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MOISTURE CONTROL APPARATUS

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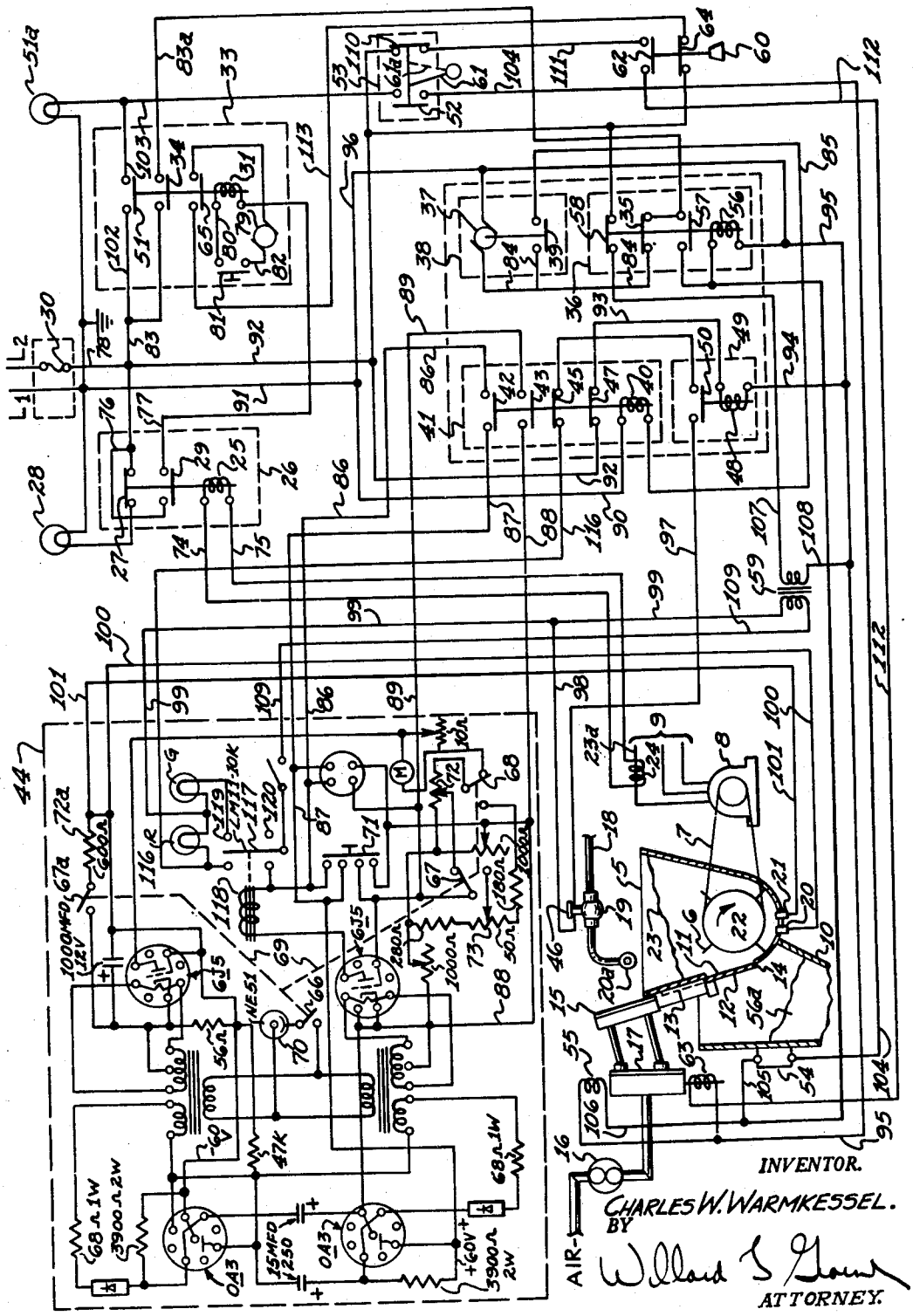

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MOISTURE CONTROL APPARATUS

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This invention pertains to improvements in moisture control apparatus particularly adapted to control the water in concrete batch mixing machines utilized in connection with concrete block making machinery.

One of the critical problems in connection with the rapid and efficient manufacture of concrete blocks of high quality and durability is to very accurately and precisely control the amount of moisture in the mixture of aggregate and cement before it is fed to the hopper of the concrete block making machine. Usually the aggregate and cement are placed together in the mixing machine hopper in dry form and mixed thoroughly in this condition first. After a suitable length of time water is then added, but a predetermined amount in relation to the volume or weight cannot be added because the great variations in the physical character of the aggregate as to moisture absorption qualities. Further, it is found that evaporative and structural changes take place during the wet mixing and that variations in the length of time of the wet mixing, dictated by the demand for material by the block making machine, makes it necessary to control the water supply at all times so that at any moment of dumping of the mixer hopper after the initial mixing period, the material will always be of the proper and required consistency for the correct operation of the block making machine.

To this end there has been provided a sensitive moisture control apparatus responsive to the electro-conductive characteristics of the mixture for at all times automatically maintaining the proper water content in the mixture.

Still another object of this invention is to provide an electro-conductive sensitive system for periodically testing the moisture content of the material during the mixing operation and to add and maintain proper moisture content at all times up to the moment of discharge of the completed mixture.

A further object of this invention is to provide means, in conjunction with the aforementioned apparatus and system, to prevent discharge of the mixture from the mixing machine unless the moisture content is exactly correct.

Also an object of this invention is to provide means for applying the controlled water application to the mixture which is automatically rendered operative by the load applied to the main drive motor for the mixer when the aggregate and cement are dumped in the mixer hopper.

And a further object is to provide means for selectively calibrating a moisture meter associated with the apparatus for different electrical conductiveness of the aggregate alone and the complete mixture.

And it is a still further object of this invention to provide control apparatus in conjunction with that recited above to automatically control the length of time the concrete can be mixed.

Further features and advantages of this invention will

appear from a detailed description of the drawings in which:

The drawing is a diagram showing the electrical apparatus and other essential elements of the moisture control apparatus incorporating the features of this invention.

As an example of one embodiment of this invention, there is shown a mixer hopper 5 in which is suitably rotatably mounted the mixing rotor 6 driven through a belt transmission 7 from the main drive motor 8 which is energized from the power supply lines 9. A discharge chute 10 is positioned to receive the mixed material from the mixer hopper 5 through the discharge opening 11 of the mixing hopper. A mixer door 12 for the discharge opening is actuated to open 13 and closed 14 positions by suitable power means such as an air cylinder 15 which is connected to a source of air pressure such as the air pump 16 through a solenoid operated reversing control valve 17 for the appropriate operation of the air cylinder 15. Water supply from the line 18 is connected through a suitable solenoid operated control valve 19 to the discharge manifold 20*a* above the mixer hopper 15. Electrical contacts 20 and 21 are mounted in the bottom of the mixer hopper 5 and have contact ends 22 engaging the materials 23 presented in the mixer hopper to provide electrical conductivity through the material between the end 22, varying in accordance with the moisture content thereof.

When the mixer hopper 5 is charged with aggregate, the load on the main drive motor 8 is increased, increasing the current flow in the power supply lines 9, around the lead 23*a* of which is located the doughnut coil 24. This induces a current in the operating coil 25 of the control relay 26 causing normally closed contacts 27 to open causing the red "Empty" mixer light 28 to go out and the normally open contact 29 to close so as to connect control current lead L2 from the fused safety switch 30 thereby energizing the relay coil 31 and timer motor in timer control relay 33. Normally open contact 34 closes first upon time out and current from lead L2 flows through the normally closed contact 35 of the control relay 36 to energize and start the timing motor 37 in the timing relay 38. Every sixty seconds, or at any other desired interval, the normally open contacts 39 in the timing relay 38 close momentarily and energize the operating coil 40 in the relay 41 causing both of normally open contacts 42 and 43 to close causing the setting and starting of the moisture meter 44. At the same time normally closed contact 45 opens prohibiting the flow of current from lead L2 to the operating solenoid 46 of the water control valve 19 and stopping the flow of water into the mixer during the initial setting of the moisture meter every sixty seconds.

Also while relay 41 is energized the normally closed contacts 47 are opened de-energizing the operating coil 48 of the delay timer relay 49 and the associated normally open contact 50 are closed. When the relay 41 has its coil 40 de-energized the coil 48 in the relay 49 is energized permitting the normally open contact 50 to close after a delay of about four seconds or an interval as required. This delay is to give further assurance that water will not flow into the mixer hopper unless the moisture meter 44 persists on remaining set.

The normally open contacts 51 in the timer control relay 33 close after the desired mixing time has been reached causing the green indicating light 51*a* to burn and connect lead L2 to the normally open contacts 52 in the selector or safety switch 53 and from there to the normally open contact in a suitable limit switch 54 in the discharge chute and on to solenoid 55 of the control valve 17 to energize the valve to cause the mixer door 12 to be opened.

If the contacts 34 have timed out and closed and the normally open contacts 52 of the selector switch 53 are closed by setting the selector switch in "automatic" position 61*a* and aggregate 56*a* gets low enough in the discharge chute, the limit switch 54 having normally open contacts (not shown) which close causing the circuit to the solenoid 55 to be completed to open the mixer door 12 when actuated by the load of aggregate 56*a*.

At the same time that the operating coil 56 of the relay 36 is energized, current from lead L2 will flow through the normally open contacts 57 of relay 36 from contacts 34 of relay 33 and keep relay 36 energized when the normally open contacts in the limit switch 54 open by the discharge of material 56*a* into the chute 10. This also maintains current from lead L2 applied to solenoid coil 55 to keep the mixer door 12 completely open for complete discharge of the mixer. Also the normally closed contacts 58 of relay 36 are opened at the same time stopping the flow of current from lead L2 through the constant voltage transformer 59 that supplies the moisture meter 44 which stops the possible flow of any water to the mixer during and after discharge.

To close the mixer door 12 the selector switch 53 is turned from "automatic" position 61*a* opening the contacts 52 and closing contacts 110 of the selector switch and the push button 60 is pressed closing normally open contacts 62 to energize the solenoid 63 of the valve 17 causing air cylinder 15 to close the door 12. By this same action of pushing the push button 60 its normally closed contacts 64 are opened breaking the normally open sealing or holding contacts 65 of relay 33 causing this relay to return to neutral ready for the next cycle.

Summarizing the operation of the device: As the hopper 5 is charged with aggregate the increased load on the main drive motor 8 causes current flow in power lead 23*a* to increase, energizing coil 24 which in turn energizes coil 25 of control relay 26 through leads 74 and 75 opening contact 27 causing red "Empty" mixer light 28 to go out and closing contact 29 interconnecting leads 76 and 77 so as to connect lead 78 from the fused safety switch 30 through leads 76 and 77 to the relay coil 31 and timer motor 79, the other end of coil 31 being connected through lead 80 and timer control contact 81 and lead 82 to the other side of the timer motor 79.

Energizing relay coil 31 closes contact 34 connecting lead 78 from lead L2 to leads 83 and 83*a* and through contact 35 of control relay 36 and lead 84 to the timing motor 37 in timing relay 38, energizing this motor 37 to cause periodic closing of contacts 39 so as to periodically connect lead 84 to lead 85 connected to operating coil 40 in relay 41, causing contact 42 to close interconnecting leads 86 and 87 and causing contact 43 to close interconnecting leads 88 and 89 to appropriately energize the moisture meter as shown in the diagram, the other end of coil 40 being connected through leads 90 and 91 to the other power lead L1. When coil 40 is energized contact 45 opens disconnecting lead 92 from leads 78 and L2 from lead 93 connected to coil 48 of delay timer relay 49 to deenergize coil 48, the other end of which is connected through leads 94, 95, 96 and 91 to lead L1. Deenergizing coil 48 opens contact 50, disconnecting lead 93 connected to L2 through lead 92 from lead 97 connected to the operating solenoid 46 of the water valve 19, the other end of coil 46 being connected through leads 98 and 99 going to the moisture meter 44 which thus has control of the operation of the meter valve.

While coil 40 is energized as stated contact 47 is held open deenergizing operating coil 48 of delay timer relay 49 opening control 50. When coil 40 of relay 41 is deenergized, contact 47 closes energizing coil 48 of relay 49 causing contact 50 to close after a delay time interval to make sure that water will not flow into the mixer hopper unless the moisture meter 44 through control

leads 98 and 99 persists in remaining set to energize the water valve coil 46.

After the moisture meter 44 has been initially satisfied by the signal received from electrical contacts 20 and 21 in the bottom of the hopper connected through leads 100 and 101 connected in the usual manner to the moisture meter as shown, the normally open contacts 51 in the timer control relay 33 close interconnecting lead 83 from lead L2 through lead 102 to lead 103 after the required mixing time has taken place which lights up the green indicating light 51*a*. The closing of contact 51 connects lead L2 through lead 103 to normally open contact 52 in the selector switch 53 and then to lead 104 connected to limit switch 54, having normally open contacts, which in turn is connected by lead 105 and lead 106 connected to the solenoid coil 55 of the control valve 17 to energize the coil 55 to cause the mixer door 11 to open, the other end of coil 55 being connected through leads 95, 96 and 91 to L1.

After contacts 34 of timer control relay 33 close and with the contacts 52 of the selector switch 53 closed interconnecting leads 103 and 104 by setting the selector switch to "automatic" position 61*a*, when aggregate gets low in the discharge chute, the normally open contacts in the limit switch 54 close causing the circuit to solenoid 55 to be completed through leads 95 and 106 as described to cause mixer door 12 to open. When coil 56 of relay 36 is energized, current from lead L2 will flow through leads 83 and 83*a* through closed contact 57 of relay 36 to keep this relay energized when the normally open contacts in limit switch 54 open by discharge of material from the hopper into the chute which also maintains current from lead L2 through leads 95 and 106 and connected leads applied to energize solenoid coil 55 keeping mixer door 12 completely open to dump the hopper completely. Also contacts 58 of relay 36 open stopping flow of current from 62 through leads 78, 92 and 107 to the constant voltage transformer 59 having its other end connected through lead 108 to lead 95 and through leads 96 and 91 to lead L1, the secondary of transformer 59 being connected to lead 99 and lead 109 supplying power to the moisture meter 44 which stops the possible flow of any water to the mixer during and after hopper discharge.

The mixer door 12 may be closed by moving selector switch 53 to position 61 away from "automatic" position opening contacts 52 and closing contacts 110 interconnecting leads 96 and 111 so that when push button 60 is pressed closing contact 62 lead 111 is connected to lead 112 connected to solenoid coil 63 of valve 17 so as to operate valve 17 to cause the door 12 to close, the other end of coil 63 being connected to lead 95 and thus to L1. Also when pressing push button 60 lead 113 is disconnected from leads 92 and L2 by opening of contact 64 breaking the holding contacts 65 of relay 33 allowing it to return to neutral ready for the next cycle.

Thus, the system is started automatically in operation by dumping the aggregate and cement in the hopper 5 which, through the increased load on the drive motor 8 as reflected in the donut coil 24 energizes the moisture meter 44 as described to put the system in operation. Further, the mixing material cannot be dumped from the hopper 5 through the door 12 unless the moisture meter has its Wheatstone bridge circuit properly satisfied by the electro-conductivity across contacts 20 and 21 and water valve 19 has shut off. Also, water may be added during prolonged continued mixing in the hopper as required by the change in the aggregate and evaporation, the contacts 20 and 21 periodically signalling the moisture meter 44 to adjust the water valve 19 to take care of this situation.

In instances where it is desired to prevent the aggregate before the cement is added it is found that a different conductivity exists in the material under mixing so that the calibration of the moisture meter must necessarily

be changed. In order to do this the control switches 66, 67, 67a and 68 in the moisture meter 44, which are preferably tied together by a suitable switch lever 69 are moved from the normally aggregate and concrete combined mixing positions shown in the drawing to closed position for switch 66 and to the opposite positions for the switches 67, 67a and 68. The red "prewet" signal lamp 70 turns on warning the operator that the unit is adjusted for prewetting the aggregate alone. Also push button 71 of the moisture meter 44 is pressed starting the moisture meter to operate and the prewet water is introduced to the mixer. When the proper amount of water has been applied as determined by the flow of current between the contacts 22 in the bottom of the mixer hopper 5, the water is shut off by de-energizing the water valve solenoid 46 by the moisture meter. When the water stops flowing the lever 69 is moved to position the switches 66, 67, 67a and 68 as shown on the drawing and the cement is then added to the present aggregate in the mixer hopper, the operation then taking place as described above. The switches 67, 67a and 68 cut in or remove different sets of resistors 72, 72a or 73 to condition the moisture meter for aggregate alone or the aggregate and cement mixture, the latter usually being of higher electrical conductivity across the points 22 when appropriately moistened. The moisture meter 44 may be of any standard commercially available type and the details of the circuit of such units are not further herein described as it forms no specific part of this invention, a preferred form being a P & S moisture control meter for semi-dry concrete mixes.

The detailed structure of the moisture meter forms no part of this invention but its circuit is shown in the drawing for information only. Suffice it to state that the moisture meter is energized through the electrical contacts 20 and 21 so that the meter indicates the moisture content of the batch 23 in the hopper 5. By pressing push button 71 of the moisture meter, additional water flows into the mixer through solenoid valve 19 as described and automatically cuts off this valve when correct predetermined moisture level has been reached.

Such a moisture meter 44 may contain a relay 117 connected to leads 109, 99 and 116 which is closed by either push button 71 or the contacts 39 in timing relay 38, thereby completing the circuit to the water solenoid valve 46. Water then flows if relay 38 persists in remaining closed until the resistance of the concrete mix, measured by contacts 20 and 21, is lowered to approximately 325 ohms, and at this resistance the bridge circuit, comprising of the various radio tubes, condensers, resistors, shown in the moisture meter 44 will lower the voltage to the coil 118 of relay 117 until it no longer will maintain the normally open points 119 and 120 closed. When relay 117 opens, this opens the circuit to the water solenoid valve 46 and the water stops flowing.

While the apparatus herein disclosed and described constitutes a preferred form of the invention, it is also to be understood that the apparatus is capable of mechanical alteration without departing from the spirit of the invention and that such mechanical arrangement and commercial adaptation as fall within the scope of the appendent claims are intended to be included herein.

Having thus fully set forth and described this invention what is claimed and desired to be obtained by United States Letters Patent is:

1. In a moisture control apparatus having a mixer hopper, a mixing rotor in said hopper, a main drive motor for actuating said rotor, a discharge chute positioned to receive mixed material from said hopper including a discharge opening in said hopper opening into said chute, a mixer door for said opening, power means operable to open and close said door, a water supply manifold for said hopper including a power operated water control valve between a source of water supply and said manifold, electrical contact means in said hopper having contact ends engaging the material while being mixed in electro-conductive relationship therewith, a moisture meter including a relay operatively connected to said contact means in said hopper so that its operation is responsive to variations in said electro-conductive relationship through the material mixing in said hopper between said electrical contacts and means in said moisture meter relay connected to said water valve to control the energizing thereof, electrical control means responsive to the load applied to said main drive motor by the material presented in said hopper to render said moisture meter operative, and a time delay relay means operatively connected to said electrical control means and connected to operate said moisture meter relay to control the energizing of said moisture meter relay after a predetermined interval of time has elapsed, said time delay relay means including means to thereafter periodically energize said moisture meter relay at predetermined intervals.

2. In a moisture control apparatus as set forth in claim 1 having means including a second relay connected to said water control valve to maintain said valve in closed position of non-flow of water to said mixer hopper during the initial setting of the moisture meter at said periodically energized intervals.

3. In a moisture control apparatus as set forth in claim 2, a second delay timer means connected to said water control valve and said relay to give further assurance that water will not flow into said mixer hopper unless the moisture meter relay persists on remaining closed to energized position of the water valve.

4. In a moisture control apparatus having a mixer hopper, a mixing rotor in said hopper, a main drive motor for actuating said rotor, a discharge chute positioned to receive mixed material from said hopper having a discharge opening into said chute, a mixer door for said opening, power means operable to open and close said door, a water supply manifold for said hopper including a power operated water control valve between a source of water supply and said manifold, electrical contact means in said hopper having contact ends engaging the material while being mixed in said hopper in electro-conductive relationship, a moisture meter control relay operatively connected to said electrical contact means in said hopper so that its operation is responsive to variations in said electro-conductive relationship through the material mixing in said hopper between said electrical contacts, and control means in said moisture meter relay connected to said water valve to control the energizing thereof, and control means in said chute actuable by the amount of mixed material therein to render said power means operable to open or close said door.

5. In a moisture control apparatus having a mixer hopper, a mixing rotor in said hopper, a main drive motor for actuating said rotor, a discharge chute positioned to receive mixed material from said hopper having a discharge opening into said chute, a mixer door for said opening, power means operable to open and close said door, a water supply manifold for said hopper including a power operated water control valve between a source of water supply and said manifold, electrical contact means in said hopper having contact ends engaging the material being mixed in said hopper in electro-conductive relationship, a moisture meter including a control relay operatively connected to said electrical contact means so as to be responsive to variations in the resistivity of said electro-conductive relationship of said electrical contact means and having means therein connected to the water valve to control the energizing thereof, limit switch actuated means in said chute actuable by the amount of mixed material therein to render said power means operable to open or close said door including further electrical control means responsive to load in said chute to maintain said door in fully open position and to deenergize said moisture meter relay to prevent the flow of any water to the hopper during and after discharge.

6. In a moisture control apparatus having a mixer hopper, a mixing rotor in said hopper, a main drive motor for actuating said rotor, a discharge chute positioned to receive mixed material from said hopper having a discharge opening into said chute, a mixer door for said opening, power means operable to open and close said door, a water supply manifold for said hopper including a power operated water control valve between a source of water supply and said manifold, electrical contact means in said hopper having contact ends engaging the material being mixed in said hopper in electro-conductive relationship, and a moisture meter having a relay connected to energize and deenergize said water valve and operatively connected to said electrical contact means so as to be controlled in response to variations in the resistivity of said electro-conductive relationship of said electrical contact means, limit switch actuated means in said chute actuable by the amount of mixed material therein to render said power means operable to open or close said door including further electrical control means connected to said moisture meter relay and responsive to the load in said chute to maintain said door in fully open position and to operate said moisture meter relay to deenergize said water valve to prevent the flow of any water to the hopper during and after discharge, and a selector switch movable to "automatic" position to effect the aforementioned operation and movable from said position to effect closing of said door, and a push button

control switch manually actuable to condition the electrical circuit to close said door and reset the same for the beginning of the next mixing cycle subject to the load applied to said main drive motor.

7. In a moisture control apparatus as set forth in claim 1, means in said moisture meter connected to said water valve selectively adjustable to variations in the electrical conductivity of the material in said hopper for premixing and wetting aggregate alone prior to mixing with the cement added.

8. In a moisture control apparatus as set forth in claim 6 wherein there is provided a timer control relay having normally open contacts adapted to close after a predetermined mixing time has been reached in said mixer hopper connected to control the operation of said power means to open and close said door so as to automatically control the length of time the concrete is mixed in said hopper.

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