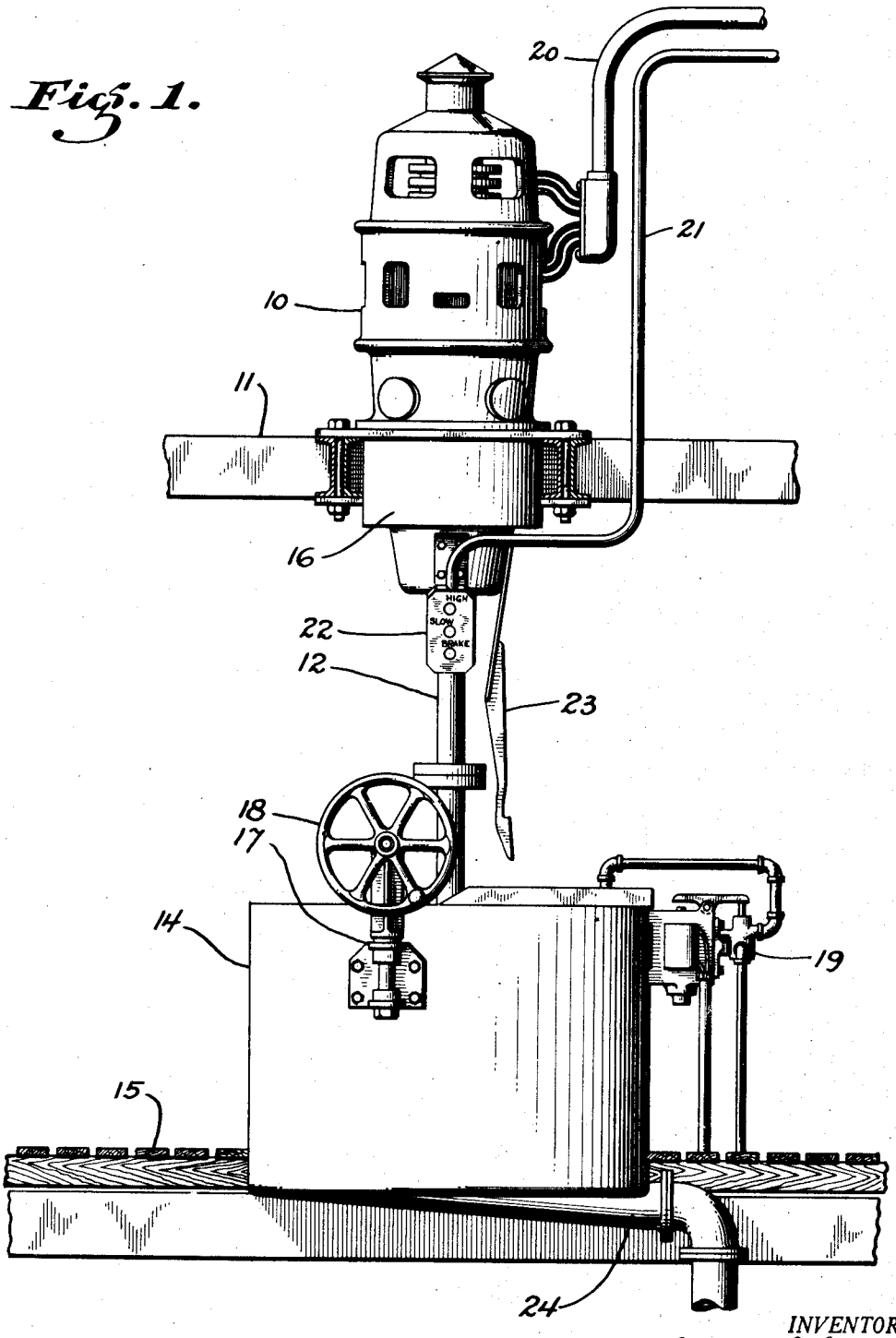
Oct. 20, 1931. C. L. CARLSON 1,828,127

CONTROL SYSTEM FOR SUGAR WASHING APPARATUS AND THE LIKE

Filed Dec. 29, 1928 2 Sheets-Sheet 1

Fig. 1.



INVENTOR.
Chester L. Carlson.

BY
Townsend, Lofton & Abbett
ATTORNEYS.

Oct. 20, 1931. C. L. CARLSON 1,828,127

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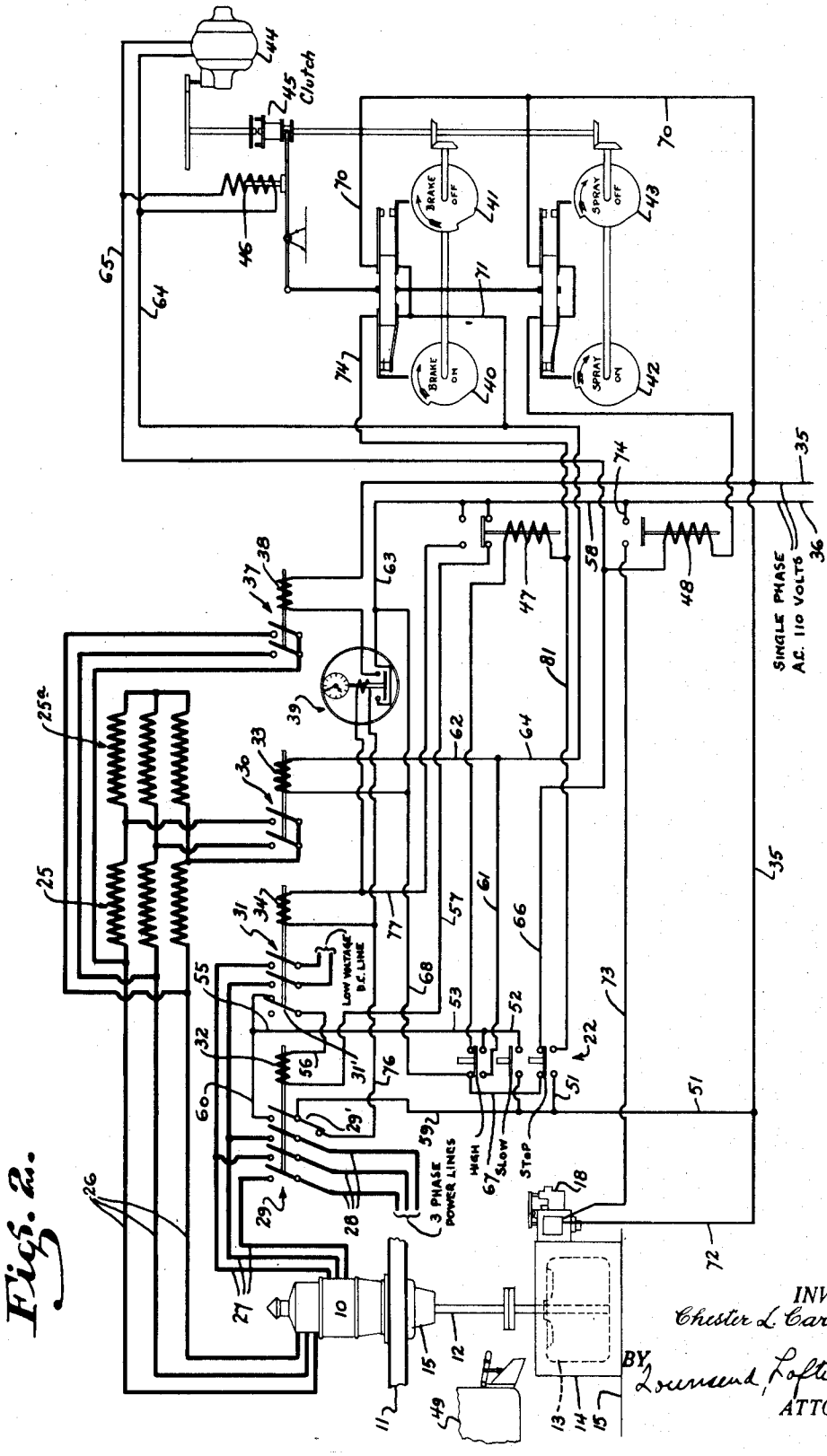


Fig. 2.

INVENTOR.
Chester L. Carlson.
BY Drummond, Lofton & Corbett
ATTORNEYS.

Patented Oct. 20, 1931 1,828,127

UNITED STATES PATENT OFFICE

CHESTER L. CARLSON, OF CROCKETT, CALIFORNIA

CONTROL SYSTEM FOR SUGAR WASHING APPARATUS AND THE LIKE

Application filed December 29, 1928. Serial No. 329,096.

My present invention relates to an electrical control system for sugar washing apparatus and the like and particularly to such a system wherein an alternating current induction motor is used as the prime mover.

An object of my invention is to provide a new and improved system of control for induction motors which is particularly well adapted to the control of such a motor in connection with sugar washing machinery and the like wherein a predetermined cycle of operation is desired.

Another object of my invention is to provide a new and novel application of dynamic braking in connection with apparatus of the above character, whereby complicated and cumbersome mechanical braking devices may be eliminated.

A further object of my invention is to provide a system of control for sugar washing apparatus wherein the period of operation will be controlled in an entirely automatic manner for a predetermined period of time after the apparatus is started.

Another object of my invention is to provide in a system of the above character, a means whereby both manual and automatic control of the apparatus may be effected independently.

Further objects and advantages of my invention will be apparent to those skilled in the art as the description proceeds and others will be referred to specifically hereinafter.

For a better understanding of my invention, reference should be had to the accompanying drawings, wherein I have shown by way of illustration and not of limitation, certain apparatus and arrangements thereof which at the present time represent the preferred embodiment of my invention as now known to me.

In these drawings—

Figure 1 is a front elevation of an installation showing a driving motor and the sugar washing apparatus, and

Figure 2 is a schematic wiring diagram illustrating my system of automatic control.

In Figure 1 of the drawings, 10 designates an induction motor of the wound rotor type which, in the present instance is designed to operate in a vertical position. The motor 10 is mounted in an elevated position upon a suitable support 11 and connected to the lower end thereof by means of a shaft 12 there is a centrifugal basket 13 which is not shown. This basket 13, it will be understood, is mounted within a protecting well or receptacle 14 located at a proper level with respect to a floor or platform 15, as is common practice with apparatus of this type. Located immediately below the motor 10 and adapted to support the shaft 12 and basket 13 there is provided a suitable step bearing 16 which is adapted to carry the load. The well 14 is provided with a pivotal support 17 and a hand wheel 18 for the purpose of controlling a plow in cleaning the basket. I also show an electro-magnetically operated valve mechanism 19 mounted upon the well 14, by means of which the spraying operation is controlled. A conduit 20 is provided through which the various electric power leads pass from the motor 10 to the external controlling apparatus and a second conduit 21 is shown leading from a suitable push button station 22 mounted conveniently above the well 14 and within the reach of the operator. This push button station 22 is shown as having three buttons which operate respectively to produce high and low speed operation and establish braking connections. A depending hook 23 is also shown as projecting downwardly adjacent the top of the well 14 for the purpose of holding the bottom gate of the basket when the latter is being discharged, and a suitable outlet 24 leading from the bottom of the well 14 is also shown for the purpose of conducting away the sugar syrup during the spinning operation.

In the operation of sugar washing centrifugals, which is one of the principal applications of my invention, it is important for best results that the operating cycle of the machine be maintained substantially uniform throughout a particular run. In a co-pending application, Serial Number 198,947, filed June 15, 1927, I have disclosed a system of control for sugar washing apparatus which will operate to control the centrifugal after it is charged and started in an entirely auto-

matic manner without further attention from the attendant. This automatic control of the centrifugal contemplates the application of a brake for stopping the machine and its driving motor after a predetermined cycle of operation and to accomplish this step resort has been had to an electro-magnetically operated friction brake. Such a brake has been found to be very satisfactory when it is in proper adjustment, but, owing to the frequent applications and complicated structure thereof, it is found that, due to wear and other causes, the brake applications are not uniform and thus, as a result, the period of the operating cycles varies from time to time. These variations in the operating cycle are reflected in the moisture content and color of the sugar and are therefore objectionable. In order to overcome this objectionable feature, I provide a braking means which is simple and which will be effective and uniform in its braking effect throughout its life. To this end I propose to apply the principle of dynamic braking to my driving motor and control the braking operation automatically by means of suitable time controlled relays. In addition to the above advantage of a uniform braking effect, the adaptation of the dynamic braking as contemplated by me also greatly simplifies the installation by the elimination of the cumbersome and complicated brake mechanisms which, in the past, have been mounted immediately above the centrifugal where they not only take up valuable space, but, owing to their complicated nature and many moving parts, require frequent oiling and thus also subject the sugar to be washed to the danger of being contaminated by dripping oil and grease. The simplicity and neat appearance of my apparatus is thought to be very well illustrated in Figure 1 of the drawings.

In the application of dynamic braking to an induction motor, it is necessary that two distinct sources of power be available, one of alternating current to energize the motor for the running operation, and another of direct current to energize the motor for the braking operations. In connection with these two sources of power, I provide certain manual, electro-magnetic and time controlled switches which operate to control the apparatus over a predetermined cycle in an automatic manner. For a better and further understanding of these aspects of my invention, attention is now directed to the showing in Figure 2 of the drawings wherein the motor 10 is shown as having a bank of external resistance 25 and 25ª connected in circuit with its secondary windings by means of conductors 26. The motor 10 is also shown as having power leads 27 which are adapted to be connected to power lines 28 by means of an electro-magnetic switch 29. It is to be understood that the power lines 28 connect with a suitable source of three-phase alternating current. The switch 29 will be hereinafter referred to as the slow speed switch, as it is the switch which is controlled by the slow speed push button and, when closed, energizes the motor for starting and slow speed operation. A second electro-magnetic switch, which I shall refer to as the high speed switch, is designated by the numeral 30. This switch is shown as connected to the resistance bank 25 so as to short out a portion thereof and thus effect a high speed operation of the motor. Located between the low and high speed switches 29 and 30, I also show a third electro-magnetic switch 31 which will be hereinafter referred to as the brake or stop switch. This switch 31 is connected between two of the motor leads 27 and a pair of power lines 28 which, it is to be understood, lead to a suitable source of low voltage direct current. As a means for operating the above electro-magnetic switches 29, 30, and 31, I provide respectively in connection therewith operating magnets 32, 33, and 34. These operating magnets are connected with a suitable source of operating current by means of the manually operated push buttons or relay contacts, as will hereinafter appear. This source of current is shown as originating at the lower side of the figure over the conductors 35 and 36, which, in the present instance, are energized by alternating current at a standard commercial frequency and voltage.

In order to provide for a quick stopping of the motor 10 and also to compensate for the reduced dynamic braking effect as the motor 10 slows up, I also provide an additional switch 37 which is connected across the secondary leads 26 between the motor and the resistance bank 25 so as to short out all of the external secondary resistance when it is closed. This switch is adapted to be actuated by an electro-magnet 38 which is energized directly from the power lines 35 and 36 in response to the actuation of a time controlled relay 39 which is to be described in more detail hereinafter.

In addition to the above described apparatus, my invention also contemplates the use of a relay similar to that described in my above referred to copending application. It is to be understood, however, that my present invention is not limited to this particular type of relay, as the same results may be carried out with any type of relay wherein means are provided for controlling a plurality of controlled circuits in a predetermined sequence. For the purpose of illustration, I have illustrated schematically a relay constructed in accordance with the showing of my above referred to application. This particular relay is shown as having four notched disks 40, 41, 42, and 43. These disks are

adapted to be driven by a constant speed motor 44 having means in the form of a clutch 45, whereby it may be connected to and disconnected from the above disks automatically by means of an electro magnet 46. The electro magnet 46, in addition to effecting a connection between the motor 44 and the driving mechanism of the disks, also serves to move a number of cooperating contacts into engagement with the periphery of the disks when it is energized and the notched disks are provided with means for returning them to their initial or starting position after the motor 44 has become disengaged so that, in operation, the motor 44, when energized, will turn the disks a predetermined distance in the direction of the arrows thereupon and, when disconnected, will permit the disks to again return to their initial starting position, which is substantially that shown in this figure of the drawings.

The above referred to cooperating contacts are shown as mounted in spaced relation upon suitable insulating members and they are provided with downwardly projecting fingers which engage the periphery of the disks. The upper contact of those which cooperate with the brake on and spray on disks is shown as having a downwardly depending finger which will cause it to open when these disks are engaged, and the lower contact of those which cooperate with the brake off and spray off disks is provided with a downwardly depending finger which engages these disks and closes these contacts when the disks are engaged. In connection with this illustration, it should be here pointed out that these contacts are here shown in a reversed condition or position from that which they will assume when the relay is in operation. In connection with these cooperating disk contacts I show relays 47 and 48 which operate respectively to control the braking apparatus and the sugar spraying apparatus, as will more fully appear in describing the operation of my invention.

The operation of my invention is as follows: It will be assumed that the centrifugal has just completed the spinning of a batch of sugar or massecuite and that the motor has come to a stop. The operator will then, upon approaching the machine, pull up the bottom gate of the basket 13 if it is a basket of this type and secure the same upon the hook 23. He will next push the slow speed button of the push button station 22. This will energize the motor for slow speed operation, as will hereinafter appear. While the motor and centrifugal are thus slowly rotating, the operator will adjust the plow and then by means of the hand wheel 18 proceed to plow out the sugar which is lodged against the walls of the basket. After the basket has been plowed out, as above, the plow will be removed and the bottom gate of the basket will then be placed in position for the reception of a further charge of massecuite which, in accordance with present practice, is conveniently stored in a suitable reservoir or mixer 49 and from which it may be discharged into the basket by gravity when the operator opens the suitable discharge gate leading therefrom. With the motor still running at slow speed, the operator will then open the gate leading from the reservoir 49 and admit the proper amount of massecuite into the basket, which massecuite, as is well known, will be thrown outwardly and held by centrifugal force against the side walls thereof. After the basket has been so charged with massecuite, the machine may be then speeded up for the final centrifuging operation. Before proceeding further, I shall describe the circuits and operation of the various electro-magnetic switches which establish the slow speed running connection.

Slow speed operation

When the operator depresses the slow speed button, he will establish a circuit across the control power lines 35 and 36 which will energize the magnet 32 of the slow speed switch 29 and thus cause the latter to close and connect the motor to the three-phase power lines 28. This control circuit may be traced as follows: Along the wire 35 from the source and along wire 51 to the left hand contact of the slow speed push button switch, across the push button to wire 52, along wire 53 to wire 55, through the lower contacts of the interlock 31′ on the brake or stop switch 31, along wire 56 to the coil 32, and back through wire 57, to the lower contacts on the brake relay 47, and back by the way of conductor 58 to the other side of the power circuit or line 36. As soon as the above circuit is established, the slow speed contactor switch 29 will close, as previously stated, and at the same time the interlock 29′ carried thereby will be moved over into a reversed position from that illustrated. This interlock will then establish a holding circuit for the magnet coil 32 which will permit a release of the push button and maintain the switch 29 closed. This holding circuit may be traced as follows: From the conductor 35 along the wire 51, along the wire 59, through the upper portion of the interlock 29′, along the wire 60, through the interlock 31′ on the stop switch, along wire 56 through the coil 32, and thence by way of conductor 57 around through the brake relay and back to the power conductor 36, as previously described. With the apparatus connected in this manner, it will be noted that the time controlled relays and the resistance controlling switches remain de-energized and inoperative so that the apparatus may be run at this slow speed for any desired period of time, the control being entirely in the hands of the operator.

High speed operation

At this point it should be stated that the normal operation of sugar washing machines of the character contemplated by my invention involves a predetermined cycle of events, that is to say, after the centrifugal is started, it is desirable to spin the sugar for a predetermined number of seconds to throw off a certain amount of the syrup before the washing spray is applied thereto. It is also necessary that the spraying operation be carried out for a limited period of time only, and that, after this washing period, the centrifugal continue to spin for a further predetermined length of time, after which the operation should be immediately stopped.

As soon as the basket has been fully charged, the operator can then, by pressing the high speed button, speed up the motor to its normal operating speed and at the same time set the automatic supervising relays into operation so that further control of the apparatus will be handled in an entirely automatic manner and leave him free to proceed with any other duties such as the charging or discharging of other similar machines. At this time it will be understood that the motor is rotating at slow speed and that the above described circuit has been established. The operator will then push the high speed button downwardly so as to bridge the lower contacts thereof and thus establish a circuit which will energize the electromagnet 33 of the high speed or resistance short-circuiting switch 30, and thus by decreasing the external resistance in the external circuit of the motor, cause it to speed up. This circuit may be traced from the conductor 35 along the wire 59, across the upper portion of the interlock 29', over the wire 60, the wire 55, and along wire 53 to the lower right hand contact of the high speed push button, then through the push button contact and wire 61, then along wire 62 to the magnet coil 33 and back along wire 63 where it connects with the other side of the line or conductor 36. Simultaneously with the establishment of the above circuit, there is also provided a second circuit through the motor 44 of the main time controlling or supervising relay. This circuit may be traced from the conductor 35 through the high speed push button along a conductor 61 and a conductor 64 to one side of the motor 44 and then back by way of conductor 65 to conductor 66 and to the upper right hand contact of the stop push button, over the jumper 67 to the conductor 68, and by wire 63 to the power conductor 36 where this circuit will be completed. At the same time that the relay motor 44 is energized, a circuit will be established through the electro-magnet 46 and, as a result, the clutch 45 will be brought into driving engagement with the motor 44 so as to drive the disks 40, 41, 42, and 43 and at the same time the cooperating contacts of the disk will be brought into operative connection therewith. As these cooperating contacts are brought into engagement, it will be understood that the contacts which cooperate with the brake on and spray on disks will be opened and that the contacts that cooperate with the brake off and spray off disks will be closed. When the contacts which cooperate with the brake off disk 41 are closed, as suggested above, there will be established a locking circuit for maintaining the contactor 30 closed and the motor 44 in operation after the high speed push button has been released.

The high speed contactor locking circuit is as follows: From the conductor 35 along the wire 70, across the brake off disk contacts to the wire 71 and along wire 64 to the wire 62, through the magnet coil 33 and back to line 36 over the wire 63; and the locking circuit of the relay motor 44 is as follows: From the conductor 35 along the wire 70, through the brake off contacts to the wire 71, along the wire 64, through the motor 44 and back along wire 65 to conductor 66, then to the upper contacts of the stop push button, through this button and jumper 67 to the conductor 68, to the other side of the line or conductor 36.

Operation of supervising relay

After these holding circuits are established, it will be understood that the motor 44 will continue to run at a uniform speed and drive the disks 40, 41, 42, and 43 in the direction indicated by arrows and, as the notches in the various disks come into cooperating relation with the respective cooperating contacts, various circuits will be established for carrying out the further automatic supervision of the apparatus. Under these conditions, the centrifugal will be operating at its proper speed and after a predetermined time, depending upon the setting of the disk 42, the contact finger cooperating therewith will drop into the notch thereupon and close a circuit which will energize the spray controlling relay 48 and, as a result, cause the contact making member thereof to move upwardly and establish a circuit from the power conductor 35 over the wire 72 and through the spray washing control magnet 18 and back along wire 73 to one of the upper contacts of this relay and back over wire 74 to the other side of the line or conductor 36. This relay 48 and the magnet 18 will remain energized until the notch upon the spray off disk 43 has moved into cooperative relation with the downwardly depending finger of the contacts which cooperate therewith and at this time this circuit will be broken and the relay 48 will drop down and open the spray controlling magnet circuit and thus stop the spraying operation.

It will be understood that the brake con-

trolling disks 41 and 42 have been continuously in operation and rotating during this spraying operation and that after a further predetermined lapse of time the notch in the brake on disk 40 will come into cooperative relation with its associated contacts and permit them to close. This will establish a circuit from the conductor 35 of the power circuit through the wire 70, the brake off disk contacts, through the brake on contacts and conductor 74 to the brake relay 47, and back to the upper contact of the high speed push button and back along conductor 68 to the power conductor 36. This will cause the brake relay to pick up and open its lower contacts and open the circuit previously established through the magnet coil 32 of the slow speed contactor and, as a result, the motor 10 will be disconnected from its source of power. During this operation, however, the circuit of the coil 33 of the high speed switch will not be affected.

Braking operation

When the lower contacts of the brake relay 47 are opened, a new circuit will be established between the upper contacts thereof which will energize the magnet 34 of the brake or stop switch 31 and connect the lower voltage source of direct current of the power lines with two of the phases of the motor stator and thus set up a stationary magnetic field which will operate dynamically upon the rotating secondary windings to stop the motor in a manner well known in the art. This brake switch controlling circuit is as follows: From the power conductor 35, the current flows over the wire 59 to the interlock 29′ upon the slow speed switch 29, across the lower half thereof to the wire 76, through the brake switch operating magnet 34 and back along wire 77, and to one of the upper contacts of the brake relay 47, across the bridging member and through conductor 58 back to the other side of the line or conductor 36. This circuit will then be maintained for a time sufficient to bring the motor 10 to a stop and finally, as the brake off disk 41 continues to rotate, the contacts cooperating therewith will drop into the notch thereof and the circuit of the relay 47 will be opened and thus the brake controlling contactor will be de-energized and, as a result, disconnect the source of braking current from the motor 10. When the brake off controlling contacts drop into the notch upon the disk 41, they will, in addition to opening the circuit of the brake relay 47, also open the holding circuit of the high speed switch magnet 33 and the relay motor 44 and, as a result, the apparatus will become completely de-energized and in condition for a repetition of the above operation by a further and similar actuation at the push button station 22.

The amount of dynamic braking effect which will be exerted upon the motor 10 by the above described arrangement will be determined largely by the particular size and design of the motor, the amount of external resistance in its secondary circuit, and also by the amount of direct current power which is applied thereto. In connection with the above described operation, it will be noted that the operation of the high speed switch 30 did not short out all of the resistance 25 in the secondary circuit of the motor 10 and, as a result, where it is desired to bring the motor to a more abrupt stop or, in other words, to produce a greater braking effect so as to shorten the spinning cycle, resort may be had to the auxiliary brake controlling switch 37 and thus completely cut all of the resistance 25 out of the secondary circuit of the motor. This particular additional aspect of my invention operates in the following manner: It will be assumed that the above described high speed operation has been initiated and that the previously described supervising relay has operated to energize the brake controlling switch electro-magnet 34. When this is done, the time relay 39, which may be any suitable type of delayed action relay, will be energized in parallel with the above electro-magnet by reason of wire 78 and 79 and, after a predetermined lapse of time after the direct current voltage has been applied to the motor, the relay 39 will operate to close an energized circuit for the electro-magnet 38 and thus close the switch 37 and effect a complete short-circuiting of the resistance, the control circuit for the electro-magnet 38 being from the power conductor 35, through the magnet 38 to the contacts of relay 39, and back through the conductor 63 and to the other side of the line or conductor 36.

Emergency control

In order that the operator may at all times have complete control of the apparatus and particularly in an emergency as, for instance, in the event that the basket should start to swing during the loading operation, I have provided at the push button station 22 a stop button which, when operated, will open the holding circuits of the various electro-magnetic switches and at the same time establish an operating circuit for the brake controlling switch 31. When the centrifugal is running at slow speed, as during the charging operation, the operator may, by pushing the stop button, open the locking circuit of the slow speed switch 29 and close the circuit of the brake controlling switch 31. This latter circuit may be traced from the control current conductor 35 along wire 51 to the lower left hand contact of the stop push button, through the bridging contact and by way of wire 81 to one side of the brake relay 47 and back to the upper contacts of the high speed push

button, and then back over wire 68 to the other side of the line, or conductor 36.

If the centrifugal machine should be running at high speed and under the control of the supervisory relay at the time of the emergency, the operation of this stop push button will also open the locking circuit of the relay motor 44 and, as a result, render this relay inoperative and permit the manual application of the brake, as above outlined.

From the above it will be seen that I have provided apparatus and a system of control therefor whereby the operation of sugar washing and similar operations may be carried out successfully with alternating current motors in an entirely automatic manner without resort to mechanical friction braking means and wherein, as a result, the apparatus is greatly simplified and many of the objectionable features of present day apparatus and systems are eliminated; and, while I have shown and described a preferred embodiment of my invention, I desire to have it understood that I aim to cover in the appended claims all embodiments and variations which fall within the spirit and scope thereof.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. The combination with an induction motor having external resistance in its secondary circuit, of alternating current and direct current sources of power, manual means for controlling the connection of said motor to the alternating current source of power for low speed operation, a second manual means for effecting a control of the external resistance of the motor for high speed operation, a time controlled relay mechanism adapted to be set in operation upon the actuation of said second manual means to automatically disconnect the motor from said alternating current source after a predetermined period of operation and connect the direct current source thereto to thereby stop said motor by effecting a dynamic braking thereof, and connections whereby the resistance control effected by said second manual means will not be disturbed during the braking period.

2. The combination with an induction motor having external resistance in its secondary circuit, of alternating current and direct current sources of power, manual means for connecting said motor to the alternating current source of power for low speed operation, a second manual means for controlling the external resistance of the motor to effect high speed operation thereof, a time controlled relay mechanism adapted to be set in operation upon the actuation of said second manual means to automatically disconnect the motor from said alternating current source after a predetermined period of operation and connect the direct current source thereto to thereby stop said motor by effecting a dynamic braking thereof, and a second time controlled relay mechanism adapted to operate to reduce the external resistance of said motor at a predetermined time after the braking connections are established to thereby maintain the braking effect as the motor decelerates.

3. The combination with an induction motor having external resistance in its secondary circuit, of alternating current and direct current sources of power, manual means for connecting said motor to the alternating current source of power for low speed operation, a second manual means for controlling the external resistance of the motor to effect high speed operation thereof, a time controlled relay mechanism adapted to be set in operation upon the actuation of said second manual means to automatically disconnect the motor from said alternating current source after a predetermined period of operation and simultaneously connect the direct current source thereto to thereby stop said motor by effecting a dynamic braking thereof, and a second time controlled relay mechanism adapted to be set in operation after said first time relay has operated to reduce the external resistance of said motor after a predetermined braking period to thereby maintain the braking effect as the motor decelerates.

4. In a system of control for electrically driven sugar washing centrifugals, the combination of an induction motor having external resistance connected in circuit with its secondary windings, an electro-magnetic switch for controlling said resistance, sources of alternating current and direct current power, electro-magnetic switches for alternately connecting said motor to said sources of power to produce respectively running and braking operations, a manual control station for controlling the operation of said electro-magnetic switches to produce low speed, high speed and braking connections for the motor, a time controlled relay mechanism for automatically establishing braking connections with the motor a predetermined period of time after said manual means is operated to produce high speed operation, and connections whereby said manual means may be operated to produce slow speed operation and braking conditions independently of said time controlled relay mechanism.

5. In a system of control for electrically driven sugar washing centrifugals, the combination of an induction motor having external resistance in its secondary circuit, an electro-magnetic switch for controlling said resistance, a source of alternating current power for operating said motor, a source of direct current power for braking purposes, electro-magnetic switches for controlling the

connections of the motor to each of said sources of power, a manual control station for controlling the operation of said electro-magnetic switches, and time controlled relay mechanisms for automatically controlling said electro-magnetic switches after high speed operation of the motor has been initiated by said manual means, and means operable by said relay mechanisms to disconnect the motor from the alternating current source of power after a predetermined period of operation and simultaneously connect said direct current source of power to the motor to effect dynamic braking thereof and subsequently vary the external resistance of the secondary circuit of the motor during the braking period.

CHESTER L. CARLSON.