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Dimensional Seed Separations

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DIMENSIONAL SEED SEPARATIONS

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Length Separators

Seeds with identical or nearly identical widths and thickness can be separated on the basis of their length differences. Existing designs of length separators are of two basic types: the Disc Separator and the Cylinder Separator. Both designs have the ability to lift short seeds from an existing mass of material with a given pocket or indent size which will reject particles of a longer nature.

Disc Separator (Fig. 1)

The Disc Separator incorporates a series of cast iron discs with thousands of pockets, each disc rotating on a horizontal shaft internal to the machine. As the discs revolve through the seed mass, the small recessed pockets with an undercut lifting edge will accept particles short enough to lodge in the opening, lifting this product and discharging it approximately 180^{o} from the lift point. Common separations include wheat from jointgrass, morningglory from long grain rice and curly dock from fescue.

In a common disc machine utilized to remove shorter contaminants from a particular seed kind, various disc sizes are arranged from smallest pocket size to largest on the horizontal shaft in the direction of the seed flow. With this type of arrangement, smaller seeds are lifted first while the larger seeds are lifted as the seed mass moves toward to discharge end.

In the actual operation of the machine, the seed enters at one end of the machine, discharging into the machine over 3 or 4 discs, and is gently moved through the eyes of the discs by conveyor blades which are mounted to each of the 3 spokes on each disc. These removable vanes are offset in relation to the disc mounted ahead which creates an operation similar to a screw conveyor to move the seed mass slowly through the open eye of each disc. As the seed moves through the center of the

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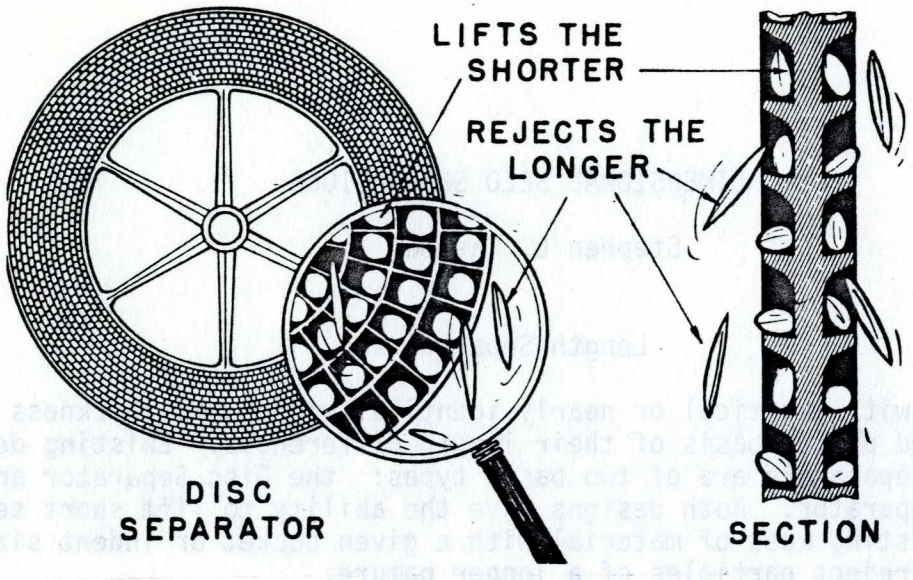

Figure 1. Disc Separator: diagram of separating action.

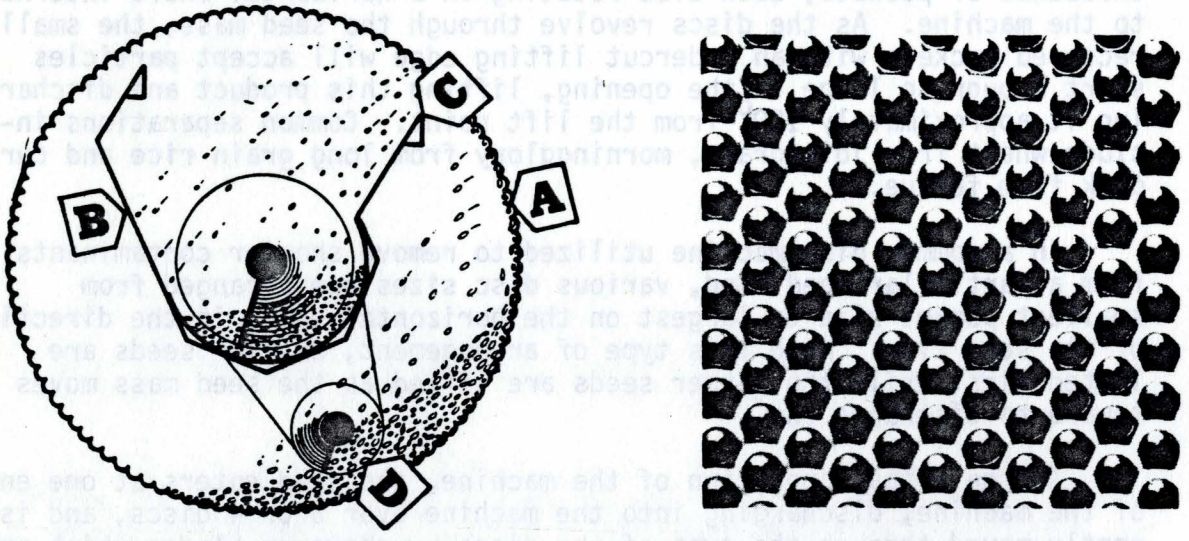

Figure 2. Cross-section of an Indented Cylinder Separator. A, cylinder wall with indents; B, adjustable trough that catches short, lifted seed; C, separating edge of adjustable trough; D, conveyor that conveys long, rejected material out of cylinder. Right: interior surface of cylinder.

machine, each disc comes in contact with the seed mass, efficiently seeking out particle sizes short enough to be accepted by the respective pocket and lifted them out of the seed mass. The conveyor blades and spokes of each disc also act as an agitator, limiting stratification of the seed as it flows down through the disc section. The disc rotor is surrounded by a sheet metal skin which incorporates a receiving port liftings discharge section and tailings or oversized long seed discharge (which is incorporated opposite the feed end).

Disc Pocket Design

The actual disc pocket is formed into a cast iron plate and each pocket is equipped with either a flat or rounded lifting edge which is undercut, similar to an elevator bucket. as the disc passes through the mass of seed at the bottom of the machine, short seed small enough to be accepted and held by the pocket will be lifted by a combination of centrifugal force and the capacity of the seed to be seated in the undercut pockets. The seed is thus lifted or rejected based upon its length and the actual position of its center of gravity. If the center of gravity extends beyond the pocket lip, the seed is rejected. The opposite end of the pocket is tapered, which allows the seed to discharge from the pocket in the same manner that an elevator bucket discharges its load.

There are three types of disc pocket shapes available in various sizes. The widths of the pocket size, measured radially from the center of the disc, is in millimeters. On the V and R type pockets, the length or height of the pocket is identical to the width, and the depth of the pocket is approximately one half of the width.

The R pocket shape is designed with a flat lifting edge and a tapered, rounded discharge edge. The pocket is designed in such as way to reject round seeds but accept flat and elongated seeds such as buckwheat, Canadian thistle and yellow foxtail. The pocket gets its name from rice because its original design was used exclusively for removing broken rice from medium and long grain rice.

The V pocket shape disc is designed with a rounded undercut lifting edge and a flat tapered discharge edge. The V pocket has a tendency to reject elongated, cigar-shaped seeds that have no round surface to bear on and have a tendency to tip out of the pocket. The V is designated for vetch because the rounded lifting edge will accept and lift seeds of a rounded nature such as lambsquarters, spurge and wild mustard more readily.

The various sizes of V and R pocket discs range from 2 1/2 to 6 1/2 millimeters in width of pockets, and 15", 18", 21", and 25" disc diameters. The third disc pocket shape available is designated in letters

denoting pocket size and has no numeral to indicate width, depth and length, but are usually made in radial widths exceeding 3/16". The pockets are all rectangular and are used to separate various crop seeds from unwanted material. In all, there are 75 various pocket sizes available, and common separations performed by lettered pocket discs include the A pocket for separating wheat from wild oats, the B pocket for separating barley from wild oats, and the J pocket for removing broken rice from long grain rice.

In the actual operation of the disc machine, the most important adjustment is the rotational speed of the discs on the shaft which is constant and should not vary many RPM either side of 55 for best results.

Whether the machine is equipped with all the same pocket discs or a combination of pocket sizes depends on how closely the seed mixture has been sized previously. The operator must use the size and type of discs depending upon the shapes and sizes of seeds typically in his product which he would like to remove.

The disc separator is also equipped with a return conveyor mounted on the liftings discharge side of the machine, which is covered by trap doors (usually 1 trap door per disc) that can be opened allowing the lifted material to drop into the conveyor which runs the opposite direction of the grain flow and be returned to the head end of the machine for rerun. This adjustment is utilized when a particular disc or set of discs are lifting material out of the main product stream which is undesired in the liftings fraction of the separation.

Capacity and efficiency of separation is determined by the ratio of the number of small particles to be removed and the number of pockets to do the job. Capacities range from 50 to 300 bushels per hour on a single disc separator. However, these capacities can vary according to foreign material content and product.

Advantages of the Disc Separator

1. Higher lifting capacity per square foot of floor space.
2. Extremely long life; high wear resistance.
3. Rerun adjustment and disc rotor flexibility.
4. Low maintenance.
5. Not affected by seed coat texture, density or moisture content of seed.
6. Performs well on lighter seed (less than 45 lbs. per bushel), i.e., grass seed.

Disadvantages of the Disc Separator

1. Application inflexibility - no quick change disc feature.

2. Disc plugging (commonly only a problem when discs are new).

Indented Cylinder Separator (Fig. 2)

The Indented Cylinder Separator performs the same type of length separation as the disc; however, it requires the additional physical property of gravity to efficiently perform an effective separation. The indented cylinder separator consists of a rotating horizontal cylinder an a movable catch trough. The cylinder is indented with thousands of equally spaced, semi-spherical indentations.

In actual operation, the seed mass to be separated lies in the bottom of the cylinder as the cylinder rotates at a given RPM commonly between 50 and 60 under the seed mass, lifting out the short seeds and at some point before reaching the top of its rotation, the seeds drop from the indent into the catch trough.

The combination of centrifugal force, specific gravity, weight of the product and indent size lifts the shortest particles and carries them the farthest from the seed mass. Next to fall from the indent is the intermediate size seed. The longest seed falls out of the indent only a short distance above the seed mass or are rejected completely. Commonly the shortest particles are lifted first at the head end of the machine because they find the bottom of the indent faster and are more easily accepted and lifted by the larger indent.

Indent sizes within each individual shell are homogenous and are described by numerical notation. The number indicates the uppermost diameter at the top of the indentation in 64ths of an inch. For example: A #19 indent equals 19/64" in diameter. Sizes range from a #2 to a #60 and in all, thirty sizes are available. You want to choose the indent size which will be large enough to satisfactorily lift all the material to be removed without lifting an excessive amount of longer seeds.

Material stratification can occur as the seed mass rolls gently within the rotating cylinder. However, seed line conveyors are welded to the bottom of the catch trough to gently but positively move the product away from the receiving end of the machine down to the discharge end of the machine. These stationary seed line conveyors also create a mixing action, limiting product stratification. New models can be equipped (as an option) with a seed stabilizer rod to prevent the

product from swinging side by side, adversely affecting the separation in low feed rate situations. This feature also limits product stratification and allows the machine to operate much more efficiently over a wider range of feed rates.

The cylinder is commonly installed on a slight incline (approximately 2^{o}) so that the machine will clean out quickly and thoroughly. The catch trough can be quickly disengaged, tipped and dumped further effecting clean out. The indented cylinder separator excels when lifting material that weighs in excess of 45 lbs. per bushel. Seeds of lighter bulk density have a tendency to float over the indent, not finding the bottom, consequently, not being lifted. Therefore, the machine is more practical for small grains and row crop seed than for forage grass seed.

The speed of the cylinder dictates how long the seed accepted by the indent will travel held in the indent before gravity overcomes the centrifugal velocity component causing the seed to fall out of the indentation. Therefore, at a specific catch trough setting, increasing the RPM enables a given indent to lift accepted material farther from the seed mass, or a decreasing RPM will allow the material to drop out closer to the seed mass. The catch trough angle can be adjusted at the setting which positions the trough edge for best separation. The trough position will depend upon indent size, RPM, level of bank of material and seed texture. Individual seed capacities will vary according to bulk density of seed, percentage of lifted material, closeness of the separation and slope of the machine. However, an optimum capacity for an indented separator on an individual machine basis for seed cleaning puposes would not exceed 100 bushels per unit per hour. A new feature currently incorporated in the indented cylinder separator is the inclusion of a split cylinder indent which is an indented drum split longitudinally in two half moons which can be quickly removed through the sides of the machine which are equipped with removable doors. This allows the operator to interchange indent sizes when switching between applications. As a footnote, within the industry there are several sizes of indented cylinders available, ranging from 17" to 23" in diameter and 60" to 90" long.

Advantages of the Indented Cylinder Separator

1. Greater and easier adjustability; can perform a more precise length separation.

2. Easier to clean out.

3. With split cylinder, provides a quick change indent feature offering more flexibility.

Disadvantges of the Indented Cylinder Separator

1. Low capacity compared to disc separator.
2. Has the ability to perform only one separation per size of indent.
3. Does not perform as well on seeds weighing less than 45 lbs./bu.

Disc-Cylinder Separator

A combination of discs and cylinders within a machine offer the seedsman the ability to remove both oversized and undersized foreign material from the product stream at high capacities. The combined unit incorporates the high capacity feature of a disc separator with the more precise length separation capability of the cylinder separator. The unit utilizing up to 8 different disc sizes and 2 different cylinder indents within a single machine removes oversized and undersized undesirable material by sizing the seed to 3 sizes of clean product: short, medium and long.

The new redesigned disc-cylinder separator is equipped with drop bottom doors under disc and conveyor areas of the machine with the cylinders mounted on a 2^{0} slope for quick and thorough clean out. Currently two sizes are offered: the 2533-QC and 2566-QC models. Capacities range from 300 to 600 bushels per hour seed cleaning applications.

Carter Precision Sizer

The precision sizer is a dimensional separator which makes separations on the basis of differences in the width and thickness of seeds similar in theory to the dimensional separating capability of the air screen machine. However, from a design standpoint there are considerable differences.

The Carter Precision Sizer utilizes cylindrical perforated screens. The product is fed into the center of the cylinder which revolves on its own axis at RPMs from 40 to 65 with a 12" diameter, 60" long cylinder, and at 35 to 52 RPMs on the 18" diameter, 84" long cylinder. The physical properties of centrifugal force and the weight of the product enables the seed to find the aperture quickly. Due to the rotation of the cylinder screen, the internal product is continually exposed to open screen area, allowing the product to "see" more screening area in a given amount of time, which increases capacity and screening efficiency. It is not uncommon to achieve screening efficiencies of 98%+ as opposed to a maximum of 85% screening efficiency on a typical flat deck screener

regardless of screening motion. In actual operation the material feeds in one end and it rolls and tumbles gently upon itself covering more than one third of the perforations at all times - more than 14" of circumference is covered the entire length of the cylinder to a depth of 3" to 4" in the 12" diameter, and 4" to 6" deep in the 18" diameter. It requires a minimum of 1 minute for the product to travel from feed end to tail end. The depth of material and the rolling action places a gentle pressure on the particle to give, in effect, a mild press fit for more accurate, uniform sizing.

The actual cylinder screens are available in three types: slotted for thickness sizing, round ribbed and round recessed for width and diameter (width) sizing. Sizes are designated in 64ths of an inch and range from 2/64" to 32/64" for the slotted perforations and 2/64" to 12/64" for the round ribbed, and 12 1/2/64" to 32/64" for the round recessed perforations. Over 95 various perforations are available.

The cylinder screens are designed in such a way as to guide the proper side or dimension of the seed to the face of the opening (Figures 3 and 4). For example, the slots perforated at the bottom of a corrugated groove with steeply slanted sides are to guide wafer shaped particles as much as 6 times as wide as thick so they can be tipped on edge to pass through the screen. Corrugation not only tips the particle on edge, but also lines it up parallel to the slot direction to guide it through. Stratification is impossible, so all particles regardless of weight, shape or texture come into contact with apertures due to tumbling action of the cylinder. The round hole perforations are made in two styles. The larger holes (including the 12 1/2/64") are perforated at the bottom of a deep recess or indentation. The deep recess which could not work on a flat screen, can upend a particle as much as 3 to 4 times as long as its diameter. A different screen construction is used for round perforations smaller than 12 1/2/64". In these smaller perforations a deep rib running lengthwise down the cylinder gives rigidity, efficient tumbling action to eliminate stratification, and a much more open area than could otherwise be obtained.

In addition to the selection of sizes and styles of perforations, there are various accessory separating aids which include a stationary inclined baffle plate inside the cylinder used on slotted screens to increase agitation and help convey when handling slick, elongated seeds such as oats, barley and wheat. In the larger round recessed perforations wide agitator blades are fastened on the inside of the cylinder to aid in tumbling large slick grains which are long and narrow, like corn. Both of these accessories prevent sliding of material on the rising side of the cylinder wall.

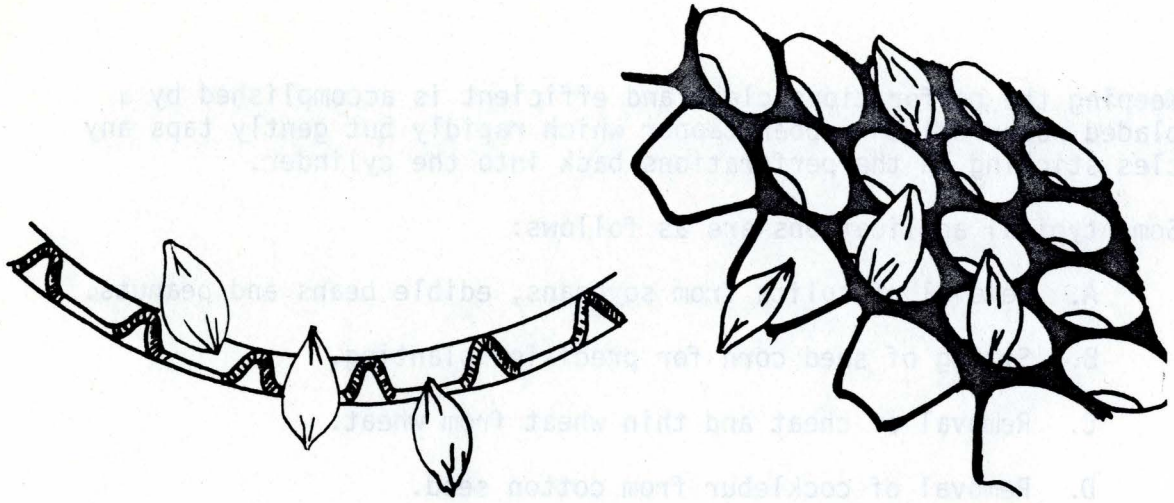

Figure 3. Schematic view of a shell used to make width separations (width).

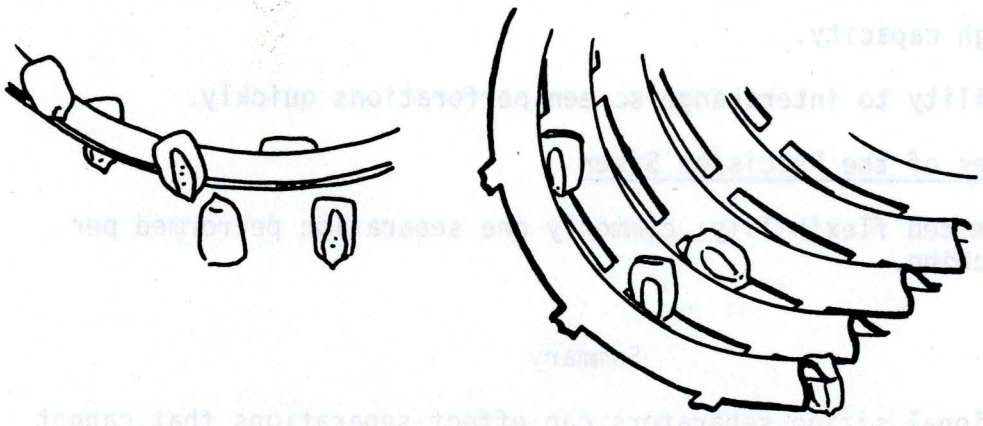

Figure 4. Schematic view of a shell used to make thickness separations (thickness).

Keeping the perforations clean and efficient is accomplished by a five bladed power driven rubber tapper which rapidly but gently taps any particles sticking in the perforations back into the cylinder.

Some typical applications are as follows:

A. Removal of splits from soybeans, edible beans and peanuts.

B. Sizing of seed corn for precision planting.

C. Removal of cheat and thin wheat from wheat.

D. Removal of cocklebur from cotton seed.

E. Removal of wild onions from fescue.

F. Removal of wild oats from barley, oats and durum wheat.

G. Precision sizing of barley, oats, wheat and rice.

H. Separation of red rice from long grain rice.

Advantages of the Precision Sizer

1. The ability to perform extremely near sized separations at high efficiencies.

2. High capacity.

3. Ability to interchange screen perforations quickly.

Disadvantages of the Precision Sizer

1. Limited flexibility; commonly one separation performed per machine.

Summary

Dimensional sizing separators can effect separations that cannot be more, or made as precisely, with other machines.