

May 22, 1928.

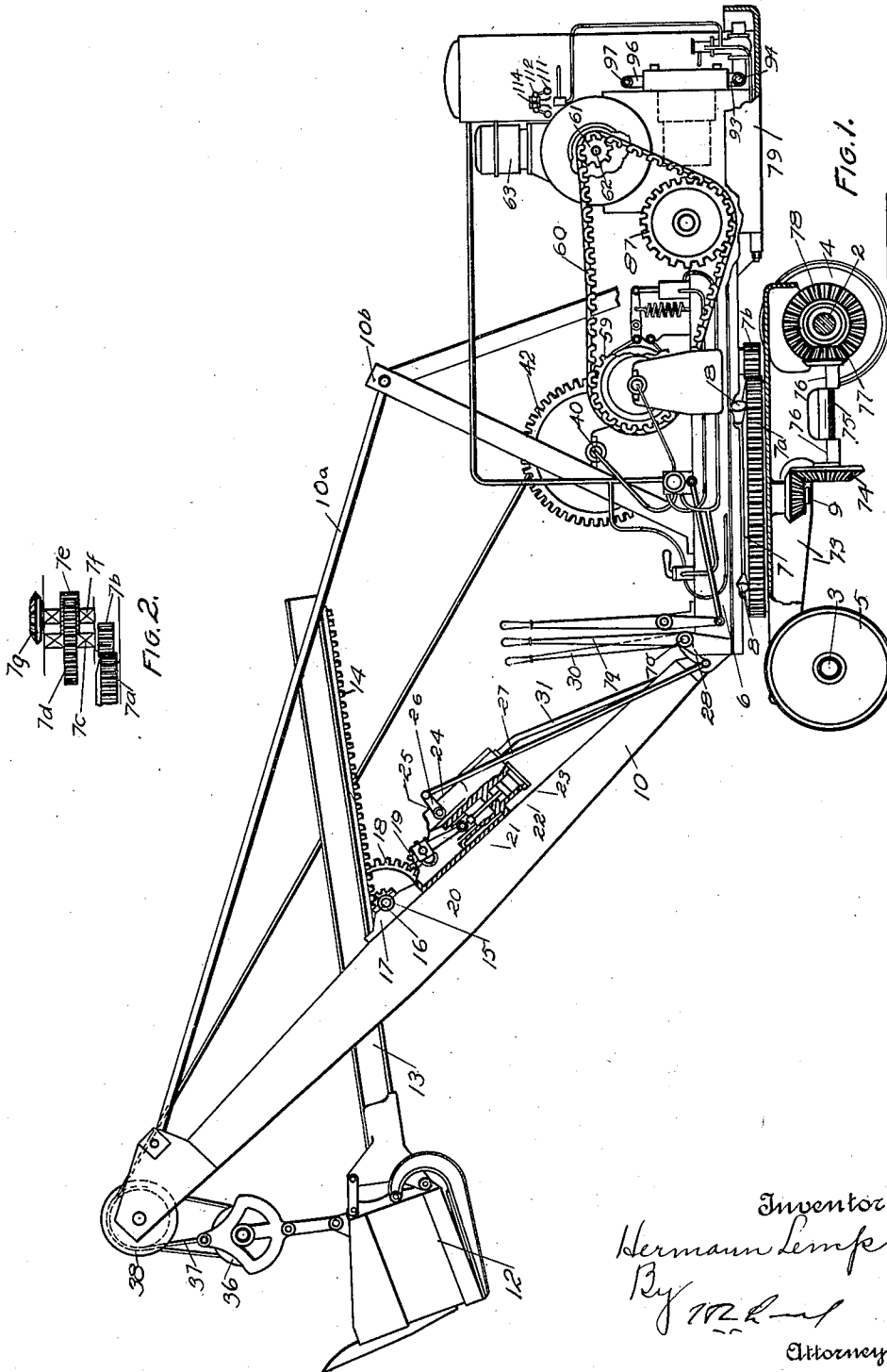
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POWER EXCAVATING MACHINE

Filed May 25, 1925

3 Sheets-Sheet 1



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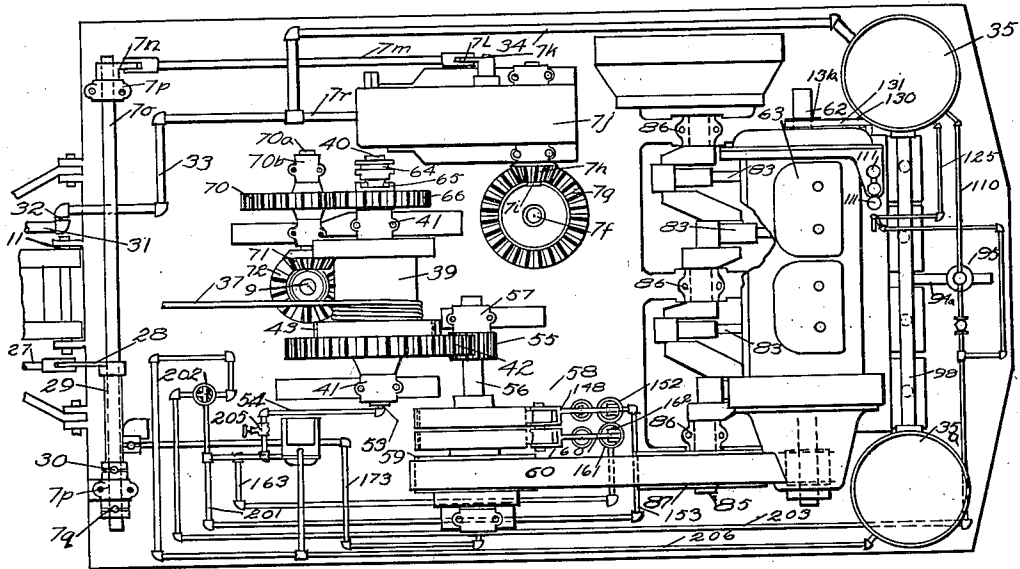
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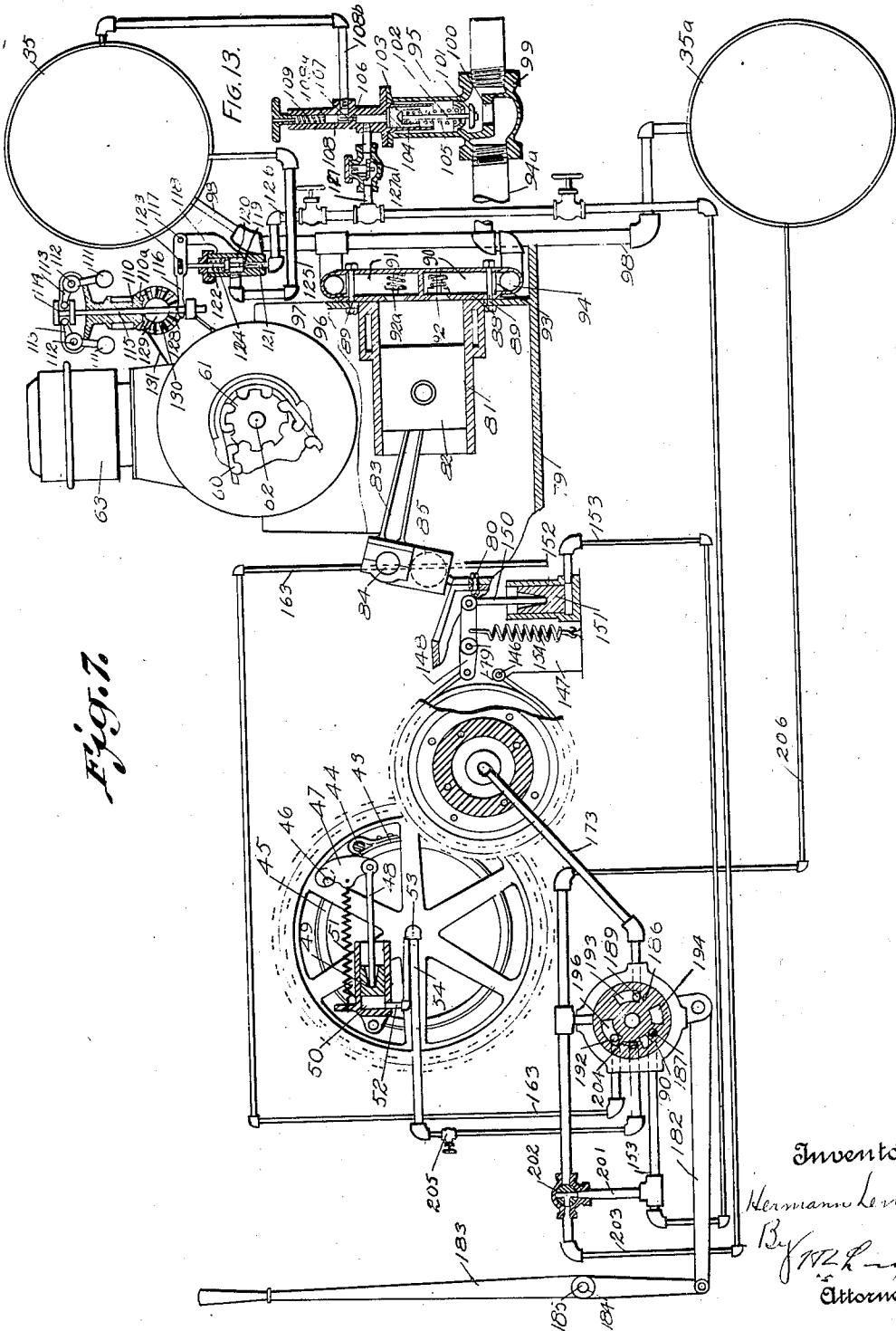
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UNITED STATES PATENT OFFICE.

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POWER EXCAVATING MACHINE.

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The present invention is designed to simplify and increase the efficiency of implements having intermittent motion, such as power shovels. Such shovels have heretofore
5 been actuated by rotative motors, such as steam engines, steam engines ordinarily being supplied for turning the platform operating the hoist and crowding the dipper. Such machines have also been operated by
10 electric motors and internal combustion engines in which each action, crowding, turning and hoisting, has been due to a direct connection leading to the instrument from the motor. The rapid acceleration of the
15 steam engine, particularly for crowding and turning and the yielding following up effect of the direct actuated steam engine for crowding, have been very much superior to the machines driven from a single source of
20 power and the turning accomplished by the steam engine has also been very much superior because of its cushioning effect at the reversal of the turning and the rapid pick-up in affecting the turning movement.

25 The present invention is designed to approximate the flexibility of the steam-driven shovel, or instrument, from a single primary motor, as exemplified, an explosive engine.

In a steam shovel, or equipment of this
30 kind, the hoisting takes a greater percentage of the entire energy of the machine and, therefore, in the present construction the hoisting is accomplished by a direct connection leading to the primary motor. The primary motor, however, builds up energy by
35 any storage means, as shown, energy through the compression of air for actuating the rotating motors affecting the crowding and steering. Thus a machine having all the advantages of an explosive engine, or other
40 primary motor may be used and the flexibility incident to a fluid-actuated rotating engine for the crowding and turning be retained.

45 The efficiency of the combination is increased by providing means whereby the primary motor may be relieved of the load of the compressor when it is subjected to the peak load of hoisting and the present invention
50 contemplates unloading the compressor automatically with a peak load on the primary motor through hoisting and as a further refinement the unloading of the com-

pressor when the speed of the primary motor is retarded below a pre-determined point. 55
The invention also contemplates the structural means whereby the several parts of the mechanism may be conveniently mounted on the rotating frame of a power shovel and so located as to assist in balancing the shovel. 60
Thus the compressor and primary motor are mounted at the opposite side from the dipper. As a further refinement the compressor is mounted so that the heads of the compressor with their valves and working mechanism are readily accessible. With these 65
general purposes of the invention indicated features and details of the invention will be more readily understood.

The invention is illustrated in the accompanying drawings as follows:—

Fig. 1 shows a side elevation of the machine.

Fig. 2 a detail view of the gear train, or turning platform. 75

Fig. 3 a plan view of the machine.

Fig. 4 a central section of the transmission mechanism.

Fig. 5 a plan view of the valve with the valve cover removed. 80

Fig. 6 a section on the line 6—6 in Fig. 5.

Fig. 6^a a plan view of the valve seat.

Fig. 6^b a section on the line 6^b—6^b in Fig. 6.

Fig. 7 a diagrammatic view, in elevation 85 and section, showing the coupling of the different instrumentalities, the different instrumentalities being varied somewhat as to scale.

1 marks the truck frame, 2 the driving axle, 3 the steering axle, 4 the driving wheels, and 5 the steering wheels. A rotating platform 6 is mounted on a turn table 7 with roller bearings 8, the platform being centered by a shaft 9. The rotating platform is provided with the usual boom 10 95 pivotally mounted at 11 on the rotating frame and supported by a rod 10^a leading from a frame 10^b on the platform.

A dipper 12 has a dipper stick 13. The 100 stick has a rack 14 meshing with gears 15. The gears 15 are mounted on a shaft 16. The shaft 16 is mounted in bearings 17 on the boom 10. A gear 18 is fixed on the shaft 16 and meshes with a gear 19 on a crank 105 shaft 20 of a fluid-actuated engine having

the usual pitman 21, piston rod and piston 22 and cylinder 23 of the ordinary fluid-actuated engine. This is controlled by a valve 24 actuated through a rod 25 from a rock arm 26. The rock arm is controlled by a link 27 extending to a rock arm 28. The rock arm 28 is mounted on a sleeve 29 and the sleeve is actuated by a hand lever 30 near the operator's position at the front of the platform. The fluid is delivered to the engine through a pipe 31 extending past the swivelled joint 32 and by pipes 33 and 34 to an air receiver 35 on the platform.

A sheave 36 is fixed on the dipper and a hoisting cable 37 operates on the sheave 38 at the end of the boom and extends to the drum 39. The drum is carried by a shaft 40 and the shaft 40 is carried by bearings 41 on the platform. The drum is driven by a drum gear 42 through a band friction clutch. The band 43 of this clutch is anchored on a pin 44 on the gear. The opposite end is mounted on an eccentric pin 46. The band operates on a friction drum 45 carried with the hoisting drum. A lever 47 eccentrically mounted relatively to the pin 46 actuates the pin 46 to tighten the band. A push pin 48 extends from the lever 47 to a plunger 49. The plunger 49 operates in a cylinder 50 mounted on the gear 42. The cylinder receives air by a pipe 52 leading from an opening 53 at the center of the shaft. A pipe 54 leads into the opening 53 and is supplied by air from the receiver 35 through a control mechanism hereinafter described. The drum gear 42 meshes with a gear 55 fixed on a shaft 56. The shaft 56 is journaled in bearings 57 on the platform and is driven through a transmission 58 from a gear 59. The gear 59 is driven by a chain 60 actuated by a sprocket 61 on a crank shaft 62 of an internal combustion engine 63. A turning gear 7^a is mounted on the frame and meshes with a gear 7^b on the platform. The gear 7^b is fixed on a shaft 7^c journaled on the platform. A gear 7^d is fixed on the shaft 7^c and meshes with a gear 7^e. The gear 7^e is fixed on a shaft 7^f journaled in the platform. A gear 7^g is fixed on the shaft 7^f and meshes with a gear 7^h fixed on a crank shaft 7ⁱ of a turning engine 7^j. The turning engine has a valve controlling rod 7^k and this is controlled by a rocker shaft 7^l. A rod 7^m extends from the rock shaft to a rock arm 7ⁿ mounted on a rod 7^o. The rod 7^o is mounted in bearings 7^p and a lever 7^q actuates the rod to control the turning engine. The turning engine receives its supply by a pipe 7^r leading to the pipe 34.

The traction train of the mechanism is as follows: A clutch element 64 is splined on the shaft 40 and adapted to be thrown into engagement with the clutch element 65 mounted on a gear 66. The gear 66 meshes with a gear 70. The gear 70 is fixed on a

shaft 70^a carried in bearings 70^b. A gear 71 is fixed on the shaft 70^a and meshes with a gear 72. The gear 72 is fixed on the shaft 9. A gear 73 is also fixed on the shaft under the truck frame and meshes with a gear 74. The gear 74 is fixed on a shaft 75 journaled in bearings 76. A gear 77 is fixed on the shaft 75 and meshes with a gear 78 on the driving axle 2. When the clutch 64—65 is in mesh, the machine is driven through the drum shaft, the drum gear, shaft 56 and transmission, this transmission being provided with the high, low and reverse schemes hereinafter described for this purpose.

The compressor and internal combustion engine are mounted on a supplemental platform 79 secured by bolts 80 to the main turning platform. A compressor cylinder 81 is mounted in the frame 79, the cylinder opening outwardly at the end of the platform. A piston 82 operates in the cylinder. A connecting rod 83 extends from the cylinder to a crank 84 of a crank shaft 85. The crank shaft 85 is journaled in bearings 86 on the supplemental platform 79 and this shaft is driven by a gear 87 in mesh with the chain 60 so that the compressor piston is continually driven and there are preferably a plurality of compressor cylinders so as to give the required capacity with a comparatively uniform load. Compressor cylinder gears 88 are secured to the cylinders and to the supplemental platform by bolts 89. Each head contains an inlet chamber 90 and an exhaust chamber 91 with an inlet valve 92 leading from the inlet chamber and an exhaust valve 92^a leading to the exhaust chamber. The chamber 90 leads by a pipe 93 to a manifold 94, this manifold being connected by a pipe 94^a with an unloader 95. The exhaust chambers lead by pipes 96 to a manifold 97 and the manifolds are connected by a pipe 98 with the receivers 35 and 35^a.

The unloader may be of any desired type. The one shown is what is known as an inlet unloader. It has a body 99, and a diaphragm 100 having the valve opening on which a valve 101 operates. The valve is carried by a stem 102. The stem is secured in a piston 103 operating in a cylinder 104. A spring 105 tends to open the valve. Air is admitted to the cylinder through an opening 106 controlled by a needle valve 107. The needle valve, which operates as a pilot valve, is secured to a plunger 108 in a cylinder 108^a. The plunger is subjected to the action of a spring 109 set at the desired relief pressure. A pipe 108^b leads from the receiver 35 to the cylinder 108^a. When the pressure in the tank rises above the desired normal, the pressure operating on the plunger 108 overcomes the pressure on the spring 109, opens the needle valve and puts the

plunger 103 under pressure, thus closing the relief valve and shutting off the intake to the compressor.

It is desirable, as heretofore intimated, to have the compressor unloaded when the speed of the engine drops below a pre-determined minimum. This is accomplished by the speed sensitive governor, or any speed sensitive controlling device as follows:—A rotating carrier 110 carries the centripetal weights 111 on pivots 112. Arms 113 connected with the weights operate on a spool 114. The spool is connected to a stem 115. A lever 116 is actuated by the stem 115. The lever is pivotally mounted at 117 on a post 118. A needle valve 119 is mounted in a chamber 120 and controls the outlet 121 from this chamber. A stem 122 extends from the needle valve to the lever 116 and has a pin and slot connection 123 with the lever. A spring 124 tends to close the needle valve. A pipe 125 leads from the receiver 35 to the chamber 120. A pipe 126 leads from the outlet 121 to a pipe 127 which leads through a check valve 127^a to the upper end of the cylinder 104. The carrier 110 has a pinion 110^a meshing with a gear 128. This is mounted on a shaft 129. The shaft is provided with a pulley 130 and a belt 131 drives this pulley from a pulley 131^a on the crank shaft. When the speed drops below the desired normal the centrifugal weights drop, pulling up the lever 116, opening the needle valve and permitting air to pass from the receiver to the unloader cylinder, thus closing the unloader valve and unloading the cylinder.

The chain sprocket 59 has a web 132 with a projection 133, the web and projection being journaled on the shaft 56 with hubs 135 and 136 and the projection 133 carries a rotating frame 134. A gear 137 is fixed on the shaft 56 and meshes with a gear 138. The gear 138 is journaled on a shaft 139 carried by the web 132 and the frame 134. Thus the shaft has an orbital movement. The gear is mounted on a sleeve 140 journaled on the shaft and a gear 141 is also fixed on the sleeve, the gear 141 being somewhat larger than the gear 138 and meshing with a gear 142. The gear 142 is fixed on a hub 143 of a drum 144. A band 145 operates on the drum. This band is anchored on a pin 146 carried by a post 147 on the platform and the opposite end is secured to a lever 148. The lever is pivoted at 149 and is operated upon by a thrust pin 150. The thrust pin is actuated by a piston 151 in a cylinder 152. The cylinder 152 is connected by a pipe 153 with a source of air supply controlled as hereinafter described. A spring 154 operating on the lever relieves the band. It will be understood that the gear 59 operates continuously carrying the shaft 139 in an orbital manner. The gear

142 being stationary forces a rotation of the gear 141 and 138 and this rotation is communicated through the gear 137 to the shaft 56 at a speed slower than the gear 59 in the well-known manner of planetary gears. The gear 155 is also fixed on the shaft 140 and meshes with a gear 156, the gear 156 being larger than the gear 137. The gear 156 is carried by a sleeve hub 157 journaled on the sleeve 143 and carries a drum 158. A band 159 operates on the drum to lock it when desired and this band is actuated exactly as the band 145 by a lever 160 actuated through a piston 162 in a cylinder 161, this cylinder 161 receiving its air supply through a pipe 163 and controlled as herein-after described. When this band 159 is set, thus locking the drum 158 the action of the gear 156 is such as to rotate the gear 137 in the well-known manner of planetary gears in a reverse direction. This accomplishes a reverse of the shaft 56 and this is useful when the machine is being driven through traction.

When it is desired to drive the shaft 56 at the speed of the gear 59 this gear is locked directly with the shaft. A friction disc 164 is hung on pins 164^a extending from the web 132. A disc 165 is fixed on the shaft 56 by a key 166. A cylinder 167 is also fixed on the shaft 156 and a disc 168 has a piston 169 extending into the cylinder 167. The disc 168 is locked against turning relatively to the cylinder and consequently the shaft 56 by means of pins 170. Air is delivered to the cylinder 167 by a passage 171 communicating with a passage 172 in the shaft which extends through the bearing and is connected with a pipe 173 leading to a valve control hereinafter described. Springs 168^a release the disc 168 from the driving disc 164.

In the operation of this clutch when air is placed on the piston 169 it drives the disc 168 against the disc 164^a which in turn is crowded against the disc 165, thus frictionally locking these surfaces together and locking the gear 59 with the shaft 56 so that there is a direct drive.

The valve for controlling the various instrumentalities involved in the operation of the hoist is as follows: A valve body 174 is provided with a cap 175 forming a valve chamber 176. Air is delivered to the chamber 176 by a pipe 177 which leads from the receiver 35^a. A rotative valve 178 operates in the valve chamber, the valve having a valve face operating upon a valve seat in the body 174. The valve is mounted on a pin 179 which extends through an opening, or bearing 180 in the valve body. A rock arm 181 is mounted on the pin and this is connected by a rod 182 with an operating lever 183. The operating lever is pivoted at 184 on a post 185 on the platform in a convenient position for the operator. The valve has a

number of ports extending entirely through it, these ports being in communication with the chamber 176 are adapted to carry air from the chamber to ports in the seat leading to the different instruments of control. An inlet port 186 operates in conjunction with a port 189 controlling the air to the pipe 173 and consequently to the direct speed clutch of the transmission. An inlet port 187 operates in conjunction with a seat port 190 controlling air through the pipe 153 to the low speed controlling cylinder 152. An inlet port 188 operates in conjunction with a seat port 191 in delivering air through the pipe 154 to the hoist drum clutch on the gear 42. A seat port 192 communicates with the pipe 163 leading to the cylinder 162 controlling the reverse of the transmission. This port is brought into communication with the valve port 188. The valve is provided with a valve exhaust port 193 operating in conjunction with the seat port 189 and exhaust ports 194 and 195 operating in conjunction with the seat ports 190 and 191 and an exhaust port 196 operating in conjunction with the seat port 192. These valve exhaust ports communicate by passages 197 with an annular passage 198 in the valve. A radial passage 199 communicates from the annular passage 198 to an axial passage 200 in the valve pin, this passage communicating with the air.

A pipe 201 leads from the pipe 153 which is connected with the low speed of the transmission through a three-way valve 202 and a pipe 203 to the pipe 27 so that when the air is turned into the pipe 153 the unloader is automatically actuated so as to relieve the compressor.

The operation of the hoisting control is as follows: In starting the hoisting, the operator through the operating lever actuated counter-clockwise throws the valve 173 bringing the port 188 over the seat port 191, thus setting the clutch between the gear 42 and the hoisting drum. A continued movement brings the port 187 over the seat port 190, thus delivering air to the pipe 153 and setting the transmission for low speed. This same connection of the valve delivers air through the pipe 201 to the unloader so that the compressor is unloaded. The parts remain in this position during the peak effort of the hoist. The port 188 has a circumferential extension 204 in the face of the valve which continues this connection with the seat port port 191 with a continued movement of the valve. When the hoist has passed through its peak load, ordinarily the digging movement, a continued operation of the valve closes the port 187 and brings the exhaust port 195 into register with the seat port 190, at the same time bringing the inlet port 186 into register with the seat port 189 and delivering air to the direct drive clutch

of the transmission through the pipe 173. A reverse movement of the valve cuts off the air through the direct drive, passes over the low speed connection through the seat port 190 so rapidly as to hardly set the devices and finally brings the exhaust port 194 and exhaust port 195 over the seat ports 190 and 191 and the exhaust port 193 over the seat port 189 and the exhaust ports 195 and 194 over the seat ports 187 and 188. By moving the valve slightly farther in a clockwise direction the circumferential extension 204 is brought into communication with the seat port 102, thus exhausting the transmission for reverse action. A return movement of the valve brings the exhaust port 196 of the valve into register with the seat valve, thus exhausting the air from the reverse and releasing its band.

When it is desired to use the device through traction effort a valve 205 is closed, closing off air from the drum clutch on the gear 42. The valve 202 is thrown to close off the pipe 201 and connect a pipe 206 from the air supply receiver 35^a direct with the unloader so that the unloader is permanently set to relieve the compressor. The valve 198 lends itself readily to the traction control being thrown to allow of direct connection, or reverse as the case may be in the same manner as it is thrown for actuating the hoist.

It will be seen from the construction that the hoisting which takes probably three quarters of the total power of the implement in ordinary digging is done by direct connection between the primary motor and the hoisting mechanism and that this may be handled with low speed, or high speeds, so as to more readily accommodate the different loads to which the hoist is subjected, and that energy is stored from the primary motor for handling the crowding of the dipper and turning of the platform through a rotative motor energized from the primary motor and thus makes it possible to have a very high degree of acceleration with the desirable crowding features of a motor designed particularly for this purpose and also a rotative turning motor of high acceleration and capable of handling the turning movement in the satisfactory manner of a fluid-actuated engine. While the indirect method of handling the crowding and turning is more or less wasteful of power the actual power required for these movements is small and the greater flexibility of such motor makes their advantage far outweigh the loss of power. Further where some types of primary motors are used the energy stored and taken from the primary motor is taken from that motor at a time when it is pulling its minimum load and consequently as in the case of an internal combustion engine, the engine may be maintained at a fairly uniform load, thus giving

ing a higher degree of economy in the motor itself than is otherwise attainable. The mounting of the motor and compressor at the rear of the platform balances the overhanging of the boom, places these parts particularly the compressors with their valve action where they are readily accessible and still gives room for the operator and other machinery on the platform, keeping the platform within reasonable limits for successful operation.

The control of the hoist and the different instrumentalities involved in this control through the air valve makes a very simple, accurate and immediately responsive control which may be readily handled by the operator from the operator's stand in connection with the operating mechanism for the crowding engine and turning engine.

What is claimed as new is:—

1. In a power excavating machine, the combination of a frame; a dipper carried by the frame; a hoist for the dipper; a hoisting drum; a clutch controlling the drum; a motor driving the drum; a two-speed transmission between the motor and the drum; an air control for the clutch and transmission; and a valve controlling the clutch and transmission adapted to throw in the clutch and transmission.

2. In a power excavating machine, the combination of a frame; a dipper carried by the frame; a hoist for the dipper; a hoisting drum; a clutch controlling the drum; a motor driving the drum; a two-speed transmission between the motor and the drum; an air control for the clutch and transmission; and a valve controlling the clutch and transmission adapted to throw in the clutch and transmission successively.

3. In a power excavating machine, the combination of a frame; a dipper carried by the frame; a hoist for the dipper; a hoisting drum; a clutch controlling the drum; a primary motor driving the drum; a two-speed transmission between the motor and the drum; an air control for the clutch and transmission; a valve controlling the clutch and transmission adapted to throw in the clutch and transmission; a secondary motor operating on the dipper; means for storing energy from the primary motor for operating the secondary motor; and devices relieving the primary motor of the effort of storing energy while the transmission is set for low speed.

4. In a power excavating machine, the combination of a frame; a dipper carried by the frame; a hoist for the dipper; a hoisting drum; a clutch controlling the drum; a primary motor driving the drum; a two speed transmission between the motor and the drum; an air control for the clutch and transmission; a valve controlling the clutch and transmission adapted to throw in the

clutch and transmission; a secondary motor operating on the dipper; means for storing energy from the primary motor for operating the secondary motor; and devices controlled by the valve relieving the primary motor of the effort of storing energy while the transmission is set for low speed.

5. In a power excavating machine, the combination of a frame; a dipper carried by the frame; a hoist for the dipper; a hoisting drum; a clutch controlling the drum; a primary motor driving the drum; a two-speed transmission between the motor and the drum; an air control for the clutch and transmission; a valve controlling the clutch and transmission adapted to throw in the clutch and transmission; a secondary motor operating on the dipper; means for storing energy from the primary motor for operating the secondary motor; devices relieving the primary motor of the effort of storing energy while the transmission is set for low speed; and speed sensitive means responsive to the speed of the primary motor actuating said relief device with a predetermined low speed of the primary motor.

6. In a power excavating machine, the combination of a primary motor; a digging implement; a direct connection between the primary motor and the implement; a secondary motor operating upon the implement; means actuated by the primary motor storing energy for the secondary motor; a relief device for relieving the primary motor of the effort of storing energy; and fluid-actuated means controlling the direct connection between the implement and the primary motor and said relief device.

7. In a power excavating machine, the combination of a primary motor; a digging implement; a direct connection between the primary motor and the implement; a secondary motor operating upon the implement; means actuated by the primary motor storing energy for the secondary motor; a relief device for relieving the primary motor of the effort of storing energy; a control device for the direct connection; and means adjacent thereto controlling the relief device.

8. In a power excavating machine, the combination of a primary motor; a digging implement; a direct connection between the primary motor and the implement; a secondary motor operating upon the implement; means actuated by the primary motor storing energy for the secondary motor; a relief device for relieving the primary motor of the effort of storing energy; a control device for the direct connection; and fluid-actuated means adjacent thereto for controlling the relief device.

In testimony whereof I have hereunto set my hand.

HERMANN LEMP.