduce the force which urges

said base and said top apart, said operative connection including devices having opposite ends moved apart upon separative movement between said base and top, and connected between their ends with said feeding device and pressed by said feeding device in a direction to form a decreasing angle between their opposite end portions as feeding takes place.

10. In a portable mine roof jack, a base adapted to rest on the floor of a mine, roof engaging and supporting means for engaging and supporting the mine roof, power operated devices operatively connected between said base and said roof engaging and supporting means for yieldingly forcing said roof engaging and supporting means upwardly into roof supporting position relative to said base, an anchor device engageable with extraneous means, toggle devices operatively connected between said base and said roof engaging and supporting means, and a horizontal feeding device operatively connected to said anchor device and to said toggle devices for moving said base and said roof engaging and supporting means horizontally relative to the floor and roof, said feeding device acting on said toggle devices in a direction to decrease the included angles of said toggle devices whereby, when a predetermined feeding force is applied to said toggle devices, they reduce the force which serves to press said roof engaging and supporting means against the roof.

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