# Improving Screens for Trash and Dirt Elimination in Sugar Beet Receiving Equipment

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### Purpose of Screens

Modern techniques of the beet sugar industry necessitate a marked decrease in the amount of dirt and trash entering both processing plants and storage piles. Such reduction can only be accomplished through the development of more efficient screens.

### Location of Screens

The most efficient trash and dirt removal equipment to date is complicated, expensive, and heavy. It does not, therefore, adapt itself readily to small comparatively inexpensive mobile equipment suitable to average field conditions. Consequently, it is logical to conclude that, in order to satisfy both grower and processor demands, an intermediate station, for the express purpose of intensifying an all out effort for trash removal, be established. Without a doubt the present receiving station is the most practical location. At such central locations the necessary equipment can be installed to both clean the beets for the processor and return the trash with the haulers to the field, where such return is permissible.

### Field Causes and Partial Prevention for Increased Trash

The advent of mechanical harvesting has, in many cases, resulted in increased trash delivered, due to inexperienced operators, poor adaptation of type of machines, overloaded screening systems of harvesters, and adverse harvesting conditions. These difficulties have been minimized in south Idaho by extensive use of the "beater topper," substitution of "short" rienks for screens in loaders and the use of picking belts on International harvesters. General field cleanliness has also contributed much to reduce the trash burden.

In spite of the above accomplishment and because of its limitations, it has still been necessary to maintain, or seek for, extremely efficient elimination at the receiving stations.

### Design Considerations

In an attempt to make changes, other considerations manifest themselves. They are listed as follows: The prevention of—1. Small beet loss; 2. Excessive breakage of beets; 3. Excessive gashing and bruising; 4. Plugging of machine from mud; 5. Jamming of maching from rocks. These conditions had to be met without affecting capacity.

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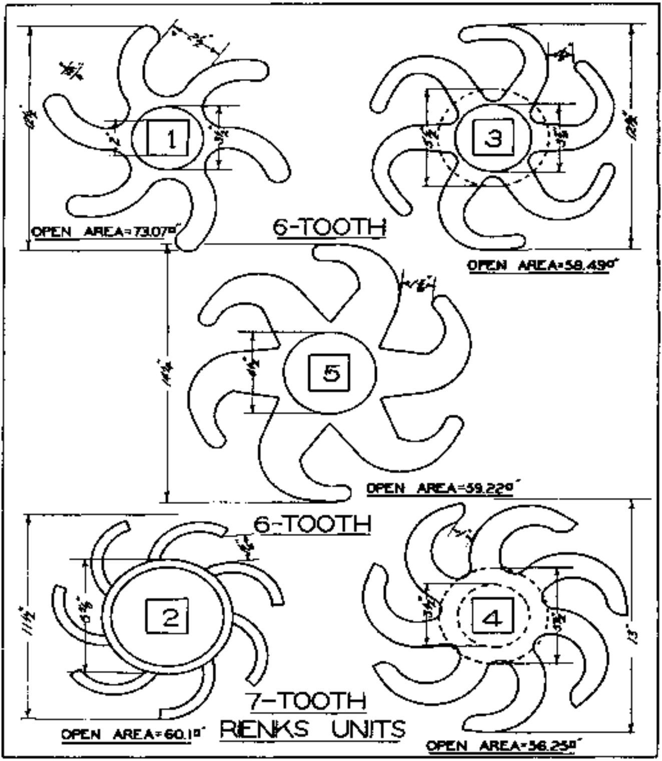


**Figure 1.**

## Progress of Screen Development

The following is a brief resume of the progress *in* screen development to date, which was done with the cooperation of the Ogden Iron Works of Ogden, Utah.

**I. Bar Type Screens:** To facilitate trash elimination in this common type screen a reverse screen chain was placed at a 45° angle between the upper and lower shaker chains as illustrated in the "Early Screen Arrange-

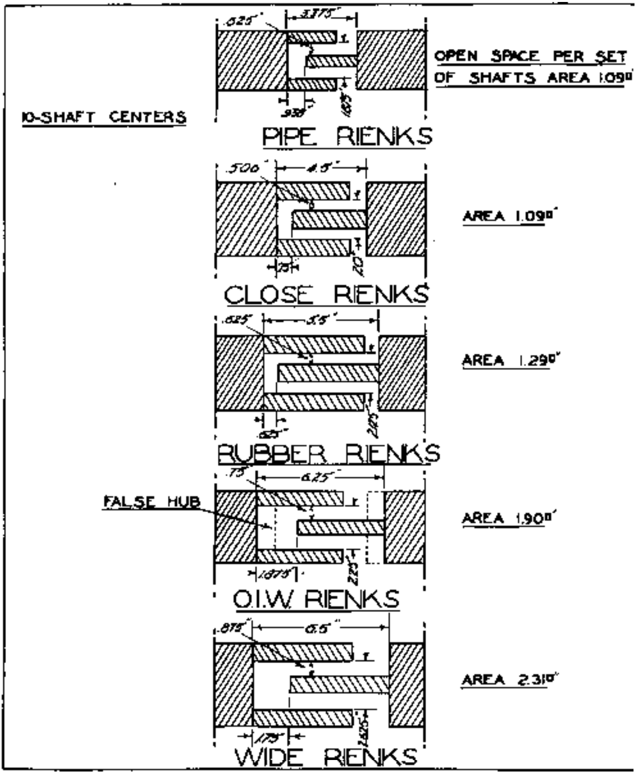


**Figure 2.**

ment." The lineal speed of these reverse chains was approximately 250 feet per minute. In order to increase their trash carrying capacity, the following changes were made: the angle of chain was reduced to approximately 30°, cleats were attached to the screen bars; reverse chains were divided into two sections, upper and lower, with lineal speeds reduced to approximately 65 feet per minute; a blower was installed to jet air upward over the top of the reverse chain to aid in holding the leaves to the chain until they were

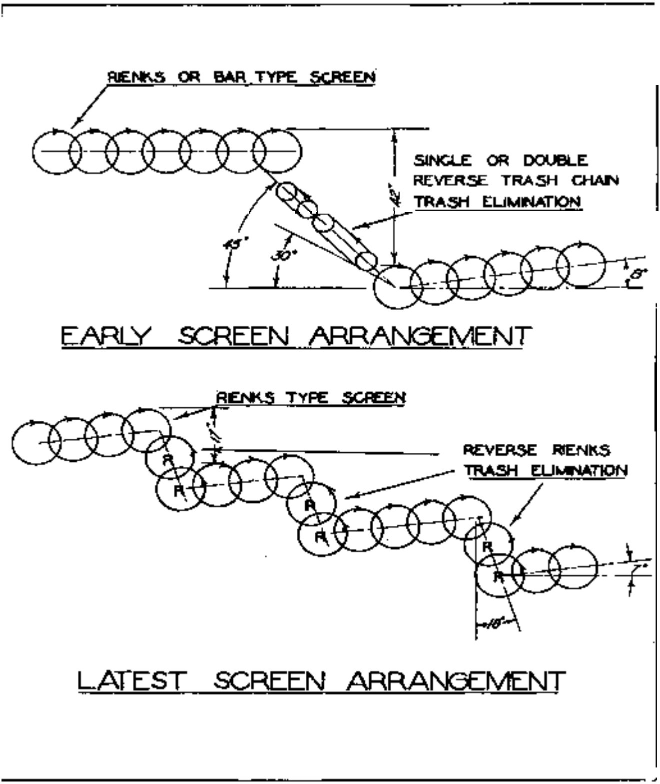


Figure 3.

discharged into the return dirt; and the flow of beets over the screen was controlled, so that a longer cleaning period could be given them if they contained excessive trash or dirt.

2. Eccentric Ring Type Screen: Trash elimination was again attempted by a split reverse screen chain placed at a 45° angle as shown in Figure 3.

**Table 1.—Showing Screen Comparison Based Upon Bar Type Tripple Screen Unit.**

| Screen Area Total Open | Screen Area Max. Open | Screen Type | Trash Separation | Load Return | Small Beet Return | Tail and Chip Return | Trash and Leave Return | Dirt Return | Tare | Stops for Rocks | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11.99 | .938 | 7-tooth pipe rienks | Reverse rienks | Same | Same | Same | Same | Same | Same | Large Incr. | Not efficient in mud |
| 12.01 | .750 | 7-tooth *Vs"* plate—close spaced rienks | Reverse chain | Same | Same | Same | Same | Same | Incr. | Small Incr. | Not efficient in mud—excessive drops |
| 14.22 | 1.000 | 6-tooth—13 shaft rubber rienks | Reverse chain | Incr. | Incr. | Incr. | Same | Incr. | Less | Less | Not affected by mud or rocks—excessive drops |
| 15.48 | 1.000 | 6-tooth 19 shaft rubber rienks | Reverse rienks | Incr. | Incr. | Incr. | Incr. | Incr. | Less | Less | Not affected by mud or rocks—excessive drops |
| 19.15 | .875 | *W* bars @ 1.5" on cent, bar screen | Reverse chain | Base | Base | Base | Base | Base | Base | Base | |
| 20.93 | 1.875 | 6-tooth—13 shaft—cast steel rienks | Reverse chain | Large Incr. | Large Incr. | Large Incr. | Same | Small Incr. | Incr. | Large Incr. | Mud build up on hubs—excessive drops |
| 21.89 | 2.000 | 6-tooth—*W'* pi. rienks | Reverse rienks | Large Incr. | Large Incr. | Large Incr | Incr. | Large Incr. | Less | Incr. | Mud build up on hubs—excessive drops |
| 22.26 | 1.000 | solid ring eccentric | Reverse chain | Same | Same | Same | Same | Same | Same | Incr. | Not efficient in mud—excessive drops |
| 22.86 | 1.875 | 6-tooth—19 shaft—cast steel rienks | Reverse rienks | Large Incr. | Large Incr. | Large Incr. | Incr. | Large Incr. | Less | Large Incr. | Mud build up on hubs—excessive drops |
| 25.36 | 1.750 | 7-tooth—7/s" plate wide spaced rienks | Reverse rienks | Largest Incr. | Largest Incr. | Large Incr. | Incr. | Large Incr. | Less | Incr. | Mud build up on hubs—excessive drops |

Through angle manipulation, as was explained previously, increased trash separation resulted but the amount was insufficient and a change from the eccentric screen to a standard rienks became necessary some **time later.** The six-tooth elements were of 34-inch thick cast steel (No. 3 in Figure 1) spaced three inches on centers having 334-inch hub diameters and located upon shafts spaced ten inches apart.

Observation indicated increased dirt and clod separation but loss in small beets, breakage of beets, numerous stops occurring from rocks and mud building up on hubs offsetting all progress gained.

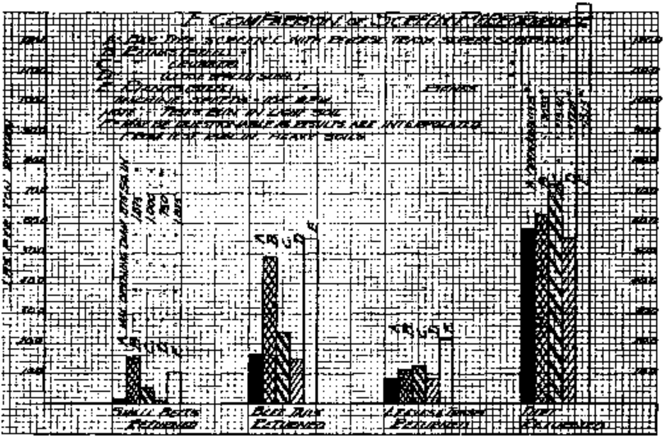

**Figure 4. Information from the above data was averaged and plotted upon this graph presenting the resulting comparison of screen performance. From an analysis of this information the following conclusions were derived: the closed type rienks and the bar type screens perform about the same with regard to screening ability; the standard spaced cast steel rienks screens, although eliminating a large amount of dirt in dry conditions, are objectionable because of excessive beet loss; trash elimination is dependent upon the removal system used and any variation in type of screen does not effect much change. The reverse rienks method of elimination separates a larger amount of trash from the beets; rubber rienks elements provide greater possibilities for future screens.**

Attempts to relieve the above drawbacks consisted first of a change in speeds varying from a high of 150 R.P.M. to a low of 60 R.P.M. It was found that at approximately 100 R.P.M. the capacity was maintained with a minimum loss of small beets and breakage. Second, in order to further reduce the loss of small beets by closing of screen, false hubs of $5^{1}/_{2}$ outside diameter were inserted, as shown by dotted insertions upon the illustrations in Figure **1.**

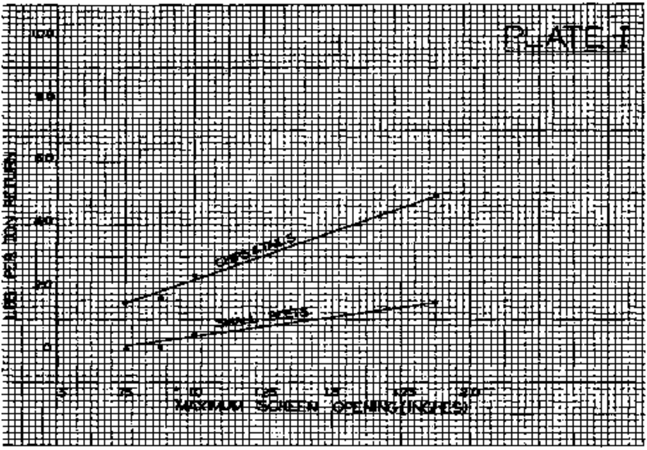


**Figure 5. The relationship of small beet and beet tail loss to maximum screen opening is shown here with the expected increase in loss as the openings extend beyond .75 inch.**

**3. [2] Standard Rienks Type Screen:** The latest piler unit was originally equipped with a rienks screen constructed of seven 5/8-inch round bar curved teeth welded in 21/2-inch rows to 65/8-inch outside diameter pipe cylinders (No. 2 in Figure 1) which were mounted on shafts ten inches apart. Trash elimination was accomplished through reversing the direction of rotation of three sets of two rolls located at each of three abrupt short drops. This method of trash elimination is shown in the elevation entitled "Latest Screen Arrangement."

Separation by this screen was quite satisfactory under ideal conditions with a minimum beet loss and breakage. However, under adverse conditions

[2] This type screen was originally developed by George Rienks, formerly of the Great Western Sugar Company, in 1929 and all adaptations since have been identified by his name.

mud build up and wedging rocks reduced the efficiency of this machine to such an extent that it was readily decided to change to two different types of rienks elements, namely, a six-tooth 3/4inch plate and six-tooth cast steel spaced three inches on centers as described above and illustrated by Nos. 1 and 3 in Figure 1. Although the above undesirable conditions improved, the problem of excessive beet loss and breakage again developed.

The screens in this piling unit were installed originally upon a seven degree back slope to retard partially the flow of beets for increased cleaning.

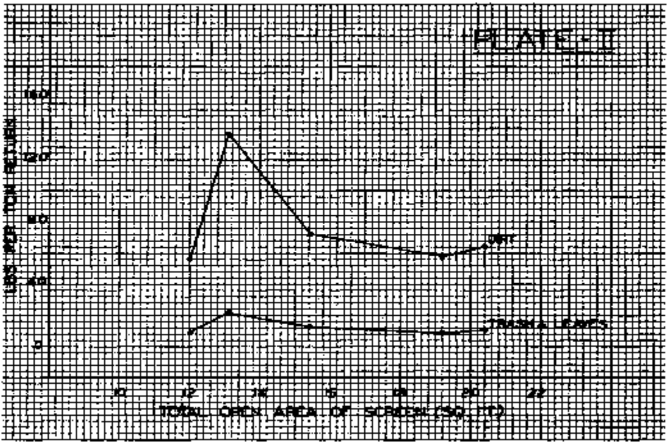


Figure 6. Only a small change is indicated by this curve in the dirt and trash separation within the range of total open area facilitated by the screens operating in this test. Therefore, in general it may be concluded that the amount of elimination depends upon the type of screen rather than the amount of open area available.

This proved to be satisfactory as long as the length of screen was short, but if it extended beyond five rolls a stagnation of beet flow resulted in a churning action just below the reverse shafts and the capacity of the machine was impaired. Changes in shaft speed had no effect upon this condition and not until the back slope was reduced was the capacity increased.

4. Trials Involving Screen Elements and Element Spacing: Analysis and comparison of screen openings (as shown in accompanying illustration) necessary to eliminate beet loss and still maintain adequate capacity were made. A part of this analysis consisted in determining the upper and lower limits adaptable to existing local conditions. This was accomplished through

the construction and trial of two test screens. One was built establishing a maximum spacing. It was composed of 7/8-inch plate seven-tooth elements spaced 31/2-inch centers having 31/2-inch outside hub diameter (No. 4 in Figure 1). A seven-tooth element was tried because previous studies indicated that a closer distance between tooth points of each individual element was desirable.

Field trials indicated that such a spacing left too great an open area for small beet loss and no doubt exceeded the maximum point desired. Trash and dirt separation was exceptionally good but was offset by the beet loss.

A calculated minimum spacing of this same type element was then set up so that they were centered at $2^3/_4$ inches apart with hubs of $5^1/_2$-inch outside diameter. From field trials of this screen it was found that beet loss and breakage was very small. Little or no rock trouble occurred; however, there was no increase in trash and dirt separation over the bar type screen. Mud accumulation on both hubs and between individual clement teeth was excessive. From the above results it was concluded that screen element spacing should approach 3 inches.

5. **Rubber Screen Development.** Alter preliminary tests a 70 durometer, six-tooth element (No. 5 Figure 1), one inch thick and $14^1/_2$ inches in diameter was molded, having a hub of $4^1/_2$ inches outside diameter. These were spaced three inches on centers upon the shafts so that their location would relive any congestion due to rocks wedging between two steel elements. Three patterns were tried: One in which there were alternating clusters of three rubber and two steel upon the same shaft, another pattern consisting of alternate shafts complete with rubber and steel, the remaining pattern involving complete rubber on all shafts.

The results from these trials were extremely satisfactory as rock wedging was completely eliminated and mud accumulation on hubs became almost negligible. Greater dirt elimination prevailed due to the fact the screen did not close from a mud build up upon the hubs. The change in spacing reduced the small beet loss to a minimum and beet breakage upon the rubber elements was reduced considerably.

After many trials it was realized that a trash removal system separate from the rienks dirt screen was necessary. An attempt to develop such trash separation is therefore in progress. It consists of tests made with four-inch pipe trash rolls which it is hoped will follow a reinks-type screen. The operation of this unit under ideal conditions has proven to be quite satisfactory; however, there are many undesirable features to be overcome.

In order to facilitate ease in comparing the screens just discussed Table **1** is included.

## Field Trials of Operating Screens

To obtain a definite comparison between several types of beet piler screens and learn more of their characteristics a screen test was run. It consisted of hauling beets from one field, harvested by the same mechanical harvester in identical soil type, over five different types of screens alternating from one to another. In such manner it was hoped to reduce the influence of the varying factors upon the comparative results. All weights and tare for each load were recorded. The return dirt was screened and separation of marketable beets, beet tails, leaves and trash, and dirt was made. Weights of each were taken and recorded. An air dry moisture test was run on each load and the moisture present recorded.

Results of trials are given in Figures 4, 5, 6 and 7.

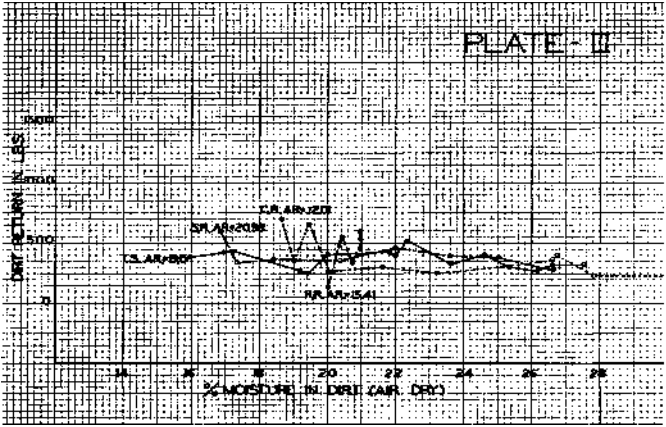


**Figure 7. Effect of moisture upon dirt return is shown upon this plate. It can be noted that there is a reduction for all types of screens used except that composed of rubber rienks elements. This latter condition is due to little or no mud build up on the hubs from the flexing quality of the rubber. Since this screen test was run in extremely light soil the actual reduction in return dirt is not as great as would be expected.**

## SUMMATION AND CONCLUSION

1. **Advancing sugar beet mechanization and necessity for a lengthened storage period of piled beets necessitates more efficient and increased dirt and trash separation.**

2. **From both a practical and economical standpoint the location for intensified trash elimination is at the receiving stations upon industrial equipment.**

3. **Development of highly efficient screens involves the consideration of many problems in connection with increased capacity such as small beet loss, excessive beet damage and mud and rock interference.**

4. Inefficiency of the bar type screen, with reverse chain trash elimination, has necessitated much additional investigation which at present has centralized upon an efficient type of rienks screen with either a reverse rotation trash separation or other more efficient means.

5. A three year trial operation in southern Idaho of rienks type screens has resulted in the formulation of the following conclusions for more efficient separation, namely, (a) speeds should not be excessive but should approach 100 R.P.M.; (b) the fall of beets should be reduced to a minimum; (c) separation of foreign materials from beets should be accomplished in two stages, first dirt separation, second trash elimination; (d) the greatest possible total open area should be allowed in screen design providing that one dimension of each individual opening is not in excess of .75 to 1.00 inch. Open area is not, however, a definite criterion as to trash removal; (e) individual rienks element diameters of 13 and 14 inches have proven best at the above speeds, and should be so constructed as to incorporate in plain view a design allowing as much open area between teeth as structurally possible; (f) a maximum distance of \\A inches between the following edge of preceding and leading edge of the following teeth was found most satisfactory for rienks elements used as, and with, reverse rotation rienks trash return units; (g) individual rienks elements should be made from a resilient material, rubber of 60 to 70 durometer proving the most satisfactory so far; (h) backsloping of rienks flights should not exceed 7° on short run and a reduction to even a level flight in case of a longer run.

6. Future development of beet receiving screens will depend largely upon the continued effort by progressive and interested groups to construct a trash remover which will not be adversely susceptible to extremely muddy and rocky receiving conditions, and will discharge a trash-free undamaged beet to storage piles.