The 48 Inch x 30 inch Continuous Automatic Recycling Centrifugal

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Since the advent of high speed centrifugals in the sugar industry some twenty years ago, there have been constant improvements *in* construction details by centrifugal manufacturers but little in the way of basic general new developments.

Now a basically different machine is available; a larger basket than is at present in general use and a degree of automatic operation ordinarily not attained.

All users and makers of centrifugals are aware of the desire for a continuous machine. In its ultimate form we conceive a centrifugal which would be started at the beginning of the campaign and would run continuously as long as massecuite is available to be purged, without an operator and with a continuous output of a constant quality sugar.

We all know that continuous machines approaching this end are in service in several industries; notably on salt, ammonium sulphate crystals, etc. Attempts have been and are being made to fit these machines into the sugar process but to date the success has been limited. In sugar, the viscosity of the mother liquor, the variations in crystal size and the large volumes which must be handled have created the difficulties which the continuous machine has not yet overcome. The attrition of the grain and the quality of the product established by the conventional batch centrifugal also are "stumbling blocks." We hope and expect that some day the ultimate in a continuous machine will be reached.

Progress cannot halt to await this ultimate goal. Concurrently with the search for a continuous centrifugal has come the actual development and utilization of the continuous batch machine.

The continuous batch machine is the conventional machine with which you are acquainted plus automatic loading, automatic plowing and automatic restarting of the next cycle.

The development of the machine evolved by stages so we will discuss the distinctive features in the order in which they were conceived.

The Automatic Plow

With conventional machines, the required low speed for plowing has been accomplished by several means; jogging the main drive clutch or motor, energizing the main drive motor with low frequency alternating current or by means of a small motor-driven worm gear reducer connectible to the main drive motor by means of a free-wheeling clutch. This last method of driving from a separate power source resulting in a fixed plowing speed was the only one which could be considered in connection with an automatic plow.

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In the interest of safety we required that the plow be removed from the basket during high speed spinning. This complicated the necessary movements to be automatically accomplished and in looking for a solution we fortunately hit upon the idea of driving the basket in reverse for plowing. Thus it was no longer necessary to remove the plow from the basket during spinning. The plow shoe now trails the direction of spinning rotation and it is impossible for it to dig into the sugar wall. A greater safety margin is obtained than if the shoe rested on the curb top.

The slow speed drive for plowing called "Turntork" is a simple device. (Figure 1) .

A worm gear reducer is mounted on top of the main drive motor with its output shaft vertical and concentric with the main motor shaft. The power is supplied by a 3 hp, 1800 rpm standard squirrel cage motor V-belt driven to the input shaft of the reducer. The combination of the V-belt reduction and the worm gear reduction give a final speed of 35 rpm for plowing.

The problem of connecting and disconnecting the gear shaft and the motor shaft has been most satisfactorily solved by the use of a Fawick air clutch (Figure 2) . This device is composed of an infiatable rubber ring with friction segments on the outside. The ring is mounted on the gear output shaft. The friction drum on which the segments act is mounted on the upper shaft extension of the main drive motor. When the ring is inflated it expands and the friction segments contact the drum. When the air is released the ring contracts and the segments move away from the drum. Air is admitted to the ring through the shaft of the worm reducer. The torque output of the clutch coupling is readily adjusted by varying the air pressure. For our service we use from 30 to 40 p.s.i.g. The 3 hp driving motor is energized at the same time that air is admitted to the clutch. Interlocks are provided which insure against simultaneous operation of the "Turntork" and the main drive.

Fhe "Turntork" drive was tried and proved with forward direction operation on many installations before it was adapted to reverse operation for automatic plowing.

With the plow remaining in the basket, the movements required for automatic operation were confined to an "In" and "Out" horizontal and "Up" and "Down" vertical motions (Figure 3) .

The plow is of the square plunger type. The square plunger is used because it permits the use of flat bearing surfaces which are readily shimmed to maintain or restore the plunger rigidity so necessary for long screen life.

The plow shoe is rigidly bolted to the bottom of the square plunger and the plow tip is flexible because of its spring mounting.

For vertical movement a double-acting air cylinder is mounted parallel to the plunger, on the swinging housing of the discharger. The lower ex-tension of the piston rod is fitted to the plow shoe just next to where it bolts to the plunger.

For horizontal movement a single acting air cylinder is built into the discharger housing. Compressed air causes the "In" movement while the "'Out" movement is by spring return. An oil dash-pot retards the "In" movement so that the pressure exerted on the plow tip when entering the sugar wall will not cause the tip to gouge deeply but the pressure will be counteracted by the dash-pot and the tip will move slowly through the sugar wall to the screen.

The plowing function is controlled by the admission of compressed air through solenoid valves. These air valves are actuated either by timers or by the completion of a particular operation, which completion causes the next operation in the sequence to start.

Basket Bottom Closure

With automatic plowing came the need for a basket bottom valve mechanically operaated. For affination and raw sugar purging, some users have been content to use a loading cone on the spindle, which requires no movement. For the most part, however, and on white sugar in particular, it is essential that the basket bottom be closed during loading to prevent any spillage of massecuite into the sugar conveyor. For this requirement we have the air-operated conical basket valve (Figure 4) .

The conical valve has a circular lip at the top into which the lifting hook engages. The hook moves from a vertical position with the valve seated through something more than 90° to reach the raised valve position. After engaging the valve lip the hook continues to move upward, raising the valve and cocking it with respect to the basket spindle. This cocked position provides room for the discharger to move down into the basket without interference and also leaves ample space to permit discharging of sugar.

The movement of the valve hook is accomplished by a double-acting air cylinder mounted vertically on the curb top. By a simple linkage system the valve hook raises as the air cylinder position moves down and lowers as the piston moves up. Air solenoid valves actuated from the automatic control cause the valve-lifting mechanism to function at the proper times in the centrifugal cycle.

The Automatic Loader

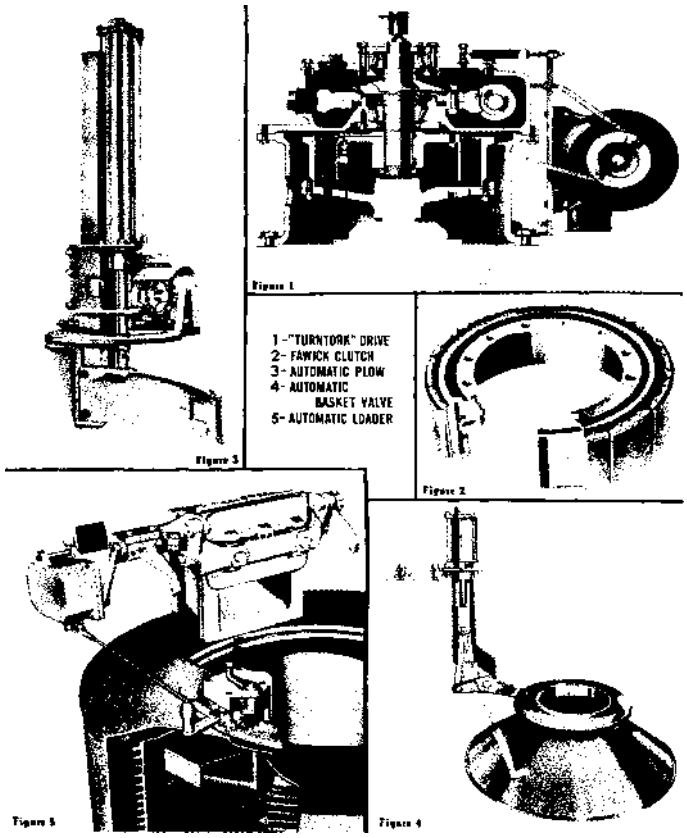
Experience in building and operating more than a hundred manual loading, automatic plowing centrifugals was attained before the first automatic loading centrifugal was built.

Several approaches to the loading problem were considered. Serious thought was given to measuring a fixed volume of massecuite in advance and loading just this amount into the basket. This was abandoned because of the complicated gear required in the mixer tank and because of cost. Timed opening was quickly cast off because the rate of flow through the charging gate varies with the head in the mixer and the fluidity of the massecuite.

Good practice requires a device which measures the charge in the basket and closes the gate in such a fashion as to reproduce in each succes-

sive charge the same volume of massecuite. This we have in the servomotor basket loader (Figure 5) .

A pneumatic operated gate is used. The load in the basket is measured by a feeler which contacts the sugar wall and moves out as the sugar builds up in the basket. A servomotor mechanism translates the movement of the feeler to a corresponding closing movement of the gate.



The feeler mechanism is mounted on the curb top. The servo-motor is mounted adjacent to the gate linkage. The movement of the feeler shoe is transmitted to the servo-motor by a lever. This movement causes an air valve in the servo-motor to control the air flow to the gate air cylinder.

When the gate opens the feeler shoe moves toward the basket wall to a position approximately halfway between the basket screen and the full load position. The loading gate at its open position now permits the loading of the basket to half load without any influence from the feeler shoe. When the basket is half charged, the sugar wall touches the feeler shoe and, as the wall thickness increases, the shoe moves "out." This "out" movement causes the air valve *in* the servo-motor to act, thereby moving the gate toward "shut" for a small increment of its total opening. As the sugar wall thickens, the gate continues its step by step throttling until the present desired basket load is reached. At this point the gate closes abruptly and the feeler shoe snaps to its maximum "out" position, well away from the sugar wall.

We now have all of the mechanical components for automatic operation of the various centrifugal functions. The automatic control must coordinate these operations to perform a complete centrifugal cycle and then repeat the cycle time after time.

The main drive motor is a two-speed generally 600/1200 rpm single-winding squirrel cage type designed for this particular service. Two-speed motors are used to reduce the power loss during acceleration and to provide regenerative electric braking to half speed. The automatic control combines the motor starting and stopping equipment with the process timers, limit switches, air and water solenoid valves, etc., to regulate the entire cycle and restart it after each completion.

We do not believe a detailed description of the control is relevant to the discussion. We rather believe our purpose would be better served if we describe what happens rather than how it is accomplished.

The Automatic Cycle

After completion of the plowing out of the previous charge, the following functions are performed:

The basket accelerates to approximately 240 rpm, the loading speed, and during this time the screen is spray flushed.

The gate automatically opens and the basket is loaded while rotating at the loading speed, shifting automatically from low to high speed after a timed interval, at approximately 500 rpm.

The gate closes when the preset load point is reached and the basket starts to accelerate toward top speed.

At about 600 rpm the first wash comes on for a 3-second interval.

Approximately 50 seconds after the closing of the gate the second wash comes on for a preset time, usually 7 to 12 seconds.

If syrup separation equipment is included, the separator trips shortly after the start of second washing.

At the end of the high speed spinning time, the high speed winding is de-energized and the low speed winding energized to regenerative brake to just about half speed. At this point the motor is de-energized and the air-operated mechanical brakes are applied, bringing the basket to rest.

When the decelerating basket reaches 50 rpm, the conical basket valve lifter starts functioning.

After zero speed has been reached, the "Turntork" motor and clutch are immediately energized and the basket rotates in counter clockwise direction at 35 rpm.

The plow now moves off the safety ledge and enters the sugar wall. After two revolutions of the basket, the plow moves down. When the plow reaches the bottom the tip remains against the screen for two revolutions and then moves half-out, remaining on the bottom for two more revolutions. This is done to get all of the sugar out .of the basket.

The plow then returns up to its safety ledge. The "Turntork" is de-energized, both motor and clutch, and the basket is braked to rest. Simultaneously the conical .basket valves seats.

When these actions are completed the motor restarts in forward direction on the next cycle.