Two Screens for Receiving Stations and Their Trash Removing Properties

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With the advent of the mechanical sugar beet harvester in the mid-'40's and the probability that sugar beets would be harvested entirely by machinery in the future, it became apparent that existing dirt and trash removing devices at receiving stations and factories had become obsolete. Although these screens and trash drags had been successful for many years, they could only attempt to extract the foreign material hauled in with the beets from mechanical harvesters. The ultimate result was damage to the factory's slicers and in extreme cases reduced factory slicing capacity.

Even though some improvement in screening ability has been made in the mechanical sugar beet harvester since its inception, and possibly further advancements will be made in the future, there apparently is a definite limit to the amount of screening capacity which a harvester can attain. The machine must be made portable and compact enough to be maneuverable, which precludes the possibility of incorporating into its design large and elaborate filtering devices. From a practical standpoint, therefore, damaging extraneous matter must be eliminated by other methods.

New Receiving Station Screening Equipment for Processors

Assuming that the processor must bear the burden of extracting the heavy dirt and trash delivered by mechanical harvesters, especially by those with high harvesting capacities which employ no hand sorting labor during their operation, the logical place to make the extraction appears to be at the receiving station itself, rather than within the factory's cleaning system. Two major developments in receiving station screening equipment have been made and have shown outstanding results.

Ogden Iron Works Co., Ogden, Utah, Combination Screen

This outstanding screening apparatus has been incorporated into the company's Silver, model 1950, 36 inch dump, and it has demonstrated its effectiveness by removing large quantities of loose beet tops, weeds and other foreign substances from mechanically harvested beets.

The Silver screening system is divided into two parts involving two dissimilar mechanical actions in the separation and removal of dirt and trash from the beets. The beets, dirt and trash are first introduced from the elevator belt to the kicker dirt screen. This screen corresponds to the Reincks type, and although the wheels, or kickers, are of different design, they have a similar action to the Reincks rolls. There are eight complete rolls of twenty-two individual kickers per roll. The first seven rolls consist of rubber kickers and the kickers in the final roll are of cast steel, or iron. All rolls are 5 feet 6 inches in length, the kickers are $13^1/_2$ inches in diameter, and all kickers are spaced within $^1/_2$ inch of each other. The composite rolls extend to a width of 6 feet 10 inches, yielding a total screening surface of 37.58 square feet.

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The entire screen lies level and all kickers are of the same elevation, the beets and trash being propelled from one end of the screen to the other by the revolving action of the kickers. All kickers rotate in one direction toward the discharge end of the screen. Rubber kickers have definite advantages over the steel type in that they are less susceptible to sticky mud adhering to them and are not so abusive to the beets. Also, less tail breakage and gouging of the roots is apparent and noteworthy. The rubber kickers are, however, more vulnerable to clogging with wet trash, particularly loose beet tops, probably due to their flexibility and consequent inability to tear through the trash.

The rubber effects more friction to the foreign material. Since the drive gear box of the following longitudinal rolls is immediately next to the final kicker roll, a bulkhead is formed for trash to hang and build up, and the use of steel kickers at this junction point results in self cleaning so plug-ups are infrequent. At the passing of the final kicker roll the beets assume a drop of approximately 16 inches to the second phase of the screening system, the parallel counter-rotating longitudinal leafer rolls.

Parallel Counter-Rotating Longitudinal Leafer Roll. This section of the screening system is a rather unique arrangement of twelve parallel counter-rotating longitudinal rolls. These rolls immediately follow, and are integral to, the kicker dirt screen. The rolls are alternate rubber covered and steel, rotating in pairs, one clockwise and the other counter-clockwise. The steel roll is fitted with a steel spiral ribbon from the top end to within 12 inches of the discharge end, which provides a downward scrolling action. The rubber-covered roll is smooth with the exception of a 6 inch reversed-action spiral ribbon at the discharge, end of the roll.

Since each pair of rolls rotates against each other with a downward motion, any foreign object caught between the rolls is rapidly pulled down between them. The long spiral on the steel roll greatly assists this action, and the rubber on the alternate rolls offers sufficient friction to be effective. Rocks, also, pass safely between the steel- and rubber-covered rolls. Without the short reversed spiral ribbon on the discharge end of the rubber-covered rolls, this screen assembly will plug badly at that end between the bearing points of the rolls. The reversed action spiral forces the trash upward and in an opposite direction to the long spirals on the steel rolls and is effective in preventing plug-ups at the rollers' discharge ends.

A blank space of 3 inches is left between the ends of the long steel roll spirals and the beginning of the short reverse spiral on the rubber-covered rolls. This allows an escape to any small beets having been caught tail-down between the rolls above the blank and therefore prevents them from being clipped in two. Tail breakage is nominal from the longitudinal rolls, and whole beets of marketable size cannot pass through the 34 inch spacing between the $4^{1/2}$ inch rolls.

All rolls are the same elevation laterally and the entire group is tilted 8° toward the discharge end. This angle provides ample pitch for the beets to move swiftly toward the discharge end. At the intake end of the longitudinal rolls, the kicker screen distributes the beets and trash in a well disbursed manner and the beets travel down the rolls . at air even depth,

Figure 1. Ogden Iron Works Co. combination screen installed on Silver 1950 36-inch dump. Note reverse spiral ribbon on lower ends of alternate smooth longitudinal rolls.

exposing the trash mixed in the beets to the grasping action of the rolls.

The rolls are 6 feet long and extend to a width of 4 feet 10 inches, giving the screen 29.0 square feet of rotating screening surface. This area plus the kicker screen's surface of 37.58 square feet yields a total of 66.58 square feet for the total system. Extraneous matter consisting of loose beet tops, small rocks and clods, weeds such as morning glory, loose water grass, small pigweeds, and other succulent species are readily removed by the longitudinal leafer rolls. Large clumps of sodded grass roots, thick or long weed stems and roots, and clods or rocks 3/4 inch diameter or larger will not pass through the rolls and cannot be separated from the beets.

In concluding the description of the Silver double-action screening system, it should be noted that some soils in a muddy and sticky condition will adhere to the longitudinal rolls at their upper ends, and after a short period of time the resultant build-up will cause the rolls to stop. This condition is relieved by spraying a small stream of water at the head end of each roll. A pipe with one small hole per roll is installed at right angles to the upper ends of the rolls at a height sufficient to clear the stream of beets as it passes from the kicker screen to the longitudinal rolls. A common hand valve controls the volume of water required.

The introduction of water to the muddy rolls tends to loosen the sticking soil and it is cast off by centrifugal force. Althought the addition of water to the rolls somewhat affects growers' screenings weights, the use of

water is the most convenient method to effectively remove the mud. Usually no more than two or three gallons are used per load, and the additional weight is actually insignificant under the circumstances. Also, it is very seldom that the use of water is necessary, even during times of wet harvesting conditions.

The data in the folowing tables reflect amounts of dirt and trash screenings removed by both the kicker dirt screen and the longitudinal leafer rolls from ten representative loads of mechanically harvested beets:

Table 1.—Distribution of Screenings Between Kicker Dirt Screen and Leafer Rolls.

Loads	Beet Ticket Nos.	Total Raw Weight (Lbs.)	Weight of Screenings Kicker Dirt Screen (Lbs.)	Weight of Screenings Long. Leafer Rolls (Lbs.)	Total Lbs.
1-10	174498-509	151,010	4,350	3,030	7,380

(a) Percent of total each screen removed.

Screen	Lbs. Screenings Removed	% of Total Removed
Kicker Dirt Screen	4,350	58.94%
Longitudinal Leafer Rolls	3,030	41.06%
Totals	7,380	100.00%

(b) Percent of total loads screened out as dirt and trash (screenings)

Screen	% of Loads Screened Out
Kicker Dirt Screen	2.881%
Longitudinal Leafer Rolls	2.006%
Total % of loads which were screenings	4.887%

Note: Above investigations were made at resumption of harvest following a substantial rain. Loads contained abnormal amounts of wet soil in a free state and also clinging to beets.

Items 1 and l-a of Table 1 indicate a total 3,030 lbs. of extraneous material removed by the longitudinal leafer rolls. This figure is significant since had they not been incorporated into the system, and had the kicker dirt screen been the only filtering device, 3,030 lbs., or 41.06 percent of the foreign matter contained in the 10 loads of beets, would have entered the factory cleaning system.

Table 2 shows an analysis of the foreign matter extracted by the longitudinal rolls. Four samples were taken at random from the ten loads tested in Table 1.

Table 2.—Percentage Analysis of Foreign Matter from Longitudinal Leafer Rolls.

No. of Sample	Total %	% Tops and Weeds	% Dirt	% Beets and Tails
1-4	100%	59.03%	13-47%	27.50%

Detail of % Beets and Tails:

Beets and Tails less than 1" in diameter	21.05%
Beets and Tails over 1" in diameter	6.45%
Beets and Tails over 11/2" in diameter	0.00%
T o t a l	27.50%

Although 13.47 percent of the total extraction was dirt, 59.03 percent of this total was a combination of loose beet tops and weeds, which are

Figure 2. Silver Engineering Works, Inc. Molnau screen installed on Silver - Roberts 30 - inch dump.

detrimental to the factory's slicers and process in general if not properly eliminated. Beets and tails comprised 27.50 percent of the total, but no beets over $1^1/_2$ inches in diameter passed through the screen and the majority which were lost were under 1 inch in size.

Silver Engineering Works Inc., Denver, Colorado, Molnau Screen

This is the second new-type filtering system to be discussed. The Molnau screen may be classed as a rotating parallel longitudinal roll type, its having no Reincks, shakers, or other agitating devices to assist in removing dirt and trash. This screen has been installed on several types and sizes of the above Corporation's receiving stations including a Silver-Roberts, Serial No. 33825, 30 inch dump.

The unit at this receiving station is comprised of eight "squirrel cage" type longitudinal rolls which lie parallel to each other and to the stream of beets. These rolls are 6 feet long, 6 inches in diameter, and have 3/4 inch spacings between the bars on the individual rolls. A one-inch space exists between each roll to allow passage of foreign matter. The Molnau rolls do not lie flat laterally but are grouped to form a concave slide, or trough. The two center rolls are at the same elevation, while the three rolls to either side are progressively higher in succession. One 6 inch smooth roller, parallel to the others, is situated at the top of either side of the screen to prevent beets from climbing over the sides. The entire unit drops 11° toward the discharge end, which has been determined to be the most efficient operating angle for this receiving station. The actual screening surface of the unit is

24 square feet, the rolls being 6 feet long and the concave surface width being 4 feet.

The Molnau rolls do not counter-rotate against each other, but are split into two banks. Looking toward the discharge end, all four rolls in the right-hand bank rotate in a clockwise direction, and the four in the left-hand bank rotate counter clockwise. This procedure tends to work the beets up the sides of the screen which in turn uniformly distributes the beets over the rolls, exposing the dirt and trash to their action. Knobs welded to each bar of the rolls form a spiral which enhances their grasping power.

Although the Molnau screen installed on the above receiving station is restricted in size, the filtering efficiency is apparently satisfactory. Results from tests have indicated that 74.22 percent of all foreign matter can be removed from mechanically harvested beets in certain areas with this particular installation. Since only 24.0 square feet of screening surface exist, it appears that the screen will successfully remove dirt and trash from mechanically harvested beets.