Dec. 11, 1934. R. P. DE VRIES 1,984,302

TIME PERIOD CONTROL DEVICE

Filed July 31, 1931 4 Sheets-Sheet 1

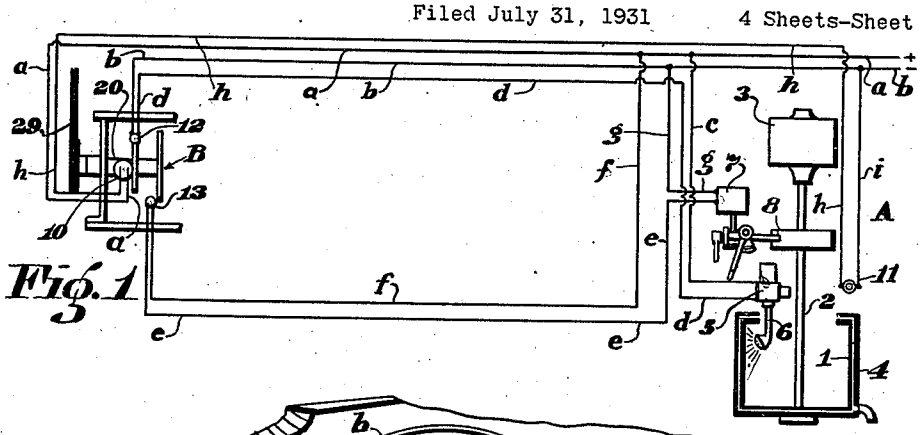


Fig. 1

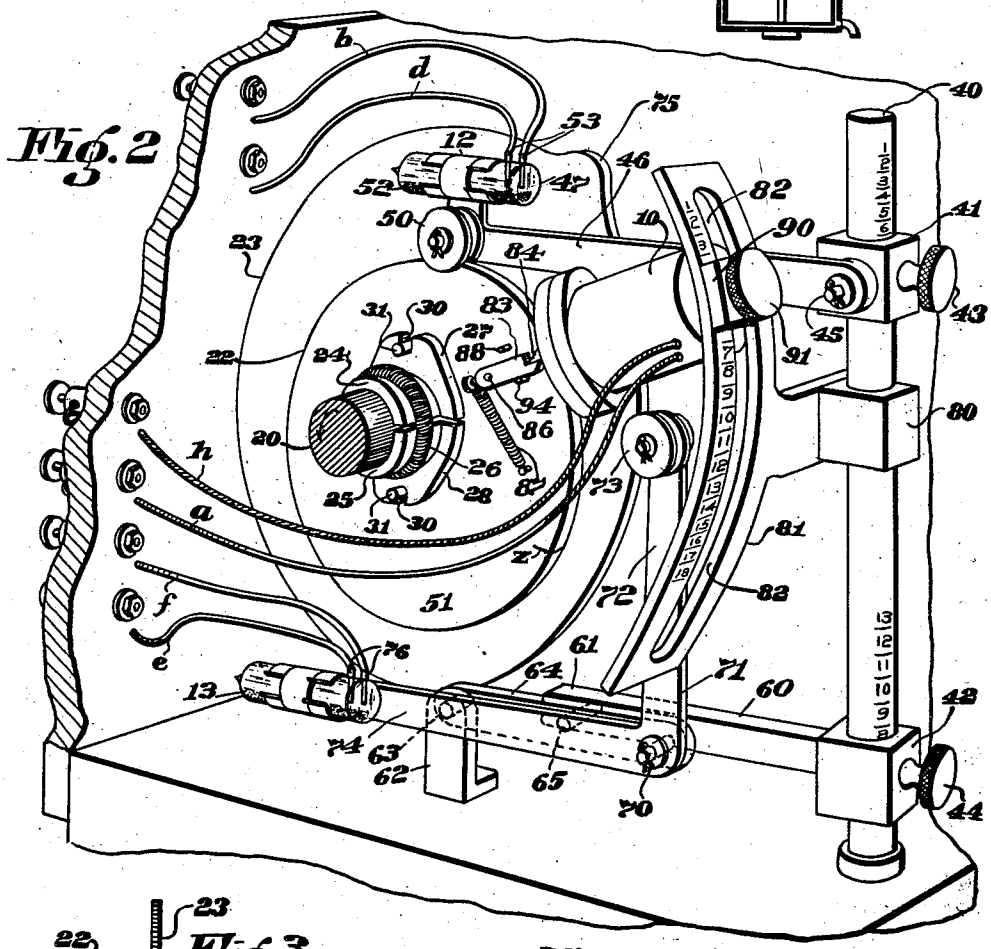


Fig. 2

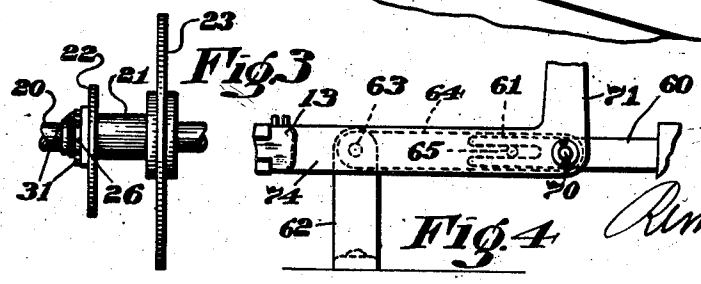


Fig. 3

Fig. 4

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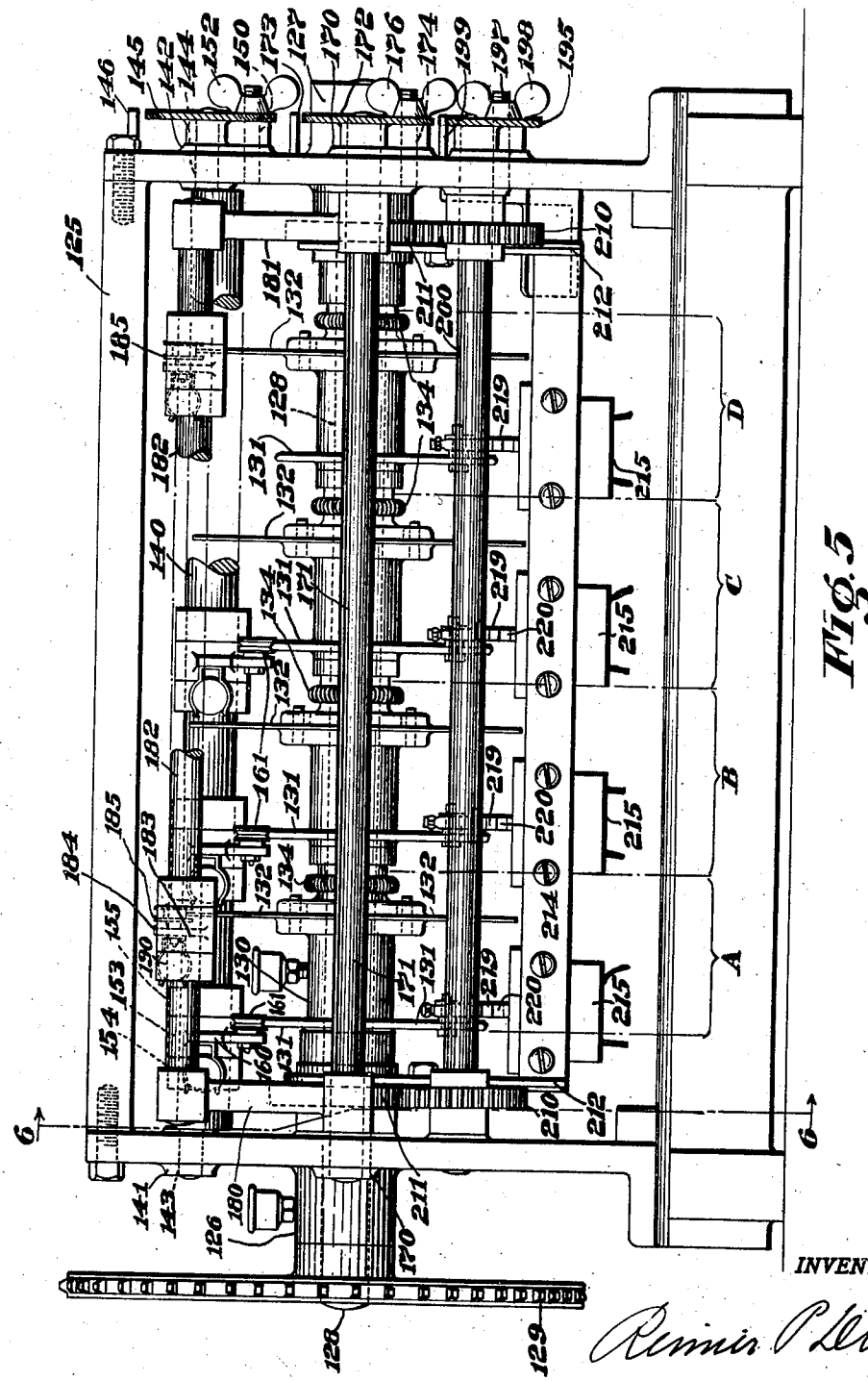


FIG. 5

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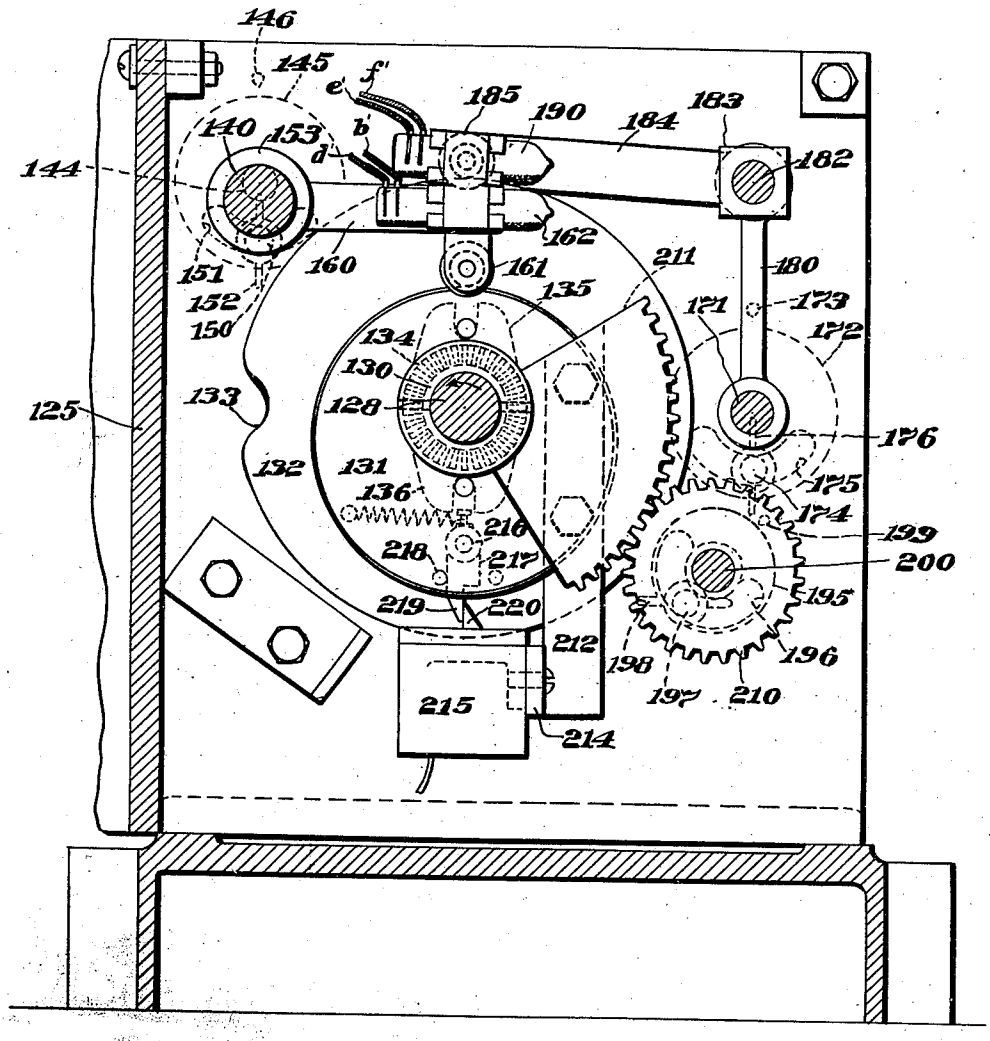


Fig. 6

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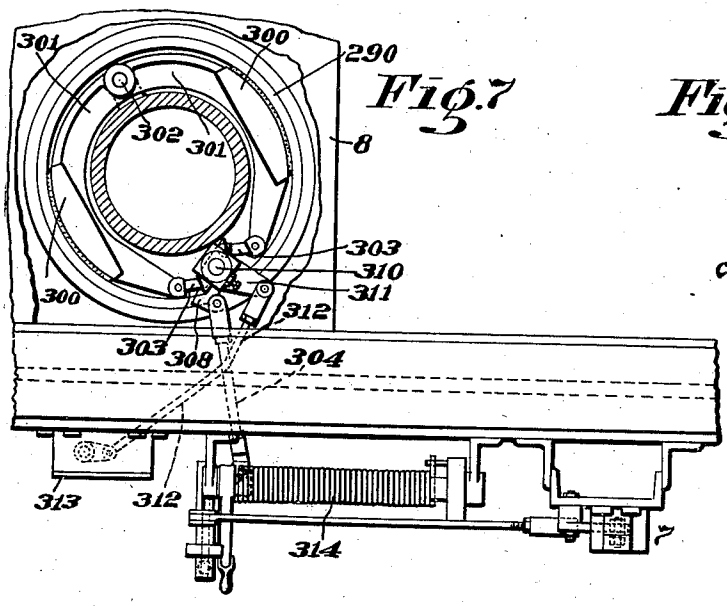


Fig. 7

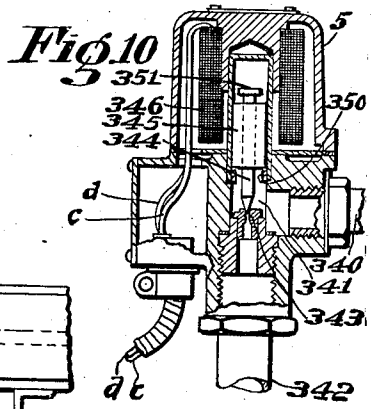


Fig. 10

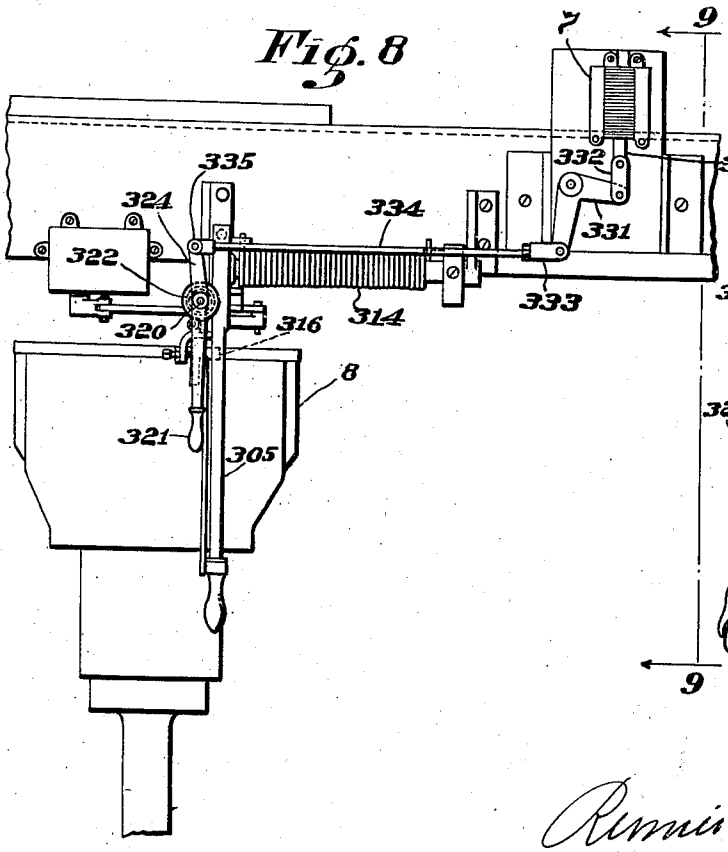


Fig. 8

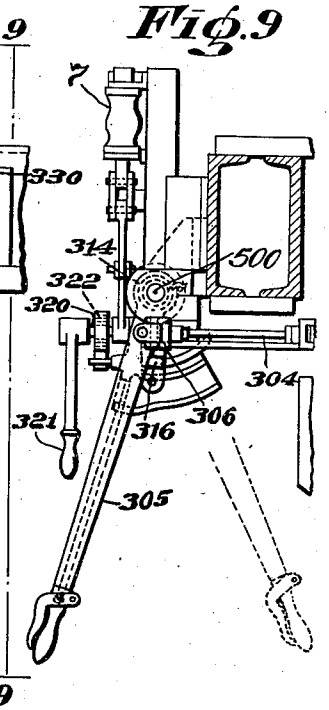


Fig. 9

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Patented Dec. 11, 1934 1,984,302

UNITED STATES PATENT OFFICE

1,984,302

TIME PERIOD CONTROL DEVICE

Reinier P. De Vries, Melrose, Mass., assignor to Revere Sugar Refinery, Boston, Mass., a corporation of Massachusetts

Application July 31, 1931, Serial No. 554,269

10 Claims. (Cl. 161—7)

This invention relates to means for controlling the time periods in a cycle of operation and particularly to a device adapted for use with sugar purifying centrifugals to control the duration of certain steps in the refining process.

Centrifugal machines are quite commonly employed in various stages of the sugar refining process. In the use of these machines the first operation consists in starting the porous basket rotating and introducing the proper amount of sugar magma. The basket continues to rotate during the first so-called purging period during which a large portion of the mother liquor is thrown out through the pores of the basket and is conducted away. This rapid rotation has the effect of walling up the sugar against the inner surface of the basket and when a large portion of the mother liquor has left the sugar, a spray of water is turned on against this inner walled surface to remove whatever liquor may still remain adhering to the crystals. At the completion of this spraying period the water is turned off and the basket continues to rotate during the drying period for the purpose of removing the excess water. At the proper time thereafter the power is shut off and brakes are applied to bring the basket to a stop after which the purified sugar is removed.

It is highly essential for efficiency of operation and uniformity of product that the various time intervals of this process be correct and unvarying for a given consistency of sugar magma. Thus if the purging period is too long the sugar will commence to harden against the walls of the basket with obvious harmful results, or, if too short, the liquor will not be sufficiently removed and an excess amount of spray water will be required for a pure product. An unduly long spraying time must always be avoided, to prevent dissolving of the sugar. For efficient centrifugal operation not only must the steps in the cycle be uniform but it is equally important that there be some way of changing these various time periods to correspond with the fluctuations in the consistency of the sugar magma as different batches are introduced.

It has been recognized in the prior art that the control of these time periods should not be left to the judgment of the operative and a number of devices have been constructed to provide automatic control for one or more of the time periods. These devices have not, however, solved the problem of automatic control as they have either been incapable of accurate adjustable control for each of the time periods in a complete cycle or they have been so complicated as to make their cost of installment and operation a serious disadvantage.

It is one of my objects to provide a control device of this nature which will be accurate in operation and capable of fine adjustment and yet which will comprise a relatively small number of working parts.

It is quite common practice to supply a battery of these centrifugal machines with sugar magma from one common supply tank which holds a large amount of material to be processed. In such case the consistency of the material will always be the same at any one time for each individual machine in the battery although it may vary with each new supply with which the supply tank is replenished. As the time periods in the cycle of operation are determined by the consistency of the magma those periods should always be the same for each machine in the battery and when a new supply of a different consistency is introduced to the main tank all of the machines will require an equal amount of adjustment. If the fluctuations in consistency are frequent and if there are quite a number of machines in the battery there will be a correspondingly large number of adjustments to be made at the same time and it is one of the objects of my invention to provide as a modification of my preferred means a master control device which will make the adjustments for each period in the cycle simultaneously for all centrifugals in the battery. One essential function of a control device of this character is that the mechanism for collective adjustment permits independence of centrifugal operation. Thus a device which required that all the centrifugals be started and stopped at the same time would be impractical as in operation it is essential that the operative be able to scrape out, start and load one centrifugal while the others are rotating and not tie up an entire battery of machines for the length of time required to scrape and load all of them.

The prior art includes certain pneumatic control devices which are intended to have a function similar to that of my individual and master control machines but these machines have not proven satisfactory due to the intricacy of the mechanism and the resultant expense of installment and operation.

These and further objects of my invention will appear from a more detailed description of the preferred embodiment of my invention taken in

connection with the accompanying drawings, in which,—

Fig. 1 is a diagram of a centrifugal machine electrically connected to my improved individual control device;

Fig. 2 is a perspective view of my individual control device;

Fig. 3 is a detail elevation view of certain parts shown in Fig. 2;

Fig. 4 is a detail elevation view of certain other parts shown in Fig. 2;

Fig. 5 is an elevation view of my master control device;

Fig. 6 is a vertical sectional view taken on the line 6—6 of Fig. 5 in which many of the parts have been omitted for clearness of illustration;

Fig. 7 is a detail plan view of the centrifugal machine brake operating mechanism;

Fig. 8 is a detail elevation view of the parts shown in Fig. 7 showing the centrifugal machine starting levers and their connections with the brake solenoid;

Fig. 9 is an end elevation, partly in section, taken on the line 9—9 of Fig. 8; and

Fig. 10 is a sectional elevation of my preferred type of electrically operated spray water valve.

In Fig. 1, I have shown diagrammatically at A a sugar purifying centrifugal machine of a common type, electrically connected to my improved control device indicated generally at B. The centrifugal machine A consists of the usual porous basket 1 suspended from vertical shaft 2 which is rotated by any suitable power operated means, such as the electric motor 3. Surrounding the basket 1 is the curbing 4 provided for the purpose of carrying away the liquors as they leave the crude sugar during rotation of the basket. I have indicated diagrammatically at 5 an electrically operated water valve adapted to introduce water to the sprayer 6, and at 7 a solenoid adapted to break the circuit (not shown) to the motor 3 and operate the brake 8 to stop rotation of the basket 1. Before describing in detail my improved control device, I will indicate the manner in which the water valve 5 is electrically operated, as well as the mechanism by which the solenoid 7 is connected to the brake 8 and to an electric switch in circuit with the motor 3 to stop the centrifugal machine.

Referring to Figs. 7, 8 and 9 wherein I have shown a type of starting and stopping mechanism well known to the art, 300, 300 (Fig. 7), indicate a pair of brake shoes fixed to the levers 301, which are pivoted on the common shaft 302 and adapted to be operated by the toggle joints 303, 303, which are linked together by a common pivot 310, rotation of which will either contract or expand the brakes against the centrifugal machine brake drum 290 in a well known manner. Fixed to the shaft 310 is a crank arm 308 which is rotated by the lever 304 to operate the brakes. Lever 304 (Fig. 9) is connected to the hand starting lever 305 by the swivel connection 306, the lever 305 being pivoted at 500. Also fixed to the pivot 310 of the toggles 303 is the crank 311 which is connected by means of the rod 312 to the electric starting switch 313 for the purpose of operating the same to introduce current to the centrifugal motor 3. By this well known mechanism, rotation of the lever 305 to its full line position, as shown in Fig. 9, breaks the toggles 303 to release the brakes 300 and close the switch 313. Reversal of this process by moving the lever 305 to its dotted line position will stop rotation of the centrifugal machine.

The starting lever 305 is usually provided with a torsional spring 314 (Figs. 8 and 9) adapted to urge the said lever and its connected mechanism into the position at which the centrifugal will be stopped. To hold the lever 305 in starting or "on" position, a spring pressed dog 316 is provided, the said dog being fixed to a shaft 320 which also carries the releasing lever 321. Surrounding the shaft 320 and having one end fixed thereto is the torsion spring 322 which urges the shaft 320, dog 316 and lever 321 in a counterclockwise direction as viewed in Fig. 8 to force the said dog 316 into its holding position in engagement with the lever 305 to retain the said lever in starting position. If the lever 321 be now manually rotated in a clockwise direction the dog 316 will slip out from behind lever 305 to permit its rotation by the spring 314 to "off" position. The dog 16 is suitably beveled whereby it will slip into locking position when lever 305 is rotated to its starting position shown in full lines. The above-described mechanism is well known to the art and therefore it is considered that this brief description will suffice.

The function of the solenoid 7 is to rotate the retaining dog 316 automatically rather than manually as has been common heretofore. For this purpose the movable core 330 of the solenoid 7 is connected to one arm of the bell-crank lever 331 by the connecting link 332. The other arm of bell-crank lever 331 is connected at 333 to a rod 334 which is connected at 335 with the upper portion of a crank 324 fixed to the shaft 320. It will thus be apparent that when current is introduced to the solenoid 7 to attract its core 330 and rotate the bell-crank lever 331 in a counterclockwise direction the shaft 320 will be rotated to move the dog 316 into releasing position to thereby stop rotation of the centrifugal machine.

In Fig. 10 I have shown my preferred type of electrically operated water valve mechanism. 340 indicates an inlet pipe through which water or any other suitable spraying liquid is conducted to the valve chamber 341 which communicates with the outlet pipe 342 leading to the sprayer 6 (Fig. 1). The valve mechanism consists of the valve seat 343 into which fits the lower tapered end of the valve stem 344 which slides loosely within the cylindrical member 345. The said member 345 comprises the movable core of a solenoid of the valve 5 and is adapted to be lifted vertically by the electric coil windings 346 through which current is introduced at certain times through the wires (*d*) and (*c*) whose exterior connections will be hereinafter more specifically described. When the valve is in closed position, as shown, with the stem 344 resting against the valve seat 343, the sliding core 345 rests against a fixed internal collar 350 and in this position it will be noticed that there is a slight clearance between the top of the cylindrical core 345 and a head 351 formed on the top end of the valve stem 344. When current is introduced to the windings 346 the core 345 immediately rises but does not lift the valve stem 344 from its seat until the top of the core 345 engages the said head 351. By this lost motion connection the core 345 is able to gain a certain amount of momentum before contacting the head 351 and thereby lifts the stem 344 more quickly and precisely than it would if the head 351 were in constant engagement with the core 345.

The control device B (Fig. 1) comprises, in general, certain mechanism which rotates slowly and at a constant rate of speed to measure the vari-

ous time intervals in the above described cycle of centrifugal operation. This mechanism includes two mercury switches indicated at 12 and 13 which at certain times are actuated to introduce current to the aforesaid solenoids 346 and 7, respectively. The said mercury switches and solenoids are connected in multiple series with electric current supply mains (*a*) and (*b*) in the following manner,—the wire (*c*) leads from the main (*a*) to one terminal of the spray solenoid 346 (Fig. 10) of the water valve 5 to the other terminal of which is connected the wire (*d*) which connects the solenoids 346 in series with the mercury switch 12 which is also connected to the main (*b*); the wire (*g*) leads from the main (*b*) to the brake solenoid 7 which is connected in series with the mercury switch 13 by the wire (*e*), said switch 13 being connected to the main (*a*) by the wire (*f*). For the purpose of starting certain parts in the control device B rotating to measure time, I have provided a solenoid 10 whose operation will be more fully described later but which is connected at one terminal to the main (*a*) and at the other terminal to the wire (*h*) leading to a control starting button or switch 11 which is connected to the main (*b*) by the wire (*i*). In operation the workman starts the basket 1 rotating by moving the starting lever 305 to its full line position, Figs. 1 and 10, and he then pours the proper amount of crude sugar magma into the basket. He then immediately pushes the button 11 to start the automatic measurement and control of the time periods. At a certain time thereafter the purging period will be complete and contact will be made in the switch 12 to actuate the water valve 5 to spray water against the sugar for a predetermined length of time, at the completion of which the connection at 12 will be broken and the water shut off. After another predetermined length of time the mercury switch 13 will be actuated to operate brake solenoid 7 to shut off current to motor 3 and apply brakes 8 to bring the basket 1 to a stop.

Referring now to Fig. 2 in which I have shown more in detail the device indicated at B in Fig. 1, 20 indicates a shaft which is constantly driven at a slow rate of speed from a source of power indicated at 29 in Fig. 1. Loosely mounted on the shaft 20, as shown in detail in Fig. 3, is the sleeve 21 which carries rigidly fixed to it the spray cam 22 and the brake cam 23. The spray cam 22 consists of a disc substantially circular in shape but eccentrically mounted to produce a gradual raising and lowering of its cam follower 50, the highest portion of the cam being designated at 51. The cam 23 consists of a circular disc mounted on center and having an abrupt raised portion 75.

Also loosely mounted on the shaft 20 are semi-circular collar segments 24 and 25 which are maintained in frictional engagement with the shaft 20 by the encircling spring 26. The lugs 27 and 28 are formed integral with and perpendicular to the collar segments 24 and 25, respectively, which lugs have slots 30 adapted to receive the pins 31 projecting from the spray cam 22. The embracing pressure of the spring 26 is of sufficient force to cause the collar segments 24 and 25, the spray cam 22 and its rigidly connected sleeve 21, and the brake cam 23 to rotate with the shaft 20. The shaft 20 rotates continuously and by this mechanism I have provided a novel frictional driving connection between the said shaft and the cams 22 and 23 so that the said cams will turn with the shaft 20 except when held stationary by certain mechanism hereinafter described.

Erected in proximity to the cams 22 and 23 is the calibrated post 40 which carries at its extremities the blocks 41 and 42 which may slide lengthwise of the post 40 and may be maintained at various elevations by means of the thumb screws 43 and 44 respectively. Pivoted at 45 to the upper sliding block 41 is the lever 46 which carries at one end the cam follower 50 adapted to ride on the top of the cam 22 and be raised and lowered thereby. Mounted on the lever 46 above the cam follower 50 is the aforesaid mercury switch 12. This switch consists of a glass vial 47 mounted parallel to the lever 46 and containing a quantity of mercury 52, as is well known in the art. Extending into the interior of the glass vial 47 are the electric terminals 53 of the spray solenoid circuit wires (*b*) and (*d*), the extremities of which terminals project in close proximity to, but at a slight distance from, the surface of the mercury when the glass vial is in a horizontal position as shown. From this arrangement of parts it will be seen that contact is made between the terminals 53 when the cam 22 raises its follower 50 to rotate the lever 46 about the pivot 45 in a clockwise direction by a sufficient amount to cause the mercury 52 to flow to the terminal end of the vial 47 and contact both points.

Extending from one side of the lower sliding block 42 is a horizontal member 60 which, as shown in Fig. 4, is bifurcated at 61. Pivoted at 63 to a supporting member 62 is the lever 64 which extends parallel to and adjacent the member 60 and carries at approximately its central portion the pin 65 received by the bifurcated end 61 of the rigid member 60. Pivoted at 70 to the lever 64 is the bell crank lever 71, the arm 72 of which carries the cam follower 73 which engages the brake cam 23. The other arm 74 of the bell crank lever 71 carries at its extremity the mercury switch 13 which is in all respects identical with the mercury switch 12 described above and which receives the terminals 76 of the brake solenoid circuit wires (*e*) and (*f*). The weight of the arm 74 and mercury switch 13 maintains the follower 73 in engagement with the brake cam 23, the raised portion 75 of which at times rotates the bell crank lever 71 in a clockwise direction about its pivot 70 to cause the mercury in the switch 13 to make contact across the terminals 76 to actuate the brake solenoid 7.

Rigidly mounted at a fixed elevation on the post 40 is the block 80 from one side of which projects the arcuate member 81 which is slotted at 82 to receive the block 90 which is constructed to slide up and down in the slot 82 and be maintained at any desired elevation by the thumb screw 91. Carried by the block 90 is the solenoid 10 which as stated above is connected in circuit with the push button switch 11 by the wires (*a*) and (*h*). Pivotally mounted at 86 on the cam 22 is a spring-pressed latch 83 adapted to engage a nose 84 on the movable core of the solenoid 10 and when in such engaging position to rest against the stop 94 projecting from the cam 22 to hold the said cam 22 and the brake cam 23 from rotating counter-clockwise with the shaft 20 as is permitted by their frictional driving connection. A spring 87 is connected at one end to the extremity of the latch 83 and at the other end to the cam 22 to quickly move the latch to a position against a second stop 88 upon retraction of the core 84.

Assuming that the parts are at rest in starting

position as shown in Fig. 2 and that the shaft 20 is rotating in a counterclockwise direction as indicated by the arrow, the cams 22 and 23 remain motionless, due to the fact that the projection 84 is in engagement with the latch 83. Current is now introduced to the solenoid 10 to withdraw the projection 84 from its engaging position with the latch 83 and the frictional drive above described rotates the cams 22 and 23 to measure the time periods in the centrifugal cycle. The cams rotate at an extremely low rate of speed but the movement of the latch 83 to its position against stop 88 prevents the core 84 from reengaging the latch if the core should quickly return to its extended position. The core 84 is urged outwardly by an interior coiled spring (not shown) and moves in that direction as soon as the current to solenoid 10 is interrupted. The mercury switch 12 will now gradually move upwardly and slant downwardly at the terminal end as the forward end of the lever 46 is raised by the gradual high portion 51 of the cam 22. This first portion of the rotation governs the length of the purging period and it continues until contact is made between the terminals 53 which contact causes a flow of current to the spray solenoid 5 to start the spray period, which contact will be maintained until the high portion 51 has passed and the mercury switch 12 again assumes the position where contact across its terminals is broken. At that instant the spray period terminates and the drying period commences. Shortly thereafter the projection 75 on the brake cam 23 will move the roller 73 to cause a tilting of the mercury switch 13 to make contact across the terminals 76, which contact is of sufficient duration to actuate the brake solenoid 7. This completes the full cycle of operation in the centrifugal machine but the cams 22 and 23 will continue to rotate until the latch 83, now resting against stop 88, again engages the nose 84 and is brought to rest against stop 94.

I have provided in my improved device a series of adjustments, one of which varies the purging time or the time interval from the moment the centrifugal is placed under the influence of my control device by actuation of the solenoid 10 to the moment when the mercury switch 12 is actuated to turn the wash water on, another adjustment which regulates the spraying time or the interval during which contact is made in the mercury switch 12 and still another adjustment for the drying period which changes the time interval from the moment when the contact in the spray mercury switch 12 is broken until contact in the brake mercury switch 13 is made.

To regulate the duration of electric contact in the spray mercury switch 12 the thumb screw 43 may be loosened and the block 41 and pivot 45 elevated or lowered to various positions. Assume, for example, that the glass vial 47 of the mercury switch 12 is in an exactly horizontal position when the follower 50 is resting on the lowest portion of the cam 22 as shown in Fig. 2. Assume also that the space between the surface of the mercury contained in the switch 12 and the extremities of the terminals 53 is of such an amount that just one quarter of a rotation of the cam 22 will cause contact to be made. The spray period commencing at that moment will occupy the next half rotation of the cam 22 and contact will be broken at the beginning of the last quarter rotation which brings the cam 22 back to its initial position. If the block 41 be now raised a few notches on the rod 40 the mercury switch 12 will be slightly rotated in a counterclockwise direction about the pivot of the cam follower 50 which will lower the end of the vial 47 opposite to that receiving the terminals 53 and cause the mercury to flow to the lower end and slightly recede from the said terminals. With the parts so adjusted, somewhat more than one quarter of a rotation of the cam 22 will be required to bring the glass vial 47 to the position in which contact is made across the terminals 53. This contact, which is maintained during the spray period, will be broken at a correspondingly earlier time and by this adjustment the spraying time has been decreased. It will be apparent that such a regulation in the spraying time also has the effect of increasing the purging period, that is, the time interval between the moment when the cam 22 commences to rotate to measure time and the moment when the spray is turned on. Adjustment of this purging period, however, can now be made in the following manner.

Again assume that the parts are in their initial position as shown in Fig. 2, except that the adjustment of the spraying time which has just been made causes actuation of the spray solenoid when the cam 22 has rotated from its position as shown to the position where the point marked Z on the edge of the cam is directly under the cam follower 50. As the length of the arc on the periphery of the cam 22 between the point Z counterclockwise to the point where the follower 50 rests on the cam in its initial position as shown determines the length of the purging period, this period can be varied by changing the length of that arc. If we now loosen the bolt 90 and move the solenoid 10 downwardly a few notches the engagement of the nose 84 with the latch 83 which in turn abuts the pin 94 will cause a corresponding clockwise rotation of the cam 22,—the frictional driving connection permitting the cam 22 to slip on the shaft 20. If we had desired to shorten the purging period by rotating the cam 22 slightly in a counterclockwise direction to elevate the starting position of the point Z, raising of the solenoid 10 slightly would have accomplished this purpose as the frictional driving mechanism would have caused the latch 83 to follow the nose 84 until it came to rest in contact therewith at its new adjusted position.

The last adjustment to be made is that of the drying period time, which, it will be remembered, is determined by the time at which the brake solenoid 7 is actuated by engagement of the raised portion 75 on the brake cam 23 with its follower 73. This adjustment should be made last due to the fact that in changing the initial position of the spray cam 22 the initial position of the raised portion 75 of the cam 23 relative to its follower 73 was also changed as the two cams rotate as a unit. The length of the arc on the periphery of the cam 23 from the raised portion 75 counterclockwise to the point of contact between the cam and the follower 73 at the initial position of the said cam measures the time period from the moment the cams start to rotate to the moment when the brakes are applied. The difference between that length of time and the sum of the lengths of time of the purging and spraying periods which we have already determined gives the drying time. If we wish to decrease this latter time period we shorten the above described arc which in this case is accomplished by altering the position of the cam follower 73. Lowering of the block 42 and the rigid arm 60 also lowers the pin 65 which

causes a slight clockwise rotation of the lever 64, which carries the said pin about its pivot 63. This in turn will lower the pivot 70 and the bell crank lever 71 and bring the cam follower 73 on the arm 72 thereof to the desired new position. It should be noted that this adjustment lowers the arm 74 without affecting the angle of inclination of the mercury switch 13. It should also be noted that by providing the lever 64 and pivoting the bell crank lever 71 to it rather than to the arm 60 directly the range of movement of the follower 73 in proportion to the corresponding movement of block 42 is greatly increased to thereby provide an increased range of braking time adjustment.

By the mechanism above described the various time periods in the cycle of operation of a single centrifugal machine can be controlled automatically and adjusted as desired. In practice the post 40 and arcuate member 81 are calibrated as shown and a number of charts are prepared giving corresponding values in units of time for the calibrated settings computed on the basis of the speed of rotation of shaft 20. In using these charts the calibrated number corresponding to the desired time in seconds for the spraying period is first determined and the spray block 41 adjusted to that number. As the position of the block 90 which determines the purging time is dependent not only on the number of seconds desired for purging but also on the point on the cam 22 at which contact will be made in the spray mercury switch 12 which point is already fixed by the spray adjustment just made, a second chart is provided which gives settings for the purging block 90 corresponding to various spray block settings and various intervals of purging time.

The last setting to be made is that of the brake block 42 which fixes the drying period. For convenience of operation it is desirable to determine brake settings which will correspond to various time intervals from the moment the spray is turned on until the moment the brakes are applied. It should be observed that as soon as the spray block 41 has been set, the relative position of the point Z on cam 22 determined by that setting and the raised portion 75 are definitely fixed due to the integral construction of the cams 22 and 23 and that therefore a chart can be prepared which gives settings for the brake block 42 to correspond with various spray block 41 settings and periods of time from spray on to brake on.

As stated above it is one of the objects of my invention to provide as a modification of the preferred embodiment of my invention an apparatus adapted to control the various time intervals in the cycle of operation simultaneously for a battery of centrifugals. The principle of operation of my master control permits the essential independence of centrifugal operation.

Referring now to Figs. 5 and 6 I will describe a device adapted to control a battery which for purposes of illustration I have assumed to consist of four centrifugal machines. Correspondingly my control mechanism comprises four separate and distinct controlling units in all respects identical, which are mounted on a common shaft and linked together by a common adjusting mechanism. As the description proceeds it will become apparent that I can provide a controlling mechanism for any number of centrifugal machines by the simple expedient of adding a corresponding number of control units.

For clearness of illustration I have divided Fig. 5 into four vertical sections designated A, B, C and D. Each one of these sections contains a control unit which is electrically connected to the spray solenoid, brake solenoid and starting switch on one centrifugal machine in the battery. The A unit is shown in vertical section in Fig. 6 and my description of the parts which are duplicated in each unit will be confined to those shown in the A section although in Fig. 5 I have numbered some of the like parts of the other units to correspond with the numberings in the A section.

I have indicated at 125 an enclosed box-like structure adapted to house my improved master control device. Journaled in suitable bearings 126 and 127 in the end walls of the casing 125 is the main shaft 128 which is continuously driven at a constant rate of speed by any suitable power operated means indicated by the sprocket wheel 129. In a manner similar to that described above for my individual control device this constantly driven shaft carries a spray cam and a brake cam for each centrifugal, each pair of which cams is mounted on a common sleeve and at times rotated by the said shaft 128 by means of a suitable frictional driving connection. 130 indicates one of the sleeves rotatably mounted on the shaft 128 and carrying rigidly fixed to it the spray cam 131 and the brake cam 132. As in my individual control device the spray cam 131 consists of a disc which is substantially circular in shape but eccentrically mounted to impart a gradual rising and falling motion to its cam follower 161. The brake cam 132 in my modified form consists preferably of a circular disc, mounted on center, which in this case is provided with a depression or recess 133 which at certain times receives its cam follower 185. The spring 134 embraces frictional driving collar segments attached to the lugs 135 and 136 which lugs in my master control device engage the brake cam 132 to drive that cam, the collar 130 and the spray cam 131 being constructed to rotate as a unit in a manner similar to that described for my individual control driving means.

Extending lengthwise of the machine and parallel to the main driving shaft 128 is the shaft 140 which is eccentrically mounted in the bearings 141 and 142 by means of the reduced, off-center, end portions 143, 144. Rigidly fixed to the reduced end 144 of the shaft 140 is the spray dial 145 having suitable calibrations which coordinate with the index 146. Rotation of this dial turns the shaft 140 eccentrically for purposes which will be hereinafter described, and it may be maintained in proper position, as indicated by the dial markings, by means of the bolt 150 extending from the end wall of the box 125 through an arcuate slot 151 (Fig. 6) in the dial 145 and receiving the thumb nut 152.

Loosely mounted on the shaft 140 is the collar 153 which is maintained in suitable position lengthwise of the shaft 140 by the retaining collars 154 and 155 rigidly fixed to the shaft and abutting the collar. Extending from the collar 153 is the lever 160 which carries at its extremity the cam follower 161 resting on the top of spray cam 131 and also carrying the mercury switch 162 adapted to receive the terminals of wires *b'* and *d'* leading to the spray solenoid of the first centrifugal, to conduct current thereto in a manner similar to that of the spray solenoid circuit described in my individual control device. By this arrangement of parts the mercury switch

162 is gradually raised to make a mercury contact across the wires *d'* and *b'* to actuate the spray solenoid, which contact is maintained for a definite period of time, at the completion of which the eccentrically mounted cam 131 will have lowered the mercury switch 162 to break contact across the wires *d'* and *b'* to shut off the spray water.

Mounted in suitable bearings 170 in the end walls of the casing 125 is the shaft 171, one end of which has fixed to it the calibrated dial 172 coordinating with the index 173 and by which dial the shaft 171 may be turned and then held in any desired position by means of the bolt 174 extending through the arcuate slot 175 of the dial 172 (Fig. 6) and receiving the thumb nut 176. Rigidly mounted on both ends of the shaft 171 are the parallel upwardly extending levers 180 and 181, the upper extremities of which form bearings for the shaft 182. Loosely mounted on the shaft 182 is the block 183, maintained in fixed position longitudinally of the shaft 182 by suitable retaining collars, from one side of which block extends the lever 184 carrying at its extremity the cam follower 185 resting on the brake cam 132 and also carrying the mercury switch 190 which receives the terminals of the brake solenoid wires *e'* and *f'*. In operation the cam 132 which is circular in shape maintains the brake mercury switch 190 in slightly elevated inoperative position until the recess 133 arrives in position beneath the roller 185, at which time the lever 184 will drop and mercury switch 190 will be tilted to close the circuit to the brake solenoid on the first centrifugal machine to stop rotation of its basket.

I will now describe means for starting the spray and brake cams rotating to measure the time of their respectively controlled intervals, which means is the same in principle of operation as that of the corresponding means in my individual control device, but which differs somewhat therefrom in its method of adjustment.

Rotatably mounted in suitable bearings in the end walls of the casing 125 is the shaft 200 which is adapted to be adjusted to various angular positions by means of the calibrated dial 195 having the arcuate slot 196 adapted to receive the bolt 197 with its thumb nut 198. Rigidly mounted at both ends of the shaft 200 are the gears 210 which are identical in pitch diameter and number of teeth and each one of which meshes with one of the gear segments 211 rotatably mounted on the shaft 128. Fixed to each of these gear segments 211 is a member 212, the lower extremities of which members are connected by the flat bar 214, which bar has fixed to it by suitable bolts the solenoid 215. These connected parts are so designed and assembled that rotation of the shaft 200 in a clockwise direction as viewed in Fig. 6 will rotate the gear segments 211, cross member 214 and solenoid 215 in a counterclockwise direction in the arcs of concentric circles whose common center is the axis of the shaft 128.

Pivotally mounted at 216 on the spray cam 131 is the spring pressed latch 217 adapted at times to abut against stop 218 and having an end portion 219 in the path of travel of which during rotation of the spray cam 131 projects the nose 220 of the movable core of the solenoid 215. In a manner similar to that described for my individual control device the members 219 and 220 are in engagement to hold the latch 217 against the stop 218 to hold the spray cam 131 and brake cam 133 stationary until the control device is to be operated. When current is introduced to the solenoid 215, the projecting end of the core is retracted to permit the end 219 of the latch 217 to pass by and the spray and brake cams to rotate.

So far in my illustration of the master control device I have described in detail the operation of the spray cam, brake cam and actuating solenoid of the A unit which controls the time periods in the operation of the first centrifugal in the battery. It will be understood that this mechanism is duplicated in the B, C and D units to provide similar mechanism for each centrifugal in the battery. Thus the main shaft 128 carries four sleeves 130 each one of which carries a spray and a brake cam and is adapted to be rotated by a frictional driving mechanism. The shaft 140 carries four cam operated levers 160, each one of which carries a mercury switch adapted to operate a spray solenoid. The shaft 182 carries four levers 184 each one of which carries a mercury switch 190 adapted to operate its brake solenoid. Fixed to the movable bar 214 are four solenoids 215, each one of which is adapted to hold its respective cams stationary until its core is withdrawn. It will thus be apparent that my mechanism provides for independence of operation of each control unit and that any one of them may be set in operation by actuating its solenoid 215 irrespective of whether any of the other control units are operating. All of the members of each control unit are assembled in the same relative position. Thus the brake cams 132 (Fig. 6) are mounted so that when the latch 217 is in the position shown against the projection 220 of the core of the solenoid the recessed portion 133 in each disc will be in the position shown in that figure. As the length of the time periods in the various steps in the cycle of operation depends solely on the relative positions of the parts, these time periods will be the same for each centrifugal unit irrespective of when that control unit is set in operation.

It is the chief object of my master control to provide mechanism adapted to regulate the purging, spraying and drying intervals collectively for all centrifugals in the battery by one adjusting mechanism for each of those intervals.

On the same theory explained in the description of my individual control mechanism the duration of the spraying period, which is the first adjustment to be made, depends upon the angle of inclination of the spray mercury switch 162. If the thumb nut 152 be loosened and the dial 145 turned, the shaft 140 will be eccentrically rotated about the axis of its reduced portions 143 and 144 to tilt each one of the mercury switches 162 the same degree and thus change the four spraying periods the same amount. The next adjustment is that of the purging time which can be varied by turning the dial 195 and its connected shaft 200 thereby rotating the gears 210, gear segments 211 and bar 214 with its four solenoids 215 and thus setting the four spray and brake cams at a new initial position. The final brake adjustment is obtained by turning the dial 172 and shaft 171 to swing the shaft 182 toward or away from the cams and thus increase or decrease the arc on the four brake cams 132 measured in a counterclockwise direction from their recessed portions 133 to their respective cam followers 185. It will be noted that this adjustment will not materially alter the angle of inclination of the mercury switch 190.

From the above description it will be appar-

ent that I have provided novel individual and master centrifugal control mechanisms which fulfill the objects hereinabove set forth. It will also be apparent that the preferred embodiments of my invention which are herein described are susceptible of various changes to suit the needs of the individual user without departing from the spirit of my invention which I do not wish to limit except as indicated in the appended claims.

As one example of a modification which has found considerable favor among the users of these machines I have frequently provided means for separating the various grades of liquor as they leave the curbing 4 (Fig. 1). Thus in operation the liquor which drains from the sugar during the purging period consists chiefly of impurities which have left the crude sugar and is not of any particular value. At the completion of the purging period when the spray water is introduced the draining liquor may contain a fairly large amount of dissolved sugar and a lesser amount of impurities and it is desirable to keep this grade of liquor separate from that derived from the purging operation. For this purpose a gate is provided beneath the spout through which the liquor leaves the curbing 4, which gate can be moved to direct the liquor into either one of two drain receptacles. As this gate shifting operation is performed first at the time the spray is turned on, and in preparation for the next cycle of operation again when the spray water is turned off, I may provide a useful automatic gate shifting mechanism comprising a gate shifting solenoid similar to the solenoids 5 and 7, which solenoid is electrically connected in the circuit leading from the spray mercury switch 12 to the spray solenoid 5 to operate simultaneously therewith.

From the above description it will also be apparent that I have provided a device of this nature which strikingly contrasts with the prior art in its extreme simplicity and low cost of installment and operation. Some of the prior art machines are so designed that their time measuring elements cannot continue to travel in the time measuring direction to return the parts to initial position but require additional mechanism adapted to reverse the direction of motion of these parts and retrieve them at the completion of their functions. It is considered that this is not a workmanlike expedient, particularly insofar as these machines require an additional manual operation immediately after the completion of the functions of the time measuring elements, and that my device is superior insofar as it permits the time measuring cams to continue in their time measuring direction of rotation after their functions have been performed and finally come to rest without shock or undue force being exerted on the adjustable parts.

There are some prior art devices particularly those of the pneumatic type which have a function similar to that of my master control device but which are subject to criticism due to the fact that their calibrated adjustments are not centralized on one dial which may be isolated from the centrifugal machine itself and kept in a clean and well lighted part of the workroom, easily accessible to the foreman. On the contrary they provide mechanical spray controlling means mounted on the framework of each centrifugal machine, each one of which spray control means requires individual adjustment and hence deprives such prior art control devices of their function of master adjustment.

Throughout the description of my individual and master control devices I have described the brakes as being applied at a definite time interval after the spray water has been shut off to thereby provide a period of rotation wherein the sugar may be dried. In practice it is frequently advisable to shut off the power to the centrifugal machine driving motor and apply the brakes at a short time before the spray water is shut off. The common type of centrifugal machine carrying a capacity load of crude sugar and rotating at a speed of approximately 1200 R. P. M. can be brought to a stop in approximately 25 seconds by a full application of the brakes. It has been found, however, that the inertia of the rotating parts is so high in machines of this type that such a full application of the brakes will require their frequent relining and to overcome this difficulty it has been found that a lighter brake application resulting in approximately 45 seconds braking time is more practical. During the time when the speed of the centrifugal machine is gradually reducing from 1200 R. P. M. to 1000 R. P. M. or slightly below, the centrifugal force exerted by the rotation of the basket is still sufficient to eliminate a large amount of liquor. This period of rotation which has been increased in time by the lighter brake application must therefore be computed as constituting part of the drying time and for that reason the adjustments provided in an individual or master centrifugal control must be of such a nature that they permit application of brakes before the completion of the spraying period particularly if a brief drying period is desired. Some of the prior art devices, particularly of the pneumatic type, do not provide for such an adjustment which is, however, a distinct feature of my invention.

Having described my invention what I wish to claim and secure by Letters Patent is:

1. In a device for automatically controlling the timing of the cycle of operation of a centrifugal machine having a wash fluid valve, the combination of cam mechanism having dwell portions and actuating portions, shaft means for rotating said cam mechanism during the cycle of operation to measure the timing of the steps constituting the said cycle, frictional drive means connecting the shaft means and the cam mechanism, cam following means adapted to respond to the configuration of said cam mechanism, means actuated by said cam following means to open the wash fluid valve at a predetermined time after the beginning of the time measuring rotation of the cam mechanism and to close the said valve at a second predetermined time after the beginning of said rotation, means to vary the initial relative positions of the actuating portions of the cam mechanism and the cam following means to alter the first of said predetermined time periods and means to vary the extent of said actuating portions to alter the second of said predetermined time periods.

2. In a device for automatically controlling the timing of the cycle of operation of a centrifugal machine having an electrically operated wash fluid valve, the combination of an electric circuit for operating said valve, cam mechanism comprising a substantially circular disc eccentrically mounted to provide dwell portions and actuating portions, means for rotating said cam mechanism during the cycle of operation to measure the timing of the steps constituting the said cycle,

cam following means adapted to respond to the configuration of said cam mechanism, electric switch means in said circuit and actuated by the cam following means to open the wash fluid valve at a predetermined time after the beginning of the time measuring rotation of the cam mechanism and to close the said valve at a second predetermined time after the beginning of said rotation, means to vary the initial relative positions of the cam mechanism and the cam following means to alter the first of said predetermined time periods and means to vary the initial position of the electric switch means relative to the cam mechanism to alter the second of said predetermined time periods.

3. In a device for automatically controlling the timing of the cycle of operation of a centrifugal machine having an electrically operated wash fluid valve, the combination of an electric circuit for operating said valve, cam mechanism having dwell portions and actuating portions, means for rotating said cam mechanism during the cycle of operation to measure the timing of the steps constituting the said cycle, cam following means adapted to respond to the configuration of said cam mechanism, an electric switch having terminals and a contact in said circuit adapted to be opened and closed by the cam following means to open the wash fluid valve at a predetermined time after the beginning of the time measuring rotation of the cam mechanism and to close the said valve at a second predetermined time after the beginning of said rotation, means to vary the initial relative positions of the cam mechanism and the cam following means to alter the first of said predetermined time periods and means to vary the initial relative positions of the contact and terminals of the switch to alter the second of said predetermined periods.

4. In a device for automatically controlling the timing of the cycle of operation of a centrifugal machine having an electrically operated wash fluid valve, the combination of an electric circuit for operating said valve, cam mechanism comprising a plurality of cams adapted to rotate as a unit, shaft means for rotating said cam mechanism during the cycle of operation to measure the timing of the steps constituting the said cycle, means to arrest rotation of the cam mechanism after a complete revolution in the time measuring direction, means for retracting said arresting means to release the cam mechanism from its arrested position for rotation in the next succeeding cycle, cam following means adapted to respond to the configuration of said cam mechanism, an electric switch having terminals and a contact in said circuit adapted to be actuated by said cam following means to open the wash fluid valve at a predetermined time after the beginning of the time measuring rotation of the cam mechanism and to close the said valve at a second predetermined time after the beginning of said rotation, means actuated by said cam mechanism for stopping rotation of the centrifugal at a third predetermined time after the beginning of said rotation, means to vary the position of the arresting means whereby to change the initial position of the cam mechanism to alter the first of said predetermined time periods, means to vary the initial relative positions of the contact and terminals of the switch to alter the second of said predetermined periods and means to vary the third predetermined period.

5. In a device for automatically controlling the timing of the cycles of operation of a battery of centrifugal machines having a wash fluid valve for each centrifugal, the combination of a time control unit for each centrifugal including time measuring means adapted to rotate to measure the timing in the cycle of its centrifugal, means for rotating the time measuring means of each of the units independently of those of the other units, means for arresting the rotation of the time measuring means of each unit when the rotation thereof in the time measuring direction after the completion of one cycle has returned it to starting position for the next succeeding cycle, means actuated by each unit for opening the wash fluid valve of its centrifugal at a predetermined time after the beginning of rotation of its time measuring means and for closing the valve at a second predetermined time after the beginning of said rotation, means actuated by each unit to stop rotation of its centrifugal at a third predetermined time after the beginning of rotation of its time measuring means, means for varying the first of said predetermined time periods simultaneously for all the centrifugals, means for varying the second of said predetermined time periods simultaneously for all the centrifugals and means for varying the third of said predetermined time periods simultaneously for all the centrifugals whereby the time periods in the cycles of all the centrifugals are independently controlled and collectively variable.

6. In a device for automatically controlling the timing of the cycles of operation of a battery of centrifugal machines having a wash fluid valve for each centrifugal, the combination of a time control unit for each centrifugal including time measuring means adapted to rotate to measure the timing in the cycle of its centrifugal, means for rotating the time measuring means of each of the units independently of those of the other units, means for arresting the rotation of the time measuring means of each unit when the rotation thereof in the time measuring direction after the completion of one cycle has returned it to starting position for the next succeeding cycle, means actuated by each unit for opening the wash fluid valve of its centrifugal at a predetermined time after the beginning of rotation of its time measuring means and for closing the valve at a second predetermined time after the beginning of said rotation, means for varying the first of said predetermined time periods simultaneously for all the centrifugals, and means for varying the second of said predetermined time periods simultaneously for all the centrifugals whereby the time periods in the cycles of all the centrifugals are independently controlled and collectively variable.

7. In a device for automatically controlling the timing of the cycles of operation of a battery of centrifugal machines having a wash fluid valve for each centrifugal, the combination of a time control unit for each centrifugal including time measuring means adapted to rotate to measure the timing in the cycle of its centrifugal, means for rotating the time measuring means of each of the units independently of those of the other units, means for arresting the rotation of the time measuring means of each unit when the rotation thereof in the time measuring direction after the completion of one cycle has returned it to starting position for the next succeeding cycle, means actuated by each unit for opening the wash fluid valve of its centrifugal at a predetermined time after the beginning of rotation of its time measuring means and for closing the

valve at a second predetermined time after the beginning of said rotation, and means for varying the position of said arresting means simultaneously for all the control units whereby to vary the initial position of the time measuring means and to change the first of said predetermined time periods in the cycles of all the centrifugals.

8. In a device for automatically controlling the timing of the cycles of operation of a battery of centrifugal machines having a wash fluid valve for each centrifugal, the combination of a time control unit for each centrifugal including cam mechanism adapted to rotate to measure the timing in the cycle of its centrifugal, means for rotating the cam mechanism of each of the units independently of those of the other units, cam following means for each of the units adapted to respond to the configuration of its cam mechanism, means actuated by the cam following means of each unit to open its wash fluid valve at a predetermined time after the beginning of the time measuring rotation of its cam mechanism and to close the said valve at a second predetermined time after the beginning of said rotation, means actuated by the cam following means of each unit for stopping rotation of its centrifugal at a third predetermined time after the beginning of said rotation, means for varying the first of said predetermined time periods simultaneously for all the centrifugals, means for varying the second of said predetermined time periods simultaneously for all the centrifugals and means for varying the third of said predetermined time periods simultaneously for all centrifugals whereby the time periods in the cycles of all the centrifugals are independently controlled and collectively variable.

9. In a time period control device the combination of a cam having dwell portions and actuating portions, cam following means comprising a lever having one end in engagement with the cam and its other end pivoted to a support in proximity to the cam, an electric circuit including a fluid switch mounted on the lever and having contact means for closing the circuit with the fluid upon actuation of the cam following means by the cam and means for varying the position of the pivoted end of the lever whereby to change the duration of contact between the fluid and said contact means during each revolution of the cam.

10. In a device for automatically controlling the time periods in a cycle of operation comprising a plurality of steps, the combination of a plurality of cams each having dwell and actuating portions, means for rotating said cams to measure time, cam following means adapted to respond to the configuration of one of said cams, means actuated by said cam following means to perform two consecutive steps in said cycle, means to vary the extent of the actuating portion of the cam to alter the time period of the second of said steps, means to vary the initial position of the cam following means relative to the actuating portion of the said cam as thus varied to alter the time period of the first of said steps, a second cam following means adapted to respond to the configuration of a second of said cams, means actuated by said second cam following means to perform a third step in said cycle and means to vary the initial relative positions of the actuating portion of the said second cam and its said cam following means to alter the time period of the third of said steps.

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