

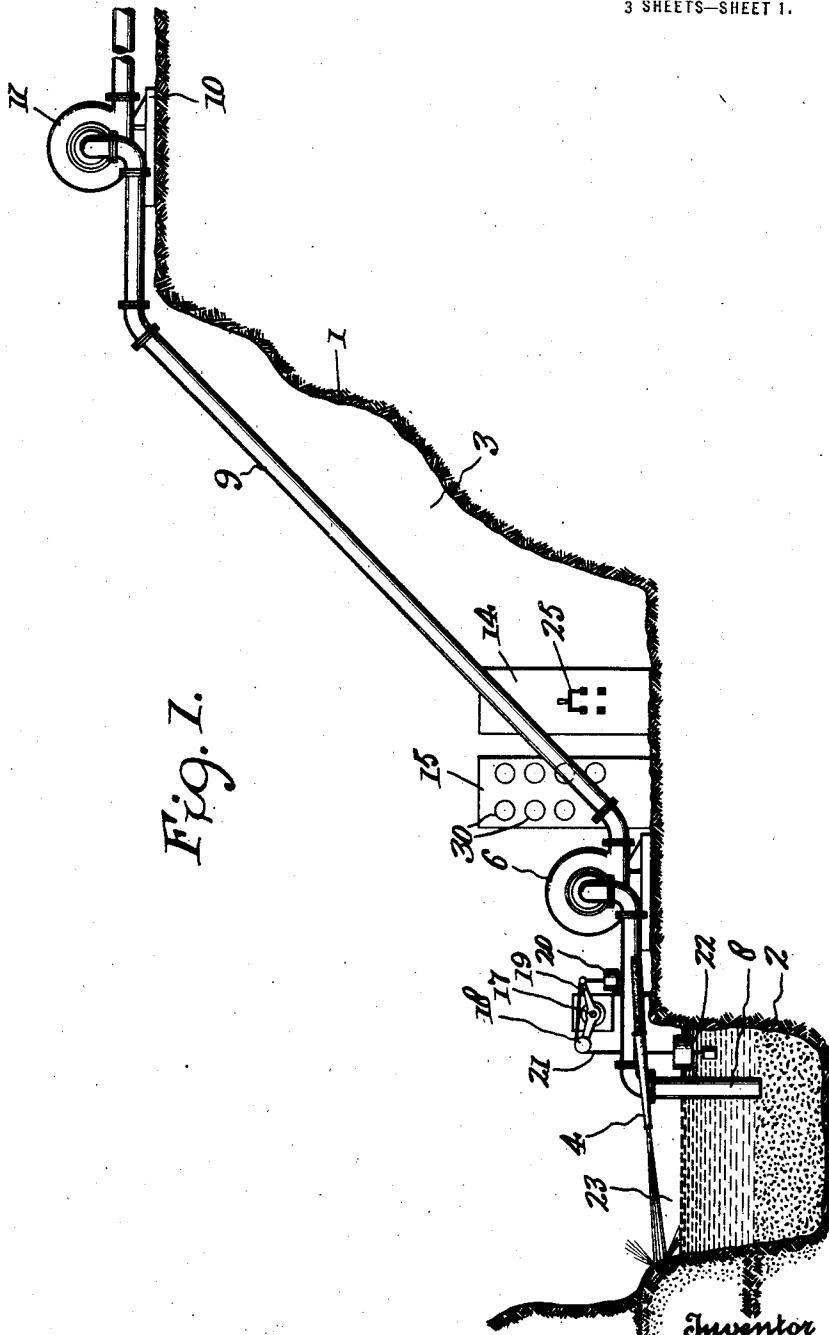
T. B. WHITTED.
 AUTOMATIC CONTROL OF MOTOR DRIVEN PUMP SPEEDS.
 APPLICATION FILED MAR. 2, 1921.

1,411,145.

Patented Mar. 28, 1922.

3 SHEETS—SHEET 1.

Fig. 1.



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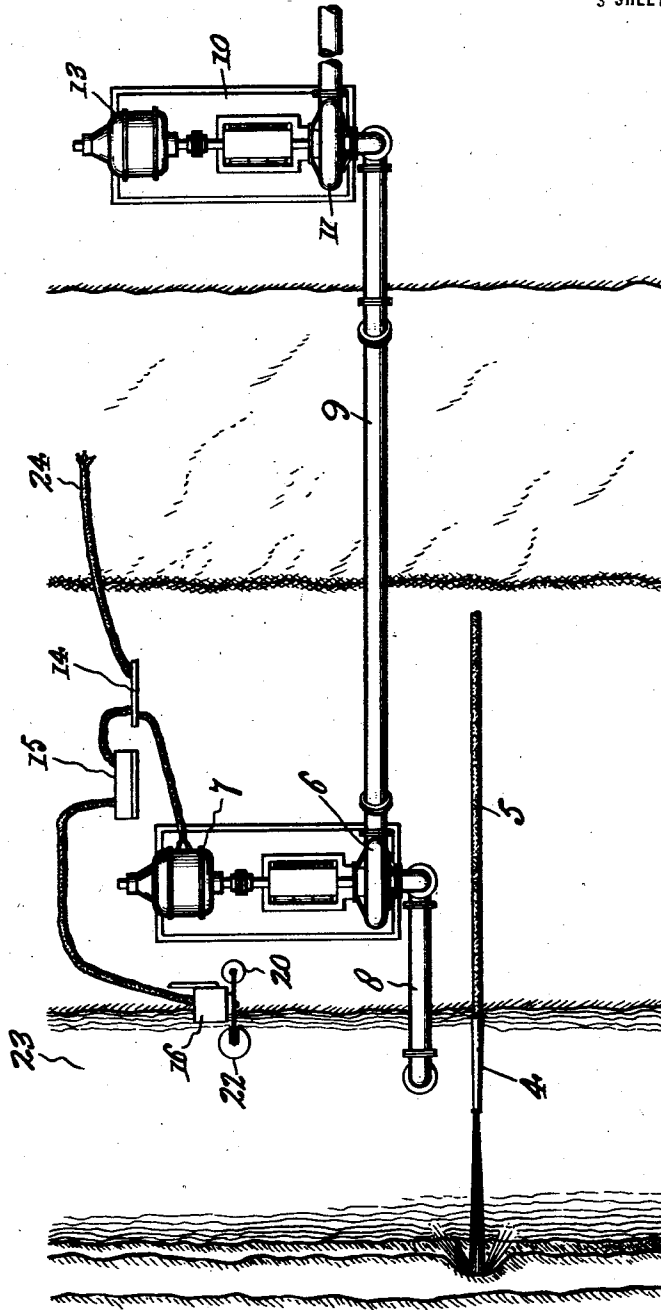
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Fig. 2.



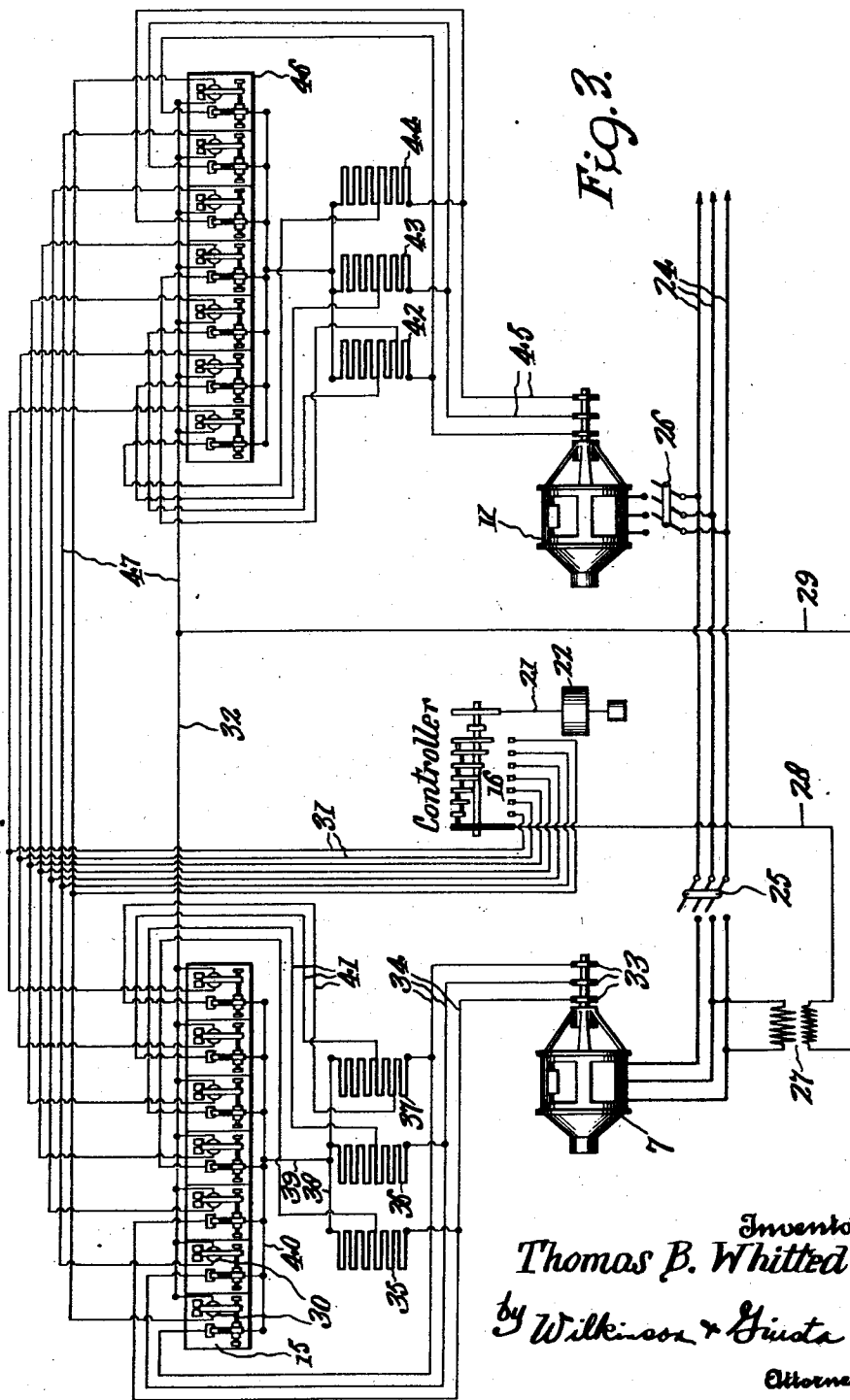
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UNITED STATES PATENT OFFICE.

THOMAS BYRD WHITTED, OF CHARLOTT. NORTH CAROLINA.

AUTOMATIC CONTROL OF MOTOR-DRIVEN PUMP SPEEDS.

1,411,145.

Specification of Letters Patent. Patented Mar. 28, 1922.

Application filed March 2, 1921. Serial No. 449,215.

To all whom it may concern:

Be it known that I, THOMAS BYRD WHITTED, a citizen of the United States, residing at Charlotte, in the county of Mecklenburg and State of North Carolina, have invented certain new and useful Improvements in Automatic Control of Motor-Driven Pump Speeds; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to a method of automatic control of speed on one or more motor driven pumps according to liquid levels. This invention has as its object the automatic control of the capacity of a motor driven sump pump by means of automatically regulating the speed of an electric motor, and the control of the capacity of one or more motor driven booster pumps by automatically regulating the speed of one or more driving motors, according to variation of liquid level in sump.

It has been produced with a view, and will probably be found most applicable to the removing of overburden and mining of phosphate rock and pebble, although it may be used to advantage in other mining or pumping operations.

Its primary object is to reduce the present cost of mining phosphate rock which is attended with the difficulties enumerated as follows:

The deposits of phosphate rock found in the United States and other countries, vary greatly in formation. Those most advantageously mined in the United States are located in and near Polk County, Florida, where these deposits are found from one to thirty feet under a layer of soil known as "overburden". The deposits vary in depth of from one to thirty feet, and largely consist of blanket formations covering considerable area.

The methods at present pursued in removing the "overburden" and mining the phosphate are quite similar, as will be explained.

To remove the "overburden" an excavation is made in depth to reach the phosphate rock, and of such dimension as will enable a pump and motor to be erected, together with such other appliances and tools as are required in this pit. Water is brought into

the pit under pressure varying from 125 to 200 pounds. The motor-driven centrifugal pump is placed as near the pit or sump hole as possible, so that it will have as short a suction as possible. This suction has a valve at the end and flexible joints so that it can be swung around in the sump hole. The discharge of pump is piped over the ground to the place the overburden is to be delivered.

The high pressure water gun is located so as to play on the bank of overburden. The overburden is washed into the sump hole, and the pump delivers this mixture through the pipe line to its destination.

The centrifugal pump is generally driven by a wound rotor type induction motor direct connected through coupling, this motor having external resistance with drum controller in the rotor or secondary circuit only, the stator or primary being controlled with a switch, particularly in case the stator is wound for 2200 volts.

The suction pipe and pump are primed by water furnished from an outside source. The sump hole is filled with water if it is not already full, and the suction of the pump submerged. The equipment is now ready to start. The motor driven pump is put into service by closing the primary switch, in the meanwhile the stream of water from the high pressure gun is turned on the bank of overburden. In case the sump hole, which is approximately a small hole, is full or rising rapidly, the motor-driven pump is brought up to full speed by means of drum controller and resistance, hand operated by the operator. In case it is found that the motor-driven pump is reducing the amount of material and water in the sump hole, and the level is falling, the motor-driven pump speed is reduced. The speed of the motor-driven pump is changed to suit the amount of water and material being washed into the sump hole. In consequence the speed of motor-driven pump is being changed from time to time to suit conditions, as the amount of material being washed down and in sump hole varies due to many varying conditions, such as bank being very hard in places, a large amount of material being undercut but not as yet ready to fall, distance of bank from sump hole, etc.

Generally the motor driving the pump

has a 50% regulation, controlled by the drum controller and resistance.

It is a very serious matter if the pump is allowed to pump the sump dry, if it does the pump will become dead, losing its priming, thereby causing a shut-down. It is also necessary to pump as fast as the material is washed into the sump hole, consequently the present method of operation is to have a motor operator stationed continuously at the drum controller, and vary the speed of the motor-driven pump to suit. Furthermore, in case of a shut-down when there is a rich mixture of solids in pipe line, they settle to the bottom of pipe and in some cases the whole pipe line has to be taken apart and the solids removed.

When the overburden is to be delivered beyond the capacity of one pump, a booster centrifugal pump is connected in series with the pump opposite sump hole, generally at a distance so that the load is divided. The booster pump is driven by the same type of motor, and has a motor operator stationed to control the speed of this motor-driven pump also by means of a drum controller and resistance to suit the conditions of operation. The motor operator of the booster pump must control the speed of his pump to suit. He has in some cases a pressure and vacuum gauge to tell him when to speed up and when to slow down. By listening to material passing through pipe line he can also control his pump, or he may be signaled from the pump house located at sump hole. He can also tell from his ammeter in primary of motor. The correct operation of the booster pump is that it should exactly follow the operation of the pump at sump hole, or there will be a shut-down causing loss of production, etc.

From the above explanation it will be seen that the successful operation of this method of handling material depends largely upon the motor operators controlling their pump or pumps so that these pumps will handle water and solids as they are delivered to sump hole, but in no case should they permit the sump hole to be pumped dry or below the end of suction pipe, so as to lose the priming and create delays, shut-downs and loss of production. In consequence the operators are required to continually change the speed of the motor-driven pump or pumps, which varies the output of materials pumped, so that it follows as nearly as possible the amount being delivered to sump hole.

In mining phosphate rock, with or without booster pump, the method is exactly similar to mining of overburden, as explained above. However, sometimes the rock deposit has to be blasted with dynamite to break it up and assist the high pressure water gun in getting out the tonnage. This

mixture of phosphate rock, debris and water is pumped to what is known as a washer plant, and the phosphate is separated from the refuse, cleaned and transported to the roaster, or elsewhere.

The labor required in connection with this operation consists of from 6 to 12 men per pit, depending upon whether one or more boosters are used. Two of these men operate the gun, one man's duty being, by means of a controller very similar to that used on an ordinary street car, to vary the speed of each motor, start and stop same. Two men are kept at the suction of the pump to keep it from getting clogged. One man is used as a helper. It will thus be seen that with one booster seven men is the minimum that can operate one pit, eight are ordinarily employed.

My invention eliminates one of these men where a single sump pump is used; it eliminates two men when there are in operation a sump pump and a booster pump. In case a second booster pump is necessary, it eliminates a third man. This applies to overburden as well as rock mining, as has been explained the methods used are similar.

Operation in Florida is generally on a 24-hour basis, consisting of three shifts. Consequently we save an average of two men on the overburden operation and two men on the rock mining operation, the total saving therefore would be twelve men per day.

A mining equipment indicates one overburden operation and one mining operation. Some of the mines in this district have as many as five or more complete mining units in service at the same time. This invention therefore will make a large reduction in cost of operation.

In the drawings, wherein like symbols refer to like or corresponding parts throughout the several views,

Fig. 1 is a sectional view made through the bank of overburden and phosphate rock and showing in side elevation an apparatus constructed according to the present invention;

Fig. 2 is a plan view thereof; and

Fig. 3 is a diagrammatic view showing the circuit arrangement.

Referring more particularly to the drawings, 1 designates the bank of overburden which lies above the stratum 2 of phosphate rock. In the bank 1 of the overburden an excavation 3 is made providing a pit for the introduction of the hydraulic and pumping apparatus and for providing a space in which the various operations required may be performed by the workmen. At one side of the pit and adjacent one bank of the overburden there is made a sump 23 in which to catch the water and washed-down material resulting from the hydraulic action.

The hydraulic gun or nozzle is designated

at 4 and is supplied with water under suitable pressure from a desired source by means of a hose 5. A centrifugal pump 6 is installed in the pit close to the sump 23 and is directly connected with an electric motor 7 by which it is driven.

The suction pipe 8 of the pump 6 extends down to a desired depth in the sump 23 and is adapted to draw the water and suspended material into the pump 6 by which such material is elevated through the discharge pipe 9 to a suitable destination without the pit 3. If desired, a second pump and motor unit 10 may be provided on the surface above the pit and including a booster pump 12 and an electric motor 13.

A panel board 14 is mounted in the pit 3 preferably close to the motor 7 and a second panel 15 carrying the solenoid contactors is also mounted in the pit and, with advantage, close beside the panel board 14. A controller 16 is mounted in the pit above the sump 23 being provided with a shaft 17 carrying arms 18 and 19, to the latter of which is attached a counterbalance weight 20. This arm 19 also receives the end of a flexible cable 21 which passes over the companion arm 18 and carries a float 22 at its lower end which rides upon the surface of the liquid in the sump 23. The arms 18 and 19 preferably diverge upwardly as indicated in Fig. 1.

Referring more particularly to the circuit diagram shown in Fig. 3, the invention is shown installed in connection with the usual three-wire alternating current system in which the main line is represented at 24 and is provided with a main switch 25 preferably operating under oil. The main circuit 24 is directly connected to the field winding of the motor 7, and, if the booster motor 11 is also employed, a switch 26, also with advantage being an oil switch, may be closed to put the field of this booster also directly in circuit with the main line 24. A transformer 27 is coupled in the main line 24 between the main switch 25 and the motor 7, the secondary of the transformer being connected in a circuit 28, 29. This circuit includes the controller and the solenoids 30 of the solenoid contactors carried by the panel 15. The solenoid contactors are shown in Fig. 3 to be seven in number to correspond with the seven contacts of the controller.

Lead wires 31, being seven in number, couple the contacts of the controller separately to one end of each of the solenoids 30, a common return wire 32 being provided, which is coupled in multiple to the other ends of the various solenoids 30; this return wire 32 being connected to the branch wire 29 of the secondary circuit. The armature slip rings 33 of the motor 7 are connected in an armature resistance circuit by wires 34

which are three in number and each of which connects with one end of one of the three resistance elements 35, 36 and 37.

The other ends of these resistance elements are coupled together in common by a wire 38, and a wire 39 connected to the wire 38 extends to a common or bus wire 40 connecting one end of the resistance elements to one of the contacts of each of the solenoid contactors. The wires 34 connect with the other contacts of the first three solenoid contactors, while additional wires 41 are secured at one end to the remaining other contacts of the solenoid contactors and at their opposite ends are secured to various sections of the resistance elements.

A similar circuit arrangement is made in connection with the booster motor 11 which is provided with sectional resistance elements 42, 43 and 44 adapted to be placed in circuit with the armature of the motor 11 by means of the wires 45. A similar bank of contactors 46 is mounted in conjunction with the armature circuit and the sectional resistance elements and the solenoids of the contactors 46 are connected in multiple with the solenoids of the contactors 15 by the circuit 47.

In operation, the pit and all the apparatus therein are assumed to be in readiness for pumping. The hydraulic stream is directed against the bank, and it washes down the overburden or phosphate rock into the sump 23 where the agitation of the water keeps the particles of rock and pebble in suspension. The main line switch 25 is closed and also the booster switch 26, if desired. The motor or motors will thereupon start at their lowest speed assuming that the level of the liquid in the sump is at low ebb. In this position the float 22 will be at its substantially lowest point and consequently the controller 16 will be in such a position that all of the resistance elements will be connected in circuit with the armature windings of the motors. This condition will continue until the liquid level rises in the sump 23, which will cause a corresponding rising of the float 22. This will have its reaction upon the controller so that through the solenoid contactors one section of the resistance will be cut out of the motor circuits, thus allowing the motor to proceed at a greater speed and to correspondingly drive its pump whereby to draw a proportionately greater amount of material and liquid from the sump commensurate to the rising level.

Should the liquid level in the sump still rise despite this increased action of the pump or pumps, the float 22 will be carried upwardly to a further point, which will actuate the controller to cut out a second section of the resistance, thus permitting the motor or motors to operate at a still faster speed. The pumping operation will in this way be increased until a maximum speed is obtained

when all of the resistance is cut out and the motor is operating with a short circuited rotating element or armature at a synchronous speed less the slip. When operating in this
5 or any other position, should the quantity of material washed into the sump begin to subside, the float 22 will act in the reverse manner, cutting in step by step more resistance and thus decreasing the speed to correspond
10 with the quantity of material to be pumped.

The electric circuits may be extended to one or more boosters, and all may thus be automatically governed by the same controller and float switch. The invention thus
15 provides for the automatic reduction or increase in speed of the pump motors in accordance with the position of the level of the liquid in the sump and in doing so it dispenses with the services of the operator
20 who is usually detailed to operate the controller. Moreover, the invention, by the use of a secondary circuit 28, 29 which is stepped down to substantially 110 volts through the transformer 27 from the main
25 circuit 24 which has usually 2200 volts, provides a comparatively safe place for the operators to perform their work inasmuch as they are not subjected to accidents occurring frequently where the high voltage of the
30 main line is directly used in and about the motors and controller.

It is obvious that various changes and modifications may be made in the details of construction and design of the above specifically described embodiment of this invention
35 without departing from the spirit thereof, such changes and modifications being restricted only by the scope of the following claims.

40 What is claimed is:

1. The herein described apparatus for automatically controlling the speed of a motor driven pump for removing the material from the sump, including control means for the
45 pump acting to raise and lower its speed in proportion to the amount of material being washed into the sump, substantially as described.

2. The herein described apparatus for automatically controlling the speed of a motor driven pump for removing the material from the sump, including automatic regulating means for the pumping apparatus adapted to cause the latter to be driven at a fast or

slow speed according to the position of the
55 liquid level in the sump, substantially as described.

3. The herein described apparatus for automatically controlling the speed of a motor driven pump for removing the material from
60 a sump, including a motor driven booster pump acting to assist the first mentioned pump, and regulating means for both of said pumps controlled automatically by the level of the fluids in the sump, substantially
65 as described.

4. The herein described apparatus for automatically controlling the speed of a motor driven centrifugal pump for removing the material from the sump, an electric motor
70 for driving said centrifugal pump, and regulating means for the motor acting to automatically increase and decrease the speed of the same in proportion to the quantities of material being delivered to the sump, sub-
75 stantially as described.

5. The herein described apparatus for automatically controlling the speed of a motor driven centrifugal pump having its intake arranged in the sump, control means for
80 said motor including sectional resistance elements, and means for automatically cutting in and out the resistance elements in accordance with the changing level of the liquid in the sump, substantially as described.
85

6. The herein described apparatus for automatically controlling the speed of a motor driven centrifugal pump adapted to remove the material from the sump, an electric motor coupled to drive said centrifugal pump, and
90 regulating means for the motor including sectional resistance elements, contactors for cutting in and out the resistance elements from the motor, and control means for the contactors, substantially as described.
95

7. The herein described apparatus for automatically controlling the speed of a motor driven centrifugal pump having its inlet disposed in the sump, an electric motor coupled to drive said centrifugal pump, governing
100 means for the electric means including a sectional resistance, and a float device in the sump adapted to rise and fall with the liquid level for controlling the cutting in and out of the resistance elements, substantially as
105 described.

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