A Continuous Sugar Centrifugal

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It is natural that, with the trend toward automation, efforts should be made to develop a machine which will continuously separate sugar from massecuite.

In 1957, it came to the attention of Mr. Silver that Hein, Lehmann & Co. of Dusseldorf, Germany, was manufacturing a continuous centrifugal which was meeting with some success in the European sugar industry. Mr. Silver was able to obtain the manufacturing and sales rights to this machine for the United States and Cuba.

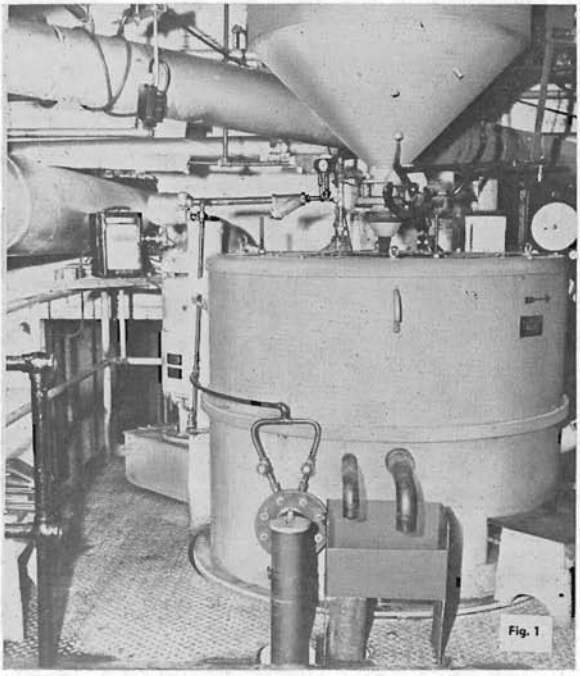

Figure 1.—The installation of a Hein, Lehmann centrifugal at the Nampa, Idaho, factory of The Amalgamated Sugar Company.

During 1958, a Hein, Lehmann centrifugal was brought over from Germany and installed at the Nampa, Idaho, factory of The Amalgamated Sugar Company. Figure 1 shows this installation. A series of test runs was made with this machine on both high raw and low raw massecuites. It immediately became apparent that the following changes would be necessary to make it acceptable to American practice.

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[1] Chief Engineer, Silver Engineering Works, Incorporated.

Three different size nozzles had been provided with which to control the flow of massecuite into the centrifugal. These had to be changed according to the viscosity of the massecuite, and this varied so rapidly that it was practically impossible to obtain good separation. This difficulty was overcome by the addition of an air operated valve on the massecuite inlet which is controlled through a transducer and Taylor controller receiving a signal proportional to the amperage of the centrifugal drive motor.

The Hein, Lehmann machine had no provision for separating a wash product from the green when operating on high raw massecuites, so another compartment for this product was added. After these changes had been completed, some extensive tests were made to determine the best operating conditions for this machine.

At the end of the campaign at Nampa, this machine was shipped back to Silver Engineering Works, an examination of all parts was made, and work was started on a design which could be manufactured in our shop. In addition to the incorporation in the new design of the flow control and the wash separation compartment, the over-all dimensions were changed to allow the machine to fit into a space which had been designed for a batch centrifugal; however, other than these changes, the basic Hein, Lehmann design was followed as closely as possible consistent with available shop tools and practices.

Figure 2 shows a cross section through the Silver Continuous Centrifugal. You will note that the machine consists of a rotating basket surrounded by three compartments; the inner compartment for green, the next compartment for wash, and the outer compartment for sugar. The wall of the inner compartment is adjustable in elevation so that the cut-off point between green and wash can be varied. Material collected in any of the compartments is transported from the machine by gravity. The rotating centrifugal basket is mounted on a vertical spindle which is V-belt driven by a 25 horsepower TEFC motor. Pulleys are provided to drive the basket at either 2000 or 2600 RPM.

The entire basket and spindle assembly is mounted on rubber blocks to dampen vibration should any unbalance occur. The ball and roller bearings of the spindle assembly are lubricated by a motor driven pump which continuously circulates oil through these bearings during operation.

Both steam nozzles and water nozzles are placed inside the basket so that either may be used to wash the sugar as it travels over the screen. Steam nozzles are also in both the green and wash compartments which can be used to steam out these compartments occasionally.

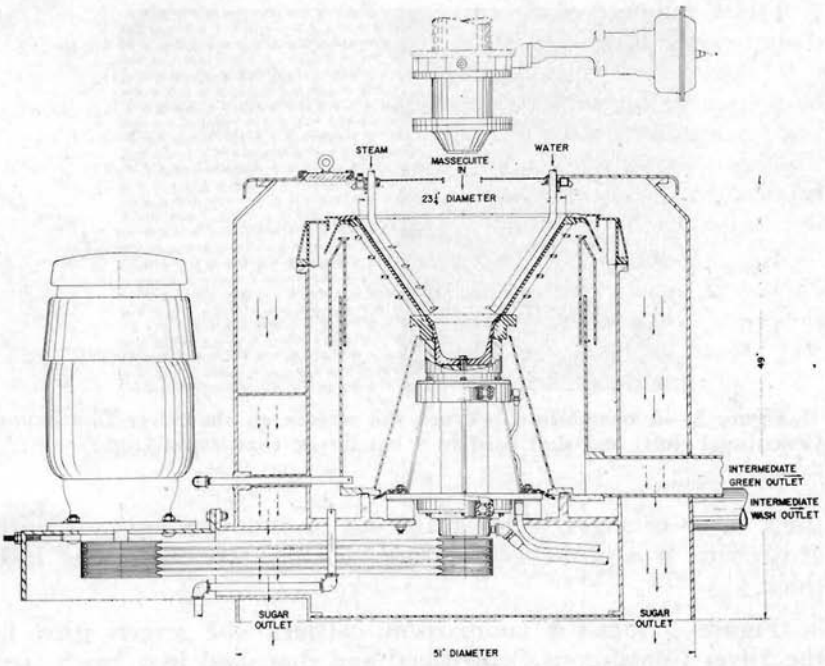


Figure 2.—A cross section through the Silver Continuous Centrifugal.

The basket is lined with a screen having perforations of 0.06 mm, or about 0.0024 of an inch wide. Screens with larger openings have been tried, but to date this is the largest size that is practical for American beet sugar massecuites. When the basket is rotating at 2600 RPM, forces of 800 g's and 2100 g's are acting at the small and large diameters respectively.

In operation, the massecuite is fed in a steady stream from the nozzle above the center of the basket. This flow is accelerated outward and upward as it comes in contact with the acceleration bowl at the bottom of the basket. As the massecuite flows out over the edge of the bowl, the syrup or molasses pass through the screen. The angle of the side of the basket has been selected so that the sugar crystals tend to cling without moving until they are crowded upward by crystals below them on the sloping side.

If the feed is stopped, the movement of the crystals across the screen is stopped. Consequently, the time that is required for a sugar crystal to travel across the screen is to a considerable extent a function of the quantity of massecuite being fed to the machine. The lower part of the basket will have a fairly

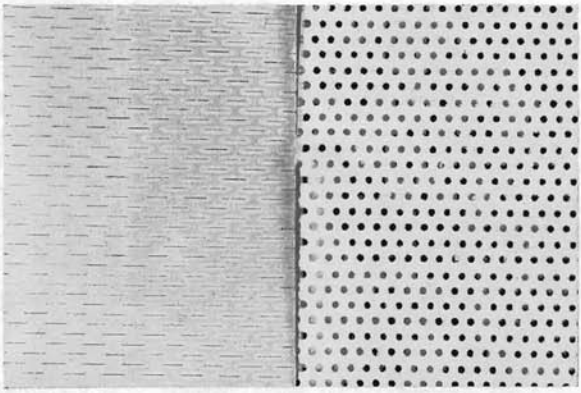
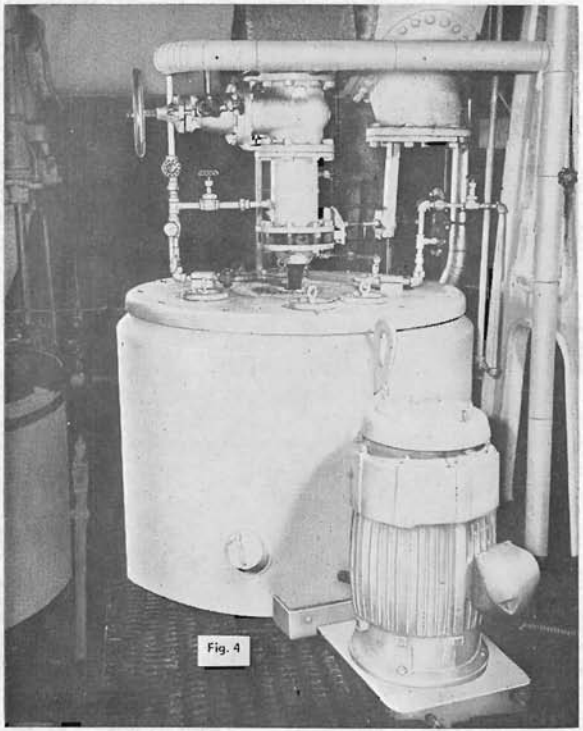


Figure 3.—A comparison between the screens on the Silver Continuous Centrifugal (left) and that used in a batch-type centrifugal (right).

thick layer of sugar which thins out as it moves upward until at the rim, it is probably no more than one-sixteenth of an inch thick.

Figure 3 shows a comparison between the screen used in the Silver Continuous Centrifugal and that used in a batch type centrifugal. The continuous centrifugal screen is about .008 of an inch thick. It is made by electrodeposition of pure nickel on a plate which has had the open areas masked to prevent deposition; in other words, the metal is built up around the hole. Electrodeposition requires a pure metal; of the pure metals, nickel is the most feasible for this purpose. The production of a screen with this size opening is undoubtedly one of the major steps in the development of the continuous centrifugal.

During 1959, Silver Continuous Centrifugals were installed at the Loveland and Johnstown, Colorado, factories of The Great Western Sugar Company and at the Nampa, Idaho, factory of The Amalgamated Sugar Company. Figure 4 shows the installation at Loveland. This machine is located in a space previously occupied by a batch type centrifugal. Figure 5 shows the installation of the machines at Nampa. The machines at both Loveland and Nampa were operated most of the time on high raw; however, the west machine at Nampa was piped up so that it could operate on either high or low raw and was occasionally used for low raw. Table 1 shows the test results obtained at Nampa with the Hein, Lehmann centrifugal during the 1958-1959 campaign. The capacity of the factory high raw machines during this campaign was approximately 4500 cubic feet per day, less whatever amount was put through the continuous machine.



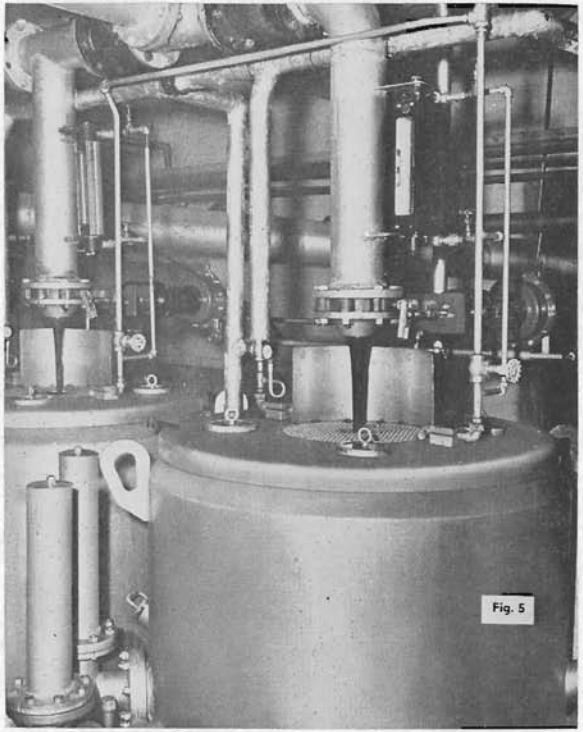


Figure 4.—(left) The installation of the Silver Continuous Centrifugal at the Loveland, Colorado, factory of The Great Western Sugar Company and Figure 5.—(right) the installation at the Nampa, Idaho, factory of The Amalgamated Sugar ompany.

Table 1.—Results of Tests of Hein, Lehmann Continuous Centrifugal During 1958-1959 Campaign at Nampa, Idaho, Factory of The Amalgamated Sugar Company.

Massecuite Tested	Number of Samples	Screen Opening Size mm	RPM	KW Input	Wash GPM	Massecuite Feed Rate Cu. Ft./Day	Apparent Purities					
							Massecuite	Continuous Centrifugal			Batch Centrifugal	
								Molasses or Green	Wash	Sugar	Molasses or Green	Wash	Sugar
Low raw	14	.06	2600	8.6	0.01	1027	79.2	62.7		93.5	61.7		92.8
High raw	27	.06	2600	16.2	1.7	3957	89.1	77.9	90.9	98.4	77.6	91.4	98.9
High raw	19	.06	2000	10.2	1.3	3993	88.8	76.6	90.2	98.4	78.2	89.9	98.8
High raw	8	.09	2000	10.5	1.6	4323	88.2	77.9	89.2	98.1	78.0	89.4	99.0

Table 2.—Ingenio Independencia, S.A. Martinez de La Torre, Vera Crus, Mexico, Results on "C" Massecuite with .06 mm Screen.

	"C" Massecuite		Continuous Type			Batch Type	
	Brix	Purity	Pol Sugar	Molasses Apparent Purity	Lbs./Hr.	Pol Sugar	Molasses Apparent Purity
Average of 53 samples of 13 days of operations from July 2, through July 15, 1959	90.75	66.02	92.17	43.96	7005	86.50	43.16
Average of 15 samples where apparent purity of molasses from continuous machines was less than that from batch machines	91.07	66.12	92.07	43.39	6347	87.23	44.26
Best individual run, July 3	89.80	65.06	93.30	41.65	5889	89.10	45.79
Best day, July 8	90.45	69.78	93.05	46.96	8345	89.34	47.26

After the original Hein, Lehmann centrifugal had been completely inspected upon its return to our plant, it was reconditioned and sold to Ingenio de San Cristobal Anexas, Mexico City. Table 2 shows a comparison of the results obtained with this machine and with their standard factory machines. This operation is in a cane mill on "C" massecuite. The product of this mill is raw sugar.

Table 3.—Results of Test Work on High Raw Massecuite Using Varying Amounts of Wash Water, Loveland, Colorado, Factory of The Great Western Sugar Company.

Wash Water Rate GPM	Massecuite Feed Rate Cu. Ft./Day	Apparent Purities			
		Massecuite	Green	Wash	Sugar
None	3000	87.7	77.0	77.9	95.5
0.35	3000	87.9	78.8	78.6	96.4
0.70	3000	88.3	79.1	79.3	97.0
0.90	3000	87.3	77.8	78.2	96.9
1.50	3000	87.4	77.7	78.6	97.5
None	4000	88.3	79.9	79.9	96.9
0.70	4000	88.3	79.6	79.5	96.9

Table 3 shows results of some test work done at Loveland during the latter days of the campaign. This centrifugal was being used throughout most of the campaign; however, when it was first put into operation, it was found to have a leak from the wash compartment into the sugar compartment through the seal at the top of the basket. A considerable amount of time was spent in trying various methods of checking this leak and it was, therefore, rather late in the campaign before any program of obtaining operating results on the continuous centrifugal was begun.

Tests consisting primarily of operating the Silver Continuous Centrifugal at a nearly constant rate and trying different quantities of wash, different location of spray nozzles, different locations of steam application, and different settings of the wash divider plate were made. However, the campaign ended before any changes could be put into effect from the evaluation of these results. You will note that the apparent purities of the green and wash do not vary greatly in these results. We believe that this is due to the design of the wash divider which allowed a flow of green into the wash compartment large enough in volume to obscure the results of the wash. This condition is being corrected.

Several tests of batch type centrifugals were made during the period operating information on the continuous centrifugal was

being gathered. These tests were made under closely controlled conditions. Water was applied 45 seconds after loading and total spin time after loading was 2 minutes. With a 6 quart wash, the purity was 97.83; with a 12 quart wash, the purity was 98.4; and with a 16 quart wash, the purity was 98.8. Under these conditions, the batch type machine showed a higher sugar purity.

Since Johnstown will be operating for several months, a test program on both "B" and "C" massecuites is planned at this plant.

Table 4 shows results of samples taken from the east machine at Nampa. This is the machine which ran continuously on high raw only. As mentioned previously, the screen used in this machine is made of pure nickel. This material is quite soft and, consequently, the wear life is not as long as desired. The life of screens on the east machine at Nampa is from 10 to 14 days. This machine is operating at a fairly high rate and is running approximately 90% of the time. We are at present working with a screen manufacturer to produce a screen of a harder material. This should not only increase the life of the screen, but should also allow more open area since the harder material will be stronger than the nickel. More open area, we feel, should increase the capacity of the machine. These new screens will be ready for service in the 1960 campaign.

Table 4.—Results of Samples from East Machine Operating on High Raw When 2 GPM or More of Wash Was Used. Nampa, Idaho, Factory of The Amalgamated Sugar Company.

Date	Control Set Point	Wash Water Rate GPM	Massecuite Feed Rate Cu. Ft./Day	Apparent Purities			
				Massecuite	Green	Wash	Sugar
12-2	32	2.3	.....	88.6	78.8	92.4	99.3
12-5	35	2.3	3720	89.5	77.9	94.4	98.6
12-7	30	2.3	.....	88.9	77.2	79.2	100.00
12-7	30	2.7	.....	88.9	78.0	84.8	99.3
12-10	32	2.3	.....	89.5	78.7	87.8	99.6
12-11	37	2.3	5350	89.9	81.0	92.1	98.7
12-15	40	2.5	6580	89.9	80.4	82.3	99.4
12-15	40	2.5	6580	89.9	80.9	82.8	99.3
12-15	40	2.5	6580	89.9	80.6	81.7	99.0
1-6	31	2.1	4600	90.2	80.0	87.4	99.1
1-6	31	2.7	4600	90.2	79.4	89.2	98.1
Average		2.4	.....	89.6	79.3	86.7	99.1
Average of 16 samples from batch centrifugals from 10-15 thru 12-7		2.3	4500	89.6	79.2	91.7	99.8

Maintenance on the Silver Continuous Centrifugal has been negligible as would be expected from such a simple design. Belt life has been shorter than expected due to operating in an atmosphere of sticky vapors. In the future, this drive will be completely enclosed to prevent this condition.

The continuous centrifugals have all been located so that they are fed from the same mixer as the batch type centrifugals: hence, they have operated under conditions which are as close as possible to optimum for the batch type centrifugal. Since the two machines are so different in their construction and operating characteristics, it is a logical conclusion that possibly the operating conditions should not be the same. It seems desirable in the near future to make a set-up where the continuous machine is fed from its own individual mixer so that the temperature, viscosity, ET CETERA, can be varied and the results evaluated.

A comparison of the results in Table 2 with those in Table 4 demonstrates that the Silver Continuous Centrifugal will do as good or better than old and poorly operated batch type machines; however, modern, well operated batch type centrifugals will produce sugar of slightly higher purity. To offset this disadvantage is the practically supervision-free operation, the low power consumption, the low maintenance cost, and the low capital investment of the Silver Continuous Centrifugal.