

July 30, 1957

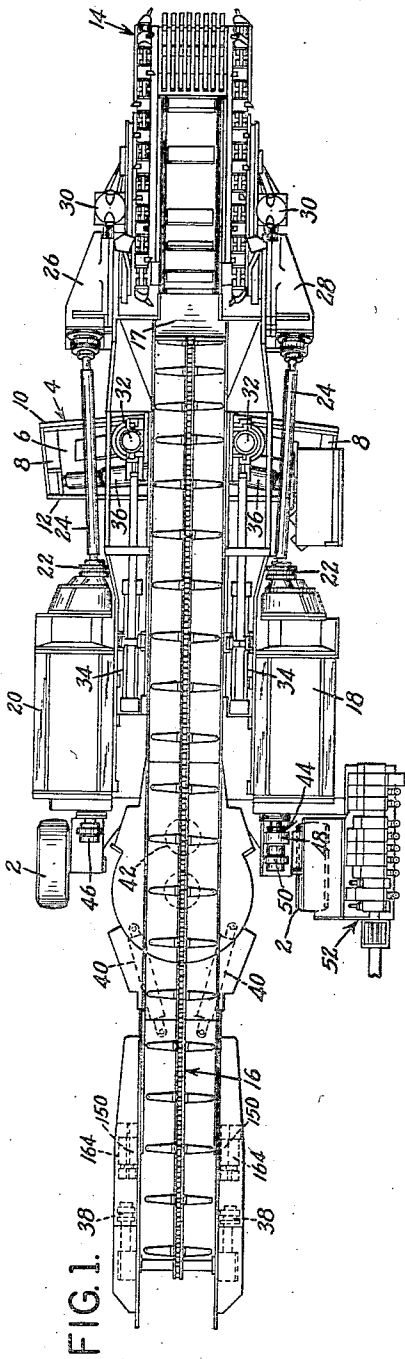
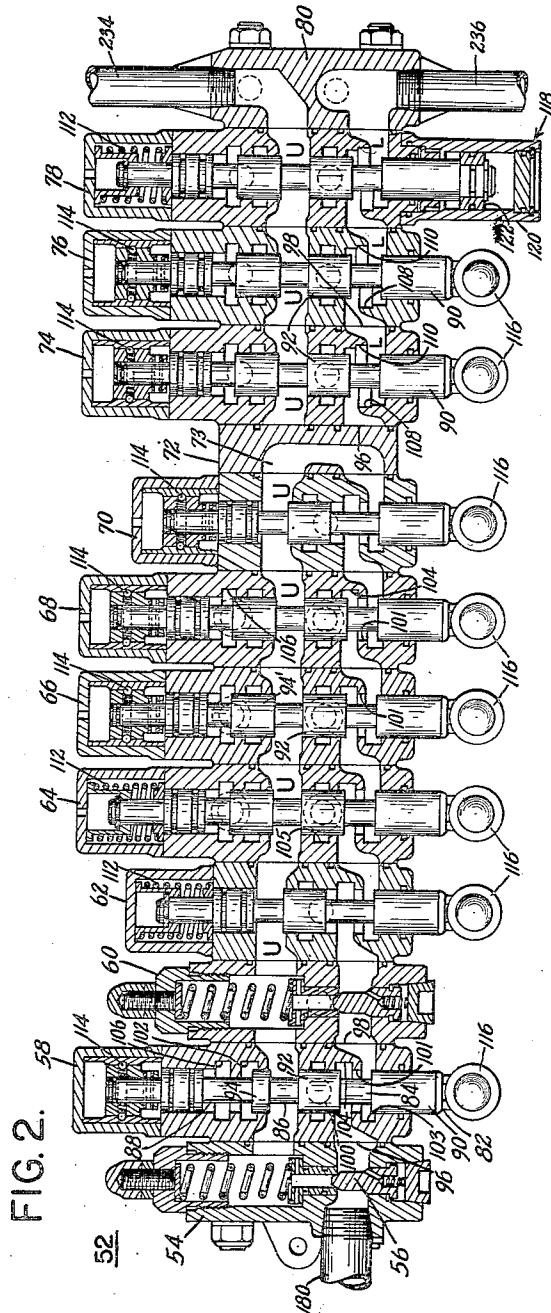
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2,800,969

AUTOMATIC CREEPER CONTROL MECHANISM FOR MINING MACHINES

Filed May 7, 1952

3 Sheets-Sheet 1



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FIG. 4.

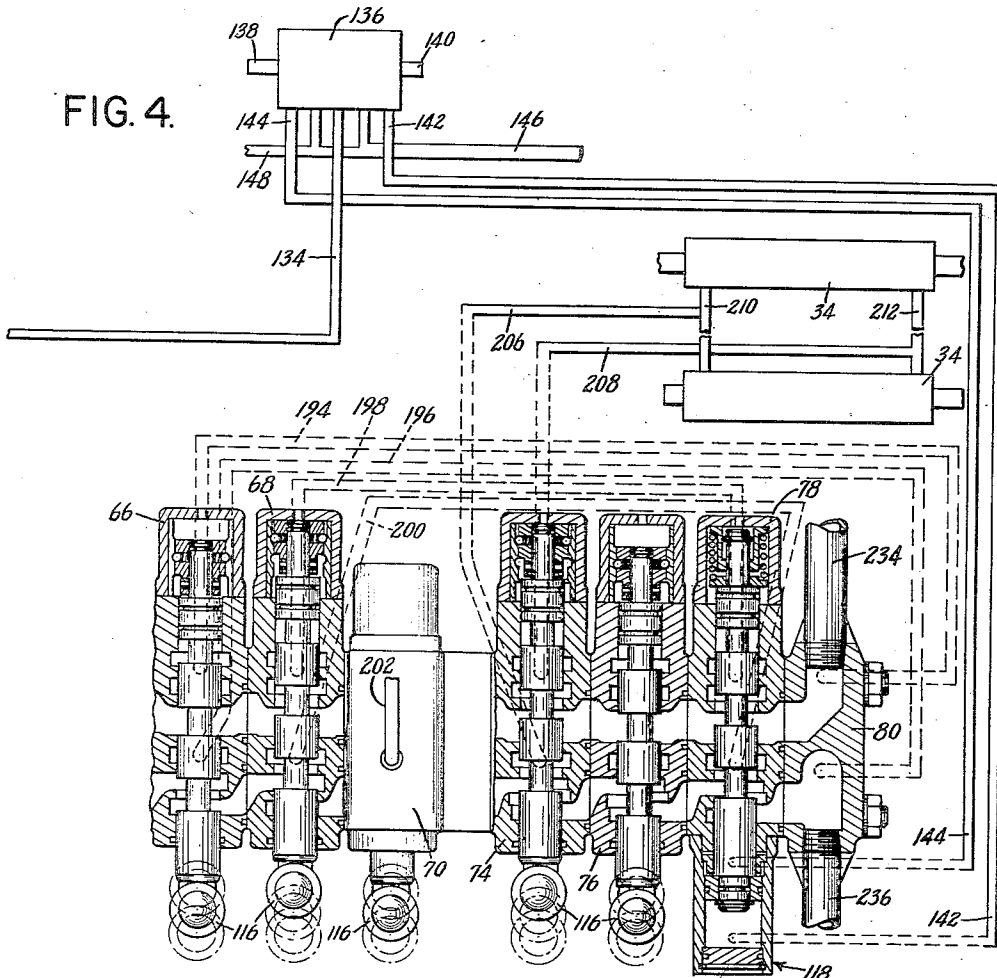
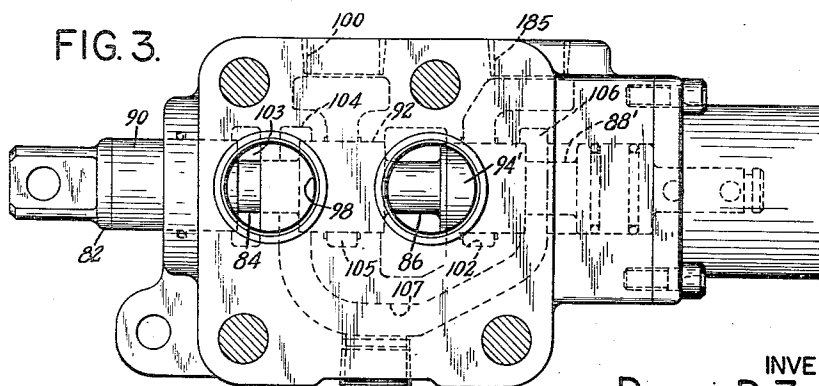


FIG. 3.



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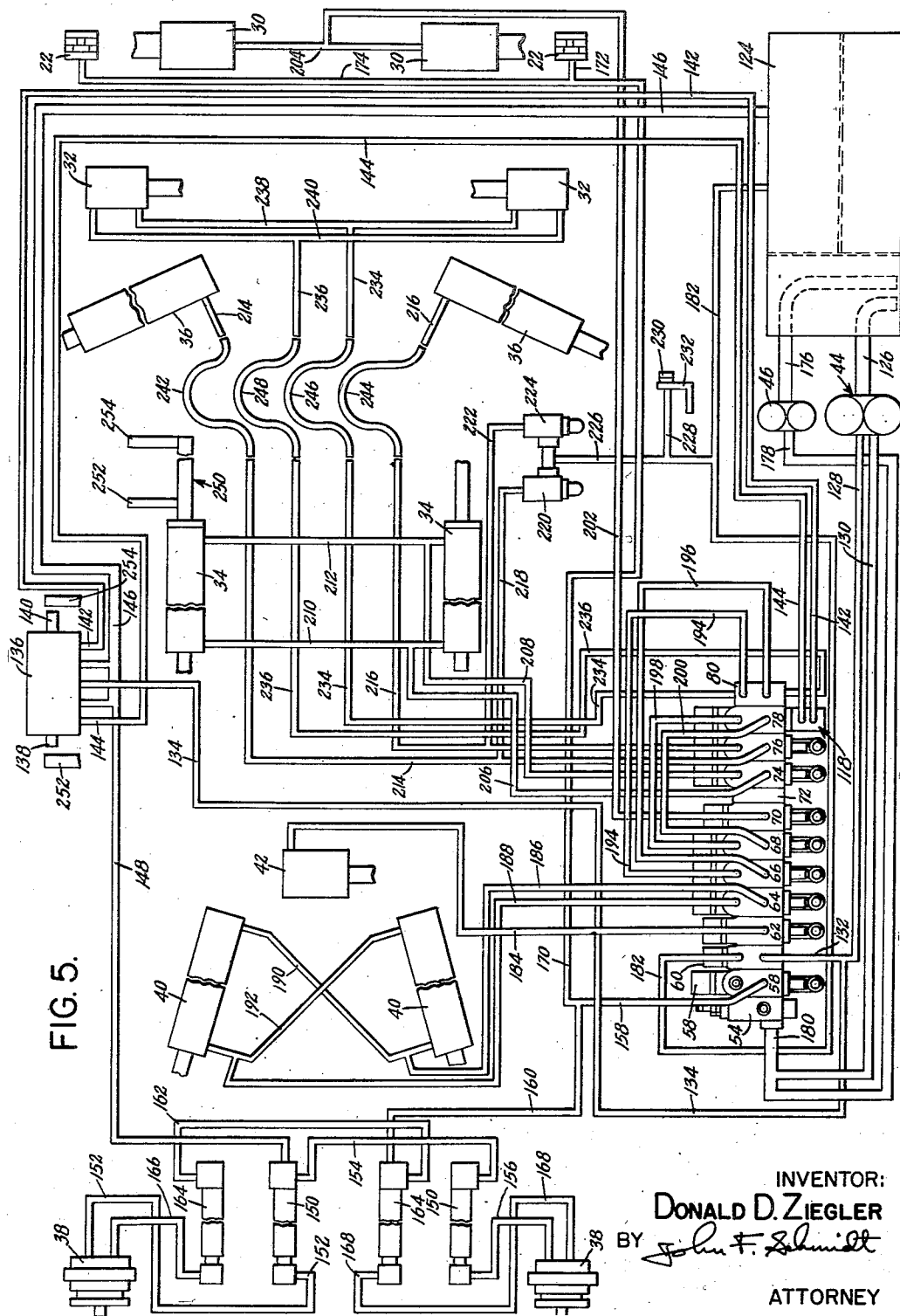
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AUTOMATIC CREEPER CONTROL MECHANISM FOR MINING MACHINES

Filed May 7, 1952

3 Sheets-Sheet 3



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2,800,969

AUTOMATIC CREEPER CONTROL MECHANISM FOR MINING MACHINES

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Application May 7, 1952, Serial No. 286,466

3 Claims. (Cl. 180—8)

This invention relates to a mining machine, especially to a continuous mining machine of the general type disclosed and claimed in patent applications Ser. No. 191,003 of Arthur L. Barrett, filed October 19, 1950, which has become abandoned, and Ser. No. 267,717 of John R. Sibley, filed January 23, 1952, now Patent No. 2,751,204 both of which are assigned to the assignee of this invention. This invention is in fact an improvement in the control mechanism of the creeper base of the above-identified Barrett application.

A machine having a creeper base such as that shown in the Barrett application is customarily maneuvered at the face by an operator who works the controls by hand. To move the machine about from place to place by means of its walker mechanism, when it is not actually mining coal or other mineral, it is desirable to make the walking mechanism automatic, so that all the operator needs to do is move one or more valve handles to a given position depending upon the direction of motion desired, and then merely walk along with the machine as it moves to its new location, providing no further control except for a possible occasional adjustment in the direction of movement of the machine. It would furthermore be advantageous to provide walking mechanism for such a creeper base which could walk the machine at a faster gait for movement from one face to another than is desirable when the machine is actually mining coal. It is furthermore desirable to provide a considerably simplified control for the creeper base over that shown in the Barrett application referred to.

It is accordingly an object of this invention to provide a creeper base for a continuous mining machine in which the control valves can be set for automatic operation of the walker mechanism to effect tram of the machine when it is not mining coal. It is another object of this invention to provide control mechanism for the tramming action which permits faster tram when the machine is not mining coal. It is a still further object to provide a walker control mechanism which simplifies and reduces the number of hose lines, etc. necessary in order to accomplish the hydraulic control of the machine which is desirable.

These and other objects are accomplished in a creeper base for a continuous miner in which two pumps provide hydraulic fluid under pressure, one of them providing fluid for the moving means of the mining machine, and the other providing fluid which drives the conveyor. The controls are so arranged that, with the conveyor drive shut down, the hydraulic fluid which would normally be used to effect such drive is added to the fluid which provides for movement of the machine by means of its creeper base, thus speeding up the walking action of the creeper base. The simplified control is accomplished by the provision of two manually operable open-center valves connected in series, the second of which is connected to deliver fluid to a pilot operated valve which directs fluid to a plurality of valves connected in parallel; the pilot operated valve is directed by a pilot valve which in turn is

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controlled by suitable trip mechanism associated with the movement effecting means of the creeper base.

In the drawings:

Fig. 1 is a top plan view of a machine made according to this invention, this being substantially the embodiment shown in Figs. 11–15 of the machine shown in the above-identified Barrett application, but provided with my improved control.

Fig. 2 is a view in detail through the bank of control valves, this view being on a much larger scale than the scale of Fig. 1.

Fig. 3 is a side view of a control valve.

Fig. 4 is a view somewhat like Fig. 2, but showing only a portion of the valve bank, and showing the valves in some of their operating positions; and

Fig. 5 is a schematic view of the hydraulic circuit of a machine made according to this invention.

As will best be understood by reference to the above-identified Barrett application, a machine made according to this invention embodies a creeper base which carries a pair of wheels 2 toward the rear of the machine, and a floor-engaging foot or support near the forward end of the machine, which support does not show in Fig. 1 but which is slightly forward of a floor-engaging shoe shown generally at 4. Although the shoe shown at 4 appears to be more elaborate than the shoe 115 in Figs. 11 and 12 of the Barrett application referred to above, it is identically the same in function and substantially the same in structure except that a bottom plate 6, side plates 8, and front and rear plates 10 and 12 respectively, are added for protection of the mechanism.

The creeper base preferably carries a vein dislodging and disintegrating mechanism 14 of the type disclosed and claimed in the above-identified Sibley application. A conveyor 16 is also carried by the creeper base and is positioned to receive material by way of a chute 17 from the vein dislodging and disintegrating mechanism 14 and to deliver it to a discharge point at the rear of the machine. Motor means are provided to furnish the main motive power of the machine, these motor means being shown in this embodiment as a pair of electric motors 18 and 20. Clutch means are connected to the motor means and to the vein dislodging and disintegrating mechanism 14; these clutch means are shown at 22 and consist preferably of hydraulically actuated clutches engageable by hydraulic control means in order to effect drive of the mechanism 14 by the motors 18 and 20. Connection of the clutches 22 to the mechanism 14 may be by any suitable mechanical means, including extensible shafts 24 and appropriate gear reduction units encased in housings 26 and 28. As is best understood by reference to the above-identified Barrett and Sibley applications, the mechanism 14 is mounted for swinging through a vertical plane about a horizontal axis, and the vertical swing effort is provided by means of vertical swing jacks 30.

The shoe 4 may be controlled in its vertical movement by means of a pair of shoe lift jacks 32, jacks 32 being associated with the creeper base and the shoe 4 in a manner which can be understood in detail by reference to the above-identified Barrett application; as will be understood by reference to that application, hydraulic fluid introduced at the lower ends of the cylinders raises the shoe 4 off the mine bottom, and the introduction of fluid under pressure to the upper ends of the jacks 32 presses the shoe 4 into engagement with the mine bottom and lifts the forward end of the creeper base with respect to the mine bottom in such a manner as to raise the floor engaging foot referred to above off the mine bottom to permit longitudinal movement of the creeper base with respect to the shoe 4. Such longitudinal movement is effected by means of sump jacks 34. Sidewise movement of the shoe 4 relative

to the creeper base is accomplished by means of side swing jacks 36.

The conveyor 16 is driven by means of hydraulic motors 38. The tail end of the conveyor 16 is mounted for swinging in horizontal planes by means of conveyor swing jacks 40. The tail end of the conveyor can be raised or lowered within limits by means of a tail conveyor lift jack 42.

The motor means 18 and 20 are connected to drive a plurality of pumps, one of which is shown at 44, connected to be driven by the motor 18, and another being shown at 46 connected to be driven by the motor 20. The pump 44 is preferably a tandem pump consisting in effect of two gear pump units 48 and 50 having a common drive shaft. Means are provided to conduct fluid under pressure from the pumps 44 and 46 to the hydraulically controlled clutches 22, to the hydraulic motors 38, and to the means for effecting movement of the machine, namely the shoe lift jacks 32, the sump jacks 34 and the swing jacks 36. These means to conduct fluid from the pumps to the indicated utilizers include valves arranged in a bank shown generally at 52, which will be described in detail below.

As is best seen in Fig. 2, the valve bank 52 comprises a supply section 54 having an integral relief valve 56, a control valve section 58, a supply and exhaust section 60, a control valve section 62 for the conveyor lift jack 42, a control valve section 64 for the conveyor swing jacks 40, a control valve section 66 to effect manual operation of the lift jacks 32, a control valve section 68 to effect automatic operation of the means to move the creeper base, a control valve section 70 for the vertical swing jacks 30, and end section 72 which serves to provide a return conduit—passage 73—for all of the sections to the left thereof and which serves also to isolate those sections from the remaining sections to the right thereof; a control valve section 74 for operation of the sump jacks 34, a control valve section 76 for operation of the shoe swing jacks 36, a control valve section 78 which is a pilot controlled valve for the distribution of fluid to the sections 74 and 76, and an end section 80 which is connected as will be seen below to the shoe lift jacks 32.

As will be well understood by those skilled in the art of hydraulic mechanisms, the valve control sections referred to above and shown in the drawings (see especially Fig. 2) are all open-center valves, quite conventional with certain exceptions noted here. Thus, the valve element 82 which is movable in the control valve section 58 is provided with grooves 84, 86 and 88 and lands 90, 92 and 94. In a conventional valve of this type, as shown at 66, for example, the land 94' is of the same length axially as the land 92. In the case of valve 58, the land 94 has been reduced in its axial length in order to provide for movement of the valve element 82 in such a direction ("pulled out") as to interrupt flow through the valve but at the same time to permit hydraulic fluid under pressure to be bypassed to the tank.

All valves of the type shown in Figs. 2 and 3 are provided with an inlet port 96, an exhaust port 98, and a discharge port 100. The discharge port 100 is actually above the plane of the section of Fig. 2 (see Fig. 3), and since it would therefore not appear in Fig. 2, its relative location in a plan view is shown in dot-dash lines. The body of this control section is of course provided with other ports, but those referred to specifically here are the ones that are of primary concern in accomplishing an understanding of the invention. An example of one of the ports is the one shown at 101, which is adapted to be closed by either the land 90 or the land 92, depending upon whether the valve element 82 is "pushed in" or "pulled out" respectively.

It will also be understood by those skilled in the art that the valve bodies of valves of the type shown are conventionally provided with a plurality of internal grooves, as shown at 102, 103, 104, 105, and 106, and that the grooves 104 and 106 are always in communication with each other

by virtue of a passage 107 in the valve body communicating with both of those grooves (Fig. 3). The details of control valves such as are shown in the drawings form no part of this invention. Control valves of this general type are well-known in the art and are available from any of a number of commercial sources as stock items.

As was pointed out above, the port 101 of control valve section 58 is closed by operation of the valve element 82 in either direction, closure being effected by the land 90 or the land 92 according to the direction in which the valve element 82 is moved. Referring now to the valves 74 and 76, it will be noted that these valves are generally similar to valves 66 and 68, except that the closable ports 101 of valves 66 and 68 have no counterpart in the valves 74 and 76. Instead, enough of the material of the valve body has been cut away at 108 and 110 in valves 74 and 76 to insure that the lands 90 and 92 of those valves will not be able to shut off flow between ports 96 and 98 of valves 74 and 76. Pilot control valve 78 is similarly cut away.

Valves 62, 64 and 78 are made self-centering by means of springs 112, meaning that springs 112 will return the movable valve elements of these valves to their "center" positions as soon as the restraining force which has moved the valve element is released. On the other hand, valves 58, 66, 68, 70, 74 and 76 are of a type which remains centered or in the "pushed in" or "pulled out" position, because of ball detents 114. Whereas valves 58, 62, 64, 66, 68, 70, 74 and 76 are provided with operating handles 116, the valve 78 is a pilot controlled valve, and is accordingly provided with a hydraulic cylinder-and-piston mechanism indicated generally at 118, and having a cylinder 120 with a piston 122 reciprocable therein connected to the end of the valve element. The valve element of valve 78 can be moved "up" or "down" as seen in Fig. 2 according to whether hydraulic fluid under pressure is admitted below or above the piston 122.

Reference was made above to the pump 44 as being a tandem type pump, having two sets of gear pump units 48 and 50. Pump 44 is connected with a fluid supply tank 124 (Fig. 5) by means of a conduit 126, and the two tandem sections of pump 44 discharge fluid under pressure by way of conduits 128 and 130. Conduit 128 is provided with two branches 132 and 134; branch 132 connects with the inlet port of valve section 60, and branch 134 connects with the pressure port of a pilot valve 136. Pilot valve 136 is a reversing valve having rods extending out its opposite ends at 138 and 140 to be actuated by a trip mechanism as will be explained below. Pilot valve 136 is provided with control ports near its ends to which are connected conduits 142 and 144. The details of this valve are shown in copending application Serial No. 283,221 of C. B. Frellsen, filed April 19, 1952, now Patent No. 2,742,922.

Conduits 142 and 144 are connected with the cylinder-and-piston mechanism 118 and control the position of valve 78 by admitting pressure alternately to the upper and lower sides of piston 122 according to the orientation of pilot valve 136. Pilot valve 136 has discharge ports which are connected with an exhaust line or conduit 146, line 146 going to the tank 124. A branch conduit 148 is also connected with the conduit 146, and is connected to receive hydraulic fluid at exhaust pressure from the hydraulic drive motors 38 by way of extension cylinders 150 and conduits 152, 154, and 156.

The conveyor drive motors 38 are connected to receive hydraulic fluid under pressure from control valve section 58 by means of a conduit 158, a branch conduit 160, a conduit 162, extension cylinders 164, and conduits 166 and 168. Another branch conduit 170 connects conduit 158 with the motor clutches 22 by means of branch conduits 172 and 174.

Pump 46 is connected with tank 124 by a suction line or conduit 176 and discharges fluid under pressure by way of a conduit 178. Conduits 178 and 130 merge into

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a single supply conduit 180 which connects with the pressure port of supply section 54.

The supply and exhaust section 60 has an exhaust port to which a conduit 182 is connected, this conduit being in communication with tank 124. A conduit 184 connects at one end with a port of control valve section 62 corresponding to port 100 of the valve in Fig. 3, and at its other end conduit 184 connects with the conveyor lift jack 42. Control valve section 64 has two ports (100 and 185 as seen in Fig. 3), which serve alternately as discharge and exhaust ports, these ports being connected with the opposite ends of conveyor swing jacks 40 by means of conduits 186, 188, 190 and 192, conduit 190 being connected with one end of one swing jack and the opposite end of the other swing jack, and conduit 192 being connected with the other end of the first swing jack and the opposite end of the second swing jack, these conduits connecting with conduits 186 and 188 respectively.

Control valve section 66 has two ports which serve alternately as discharge and exhaust ports and which are connected with ports in the end section 80 by means of conduits 194 and 196. Corresponding ports of control valve section 68 are connected with similar ports in the pilot controlled valve 78 by means of conduits 198 and 200. Control valve section 70 has a single port which communicates with the vertical swing jacks 30 by means of conduits 202 and 204. Control valve section 74 has two ports which alternately serve as discharge and exhaust ports, these two ports being connected with the sump jacks by means of conduits 206, 208, 210 and 212, conduit 210 being connected with one end of each of the two sump jacks 34 and with conduit 206, and conduit 212 being connected with the opposite ends of the sump jacks 34 and with conduit 208.

Control valve section 76 has two ports which alternately serve as discharge and exhaust ports and are connected with the shoe swing jacks 36 by means of conduits 214 and 216. Conduit 214 has a branch conduit 218 which connects with a relief valve 220; similarly, conduit 216 has a branch conduit 222 which is connected with a relief valve 224. Relief valves 220 and 224 are connected with a common exhaust conduit 226 which joins the conduit 182 and thus discharges to the tank by way of conduit 182.

A branch conduit 228 is connected at its one end with conduit 226 and at its other end with a self-sealing coupling 230 held in a bracket 232 and providing means for replenishing the system with hydraulic fluid when necessary. The complete details of the fluid replenishing means are not shown here because they form no part of this invention, and furthermore because they are the subject of routine practice which is well understood by those skilled in the art of hydraulics.

End section 80 has two ports which alternately serve as discharge and exhaust ports and which are connected with the shoe lift jacks 32 by means of conduits 234, 236, 238 and 240, conduit 238 being connected with the lower end of each shoe lift jack and with conduit 234, and conduit 240 being connected with the upper end of each shoe lift jack and with the conduit 236.

Each of conduits 214, 216, 234 and 236 is provided with any suitable type of extension device to permit lengthening and shortening of the conduit without a change in volume. Such a device is shown schematically in Fig. 5 as a loop, being identified as loops 242, 244, 246 and 248 for the conduits 214, 216, 234 and 236 respectively.

Reference was made above to the pilot valve 136, and to its control rod ends 138 and 140 to be actuated by a trip mechanism. Such a trip mechanism is disclosed in detail in the above mentioned patent application Serial No. 283,221, and is shown schematically at 250 (Fig. 5) as a pair of knockers or trip arms 252 and 254 mounted for movement with any selected portion of the sump mechanism, but here shown as being mounted for move-

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ment directly by one of the sump jacks. The arms 252 and 254 are positioned so as to engage the ends 138 and 140 respectively as the mechanism moving with the sump jacks approaches the end of a stroke.

Operation

Hydraulic fluid under pressure is delivered by the two pumps 44 and 46 as soon as electric motors 18 and 20 are put in operation. Movement of the valve handle of control valve 58 to the "pushed in" position causes fluid to flow from the valve through conduits 158, 160 and 162, extension cylinders 164, conduits 166 and 168 to the hydraulic motors 38 which drive the conveyor 16. Exhaust fluid flows from motors 38 to the tank by way of conduits 152 and 156, extension cylinders 150, and conduits 154, 148 and 146. At the same time, fluid flows from conduit 158 to branch conduit 170, and thence to the hydraulic clutches 22 by way of branch conduits 172 and 174. Hydraulic clutches 22 are thus engaged and drive of the vein dislodging and disintegrating mechanism 14 is begun.

Assuming that the machine is poised in front of a face and is ready to mine coal or other mineral, the mechanism 14 is sumped into the face by operation of the valve sections 66 and 74. It will be remembered that the movable valve element 82 of valve section 58 is in its "pushed in" position, so that the land 90 blocks port 101 and prevents fluid flow through the exhaust port 98 of valve section 58. Accordingly, the only fluid flow available to effect tram of the machine is that which enters the supply and exhaust section 60 by way of the pressure line 132, receiving fluid from pump 44 by way of conduit 128. Fluid under pressure thus flows to control valve section 66 through the control valve sections 62 and 64 which occupy their centered positions.

With the movable valve element of control valve 66 in its "pushed in" position, fluid under pressure leaves the valve by way of grooves 104 and 105 and port 100, and flows through conduit 196 to the end section 80 where it is in communication with the lower chambers or passages of valve sections 74, 76, 78 and with conduit 236. The "lower passages" referred to are formed by the grooves 103, 104 and cutaway portions 108, 110, and may for convenience be designated L.

With the movable valve element of valve section 74 in its "pulled out" position, fluid flows through section 74 via groove 104, passage 107, grooves 106 and 102, port 185, and from section 74 to the sump jacks via conduits 208 and 212 as will readily be understood from reference to Figs. 2, 3, and 5. Meanwhile, fluid under pressure flows from end section 80 by way of conduit 236 to the upper ends of the shoe jacks 32 by way of conduits 236 and 240, with the result that the shoe 4 is first tightly pressed to the floor, ground, or mine bottom, after which continued flow of fluid to the shoe jacks 32 begins to raise the front end of the machine off the floor by lifting the foot in front of the shoe 4 clear of the floor.

Fluid flows from the lower ends of shoe lift jacks 32 to tank 124 via conduits 238 and 234, end section 80, conduit 194, port 185 of valve section 66, groove 102, through upper passages U of valve sections 66, 64, and 62, and out through supply and exhaust section 60 to conduit 182.

It will be noted that there is pressure on the forward ends of the sump jacks at the same time that there is pressure exerted at the upper ends of the shoe lift jacks. Which of these jacks is actuated first depends upon which one offers the least resistance to movement. With the foot on the machine referred to in engagement with the floor, there will be so much resistance to forward movement of the mechanism 14 as to prevent operation of the sump jacks. As soon as the mining machine and its ground engaging foot are raised somewhat by operation of the shoe lift jacks 32, this resistance decreases sufficiently to permit fluid flow into the forward ends of sump jacks 34 (right ends as seen in Fig. 5).

Inasmuch as the piston rods are secured at their forward ends to the shoe 4 which is now tightly engaged with the mine bottom, the only relative movement in the sump jacks which is feasible is a forward movement of the sump jack cylinders relative to the pistons, and this forward movement moves the mining machine forward, effecting sumping-in of the mechanism 14.

As fluid enters the right ends of the sump jacks, it is pushed out of the left ends toward tank 124 via conduits 210 and 206, port 100 of valve section 74, upper passages U of valve sections 74, 76, and 78, end section 80, conduit 194, etc. as in the case of fluid from the shoe jacks as described above.

It will be noted that the same principle—operation of those jacks offering the least resistance—is involved if the valve element of control valve section 76 is operated in order to effect swing. In other words, side swing will not take place until the foot on which the forward end of the machine rests on the mine bottom is raised sufficiently to reduce the resistance to side swing to such a point that the swing cylinder which is engaged for operation can effect side swing. Again, the selected swing jack and the sump jacks are subjected to fluid under pressure simultaneously, and that one will function first which offers the least resistance to movement. If the mechanism 14 is not in engagement with coal or other mineral, the sump jacks 34 and a selected side swing jack 36 will probably move simultaneously.

Returning now to the discussion of sumping-in, before the explanation of side swing was brought in, it will be evident that the mechanism 14 will move into the face of mineral to the end of the stroke of the sump jacks, dislodging mineral and conveying it back to the discharge point of the machine. At the end of the sump stroke, the operator returns the control valve section 66 to neutral, and operates the control valve 70 to effect upswing of the mechanism 14. As soon as mechanism 14 has been swung upward as far as many be desired, the movable valve element of control valve section 70 is returned to its neutral or centered position by the operator, and the machine is ready for the withdrawal, or "retract," stroke.

Withdrawal of the mechanism 14 is effected by reversing the position of the movable valve element of the control valve section 74, this involving pushing the valve element all the way in to its fully "pushed in" position. Valve 66 is "pushed in," as before. Accordingly, fluid flows to the left ends (as seen in Fig. 5) of the sump jacks 34 by way of conduits 206 and 210. Fluid leaves the right ends of the sump jacks by way of conduits 212 and 208, passages U of valves 74, 76, 78, and discharging to the tank by way of end section 80, conduit 194, control valve section 66, passages U of valves 66, 64, 62, supply and exhaust section 60, and conduit 182. It will be noted that the upper ends of the shoe lift jacks 32 continue to be exposed to fluid under pressure so there is no change in the position of the shoe lift jack pistons. The mechanism 14 is thus retracted because the only feasible change in the sump jacks 34 is for the piston to hold fast and for the cylinder to move to the left with respect to the piston, thus retracting the mechanism 14.

At the end of the retract stroke, the movable element of control valve section 66 is again restored to its centered position, whereupon the movable valve element of control valve section 70 is pulled out, permitting fluid to leave the vertical swing jacks 30 by way of conduits 204 and 202, valve section 70, passages U of valve sections 70, 68, 66, 64 and 62, supply and exhaust section 60, and conduit 182, to discharge to the tank 124. Thus the mechanism 14 is lowered by its own weight.

The control valve section 66 is next manipulated by the operator by moving the movable valve element to its "pulled out" position, this putting the conduit 194 under pressure and conveying fluid under pressure by way of

conduit 234 to the lower ends of the shoe lift jacks 32. Fluid is now free to leave the upper ends of the shoe lift jacks 32 by way of conduits 240 and 236, and section 80, conduit 196, control valve section 66, passages U of valves 66, 64, and 62, supply and exhaust section 60, and conduit 182, flowing to the tank 124. Such flow will not actually take place unless and until the way is clear for the shoe lift jacks to operate to pick up the shoe 4. Inasmuch as the only resistance is the weight of the shoe, the jacks operate, and pick the shoe up off the mine bottom, with the result that the foot of the machine firmly engages the mine bottom, supporting the forward end of the machine in this manner.

The object now is to move the shoe 4 forward to put the machine in readiness to begin another cycle. Inasmuch as shoe 4 is secured to the piston rods of the sump jacks, shoe 4 can be moved forward by moving the pistons of the sump jacks to the right relative to their cylinders. This is accomplished by admitting fluid to the left ends of the sump jacks 34 by way of conduits 210 and 206, for which the movable valve element of the control valve section 74 must be moved to its "pulled out" position (remembering that passage U of valve 74 is under pressure). Fluid will enter the left ends of the sump jacks as aforesaid, and will leave the right ends by way of conduits 212 and 208, port 185 and passage 107 of control valve section 74, passages L of valves 74, 76, 78, end section 80, conduit 196, control valve section 66, passages U of valves 66, 64, 62, supply and exhaust section 60 and conduit 182, flowing to the tank 124. The sump jacks function until they reach the end of their stroke, thereby advancing shoe 4, and the machine is ready to begin another cycle.

Reference was made above to the fact that the operation of the movable element 82 of control valve section 58 to its "pushed in" position effects blocking of port 101 by the land 90. Let it now be supposed that manual tramming of the machine is accomplished without engagement of a face of mineral, so that the mechanism 14 and the conveyor 16 need not be in operation, with the result that the movable valve element of control valve section 58 may occupy its centered or neutral position. Under these circumstances, fluid may flow from conduit 180 through the supply section 54, into valve section 58 by way of intake port 96, through port 101, out of exhaust port 98, and into the supply and exhaust section 60, thus reinforcing and augmenting the fluid which is entering section 60 by way of conduit 132. The additional fluid thus entering the tramming system will speed up the tramming operation, as will be readily understood by those skilled in the art, because the additional volume of fluid will cause the jacks to operate faster. This is true whether tramming is effected manually, as can be understood from the foregoing description, or whether it is accomplished automatically, as will be understood from the description to be made below.

The automatic operation of the mechanism will now be described. Automatic tram will ordinarily be used only for moving the machine about from place to place, and not when the machine is actually mining coal. Under these circumstances, all of the movable valve elements of the control valve sections 58, 62, 64, 66 and 70 will be in their centered or neutral positions. The position of the control valve section 70 in this case will usually not be critical, because the operating position of control valve section 68 will prevent the flow of fluid to section 70. However, the movable element of section 70 will ordinarily be in its centered position in order to hold the mechanism 14 at a desired level.

It will be assumed that the operator desires to accomplish automatic tram of the mining machine in the forward direction—i. e., to the right as seen in Fig. 1. To accomplish forward tram without turning to the right or left, the operator pulls handles 116 of control valve sections 68 and 74 out, and those valves remain in those positions so long as forward tram is desired. Let it be

assumed that the pistons in the sump cylinders are at the left ends of their cylinders, which means that the arm 254 has bumped the rod end 140 of pilot valve 136 to the left. Fluid thereupon flows under pressure through pressure conduit 134, through valve 136, through conduit 142, to the lower face of piston 122 of the mechanism 118. With pressure on the lower face of the piston, the movable valve element of valve section 78 is operated to the "pushed in" position (up as seen in Fig. 2).

Fluid now flows from conduits 132 and 180 into the supply and exhaust section 60, through valve sections 62, 64 and 66 which are all in their centered positions, into the inlet port of control valve section 68. With the movable element of control valve section 68 in the "pulled out" position, flow through port 101 is blocked, and fluid must flow through the cored passage 107 (Fig. 3) communicating groove 104 with groove 106. Fluid flows from groove 106 into groove 102 and out of the valve body by way of port 185 and conduit 198 to port 185 of valve section 78. Valve section 78 is in its "pushed in" position as noted above, so fluid will flow through groove 102 into the upper passage U of valve section 78. Fluid under pressure is thereupon available to conduit 234 and to the two corresponding upper passages of valves 74 and 76. Accordingly, fluid under pressure exists in conduits 234 and 238, and is as a consequence admitted to the lower ends of the shoe lift jacks 32. The upper ends of the shoe lift jacks 32 are connected with the tank by way of conduits 240 and 236, end section 80, passage L of valve section 78, conduit 200, valve section 68, the upper passages U of control valve sections 68, 66, 64 and 62, supply and exhaust valve section 60, and conduit 182.

With pressure in the upper passage U of valve section 78, fluid under pressure is transmitted to the upper passage U of valve section 74 and to the left ends of the sump jacks by way of conduits 206 and 210. The right ends of the sump jacks are connected with the tank by way of conduits 212 and 208, valve section 74, including groove 106, cored passage 107, and groove 104, the lower passages L of valve sections 74, 76 and 78, conduit 200, control valve section 68, the upper passages of valve sections 68, 66, 64, 62, and conduit 182.

We now have fluid under pressure at the lower ends of the shoe lift jacks 32 and at the left ends of the sump jacks 34. The shoe lift jacks operate to pick the shoe 4 off the floor, whereupon the pistons in the sump jacks move to the right and advance the shoe 4 the full amount of the stroke of the sump jacks. As the sump jacks approach the end of their stroke, the arm 252 engages the rod end 138 and bumps the movable element of pilot valve 136 to the right.

The result of the shifting of pilot valve 136 is to shift the movable valve element of valve section 78 from its "pushed in" position which it previously occupied to its "pulled out" position which it now occupies. Inasmuch as the position of the valve element of section 68 has not been changed, conduit 198 is still under pressure. However, the movable valve element of section 78 has now been shifted, with the result that fluid flows from groove 106 to groove 104 via passage 107, and puts the lower passages L of sections 78, 76 and 74 under pressure, at the same time that it puts conduit 236 under pressure.

Fluid flows from conduit 236 to the upper ends of shoe lift jacks 32, and fluid leaves the lower ends of jacks 32 and passes to the tank by way of conduits 238 and 234, end section 80, passage U and groove 105 of valve section 78, conduit 200, the upper passages U of valve sections 68, 66, 64 and 62, supply and exhaust valve section 60, and conduit 182. As a result, the shoe lift jacks 32 are operated to press the shoe 4 firmly in engagement with the floor or mine bottom, and to pick the forward foot of the machine off the mine bottom.

Simultaneously fluid flows left through the lower passages of valve sections 78, 76 and 74, from groove 104 of valve section 74 to groove 106 by way of cored pas-

sage 107, out of valve section 74 by way of port 185 and conduit 208, and to the right ends of the sump jacks through conduit 212. Fluid is enabled to leave the left ends of the sump jacks via conduits 210 and 206, groove 105 of valve 74, the upper passages U of valve sections 74, 76 and 78, out of valve section 78 by way of groove 105, port 100, and conduit 200, into valve section 68 via port 100 and groove 105, through the upper passages U of valve sections 68, 66, 64 and 62, supply and exhaust section 60, and conduit 182, to tank 124.

With fluid under pressure at the right end of the sump jacks 34, and with the pistons of the sump jacks relatively stationary because shoe 4 is in firm engagement with the mine bottom, the cylinders of the sump jacks move to the right (as seen in Fig. 5) relative to the pistons, advancing the mining machine in the forward direction for substantially the full amount of the stroke of the sump jacks. As the sump jacks approach the end of their stroke, arm 254 bumps the rod end 140 of the pilot valve and shifts it leftward. The parts are now in a position to repeat the cycle at the stage with which the description of the automatic operation started.

Turning of the machine is accomplished either simultaneously with forward tram or without forward tram by operation in one direction or the other of the handle 116 of the control valve section 76, bringing the shoe swing jacks 36 into operation. The valve elements of the valve sections 74 and 76 may be manually positioned to effect simultaneous feeding and turning of the machine under the control of the fluid actuated pilot controlled valve of the valve section 78, so that the machine as it is advanced by the feed cylinders may move along a curved path either to the right or left. During simultaneous advance and turning of the machine the pilot valve 136, which is mechanically actuated at the ends of the feeding strokes of the feed cylinders, effects actuation of the fluid actuated valve element of the valve section 78. Of course, either feeding or turning of the machine may function independently of the other so that the machine may advance without turning or may turn without advance and vice versa simply by properly positioning the valve elements of the valve sections 74 and 76.

Automatic operation of the machine for reverse tram will now be considered. It will be assumed that the pistons of the sump jacks 34 are at the left ends of their respective cylinders, and that consequently the pilot valve 136 has been actuated into its leftward position. Valves 68 and 74 have been actuated by the operator by moving their handles to the "pushed in" position, which is the position shown in Fig. 4.

With the parts in the positions indicated, the pilot controlled valve 78 is moved by the hydraulic piston and cylinder mechanism 118 to its "pushed in" position. The hydraulic fluid in conduit 200 is accordingly under pressure, with the result that the lower passages L of valves 74, 76 and 78, and conduit 236 of end section 80, are all under pressure. With valve 74 in the "pushed in" position, conduit 206 is also under pressure, putting conduit 210 and the left ends of the sump jacks under pressure. Conduit 236, which connects with the upper ends of the shoe lift jacks 32, is also under pressure, so the first result will be for the shoe lift jacks 32 to be actuated to move the shoe 4 into firm engagement with the floor or mine bottom, picking the foot at the forward end of the machine off the mine bottom.

With the foot off the mine bottom, the cylinders of the sump jacks 34 are free to move with respect to the pistons, and the cylinders will accordingly move to the left relative to their pistons, moving the mining machine leftward as seen in Figs. 1 and 5. As the sump jacks near the end of their stroke, the actuating arm 252 engages the rod end 138 of the pilot valve 136, bumping the pilot valve to the right as seen in Fig. 5. With this new orientation of pilot valve 136, valve 78 is automatically moved by fluid pressure to its "pulled out" position.

The rest of the cycle for rearward tram will be readily understood by those skilled in the art from the foregoing description of the operation of forward tram, and need not be detailed here.

It will be evident to those skilled in the art that I have here provided a control for the tramming mechanism of a mining machine or the like, which control enables automatic tram forward or rearward, and which permits faster tram when the machine is not actually operating to mine coal or to function in some other manner to accomplish its intended purpose, but is merely being moved about from job to job. It will also be evident that I have provided a relatively simple control mechanism to accomplish the stated objects. Other advantages will be 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 the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

I claim:

1. In a mining machine of the character disclosed, a walking base movable over a floor surface, fluid operated means for effecting walking movement of said base including means for advancing and elevating said base, fluid operated steering means operatively associated with said base moving means for turning said base either to the right or left during base movement, a source of fluid under pressure, manually operable valve means for connecting said fluid source to both of said fluid operated means for initiating the operation of the same to cause simultaneous advance and turning of said base, a pilot valve, trip means actuated by base movement for shifting said pilot valve, and a fluid operated valve to which pressure fluid is supplied under the control of said pilot valve for automatically controlling flow of pressure fluid to said fluid operated base moving and steering means for effecting continued operation thereof without manual intervention after such initiation of operation whereby said base may automatically advance step by step along a curved path.

2. In a mining machine of the character disclosed, a walking base movable step by step forwardly over a floor surface including relatively movable floor-engaging walking elements, a fluid controlled jack for effecting relative movement of said walking elements for feeding said base forwardly and a fluid lifting jack for at times at least partially removing the weight of the machine from one of said elements during relative movement thereof, a fluid jack for turning said base either to the right or left during walking of the base, a source of fluid under pressure, means for automatically effecting concurrent operation of said jacks to cause step by step relative movement of said walking elements and for turning said base automatically to cause step by step advance of the machine along a curved path including an automatic pilot valve for controlling fluid flow from said source to said jacks, trip means actuated by said feed jack for shifting said pilot valve, a fluid actuated valve the flow of pressure fluid to which is controlled by said pilot valve for controlling fluid flow to said jacks, and means for connecting said jacks for control by said fluid actuated valve.

3. A mining machine comprising, in combination, a walking base movable over a floor surface, a feeding device for said base for moving the latter in a forward direction and including relatively movable floor-engaging elements and fluid operated moving means therefor, fluid operated elevating means for at least partially removing the weight of said base from certain of said elements during the moving operation, fluid operated means operatively associated with one of said elements for turning said base to the right or left as it is advanced step

by step by said moving means, valve means for initiating the operation of said moving and elevating means, valve means for initiating operation of said swinging means, and means controlled by base movement for automatically controlling operation of said moving means, said elevating means and said swinging means, said automatic control means including a shiftable control valve responsive to base movement, a valve controlled by said pilot valve, a cylinder and piston device for actuating said last mentioned valve, said shiftable control valve controlling the flow of pressure fluid to the cylinder of said device, and said second mentioned valve controlling the flow of pressure fluid to said moving, elevating and swinging means for operating the moving and swinging means in unison automatically in sequence with said elevating means.

4. In combination, a walking base, a hydraulically operated mechanism, a source of hydraulic fluid under pressure, control means for said mechanism including a control valve device having inlet and discharge ports and a shiftable valve element for controlling the opening and closing of said ports to effect or interrupt operation of said mechanism, hydraulically operated means for effecting walking movement of said base including means for advancing and elevating said base, a second source of hydraulic fluid under pressure, control means for said base moving means including a second control valve device having inlet and discharge ports and a shiftable control valve element, and means for connecting the discharge port of said first mentioned valve device with the inlet port of said second control valve device whereby when drive of said hydraulic mechanism is interrupted by said first valve element a greater volume of liquid flows to said second valve device to increase the speed of operation of said base moving means.

5. In a machine of the character disclosed, a walking base, hydraulically operated means for effecting walking movement of said base including means for advancing and elevating said base, a source of hydraulic fluid under pressure, means to deliver fluid from said source to said movement effecting means including two manually operable control valves connected in series whereby operation of any of said last two valves prevents fluid flow to the next succeeding valve, a pilot controlled valve operated by pressure fluid, fluid conduit means connecting the last of said two valves to said pilot controlled valve, and a plurality of manually operable valves connected in parallel concurrently to receive fluid from said pilot controlled valve, pilot means, means operatively connecting said pilot means to said pilot controlled valve, and means operatively associated with the base movement effecting means for operating said pilot means.

6. In a machine of the character disclosed, a walking base, hydraulically operated means for effecting walking movement of said base including means for advancing and elevating said base, a pump, means to deliver fluid under pressure from said pump to said movement effecting means including two manually operable valves connected in series whereby operation of the first of said valves to receive fluid prevents fluid flow to the second valve, a fluid actuated pilot controlled valve, conduit means connecting the second of said two valves to said pilot controlled valve, a plurality of manually operable valves connected in parallel for concurrently receiving fluid from said pilot controlled valve, hydraulic mechanism operatively associated with said pilot controlled valve, a pilot valve, fluid conduit means connecting said pilot valve to said hydraulic mechanism, and trip mechanism operable by said base movement effecting means for operating said pilot valve.

7. A machine of the character disclosed, a creeper base movable step by step over a floor surface, a plurality of hydraulically operated means for effecting simultaneous longitudinal and sidewise step-by-step movements of said base including means for advancing, elevating and

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turning said base, a pump carried by said base, fluid conduit means connecting said pump to said plurality of hydraulically operated means including two manually operable valves connected in series whereby operation of the valve first to receive fluid prevents fluid flow to the second valve, a fluid actuated pilot controlled valve, conduit means connecting the second of said two valves to said pilot controlled valve, a plurality of manually operable valves connected in parallel for concurrently receiving fluid from said pilot controlled valve, a hydraulic cylinder and piston mechanism connected to operate said pilot controlled valve, a pilot valve, fluid conduit means connecting said pilot valve with said hydraulic cylinder and piston mechanism, and means operable by movement of one of said hydraulically operated means for operating said pilot valve.

8. In a machine of the character disclosed, a creeper base movable step by step rectilinearly and curvilinearly over a floor surface, said creeper base including a floor engaging support, a frame carried thereby and mounted thereon to swing horizontally relative thereto, fluid operated means for lowering said support into frame supporting engagement with the floor and for elevating said

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support, fluid operated means for moving said frame longitudinally relative to said support when the latter is in floor engaging position, fluid operated means for swinging said frame horizontally relative to said support when the latter is in supporting engagement with the floor, a source of fluid under pressure, and means for automatically effecting operation of either of said fluid operated means step by step in a definite sequence including an automatic fluid distributing valve for controlling fluid flow from said source to said fluid operated means, and means for simultaneously connecting said fluid operated means for concurrent control by its automatic distributing valve whereby said base may advance along a curved path.

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