G. W. KING, H. J. BARNHART & C. B. KING.

EXCAVATING MACHINE.

APPLICATION FILED MAR. 20, 1909.

959,756.

Patented May 31, 1910.

4 SHEETS—SHEET 1.

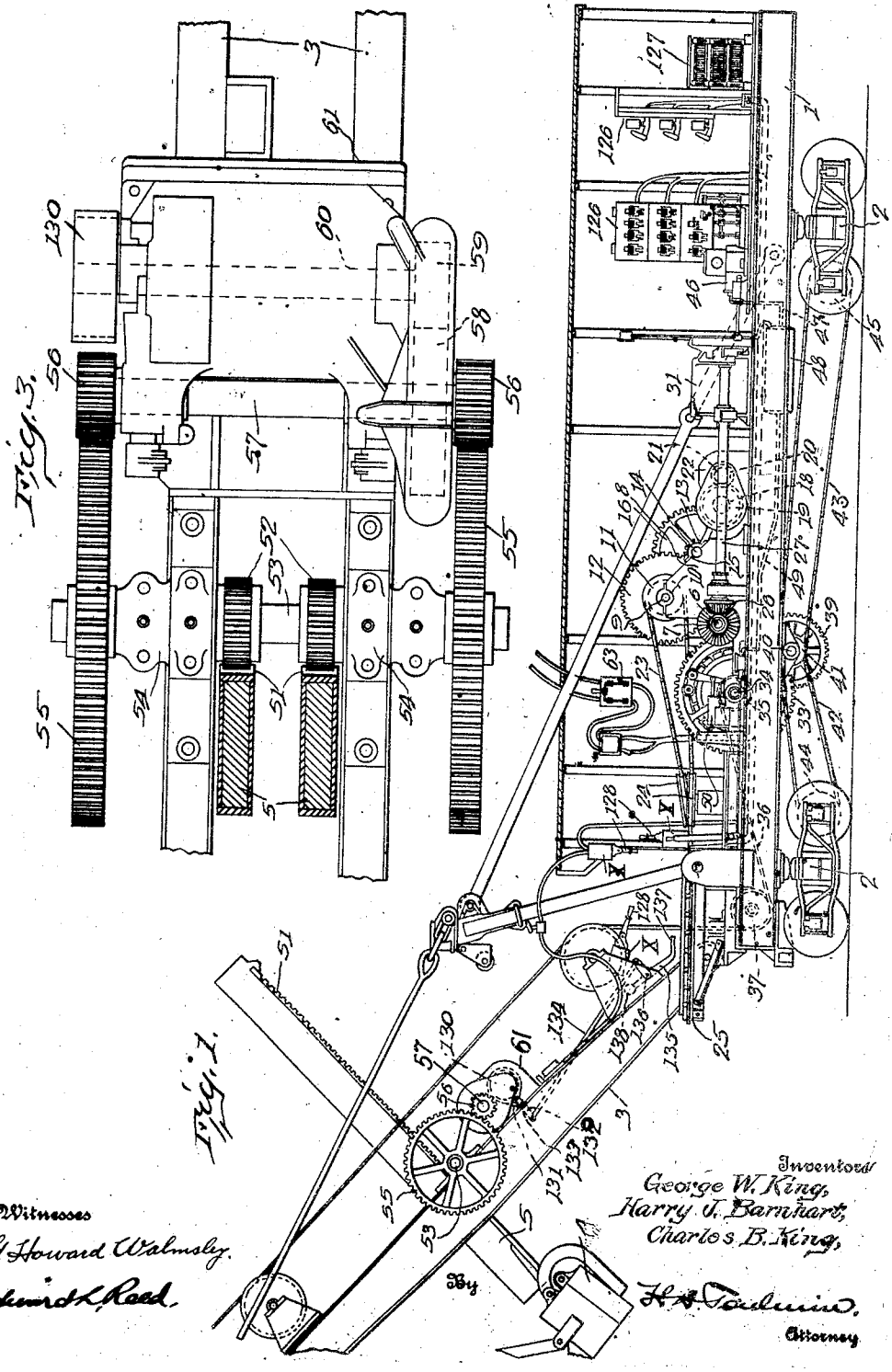

Fig. 3.

Fig. 1.

Witnesses

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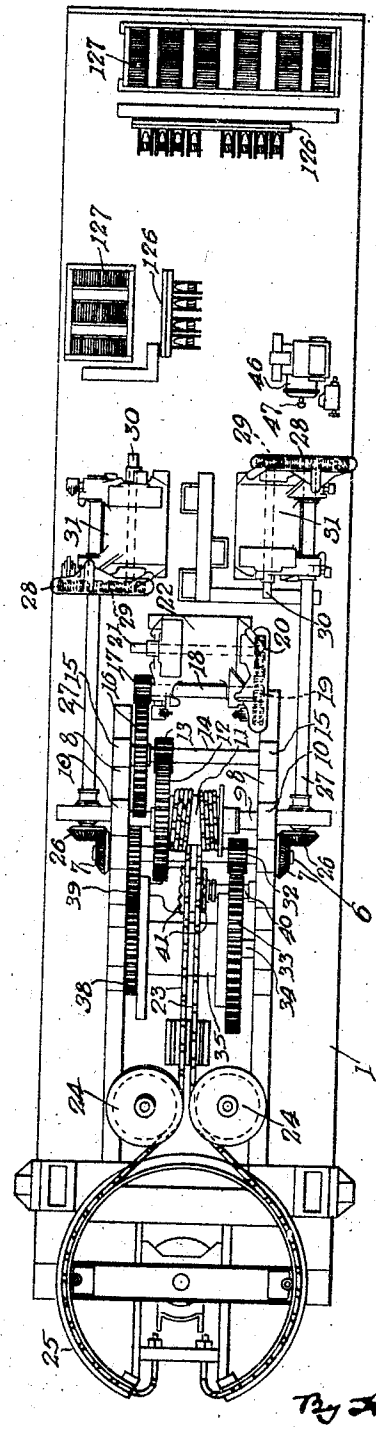

Fig. 2.

Witnesses

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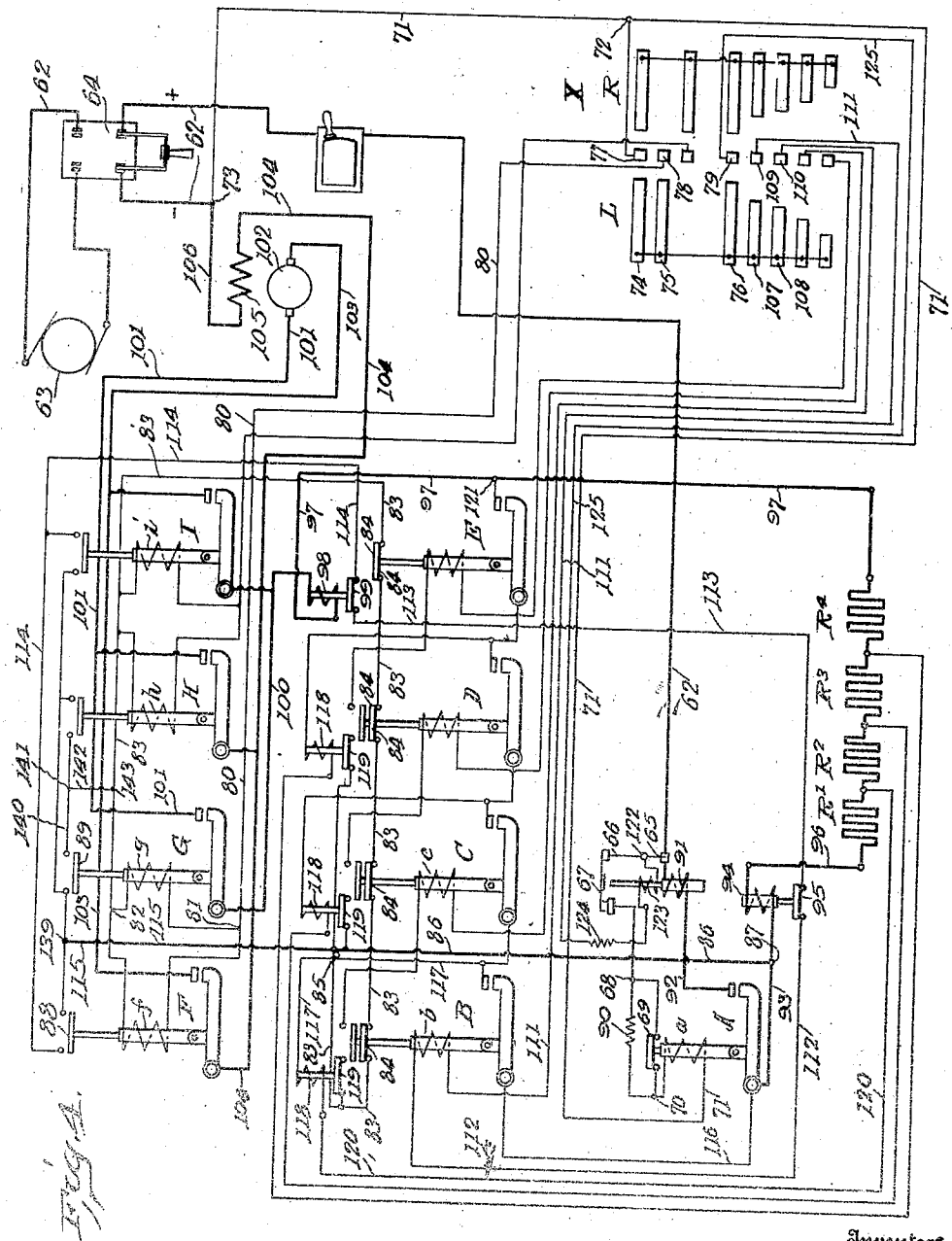

Witnesses

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4 SHEETS—SHEET 4.

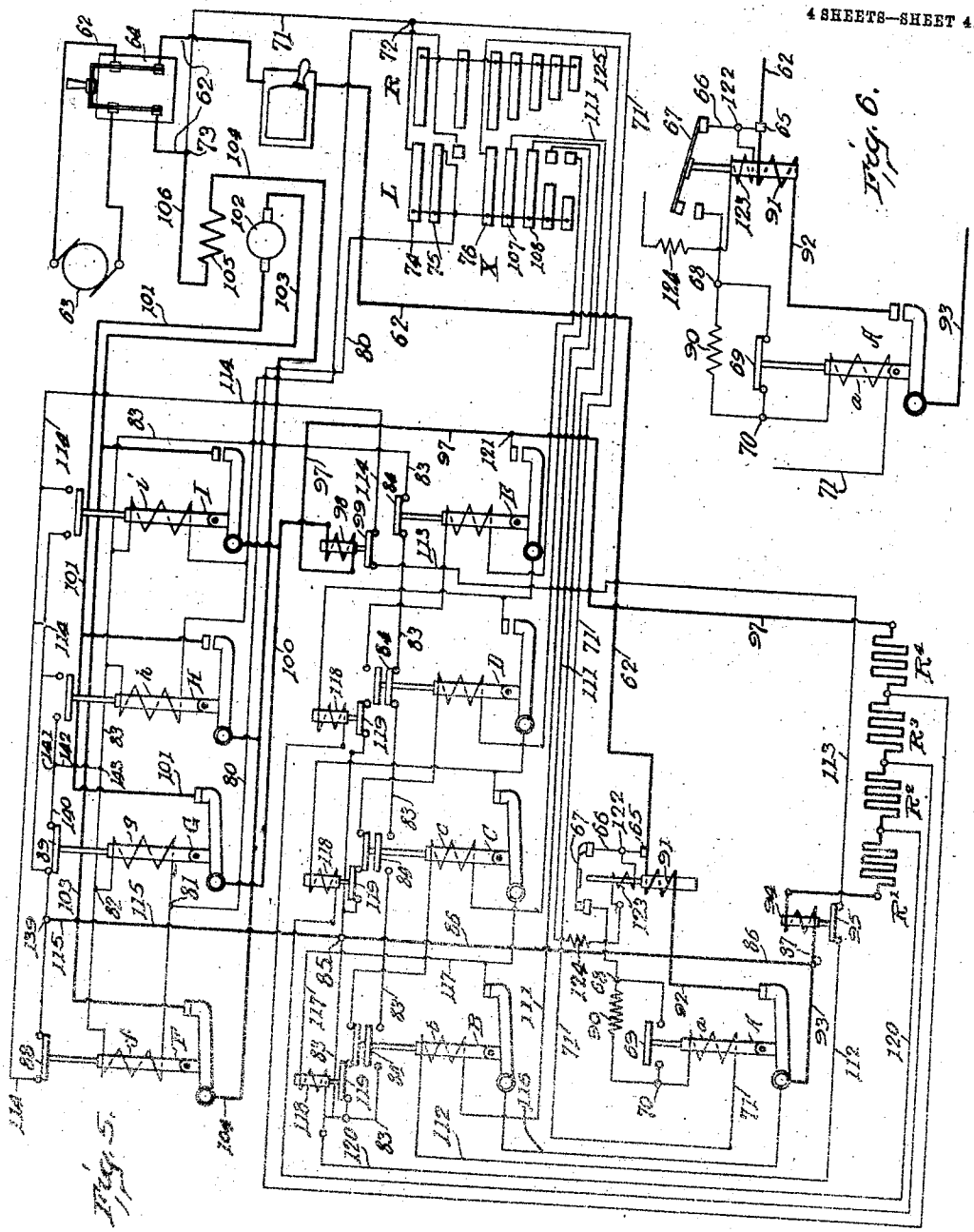

Fig. 5.

Fig. 6.

Witnesses

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UNITED STATES PATENT OFFICE.

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EXCAVATING-MACHINE.

959,756. Specification of Letters Patent. Patented May 31, 1910.

Application filed March 20, 1909. Serial No. 484,651.

To all whom it may concern:

Be it known that we, GEORGE W. KING, HARRY J. BARNHART, and CHARLES B. KING, citizens of the United States, residing at Marion, in the county of Marion and State of Ohio, have invented certain new and useful Improvements in Excavating-Machines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to excavating machines, and is more particularly designed for use in connection with power shovels of the general type usually known as steam shovels.

The object of the invention is to provide such a shovel with electrical driving means, and, to this end, it is a further object of the invention to provide automatic motor controlling means whereby the motor or motors of the driving mechanism will be protected against excessive current and whereby the motor or motors will be so controlled as to cause the same to exert a continuous pressure or "pull" upon the dipper, or other excavating member, when excessive resistance is offered to the movement of that dipper or member, without the liability of the motor building up beyond the danger point.

A further object of the invention is to provide an electrically driven mechanism of this character which can be readily substituted for the ordinary operating mechanism of a steam shovel and the substitution of which will require but slight alteration in the construction of the shovel as a whole; further, to so arrange and combine the several parts of the operating mechanism as to attain a high degree of efficiency, and, at the same time, to so place the mechanism as to economize space and distribute the weight thereof at points where it is most desirable; and further, to so arrange and locate the manual controlling devices for the motors that the same will be within convenient reach of the operator and that the operation and location of the same will be substantially the same as the operation of the controlling devices for the steam shovel.

With these objects in view our invention consists in certain novel features and in certain combinations and arrangements of parts hereinafter to be described, and then more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of a power shovel embodying our invention; Fig. 2 is a top plan view of the same; Fig. 3 is a top plan view of a portion of the boom, showing the "crowding" mechanism; Fig. 4 is a conventional illustration of the motor-controlling mechanism, with the main circuit open and the master controller at zero; Fig. 5 is a similar view, with the main circuit closed and the master controller set for third speed; and Fig. 6 is a detail view showing the action of the overload circuit breaker.

In these drawings we have illustrated one embodiment of our invention and have shown the same as comprising a main frame or car body 1 mounted upon the usual trucks 2. The main frame is provided at its forward end with a boom 3 so supported upon the main frame as to be movable about a vertical axis. An excavating member or dipper 4 is supported from the boom 3 by an arm 5 which is movably mounted thereon. The construction of the shovel so far described is that of the ordinary steam shovel, and, to substitute the electrical driving mechanism for the steam driving mechanism the balance wheels or disks are removed from the shaft 6 and the bevel gears 7 are substituted therefor. The engines and the engine bed are also removed and in their place are mounted two vertically arranged parallel castings or bearing plates 8, on the upper ends of which is supported a shaft 9 journaled in suitable bearings 10 and having secured thereto a cable drum 11 and a gear 12 adapted to mesh with a pinion 13 carried by a shaft 14 journaled in bearings 15 formed in the castings 8 at a point beneath the bearings of the shaft 9. Mounted on the shaft 14 is also a gear 16 adapted to mesh with a pinion 17 carried by one end of a counter or reducing-shaft 18, on the opposite end of which is a gear 19 adapted to mesh with a pinion 20 mounted on a shaft 21 of a motor 22. This motor is preferably of the usual reversible street car type and is not shown in detail, but is indicated only by its inclosing casing. The swinging-drum 11 has wound thereon a cable 23 which extends about guides 24 and about a vertical drum 25 secured to the boom 3 and adapted to move the same about its vertical axis when the cable is actuated. The bevel gears 7 carried by the shaft 6 mesh with bevel pinions 26 mounted on shafts 27 arranged longitudinally of the main frame 1 and having their rear ends provided with

gears 28 adapted to mesh with pinions 29 secured to shafts 30 of motors 31. The shaft 6 has mounted thereon a pinion 32 meshing with a large gear or bull-wheel 33 mounted on a shaft 34 which carries a hoisting drum 35. This hoisting drum is connected to the boom 3 by means of a cable 36 wound about the drum and extending about a guide 37 at the base of the boom 3 and thence upwardly in the usual manner. Mounted on the shaft 34 is a gear 38 which meshes with a pinion 39 mounted on a shaft 40 to which is secured suitable sprockets or driving disks 41 about which extend driving chains 42 and 43 which also extend about the corresponding sprocket wheels 44 and 45 on the axles of the front and rear trucks, respectively, whereby means are provided for propelling the shovel from one point to another, the drum 35 being connected to the shaft 34 by the usual friction clutch mechanism, which is not here shown. This operating mechanism as a whole is the same as employed in a steam shovel with the exception of the substituted parts comprising, principally, the bevel gears 7, pinion 26, shafts 27 and their operating motors, together with the supporting plates or castings 8 and the motor for actuating the parts carried thereby, the remaining gears and their shafts being standard parts of a steam shovel. Consequently, it requires but a very slight change to transform a steam shovel into an electrically driven shovel.

An electrically driven air compressor 46 is mounted on the main frame 1 and is connected by a pipe 47 with an air storage tank 48, which, in turn, is connected by a pipe 49 with the cylinder 50 of a suitable brake-operating mechanism for the hoisting drum. This brake-operating mechanism forms no part of the present invention and is substantially the same as that shown in Patent No. 666,348, granted to King and Barnhart Jan'y. 22, 1901, the principal difference being in the combination of an electrically operated air compressor with the brake-operating mechanism.

The crowding mechanism is substantially the same as that of a steam shovel, it being modified only to such an extent as is necessary to apply the electrical power thereto. As here shown, the arm 5 carrying the dipper 4 is provided with teeth 51 which mesh with pinions 52 carried by a shaft 53 journaled in bearings 54 on the boom 3. This shaft is provided on opposite sides of the boom with gears 55 which mesh with pinions 56 carried by the outer ends of a counter or reducing shaft 57 supported on the boom 3 and having a gear 58 adapted to mesh with a pinion 59 on the shaft 60 of the motor 61. Suitable brake-mechanism is provided for controlling the movement of the dipper should the motor become inoperative or should it be desirable to check the movement of the dipper for any reason. To this end we have provided the shaft 60 of the motor with a drum 130 which is rigidly secured to the shaft and about which extends a brake band 131, the opposite ends of which are secured to a lever 132 which is pivotally mounted on the boom 3, as shown at 133. One end of the band is secured to the lever at its pivotal center and thus has no movement relatively to the boom, while the other end of the band is secured to the lever 132 at a point removed from its pivotal center, whereby the movement of the lever about its pivotal center will cause the brake band to be tightened about the drum and to resist its movement. The lever 132 is connected by means of a rod 134 to one arm of a bell crank lever 135 which is pivotally mounted on the boom 3 at 136 and has its other arm provided with a foot plate 137. A weight 138 is secured to the bell crank lever on that side of its pivotal center opposite the foot plate 137 in such a manner as to hold the foot plate normally raised and thus maintaining the brake band in its inoperative position. The lever 135 and the foot plate 137 are arranged within convenient reach of the operator for the crowding mechanism, and should the current be suddenly cut out of the motor or should it become desirable for any other reason to control the movement of the dipper, he can instantly apply the brake thereto.

Independent controlling means are provided for the motors operating the hoisting, swinging and crowding mechanisms, respectively. These controlling mechanisms are substantially the same and, therefore, we will describe but one of the same and this description will apply to the three controlling mechanisms. For the purposes of this description we will use the controlling mechanism for the hoisting motors. It may be noted here that the arrangement of the hoisting mechanism is such as to enable two motors to be utilized and further to enable these motors to be placed in the rear of the driven mechanism and in a position in which they are not only out of the way, but in which the weight will be disposed toward the rear of the car. Further, two small motors can be started or stopped with much less effort than can a single motor of a horse-power equal to the combined horse-powers of the two motors. Consequently, there is less "acceleration" with two motors than with one. These two motors are controlled in common from a single controlling mechanism, which mechanism is such as to automatically control the successive cutting out of the resistance to increase the current to the motor, to so control the current to the motor as to cause the motor to exert a continuous pressure or pull upon the dipper 4 should the dipper meet with unusual resist-

ance, as by coming in contact with a ledge of rock, without permitting the motor to build up to the danger point. Further, this controlling mechanism is such as to break the main circuit and cut out the motor entirely should the current become excessive for any reason, such, for instance, as the failure of some part of the controlling mechanism to operate.

In Figs. 4 and 5 the main circuit is indicated at 62 and is provided with a generator 63 which is provided with a service switch 64. In describing this controlling mechanism we will trace the circuit from the service switch 64 through the various parts of the controlling mechanism. In Fig. 4 we have shown the service switch 64 as open, the circuit broken and all the parts in their inoperative positions. The first step in the operation of the shovel is to close the service switch 64. By so doing the circuit is closed through the main line 62 to a point 65, at which point the circuit is divided, one part extending through the line 66, through the hinged arm of a circuit breaker 67 to a point 68, thence through a circuit breaker 69 to a point 70, thence through a solenoid *a* forming the electro-magnetic operating means for the circuit breaker and closer A. The current passes from the solenoid *a* through a line 71 to a point 72, thence upwardly to a point 73 where it is connected with the negative side of the main circuit, thus completing the circuit through the solenoid *a* and closing the circuit breaker A in the main circuit. The mechanism is now in its operative position and is under the control of the master controller X, which is of the ordinary type. This master controller is, as usual, divided into two parts, right and left, indicated by R and L, respectively, and the operating handle is operated in one direction or the other to actuate the motor in a forward or reverse direction. When the handle has been turned in one direction, say to the left, a single notch the contact bars 74, 75 and 76 will be moved into engagement with the contact fingers 77, 78 and 79, respectively. This action of the master controller closes the controlling circuit through the circuit breakers and closers on the opposite sides of the armature as follows: The main circuit passes from the point 65 through the coil 91 of the overload magnet, through the line 92, circuit breaker and closer A, line 93 to 87, thence through the line 86 to the point 85, through the line 83 and the several circuit breakers and closers 84 to the point 82 where the circuit divides and a part passes through each of the solenoids *f* and *g* of the circuit breakers and closers F and G to the point 81, where the two branches of the circuit again unite and extend through the line 80 to the contact finger 78 of the master controller, thence through the contact bars 75 and 74, finger 77 to the point 72, thence through the line 71 to the negative side of the circuit at 73. The circuit is thus completed through the solenoids *f* and *g* and actuates the circuit breakers F and G, closing these circuit breakers and closers and completing the main circuit, and, at the same time, closing the circuit breakers and closers 88 and 89. The action of the solenoid *a* has served, at the same time the circuit breaker and closer A was closed, to open the circuit breaker and closer 69, thus causing the current to pass from the point 68 to the point 70 through a resistance 90, but maintaining a sufficient current through the solenoid *a* to retain the circuit breaker and closer A in its closed position. These several steps having taken place the main circuit 62 extends from the point of division 65 through the solenoid 91 of the overload circuit breaker and closer, through the line 92, circuit breaker and closer A, line 93, solenoid 94 of a circuit breaker and closer 95 located in the controlling circuit of the second circuit breaker and closer B, as will be hereinafter described, thence through the line 96 and the several sections of resistance indicated at R', R^2, R^3 and R^4, through the line 97 and solenoid 98 of a second circuit breaker and closer 99 located in the controlling circuit of the circuit breaker and closer B, thence through the line 100, through the circuit breaker and closer G, line 101 and the armature 102 of the motor. We have here shown but one armature, but in the hoisting mechanism the circuit will pass through the armatures of both motors. After leaving the armature 102 the circuit follows the line 103 through the circuit breaker and closer F, through the line 104, thence through the series field 105 of the motor and from the field magnet to the line 106 and the negative side of the main circuit 62 at the point 73, thus completing the power circuit through the motors and operating the motors at their slowest speed, as the current is passing through all the resistance.

In Fig. 5 of the drawings the circuits are shown with the several parts in the positions just described, but, in this drawing, the master controller X has been advanced to the third notch, thereby cutting out two sections of the resistances and operating the motor at about half speed. This operation takes place as follows: When the master controller has been moved to the third speed the contact bars 107 and 108 will be moved into contact with the contact fingers 109 and 110, respectively. The master controller having been first moved to the second notch the controlling circuit will be completed through the second circuit breaker and closer B of the main circuit as follows. The current passes from the point 87 of the line 93

upwardly through the line 86, as before, to the point 85, thence upwardly through the line 115 to the point 139 where it divides, a part passing through the circuit breaker and closer 88, which has been closed by the action of the solenoid *f*, through the line 114 and circuit breaker and closer 99, line 113, circuit breaker and closer 95, line 112 to the solenoid *b*, line 111 to the finger 109 of the master controller and thence through the contact bars 76 and 74, finger 77 to the line 71 at 72 and thence to the negative side of the line at 73, thus closing the circuit through the solenoid *b* and actuating the same to close the circuit breaker and closer B and to open that circuit breaker and closer 84 of the line 83 which is connected with the solenoid *b*. As stated, the circuit divides at the point 139, a part passing to the right through the circuit breaker and closer 89, which has been closed by the action of the solenoid *g*, through the line 140 to the point 141, thence through the line 142 to the point 143 of the line 83, thence through the solenoids *f* and *g* to the line 80 and the master controller as before described, thereby maintaining the circuit breakers and closers F and G closed. The circuit breaker and closer B of the main line having been closed by the action of the solenoid *b* permits the current to pass from the circuit breaker and closer A through line 116 to the circuit breaker and closer B, thence through the line 117, through the solenoid 118 of the circuit breaker and closer 119, through the line 120 to the second section of resistance, R^2, thence through the line 97, circuit breaker and closer G, armature 102, circuit breaker and closer F, field magnets 105 to the negative side of the line, thus cutting out of the power circuit the first section of resistance, R'.

The movement of the master controller X to the third notch brings the contact bar 108 into contact with the finger 110 and closes the third controlling circuit to actuate the solenoid *c* to close the circuit breaker and closer C, the circuit tracing in the same manner as in the case of the circuit breaker and closer B, and to cut out a second section of resistance, R^2. The circuit breakers and closers B, C, D and E are closed successively in this manner until all the resistance has been cut out and the main circuit is connected directly from the circuit breaker and closer E to line 97 at 121. It will be noticed that after passing through each of the circuit breakers A, B, C, D and E the power circuit will pass through the solenoid 118 of a magnetically operating circuit breaker and closer 119 which is located in the controlling circuit of the next succeeding circuit breaker and closer in the main line. The circuit breakers and closers for the controlling circuits are so adjusted as to be inoperative under normal current, but, when one of the main circuit breakers and closers is first closed, the current passing through the line is excessive and is sufficient to energize the solenoid of the circuit breaker and closer in the next successive controlling circuit and break that circuit. So long as this controlling circuit is broken the next succeeding circuit breaker and closer of the main line cannot be closed, regardless of the position of the master controller. As soon as the motor has adjusted itself to the increased current the solenoid of the circuit breaker and closer in the controlling circuit will be deënergized and the circuit again closed, thus enabling the next circuit breaker and closer in the main line to respond to the movement of the master controller. By means of this controlling mechanism it will be apparent that even should the master controller be thrown on full speed at one movement, the resistance will be cut out gradually, as the motor acquires speed.

Should the excavating dipper strike an immovable or solidly embedded rock or meet with other resistance of an unusual character the motors will rapidly build up toward the danger point. In order to maintain a continuous pressure or pull on the dipper and yet avoid the danger of burning out the motors we have provided means for cutting in a part of the resistance when the current has become abnormal. To this end the circuit breaker and closer 99 located in the controlling circuit for the main line circuit breaker and closer B has the coil of its solenoid connected into the main power circuit beyond the last circuit breaker and closer E of the main line. This solenoid is adjusted to operate only when the current in the motor reaches the danger point. When the current reaches this point the circuit breaker and closer 99 is opened, thus breaking the controlling circuit for the main line circuit breaker and closer B and allowing that circuit breaker and closer to open, thereby breaking the main circuit at that point and forcing the current to pass from the first circuit breaker and closer A of the main line through the line 93, circuit breaker and closer 94—95 and line 99 to the first section of resistance R' and through all the resistance to the motor. This excessive current operates the circuit breaker and closer 95 to open the controlling circuit of the circuit breaker and closer B and maintain the same open after the circuit breaker and closer 99 may have closed. Thus, the main line circuit breaker and closer B cannot again close until the current has been reduced to normal and the circuit breaker and closer 95 of the controlling circuit 112—113 closed, thus permitting the motor to again build up in the manner above described.

To provide against abnormal conditions,

such as the failure of some part of the controlling mechanism to operate, we have provided the overload circuit breaker and closer 67—91, shown in detail in Fig. 6. The solenoid 91 of this circuit breaker and closer is adjusted to be actuated only by an abnormal current, and, when so actuated, will raise the hinged contact arm 67 and break the controlling circuit for the circuit breaker and closer A of the main line, thus cutting out the current entirely from the motor. The controlling current for this circuit breaker and closer A divides at the point 122, before it reaches the contact finger 67, and passes through a coil 123, through the resistance 124, line 125 to the contact finger 79 of the master controller, thence through the contact bars 76—74 and finger 77 to the line 71 at the point 72, thence upwardly to the negative side of the main circuit at 73, thus maintaining a closed circuit through the coil 123 so long as the master controller stands on or beyond the first notch. This current is sufficient to hold the overload circuit breaker and closer in its open position, after it has been once actuated, and before this overload circuit breaker and closer can be again closed the master controller must be moved to zero to break the circuit through the coil 123.

We have so far described the action of the controlling mechanism when the controller handle is turned to the left, and it will be understood that, when the handle is turned to the right, the controlling circuit will be closed through the solenoids *h* and *i* and the circuit breakers and closers H and I closed, thus completing the circuit through the armature 102 in the direction opposite to that heretofore described. Otherwise, the operation is the same. It will also be obvious that the amount of resistance and the number of circuit breakers and closures interposed in the main line may be varied according to existing conditions and the requirements of the machine to which the mechanism is to be applied. The detail construction of this controlling mechanism does not form a part of our invention and we have, therefore, described the same only in a general way, sufficient, however, to enable its operation and the manner in which it is combined with the excavating mechanism to be understood. In applying the controlling mechanisms to the motors described in connection with the excavating mechanism, each controlling mechanism is arranged entirely separate from the other controlling mechanism and the circuit breakers and closers are mounted on plates 126 of non-conducting material and the resistance, which is put up in the usual manner, is mounted in the rear of the supporting plates 126, as shown at 127. The main circuit breaker 63 is arranged near the front of the machine, where the same is within easy reach of the operator. The master controllers X are each provided with a handle 128, these handles being arranged to move in the same manner as do the throttles controlling the steam engine of the steam-controlled shovel.

The operation of the device will be readily understood from the foregoing description, and it will be apparent that the closing of the service switch 63 serves to close the circuit breaker and closer A of the main circuit and that, as soon as the master controller has been actuated to close the controlling circuit through the solenoids *f* and *g* and thus close the switches F and G, the circuit will be completed through all the resistances and through the motor, starting the machine at the lowest speed; that, as the master controller is advanced notch by notch, the circuit breakers and closers for the main line are successively actuated and the actuation of each successive circuit breaker and closer cuts out an additional amount of resistance until, when the circuit breaker and closer E has been closed, the entire resistance will have been cut out and the motor will be running at full speed. It will also be apparent that, if the master controller be rapidly advanced from notch to notch, the controlling mechanism will automatically prevent the operation of the succeeding circuit breaker and closer for the main circuit until the motor has adjusted itself to receive the additional amount of current; that, should the excavating mechanism or other part of the machinery meet with abnormal resistance, such as to cause the motor to build up very rapidly, the controlling circuit 111, 112, 113 and 114 for the circuit breaker and closer B in the main circuit will be broken, thus causing the main circuit to be broken at B, and in this manner cutting in again all the resistance, and allowing the motor either to continue its operation at a lower rate of speed or to come to a standstill, but maintaining a constant torque in the motor and causing the same to exert a continuous pull or pressure upon the excavating member; that, by means of this controlling mechanism the amount of current admitted to the motor is regulated by the movement of the excavating member or dipper, thereby automatically regulating the amount of current admitted to the motor under various operating conditions, as when the excavating member or dipper encounters an obstruction or an excessive resistance to its movement; that, should the current become excessive for any reason, such as the failure of some part of the controlling mechanism to operate, the main circuit will be automatically broken and the current cut out of the motor entirely; and that it will be neces-

sary to return the master controller to zero before the circuit can again be completed through the motor. It will also be apparent that we have provided an electrical driving mechanism for an excavating machine which can be readily substituted for the ordinary steam driving mechanism of a steam driven excavating machine; that the driving mechanism is so arranged as to occupy a minimum amount of space and is arranged in such a manner as to secure the highest degree of efficiency; that the controlling mechanism and the resistance are arranged in the rear of the motors where they will be out of the way; and that the whole construction and arrangement is such as to distribute the weight to the best possible advantage.

As above stated, we do not claim as our invention the specific electrical mechanism herein shown and described, but we do claim to be the first to have provided a power excavating machine with electric driving mechanism; and to so control this mechanism from the excavating mechanism that the motors will exert a continuous pull against a fixed resistance, that is, if the excavating member or dipper meets with an excessive amount of resistance to its movement, the motor will be allowed to build up to a predetermined point only and then resistance will be cut into the circuit in sufficient quantities to materially reduce the amount of current admitted to the motors, but to permit the motors to continue their operation at a lower rate of speed, or to come to a temporary stop, and to maintain a constant torque in the motor, thus exerting a continuous pull or pressure upon the excavating member.

While we have particularly described the controlling means for the hoisting mechanism, it will be understood that this same controlling means is applied, with but slight modifications, to both the swinging mechanism and the crowding mechanism and these modifications are of such a minor character that it is unnecessary to herein describe the same. The controlling means above described in connection with the hoisting mechanism is of particular value in connection with the crowding mechanism in that it is in this crowding mechanism that it is more often desirable to cause the dipper to exert a steady, continuous pull against the work, even though the resistance offered to the dipper may be such as to entirely prevent its movement. When such resistance is offered to the dipper the current admitted to the motor is so controlled that a continuous torque is kept up in the motor, which is sufficient to move the motor at a low rate of speed, but is not sufficient to damage the motor should the armature come to a temporary stop, as, when the dipper strikes a ledge of rock.

The mechanism herein shown and described is chosen for the purpose of illustration only and it will be obvious that many changes might be made therein, and we, therefore, wish it to be understood that we do not desire to be limited to the details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:—

1. In an excavating machine, the combination, with an excavating member, a motor for actuating said excavating member, a motor circuit, and a master-controller for said circuit, of means controlled by said excavating member for cutting resistance into said circuit, and means to prevent the cutting out of the resistance from said circuit before said master-controller has been moved to zero.

2. In an excavating machine, the combination, with an excavating member having a plurality of movements, of a separate motor for imparting each of said movements to said excavating member, independent automatic controlling mechanism for each of said motors, an independent master controller for each of said motors, said master controllers being grouped about a common point and arranged within reach of the operator from a single position.

3. In an excavating machine, the combination, with a frame, and an excavating member, of a shaft arranged transversely to said frame, means for operatively connecting said shaft to said excavating member, gears mounted on said shaft near the opposite ends thereof, other shafts arranged near the opposite sides of said frame, pinions mounted on said other shafts and meshing with the respective gears on said first-mentioned shaft, and means for actuating the last-mentioned shafts in unison.

4. In an excavating machine, the combination, with a frame, and an excavating member, of a shaft arranged transversely to said frame, means for operatively connecting said shaft to said excavating member, gears mounted on said shaft near the opposite ends thereof, a shaft arranged near each side of said frame and extending longitudinally thereto, pinions mounted on said longitudinal shafts and meshing with said gears, an electric motor connected to each of said longitudinal shafts, and means for controlling said motors in common.

5. In an excavating machine, the combination, with a frame, and an excavating member, of a shaft arranged transversely to said frame, means for operatively connecting said shaft to said excavating member, gears mounted on said shaft near the opposite ends thereof, a shaft arranged near

each side of said frame and extending longitudinally thereto, pinions mounted on said longitudinal shafts and meshing with said gears, an electric motor connected to each of said longitudinal shafts, means for controlling said motors in common, a second transverse shaft arranged in the rear of the first-mentioned transverse shaft, means for operatively connecting said second transverse shaft to said excavating member, an electric motor arranged between said longitudinal shafts and operatively connected to said second transverse shaft, and means for controlling said motor independently of the first-mentioned motors.

6. In an excavating machine, the combination, with a main frame, an excavating member, a shaft, and a drum mounted on said shaft, all of standard design, of a supporting frame adapted to be removably mounted upon said main frame and support said shaft, a motor mounted on said main frame in the rear of said supporting frame, and means for operatively connecting said motor to said shaft.

7. In an excavating machine, the combination, with a main frame, and an excavating member, of a hoisting-drum mounted on said main frame, a swinging-drum mounted on said main frame in the rear of said hoisting-drum, a motor mounted on said main frame in the rear of said swinging-drum and operatively connected thereto, another motor mounted on said main frame in the rear of said swinging-drum, and means for operatively connecting said last-mentioned motor to said hoisting-drum.

8. In an excavating machine, the combination, with a main frame, and an excavating member, of a shaft arranged transversely to said main frame, a hoisting-drum mounted on said shaft, a second shaft mounted on said main frame, a swinging-drum mounted on said second shaft, a motor arranged [illegible] of said swinging-drum and operatively connected to said second shaft, longitudinal shafts arranged on each side of said motor, operatively connected to said first-mentioned shaft and extending to points in the rear of said motor, and a motor connected to each of said longitudinal shafts.

9. In an excavating machine, the combination, with a main frame, and an excavating member, of a shaft, a hoisting-drum mounted on said shaft, a supporting frame mounted on said main frame in the rear of said shaft, a swinging-drum mounted on said supporting-frame in a plane above the first-mentioned shaft, a motor mounted on said main frame in the rear of said supporting-frame and operatively connected to said swinging-drum, longitudinal shafts mounted on said main frame on each side of said supporting-frame and operatively connected to the shaft of said hoisting-drum, and a motor connected to each of said longitudinal shafts.

10. In an excavating machine, the combination, with a main frame, and an excavating member, of a shaft, a hoisting-drum mounted on said shaft, a supporting-frame mounted on said main frame in the rear of said shaft, a swinging-drum mounted on said supporting-frame in a plane above the first-mentioned shaft, a motor mounted in said main frame in the rear of said supporting-frame and operatively connected to said swinging-drum, longitudinal shafts mounted on said main frame on each side of said supporting-frame and operatively connected to the shaft of said hoisting-drum, a motor connected to each of said longitudinal shafts, and automatic controlling mechanism for all of said motors mounted on the main frame in the rear of the last-mentioned motor.

11. In an excavating machine, a main frame, a boom movably mounted near the forward end of said frame, and an excavating dipper carried by said boom, hoisting and swinging drums mounted on said main frame in the rear of said boom, electric motors mounted on said main frame in the rear of said drums and operatively connected to said hoisting and swinging drums, respectively, and controlling mechanism for said motors supported on said frame in the rear of said motors.

12. In an excavating machine, a main frame, a boom mounted at the forward end thereof, an excavating dipper carried by said boom, a hoisting drum mounted on said main frame in the rear of said boom, a shaft rotatably mounted on said main frame in the rear of said hoisting drum and operatively connected thereto, bevel gears carried by the opposite ends of said shaft, longitudinally arranged shafts supported near the opposite sides of said main frame, a bevel pinion secured to the forward end of each of said shafts and meshing with the respective bevel gears, an electric motor operatively connected to the rear end of each of said shafts, a removable supporting frame mounted on said main frame in the rear of said hoisting drum and between said longitudinal shafts, a swinging drum rotatably mounted on said supporting frame, an electric motor supported on said main frame in the rear of said supporting frame and between said longitudinal shafts and operatively connected to said swinging drum, automatic controlling mechanism for said motors mounted on said main frame near the rear end thereof, and master controllers for said motors supported near the forward end of said main frame.

13. In an excavating machine, the combination, with a boom, and a dipper mount-

ed thereon and movable relatively thereto, of an electric motor mounted on said boom and operatively connected to said dipper, and means controlled by the movement of said dipper for cutting out a part only of the current from said motor.

14. In an excavating machine, the combination, with a body portion, a shaft mounted thereon, means for rotating said shaft, a drum mounted on said shaft, friction clutch mechanism for connecting said drum to said shaft, and a power cylinder for actuating said clutch mechanism, of an air compressor mounted on said body portion and connected with said power cylinder, and an electric motor for driving said air compressor.

In testimony whereof, we affix our signatures in presence of two witnesses.

GEORGE W. KING.
HARRY J. BARNHART.
CHARLES B. KING.

Witnesses:
W. R. WADDELL,
C. M. WRIGHT.