April 15, 1952 H. H. VANDERZEE 2,593,367

REELING MECHANISM

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Fig. 1.

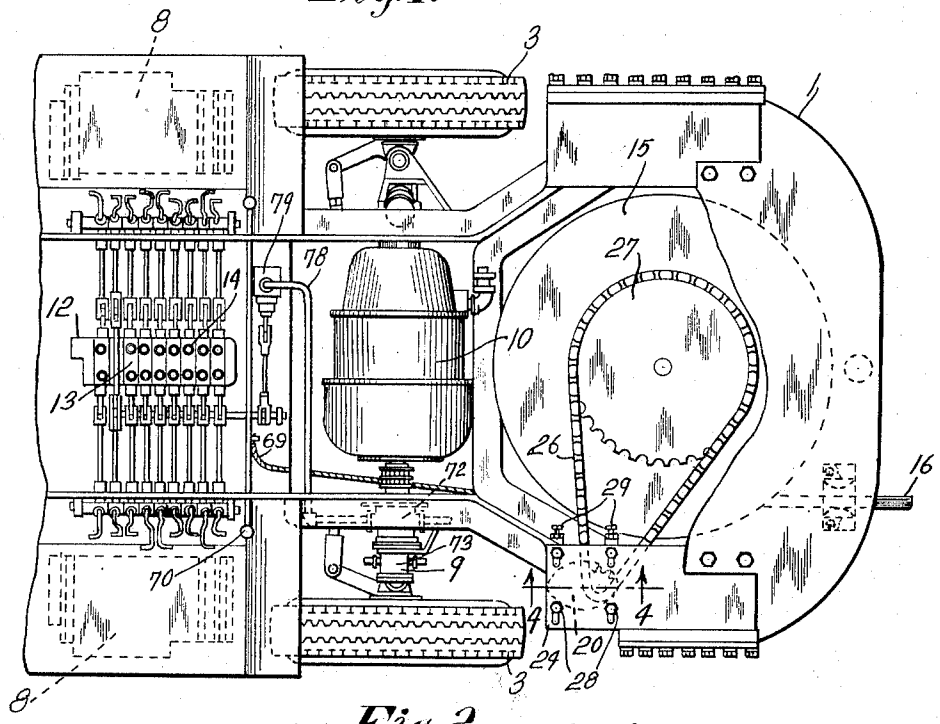


Fig. 2.

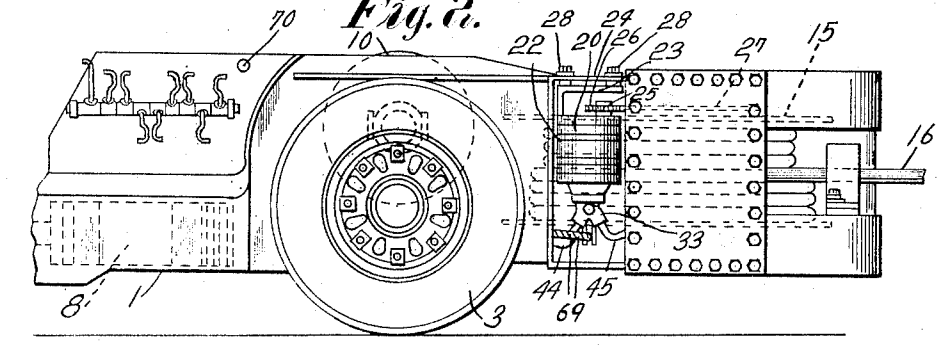
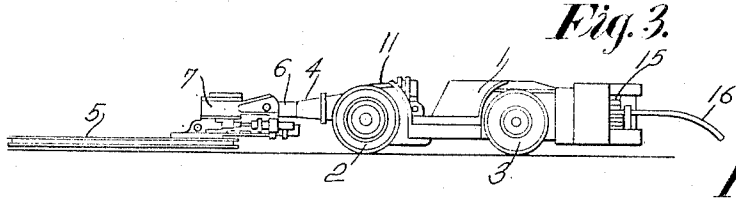


Fig. 3.



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REELING MECHANISM

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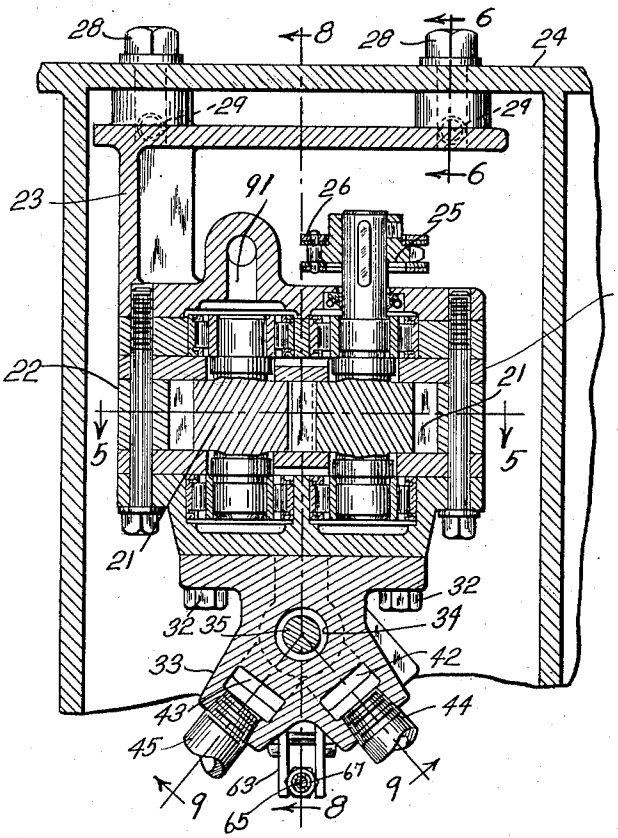


Fig. 4.

Fig. 7.

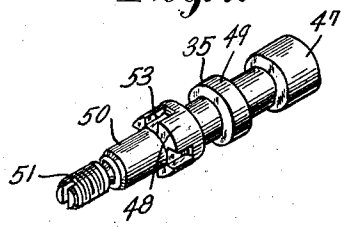


Fig. 5.

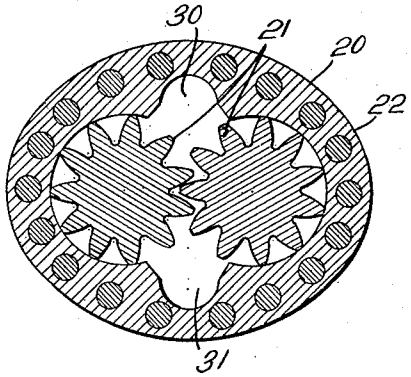
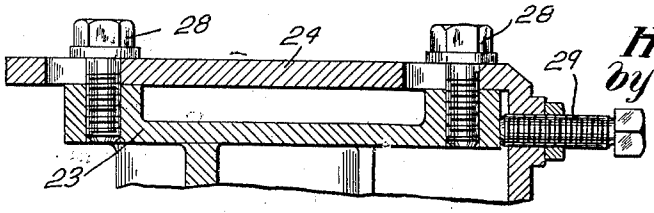


Fig. 6.



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REELING MECHANISM

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Fig. 8.

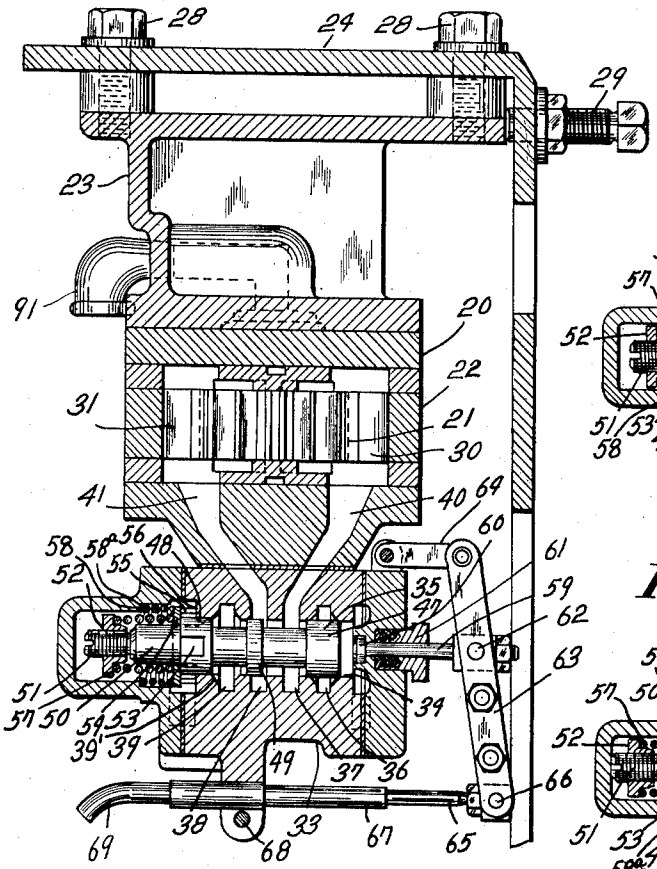


Fig. 9.

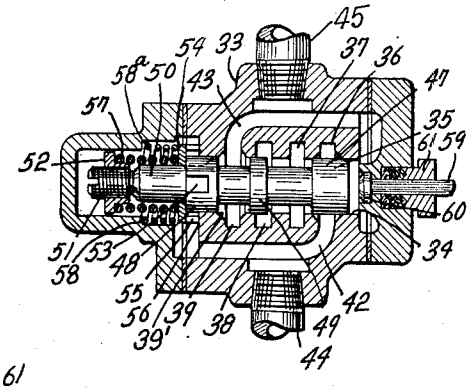


Fig. 10.

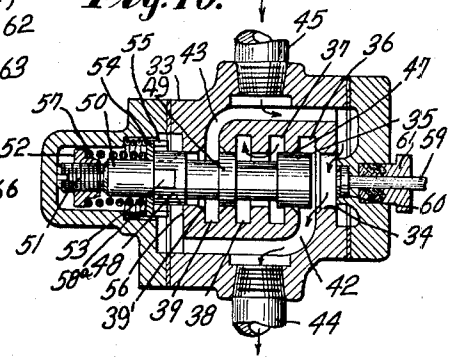


Fig. 12.

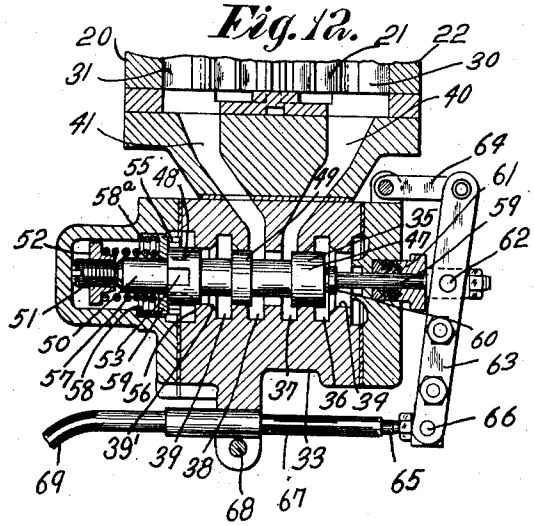
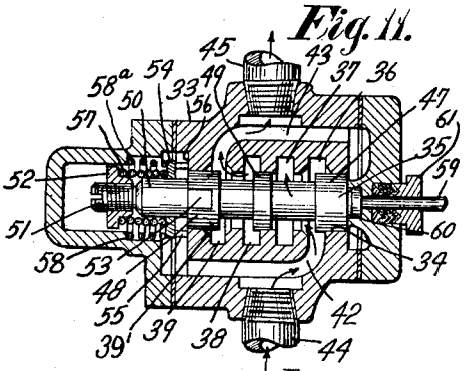


Fig. 11.



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REELING MECHANISM

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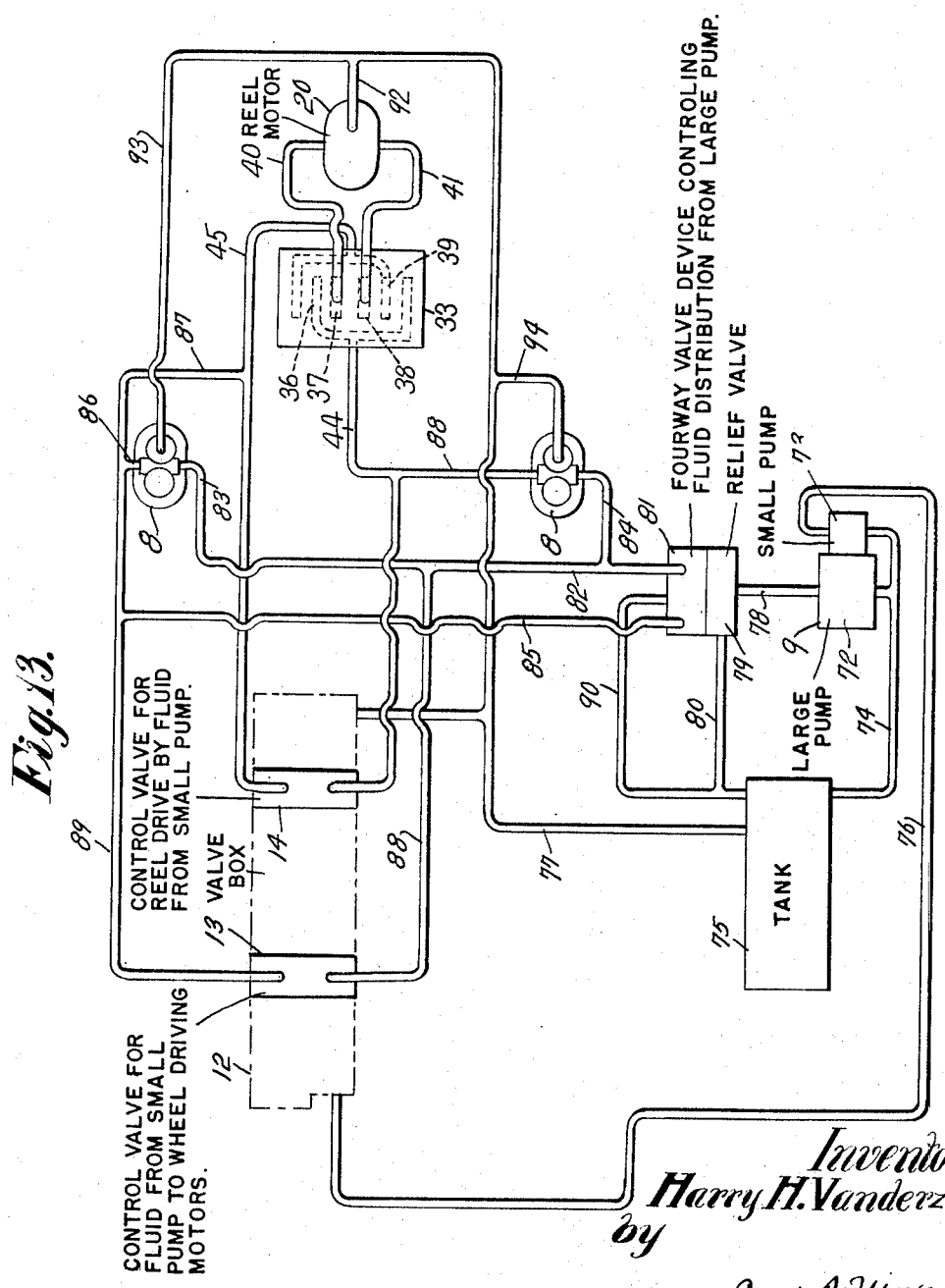


Fig. 13.

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Patented Apr. 15, 1952

2,593,367

UNITED STATES PATENT OFFICE

2,593,367

REELING MECHANISM

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Application January 9, 1945, Serial No. 571,991

15 Claims. (Cl. 242—90)

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This invention relates to reeling mechanism and more particularly to improvements in a power conductor reeling mechanism, especially designed for use with coal mining equipment such as a coal mining machine.

In mining equipment such as mining machines used in coal mines, a reeling mechanism is usually associated with the mining machine for winding in and permitting the drawing off of the element which conducts power to the mining machine as the latter travels back and forth. As the mining machine moves forwardly from the main entry into a room, the power conductor element is freely unwound from the reeling mechanism, and, as the mining machine backs from the room toward the main entry, the power conductor element is automatically wound in by the reeling mechanism. Heretofore in such reeling mechanism, there was usually provided a slip clutch or ratchet in the reel drive so that when the mining machine moved forwardly, the power conductor element was freely unwound from the reel due to slippage of the clutch or ratchet, and, when the mining machine moved rearwardly, the clutch or ratchet automatically effected reel drive in the direction to wind in the power conductor element. In such mining equipment, it is desirable to be able to wind in or to permit the drawing off of the power conductor element when the mining machine remains stationary, and it is also desirable, at times, to permit the drawing off of the power conductor element as the mining machine moves rearwardly and to wind in the power conductor element as the mining machine moves forwardly.

An object of the present invention is to provide a power conductor reeling mechanism embodying improvements over previous devices. Another object is to provide an improved power conductor reeling mechanism having improved driving and controlling means for the reel whereby the latter may permit the drawing off of the power conductor element, or effect its winding in by power, as desired. A further object is to provide an improved power conductor reeling mechanism having improved fluid operated driving means and improved controlling means associated therewith. A still further object is to provide an improved power conductor reeling mechanism driven by a fluid actuated motor and embodying means whereby the operating fluid is automatically by-passed with respect to the motor to permit free unwinding of the power conductor from the reel. Still another object is to provide an improved power conductor reeling mechanism having its driving means associated with the propelling means of the coal mining machine with which the reeling mechanism is associated. A still further object is to provide an improved hydraulically operated and controlled driving mechanism

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for the reel of a reeling mechanism. Another object is to provide an improved by-pass means for the operating fluid having manually operated control means associated therewith for actuating the by-pass valve, whereby fluid flowing to the reel motor may be by-passed to enable free paying out of the power conductor element as desired. Yet another object is to provide an improved control means for a reeling mechanism of the above character, whereby the power conductor element may be drawn off from the reeling mechanism as the mining machine moves backwards or at any time when it is desired manually to unwind the power conductor element regardless of movement of the machine. A still further object is to provide an improved fluid operated means for driving the reel in winding direction and having embodied therein automatic by-pass means, whereby the reel may revolve freely in unwinding direction. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings:

Fig. 1 is a plan view of the rearward portion of a coal mining machine with which an illustrative form of the invention is associated.

Fig. 2 is a side elevational view of the rearward portion of a mining machine shown in Fig. 1.

Fig. 3 is a side elevational view, on a reduced scale, of the complete mining machine.

Fig. 4 is an enlarged vertical sectional view taken substantially on line 4—4 of Fig. 1.

Fig. 5 is a horizontal sectional view taken on line 5—5 of Fig. 4.

Fig. 6 is a detail vertical sectional view taken on line 6—6 of Fig. 4.

Fig. 7 is a perspective view of the control valve element.

Fig. 8 is a vertical sectional view, slightly enlarged, taken substantially on line 8—8 of Fig. 4.

Fig. 9 is a sectional view taken on line 9—9 of Fig. 4.

Figs. 10 and 11 are sectional views similar to Fig. 9, showing the control valve in different positions.

Fig. 12 is a fragmentary sectional view taken on the plane of Fig. 8, showing the control valve manually held in its by-passing position.

Fig. 13 is a diagrammatic view illustrating the hydraulic system.

In this illustrative construction the improved power conductor reeling mechanism is shown associated with a coal mining machine of the kerf cutting type, although it will be evident that the same may be associated with other types of mining or other equipment. The coal mining ma-

chine disclosed herein is of the rubber-tired universal type, especially designed for use in trackless coal mines and may be generally similar to that shown in a copending application Serial No. 378,728, filed February 13, 1941, now abandoned, in which I am one of the co-inventors. While the machine disclosed is mounted on rubber-tired wheels adapted to travel along the floor of a mine without the aid of a guiding trackway, it will be obvious that the same may be provided with track engaging wheels or with endless traction treads in manners well known to those skilled in the art.

The coal mining machine disclosed herein comprises a portable base frame 1 mounted on rubber-tired wheels including front traction wheels 2 and rear steering wheels 3. Supported by the base frame and projecting forwardly therefrom is an elongated supporting structure or boom frame 4 carrying at its outer extremity an elongated plane kerf cutter 5. The boom frame 4 is mounted on the base frame to swing in horizontal and vertical directions with respect thereto in the manner fully described in the copending application above referred to, and includes an outer frame 6 rotatable about an axis extending longitudinally of the boom frame and a support 7 mounted on the rotatable frame 6 for tilting movement with respect thereto about an axis disposed at right angles to the longitudinal axis of the boom frame, and the kerf cutter 5 is pivotally mounted on the cutter support 7 to swing relative thereto about an axis at right angles to the axis of cutter support tilt. By adjusting the boom frame either horizontally or vertically, by rotating the frame 6 and tilting the cutter support 7, the kerf cutter 5 may be located in any desired cutting position with respect to the working face of a coal seam all in the manner fully described in the above mentioned copending application. As is also fully described in the above mentioned copending application, the various adjustable parts of the mining machine are hydraulically operated and controlled, and the front traction wheels are independently driven by conventional reversible hydraulic motors 8, 8. The hydraulic system of the mining machine, as shown in Fig. 13, which may be noted to be made after the nature of a top plan view so that certain parts appear differently from their disclosure in Figs. 9, 10 and 11, embodies a liquid pumping means 9 driven by a motor 10, and the kerf cutter is driven by a motor 11 carried by the boom frame 4, likewise fully described in the above mentioned copending application. Carried by the mining machine is a valve box 12 containing manually operable valve devices for controlling the various hydraulically operated devices of the machine, and the valve device 13 controls the supply from a smaller pump 73 hereinafter described to the traction wheel driving motors 8, while the valve device 14 controls the operation of the power conductor reeling mechanism, so far as this is effected by fluid from such smaller pump 73, as hereinafter explained.

Now referring to the improved power conductor reeling mechanism, it will be noted that journaled for rotation on a vertical axis in a relatively low horizontal position on the rearward portion of the portable base frame, as shown in Figs. 1 and 2, is a power conductor or cable reel 15 on which a power conductor element 16 is wound, for conducting motive power to the motors 10 and 11 of the mining machine. The motors 10 and 11 are herein preferably electric motors, and

the power conductor element 16 is herein in the form of an electric cable for conducting electricity to the electric motors, and the conductor cable is connected in a well-known manner through usual contactor devices to conductor cables leading to the motors. Evidently, if desired, the mining machine motors may be fluid actuated and the power conductor cable on the reel may be replaced by a fluid supply hose in a well-known manner.

The cable reel 15 may be driven in a direction to wind in the power conductor cable 16 by a hydraulic motor 20 (Figs. 4 and 5) comprising intermeshing rotors 21 journaled on parallel vertical axes within a casing 22, the latter being suspended by a bracket 23 from a horizontal top plate 24 of the machine base frame. Keyed to the upper end of one of the rotor shafts, as shown in Fig. 4, is a chain sprocket 25 connected by an endless drive chain 26 to a sprocket 27 suitably fixed to the reel drive shaft. The bracket 23 is secured by bolts 28 to the plate 24, and the plate is slotted to permit horizontal adjustment of the bracket when the bolts are loosened. Set screws 29 are provided for adjusting the bracket together with the motor casing with respect to the reel so that the chain 26 may have its tension adjosted as desired. After proper adjustment has been made, the bolts 28 may be tightened to secure the parts firmly in adjusted position.

As shown in Figs. 5 and 8, the reel driving motor 20 has a liquid supply chamber 30 and a liquid exhaust chamber 31. Attached by screws 32 to the bottom of the motor casing 22 is a valve casing 33 having a horizontal bore 34 containing a control valve 35 of an improved design. The walls of the bore 34 are annularly grooved at 36, 37, 38 and 39 at longitudinally spaced points, and the intermediate grooves 37 and 38 are respectively connected by passages 40 and 41 to the supply and exhaust chambers of the motor. Communicating with the end grooves 36 and 39 are passages 42 and 43 connected respectively to conduits 44 and 45, and these conduits lead to the valve device 14 of the valve box 12 (Fig. 13). The valve 35 is of the sliding spool type and has end spools 47 and 48 and an intermediate spool 49, and projecting outwardly from the left-hand spool 48 (Figs. 7 and 8) is a reduced portion 50 threaded at 51 to receive an adjusting nut 52. The left-hand spool 48 is grooved at 53 longitudinally of the valve at spaced points about its periphery, and the groove 39 is countersunk at 39' around the bore 34, at its left-hand side, so that in certain positions of the control valve 35 the grooves 53 open into the groove 39, as shown in Fig. 11. A washer 54 surrounds the reduced portion 50 and is engageable with the outer end surface of the spool 48 in the manner shown in Fig. 8, and this washer has spaced projections 55 engageable with a surface 56 surrounding the left-hand end of the valve receiving bore 34. Interposed between the washer 54 and the nut 52 and surrounding the reduced valve portion 50 is a spring 57 for urging the washer toward the outer end surface of the valve spool 48. This nut 52 may be adjusted with respect to the valve to vary the tension of the coil spring. When the valve 35 moves toward the right into the position shown in Fig. 9, the washer projections 55 engage the surface 56 and further movement of the valve toward the right, i. e., toward the position shown in Fig. 11, is resisted by the spring 57. Interposed between a surface

58 on the valve casing and the washer 54 and surrounding the spring 57 is a spring 58a which tends to hold the valve 35 in the neutral or central position shown in Fig. 8. For manually shifting the valve 35 toward the left in Fig. 8 into the position shown in Fig. 12, there is provided a plunger 59 coaxial with the valve and having an inner head 60 engageable with the right-hand end of the valve. This plunger projects outwardly through a stuffing box 61 from the valve casing and is pivotally connected at 62 to an operating lever 63, the latter in turn being pivotally connected by a loose link 64 to the valve casing. An operating shaft 65 is pivotally connected at 66 to the operating lever, and this shaft is guided in a tubular casing 67 secured at 68 to the bottom of the valve casing. The shaft 65 may be actuated through a conventional flexible shaft or Bowden wire 69 by an operating rod 70 located at the top of the machine base frame in adjacency to the valve box 12, as shown in Fig. 1.

As shown diagrammatically in Fig. 13, the pumping means 9 includes a large capacity pump 72 and a small capacity pump 73, and the pump intakes are connected by a suction line 74 to a liquid tank 75 carried by the machine base frame beneath the valve box 12. The small pump discharge is connected by a pressure line 76 to the supply passage of the valve box 12. The exhaust or return passage of the valve box 12 is connected by a return line 77 back to the tank. The discharge of the large capacity pump is connected by a pressure line 78 to a relief valve device 79. When the pressure in the line 78 becomes excessive, the relief valve device automatically connects the line 78 to a return line 80 leading to the tank. The pressure line 78 is connected to a four-way valve device 81 also fully described in the above mentioned copending application and which is connected by a conduit 82 and branch conduits 83 and 84 to the traction wheel driving motors 8 at one side of the latter. Also leading from the four-way valve device 81 is a conduit 85 connected by a branch conduit 86 to the motor 8 shown near the top of Fig. 13, and through a branch conduit 87 to the conduit 45. The other side of the other wheel driving motor 8, shown in Fig. 13, is connected by a conduit 88 to the conduit 44. The conduits 82 and 85 are connected by branch conduits 88 and 89 to the valve device 13. The four-way valve device 81 is connected by a return line 90 back to the tank. As shown in Fig. 4, the reel driving motor 20 has a leak passage 91 communicating with the rotor chamber to carry away any leakage of liquid, and the wheel driving motors 8 have similar leak passages. These leak passages are connected by branch conduits 92, 93 and 94 (see also Fig. 13) to the return line 77 so that any liquid leaking through these motors is conducted back to the tank.

The general mode of operation of the improved power conductor reeling mechanism is as follows: When the mining machine is propelled in a forward direction, for instance, from the main entry into a room, the free end of the conductor cable 16 is attached in the usual manner to the trolley line in the main entry, and the four-way valve device 81 is positioned to supply liquid under pressure from the large pump 72 through the pressure line 78 and past the suitably adjusted four-way valve to the conduit 85 and branch conduit 86 to the upper one of the wheel driving motors 8, shown in Fig. 13. Concurrently liquid under pressure flows through conduit 87 to conduit 45 and through passage 43 (see Fig. 10) to the valve receiving bore 34 at the right-hand end of the valve 35 and past the latter, which will then be displaced by the liquid to the position of Fig. 10, to passage 42 and conduit 44 and through conduit 88 to the intake of the bottom wheel driving motor 8, shown in Fig. 13. As a result the motors 8 are concurrently operated in a direction to effect propulsion of a mining machine in a forward direction, i. e., to the left as viewed in Fig. 3. The discharge sides of the wheel driving motors 8 are connected through the branch conduits 83 and 84, conduit 82, through the four-way valve device 81 and return line 90 back to the tank 75. During such forward propulsion of the mining machine, the valve 35 is in the position shown in Fig. 10 so that the supply and exhaust passages 40 and 41 of the motor 20 are connected together by the valve 35, and, as a result, the liquid within the reel driving motor 20 may be freely circulated and thereby permit the conductor cable to freely unwind from the cable reel as the mining machine moves forwardly. When it is desired to reverse the direction of movement of the mining machine, i. e., to back the machine out of the room in a direction toward the right in Fig. 3, the four-way valve device 81 is adjusted to connect the conduit 82 with the pressure line 78 and to connect the conduit 85 with the return line 90, and, with the valve device so positioned, liquid under pressure may flow from the large pump 72 through the pressure line 78 through the four-way valve device and through the conduit 82 and branch conduits 83 and 84 to the wheel driving motors 8 to operate the latter in the reverse direction. Exhaust from the motor 8 near the top of Fig. 13 flows freely back to the tank 75 through conduits 86 and 85, the valve device 81 and conduit 90. Concurrently, the exhaust side of the motor 8 shown at about the vertical center of Fig. 13, is connected by conduit 88 and conduit 44 to the passage 42 (see Fig. 9). The liquid in the passage 42 flows to the left-hand end of the valve casing 33 and acts on the left-hand end of the valve 35 to move the latter toward the right from the position shown in Fig. 9 to the position shown in Fig. 11. When the by-pass valve 35 is held by the pressure of the liquid to the right, as shown in Fig. 11, the grooves 53 in the left-hand valve spool 48 connect the passage 42 with the passage 43 so that some of the liquid may flow past the valve to discharge. This event takes place when the volume of liquid flow through the passage 40 to the reel driving motor 20 is substantially less than that flowing to the valve casing through the conduit 44, to enable some of the liquid flowing to the valve casing to by-pass the valve to discharge. Liquid under pressure then flows through passage 42 past the valve 35 between the spools 47 and 49, through groove 37 and passage 40 to the supply chamber 30 of the reel driving motor 20, thereby causing the cable reel to be driven in a direction to wind in the conductor cable as the mining machine moves rearwardly. The exhaust from the reel driving motor 20 at this time flows through passage 41 past the valve 35 between the spools 48 and 49, through groove 39 and passage 43 to conduit 45 and thence to conduits 87 and 85 through the four-way valve device 81 and through return line 90 back to the tank. The exhaust from the upper wheel driving motor 8, shown in Fig. 13, is concurrent-

ly conducted, as above noted, through conduits 86 and 85, the four-way valve device, and the return line 90, to the tank. It is accordingly evident that when the mining machine is propelled in a forward direction by the wheel driving motors 8, the control valve 35 moves under the action of the liquid automatically into a position to effect free circulation of liquid through the reel driving motor so that the conductor cable may be freely unwound from the cable reel, and, when the mining machine is propelled in a rearward direction by the wheel driving motors, the reel driving motor 20 concurrently effects drive of the cable reel in a direction to wind in the conductor cable. If it is desired to enable free unwinding of the conductor cable while the mining machine is stationary, or, if it is desired to unwind the conductor cable during rearward movement of the mining machine, this may be accomplished simply by actuating the control rod 70 to swing the lever 63 in a direction to move the plunger 59 inwardly, i. e., to the left as viewed in Fig. 8, manually to shift the valve 35 to the position shown in Fig. 12 wherein the liquid in the reel driving motor is free to circulate, permitting the conductor cable to be freely drawn off as desired. When the conduits 82 and 85 are both closed by the four-way valve device 81, the valve device 13 may be manually operated to supply liquid under pressure from the small pump 73 through conduit 88, conduit 82 and branch conduits 83 and 84 to the wheel driving motors 8, to move the machine backwards, and concurrently the reel driving motor 20 is operated to drive the reel in cable winding direction. Also the valve device 13 may be manipulated to supply liquid under pressure from the small pump to the wheel driving motors to effect forward propulsion of the machine, and at that time the liquid in the reel motor is automatically by-passed by the valve 35 to permit free unwinding of the cable from the reel. When the machine is stationary, the valve device 14 may be employed to effect rotation of the reel to wind in the cable, and the pressures built up at the motors 8 will be inadequate to cause these to turn for the grooves 53 will, as valve 35 is automatically adjusted, vent all pressure above some predetermined value suited to effect reel drive with the desired torque.

As a result of this invention, it will be noted that an improved power conductor reeling mechanism is provided having improved driving and controlling means, whereby the power conductor element may be wound in or permitted to be drawn off as desired. By the provision of the improved reel driving mechanism associated with the driving motors for the traction wheels of the mining machine, together with the improved automatic control means, the cable reel is always freely rotatable to permit drawing off of the conductor element during forward movement of the mining machine and effective to wind in the conductor element by power as the mining machine moves rearwardly. By reason of the provision of the improved manual control means associated with the automatic control valve the conductor element may be freely drawn off irrespective of the bodily movement of the mining machine. Other uses and advantages of the invention will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may

assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be 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 a reeling mechanism, a reel, a fluid actuated driving motor therefor, a fluid supply, means for conducting fluid from said supply to said driving motor and for exhausting fluid from said motor, a valve element for controlling fluid flow through said conducting means and operative in one position to cut off communication between said fluid supply and said motor through said means for conducting fluid from said supply to said motor and having means operative automatically, under the action of the fluid thereon upon flow of fluid from said supply to move said valve element in one direction into a position to admit fluid to said motor, adjustable spring means for opposing movement of said valve element under the action of the fluid, and passage means controlled by movement of said valve element for by-passing a portion of the fluid in said conducting means to exhaust when said valve element is moved under the action of fluid and against the action of said spring means into substantially its limit of travel in said one direction and still continues to admit fluid to said motor.

2. In a reeling mechanism, a reel, a fluid actuated driving motor therefor, a fluid supply, means for conducting fluid from said supply to said motor and for exhausting fluid therefrom, a valve element for controlling the flow of fluid through said conducting means and operative in one position to cut off fluid supply to said motor and to connect said motor so that fluid may freely circulate through said motor, said valve element having means operative automatically, under the action of the fluid thereon upon flow of fluid from said supply, to move said valve element in one direction into a position to admit fluid to said motor, adjustable spring means for opposing movement of said valve element under the action of the fluid, and passage means controlled by movement of said valve element for by-passing a portion of the fluid in said conducting means to exhaust when said valve element is moved under the action of fluid and against the action of said spring means into substantially its limit of travel in said one direction and still continues to admit fluid to said motor.

3. In a reeling mechanism, a reel, a fluid actuated driving motor therefor, a fluid supply, means for conducting fluid from said supply to said motor and for exhausting fluid therefrom, a fluid actuated by-pass device including a valve element actuated by the fluid in said conducting means for controlling the flow of fluid in said conducting means to said motor to effect reel rotation in one direction, said valve element having means for automatically by-passing through itself fluid with respect to said motor upon fluid flow in the reverse direction so that the reel may freely revolve in the opposite direction, and manually operable means for shifting said valve element in the direction opposite to that in which it is moved by the pressure of the fluid to effect reel rotation and against the opposition of such pressure.

4. In a reeling mechanism, a reel, a fluid actu-

ated driving motor therefor, a by-pass valve element having a casing, a pair of fluid conduits connected to said valve casing, said conduits adapted to serve alternately as fluid supply and fluid exhaust conduits, a pair of passages connecting said valve casing with said motor, said valve element having means operative upon fluid supply through one of said conduits for moving it into a position automatically to connect said supply conduit through one of said passages to the motor to effect drive of the reel in one direction, and said valve element having means operative upon fluid supply through the other of said conduits automatically to move it into a position to connect the then fluid-supply conduit with the then fluid-exhaust conduit and to by-pass said motor while connecting the latter through said passages so that said reel may freely revolve in the opposite direction, and spring means for controlling the movement of said valve element in one direction normally maintaining it in an intermediate position between said first two positions.

5. In a reeling mechanism, a reel, a fluid actuated driving motor therefor, a by-pass valve element having a casing, a pair of fluid conduits connected to said valve casing, said conduits adapted to serve alternately as fluid-supply and fluid-exhaust conduits, a pair of passages connecting said valve casing with said motor, said valve element having means operative upon fluid supply through one of said conduits for automatically moving it into a position to connect said then supply conduit through one of said passages to the motor to effect drive of the reel in one direction, and said valve element having means operative upon fluid supply through the other of said conduits for automatically moving it into a position to connect the then fluid-supply conduit with the then fluid-exhaust conduit and cause the fluid to by-pass said motor while connecting the latter, by the interconnection of said passages, so that said reel may freely revolve in the opposite direction, spring means for opposing the movement of said valve element to said last mentioned position, and manually operable means for shifting said valve element, to interrupt reel drive, in the direction opposite that in which it is moved by the fluid supply to effect reel drive by the fluid.

6. In a reeling mechanism, a reel, a fluid actuated driving motor for said reel, a by-pass valve element having a casing providing a chamber in which said valve element is movably received, a first pair of fluid passages connected to said casing and with said motor and each adapted to lead fluid from the casing to the motor while the other leads fluid from the motor to the casing, a second pair of fluid passages connected to said casing and each adapted to lead fluid to said casing while the other leads fluid from it, each of said second pair of passages having two connections with said chamber, one at an end of the latter and one spaced from said end, said end connections for said second pair of passages being with different ends of the chamber, said valve element having areas subjected to fluid pressures exerted through said end connections to move the same, and said valve element and said casing together forming fluid conducting means effective in one position of said valve element to interconnect said first pair of fluid passages so that said motor may freely revolve and to connect said second mentioned pair of passages together so that fluid may pass freely between them, and in another

position of said valve element to connect one of said first pair of passages with one of the second pair and the other of said first pair with the other of said second pair, so that fluid may pass from one of said second pair of passages through said motor and to the other of said second pair of passages, and resilient means for normally maintaining said valve element in a position in which fluid pressure exerted through one or the other of said end connections can effect movement of said valve element towards one or the other of said positions.

7. In combination, in a valve mechanism, means forming a casing providing a series of four coaxial grooves connected by a valve receiving bore, each of said grooves having in communication with it a conduit, constantly open connections from the conduits communicating with each of the end grooves leading to the respectively opposite ends of the valve bore, whereby each conduit communicates with an end groove and with the end of the valve bore which is the more remote from the end groove with which it communicates, a spool valve in said bore operative in an intermediate position to interconnect the two inner grooves and in one extreme end position of said valve to connect each intermediate groove with the adjacent end groove, and spring means for normally maintaining said valve in said intermediate position.

8. In combination, in a valve mechanism, means forming a casing providing a series of four coaxial grooves connected by a valve receiving bore, each of said grooves having in communication with it a conduit, constantly open connections from the conduits communicating with each of the end grooves leading to the respectively opposite ends of the valve bore, whereby each conduit communicates with an end groove and with the end of the valve bore which is the more remote from the end groove with which it communicates, a spool valve in said bore operative in an intermediate position to interconnect the two inner grooves and in one extreme end position of said valve to connect each intermediate groove with the adjacent end groove, and spring means for normally maintaining said valve in said intermediate position and returning it thereto after motion therefrom in either direction.

9. In combination, in a valve mechanism, means forming a casing providing a series of four coaxial grooves connected by a valve receiving bore, each of said grooves having in communication with it a conduit, constantly open connections from the conduits communicating with each of the end grooves leading to the respectively opposite ends of the valve bore, whereby each conduit communicates with an end groove and with the end of the valve bore which is the more remote from the end groove with which it communicates, a spool valve in said bore having thereon fluid conducting conduits operative in one intermediate position and in one extreme position to interconnect the two inner grooves and in the other extreme end position of said valve to connect each intermediate groove with the adjacent end groove, and spring means for normally maintaining said valve in said intermediate position.

10. In combination, in a valve mechanism, means forming a casing providing a series of four coaxial grooves connected by a valve receiving bore, each of said grooves having in com-

munication with it a conduit, constantly open connections from the conduits communicating with each of the end grooves leading to the respectively opposite ends of the valve bore, whereby each conduit communicates with an end groove and with the end of the valve bore which is the more remote from the end groove with which it communicates, a spool valve in said bore having grooves operative in an intermediate position to interconnect the two inner grooves and in one extreme end position of said valve to connect each intermediate groove with the adjacent end groove, spring means for normally maintaining said valve in said intermediate position, and manually operable means for moving said valve longitudinally against the action of said spring means.

11. In combination, in a valve mechanism, means forming a casing having spaced end chambers connected by a bore and, intermediate said end chambers, four ports each communicating with said bore, one of said ports near one of said end chambers, another of said ports near the other of said end chambers, and the other two of said ports intermediate the ports which are near said end chambers, a passage connecting one of the ports near an end chamber with the other end chamber, a passage connecting the other of the ports near an end chamber with the opposite end chamber, and a three spool valve in said bore having between the spools thereof grooves one of which is adapted to connect the two intermediate ports or one of said intermediate ports and the nearer one of said ports near an end chamber.

12. In combination, in a valve mechanism, means forming a casing having spaced end chambers connected by a bore and, intermediate said end chambers, four ports each communicating with said bore, one of said ports near one of said end chambers, another of said ports near the other of said end chambers, and the other two of said ports intermediate the ports which are near said end chambers, a passage connecting one of the ports near an end chamber with the other end chamber, a passage connecting the other of the ports near an end chamber with the opposite end chamber, and a three spool valve in said bore having between the spools thereof grooves one of which is adapted to connect the two intermediate ports or one of said intermediate ports and the nearer one of said ports near an end chamber, and another of which grooves is adapted to connect the other of said intermediate ports and the nearer one to it of the ports near an end chamber.

13. In combination, in a valve mechanism, means forming a casing having spaced end chambers connected by a bore and, intermediate said end chambers, four ports each communicating with said bore, one of said ports near one of said end chambers, another of said ports near the other of said end chambers, and the other two of said ports intermediate the ports which are near said end chambers, a passage connecting one of the ports near an end chamber with the other end chamber, a passage connecting the other of the ports near an end chamber with the opposite end chamber, and a three spool valve in said bore having between the spools thereof grooves one of which is adapted to connect the two intermediate ports or one of said intermediate ports and the nearer one of said ports near an end chamber, said valve having in one spool thereof at least one groove operative in a predetermined position of said valve to connect an end chamber and the port near said end chamber.

14. In combination, in a valve mechanism, means forming a casing having spaced end chambers connected by a bore and, intermediate said end chambers, four ports each communicating with said bore, one of said ports near one of said end chambers, another of said ports near the other of said end chambers, and the other two of said ports intermediate the ports which are near said end chambers, a passage connecting one of the ports near an end chamber with the other end chamber, a passage connecting the other of the ports near an end chamber with the opposite end chamber, and a three spool valve in said bore having between the spools thereof grooves one of which is adapted to connect the two intermediate ports or one of said intermediate ports and the nearer one of said ports near an end chamber, said valve having in one spool thereof means operative in the latter position thereof for connecting the other of said ports near an end chamber and the end chamber nearer to said last mentioned port.

15. In combination, in a valve mechanism, means forming a casing having spaced end chambers connected by a bore and, intermediate said end chambers, four ports each communicating with said bore, one of said ports near one of said end chambers, another of said ports near the other of said end chambers, and the other two of said ports intermediate the ports which are near said end chambers, a passage connecting one of the ports near an end chamber with the other end chamber, a passage connecting the other of the ports near an end chamber with the opposite end chamber, a three spool valve in said bore having between the spools thereof grooves one of which is adapted to connect the two intermediate ports or one of said intermediate ports and the nearer one of said ports near an end chamber, and spring means arranged wholly at one end of said valve for normally maintaining it in a position from which it is movable in either of opposite directions by an unbalanced pressure in either of said end chambers.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
149,068	Rogers	Mar. 31, 1874
570,045	Ongley	Oct. 27, 1896
679,533	Moore	July 30, 1901
1,045,903	Smith	Dec. 3, 1912
1,843,504	Coseo	Feb. 2, 1932
2,126,172	Cartlidge	Aug. 9, 1938
2,229,086	Joy	Jan. 21, 1941
2,307,585	Harrington	Jan. 5, 1943
2,362,349	Bryant	Nov. 7, 1944
2,395,302	Slomer	Feb. 19, 1946
2,424,901	Richolt	July 29, 1947