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SOME USEFUL AND SPECIAL PROCESSING EQUIPMENT

George Dougherty 1/

The machines to be considered in this session more or less complement the basic machines employed in the processing of most crop seeds. They can be classified as being either precleaning or preconditioning machines -- those which improve the condition of the seed before it reaches the basic cleaning machines, or auxiliary machines -- those which perform a specific type of seed separation.

Let us first consider scalpers. Scalping or rough-cleaning is a precleaning operation. More specifically, scalping is a process in which material that is larger than the crop seed is removed from the seed-lot. Rough-cleaning, on the other hand, is a process in which material both large and smaller than the crop seed is removed from the seed-lot. Once considered optional, scalping or rough-cleaning is now regarded as a basic operation by many seedsmen. This is because seed harvested with modern combines are, more often than not, heavily contaminated with foreign material consisting of sticks, stems, leaves, trash and weed seeds. This type of material, which may represent as much as 60% to 70% of the volume of the combine-run seed-lot, needs to be removed before a seed-lot can be safely stored, efficiently dried or effectively cleaned.

Processors preferences differ. Consequently, there are many different sizes and types of scalpers available from which he can select a unit to best satisfy his specific needs (Figures 1,2,3,4). Sizes will range from high capacity receiving type scalpers down to the small diameter reel scalpers found, as standard equipment, on disk cylinder separators. Types will range from the single reel that will remove long stems and straw, or the single flat perforated screens that will remove long straw and green material, to the more complete units consisting of several flat screens or reels with one or more controlled air current separations. A more complete removal of foreign material is possible with the units that incorporate both screening and aspiration. Therefore,

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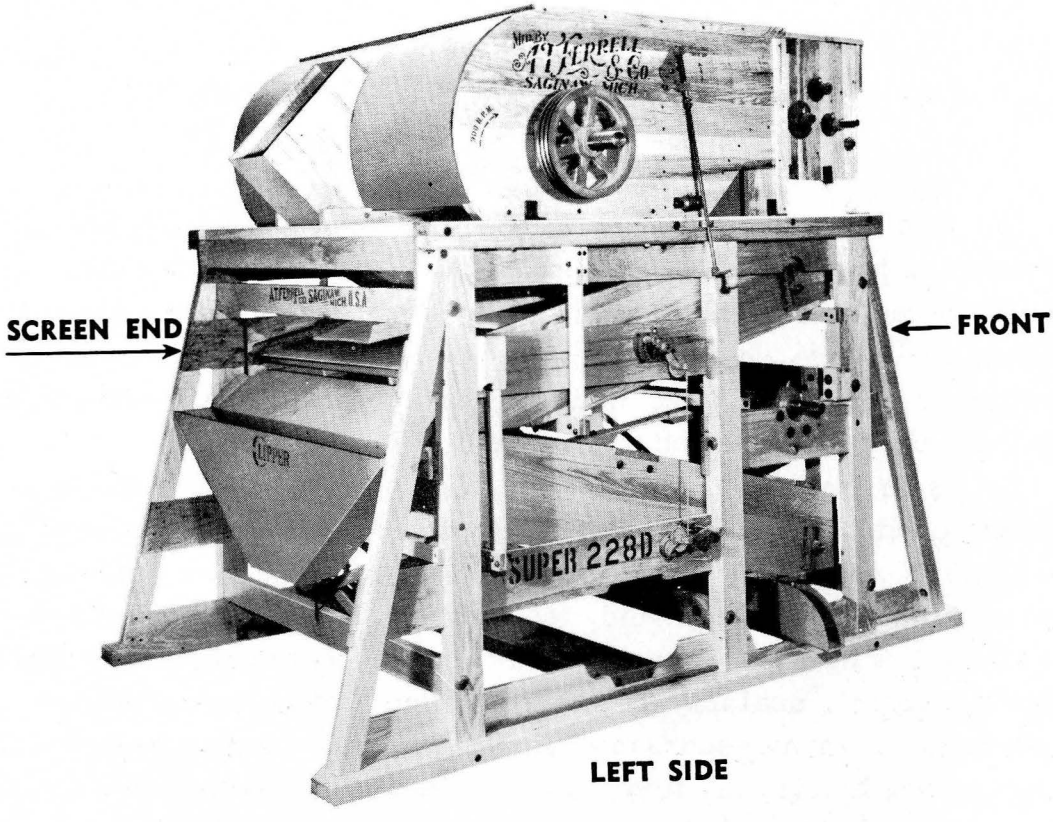


Figure 3. A. T. Ferrell Super 228-D Receiving Separator

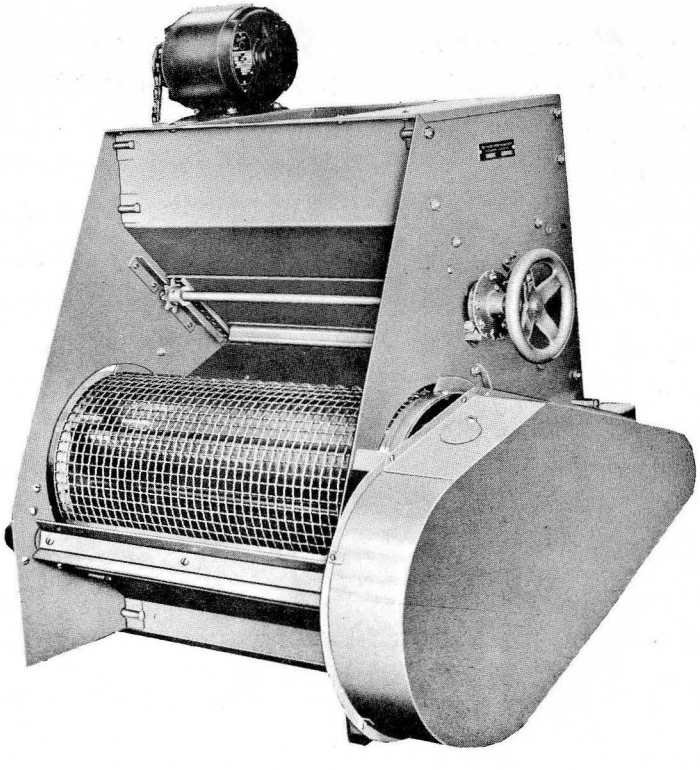


Figure 4. Carter-Day No. 4 Reel Type Scalper

they will usually be most effective in preparing the combine-run seed for further processing on the basic cleaners.

To capitalize on the benefits to be derived from scalping or rough-cleaning the scalper should, with few exceptions, be the first piece of equipment used when the seed comes in from the field. For example, many experienced drying and storage facility operators install one or more receiving scalpers to rough-clean all seed-lots that are to be dried or stored prior to being cleaned. These operators know that by removing most of the trash and green material as the first step in their operation they will experience fewer handling problems, reduce their drying costs and save on storage space.

Likewise, a processing line scalper should also always be the first piece of equipment used in the processing plant. In my opinion it should be installed ahead of the main receiving elevator. A second choice would be just ahead of the air-screen cleaner. Installed ahead of the main elevator it will allow for easier and more rapid elevating of the combine-run seed-lots, and increase the capacity of the holding bins. However, even if installed just ahead of the basic cleaner a scalper still has its advantages. For example, scalping will increase the capacity of the basic cleaner by minimizing feed hopper flow stoppages. As a result, feeding will be more uniform which means that an operator can make more accurate and sensitive machine adjustments. Scalping with a scalper-aspirator unit before the seed-lot enters the processing area of the seed plant has still another advantage. It will help relieve the dust problem, and this is a health as well as a plant safety feature.

Removal of most foreign material will not always complete the precleaning needed for precision cleaning. In many cases the combine-run seed-lot contains unthreshed pods, seed heads, seed clusters or double seed. If good seed loss is to be minimized the processor must break up these unthreshed seed units before cleaning the seed-lot on the air-screen cleaner. A prerequisite for good cleaning results is that all seeds must act as individual particles. Consequently, many seedsmen will install a debearder to complete the threshing operation.

Although primarily designed for the debearding of barley to improve its appearance and planting qualities, debearders are now used with many other crops. Its principle use today is probably the clipping of seed oats to improve their appearance and to raise their test weight. However, some other uses include the partial decortication of sugar beet seed, the hulling of "whitecaps" in wheat, defringing of carrot seed, polishing and removing mold from pepper balls, and the breaking up of flax balls, legume pods and seed heads. Another use is the deawning of weed seeds to permit their separation from crop seeds. For example, by removing the awn and outer glume from watergrass seed harvested with sudan-

grass seed, the size of the watergrass seed is reduced to the extent that it can be separated from the sudangrass seed on an air-screen cleaner. Other similar separations are also possible.

Debearders are available in many sizes and in at least two types. Both types are similar in operation but one uses rectangular shaped beater arms whereas the other uses cylindrical (pipe-like) beater arms. The units here at the laboratory are all equipped with the rectangular beater arms. In these units the beater arms are mounted at a slight angle on a central beater shaft which rotates. Stationary arms positioned along the inside of the housing cylinder prevent the seed mass from swirling or rotating with the beaters when the machine is operating.

In operation, the seed is fed in at one end of the cylinder, conveyed through the unit by the pitch of the beater arms, and discharged through a weighted door at the opposite end of the machine. Removal of beards, points of attachment, hulls, etc. is effective both directly and indirectly by the action of the beater arms. Much of the debearding, however, occurs when the seeds rub against each other.

For satisfactory results a debearder must be adjusted for the kind of seed being handled. Experienced processors know that operating speeds and capacities of debearders are never constant, exact settings must be determined for each run of seed.

Another very useful piece of processing equipment is the huller or huller-scarifier. Following scalping, and possibly debearding, most kinds of seed go directly to the basic air-screen cleaner. Others, principally legumes and some grasses, may require hulling and/or scarification. However, because some seeds lose viability rather rapidly in storage after being hulled or scarified, these processes may be deferred until just before planting time.

The objective of hulling and scarifying is generally to hasten germination by removal of a growth inhibiting substance or by increasing the seed's permeability to water or oxygen. The terms "hulling" and "scarifying", however, refer to two different processes. In hulling, only the hull or husk surrounding the seed is removed, the seed itself remains unscathed. It is generally done to improve the seed's planting qualities but it may also be done to improve the seed's cleaning characteristics. In scarification, on the other hand, the seedcoat itself is scratched or ruptured to facilitate the absorption of water thereby hastening germination. Some examples of seeds that may require hulling and/or scarification are:

A. <u>Seeds that may require hulling</u>:

Bermudagrass, Buffalograss, Bahiagrass, Korean Lespedeza, Kobe Lespedeza, Common Lespedeza, Bicolor Lespedeza

B. Seeds that may require scarification:

Alfalfa, White Clover, Subclover, Hairy Indigo, Crotalaria, Wild Winter Peas

C. Seeds that may require hulling and scarification:

Sweet Clover, Crown Vetch, Sericea Lespedeza, Sourclover, Black Medic

Hulling and scarification may be performed either separately or jointly. A huller-scarifier (Figures 5 & 6) will hull, scarify, or hull and scarify. When using this machine, and hulling alone is desired, the seed are usually either rubbed between two rubber-lined surfaces or impelled against stationary hardened rubber discs. If instead, scarification or hulling and scarification is required, the rubber surfaces are removed and replaced with an abrasive surfaced material such as corborundum stone. A scarifier machine (Figure 7) will usually have permantly embedded abrasive surfaced segments. Therefore, it should be used only when scarification or hulling and scarification is required.

It should always be remembered that scarification is a delicate operation. The severity of the abrasion or the force of the impact must be accurately controlled to prevent seed damage. Correct machine settings should be determined for each individual seed-lot, keeping in mind that seeds with a high moisture content are harder to hull and scarify than seeds of low moisture content.

Scarification should never be attempted until after the seed-lot has been over an air-screen cleaner. Clean seed scarifies much more uniformly, with less seed damage, than "dirty" seed. Therefore, the scarifier should be installed either behind the air-screen cleaner or further along the processing line. Hullers, on the other hand, may be installed either between the scalper and air-screen cleaner or further down the processing line. This will depend on whether all, or only a portion, of the seed is to be hulled. The huller should be located behind the machine that separates hulled from unhulled if only a portion of the seed is to be hulled.

Precleaning and preconditioning machines such as scalpers, debearders, and huller-scarifiers are usually employed to condition seed for easier cleaning or handling. Auxiliary machines such as the spiral, draper, vibrator and aspirator separate seed by classifying them according to physical characteristics.

Spiral separators will separate, divide or classify seed according to shape, density and degree of ability to roll. For example, it is used to separate split beans and corn from whole soybeans, moon flower (Calonyction muricatum) from soybeans, dogfennel and vetch from wheat, peas and vetch from oats,

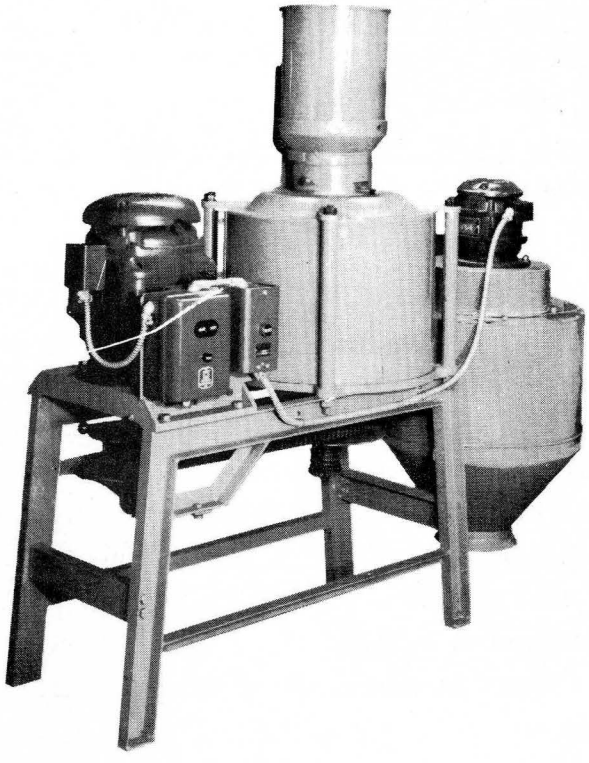


Figure 5. A. T. Ferrell Eddy-Giant Huller and Scarifier

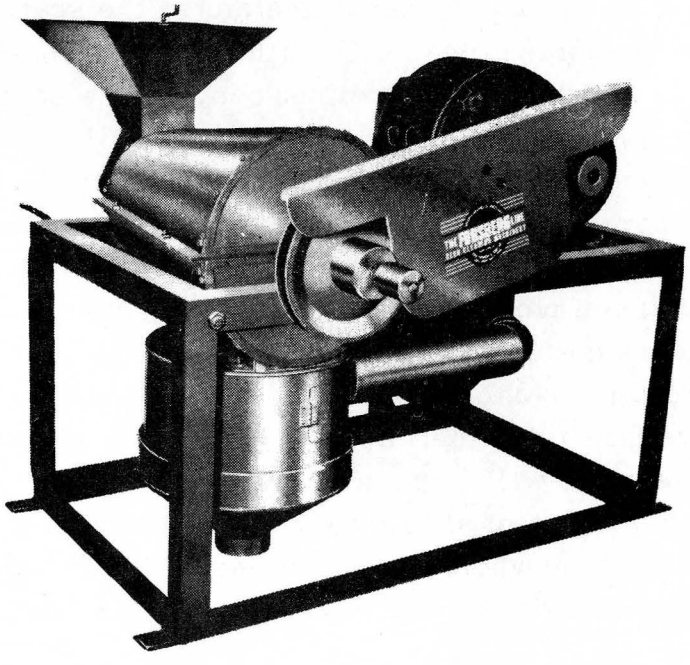


Figure 6. Forsberg Huller and Scarifier

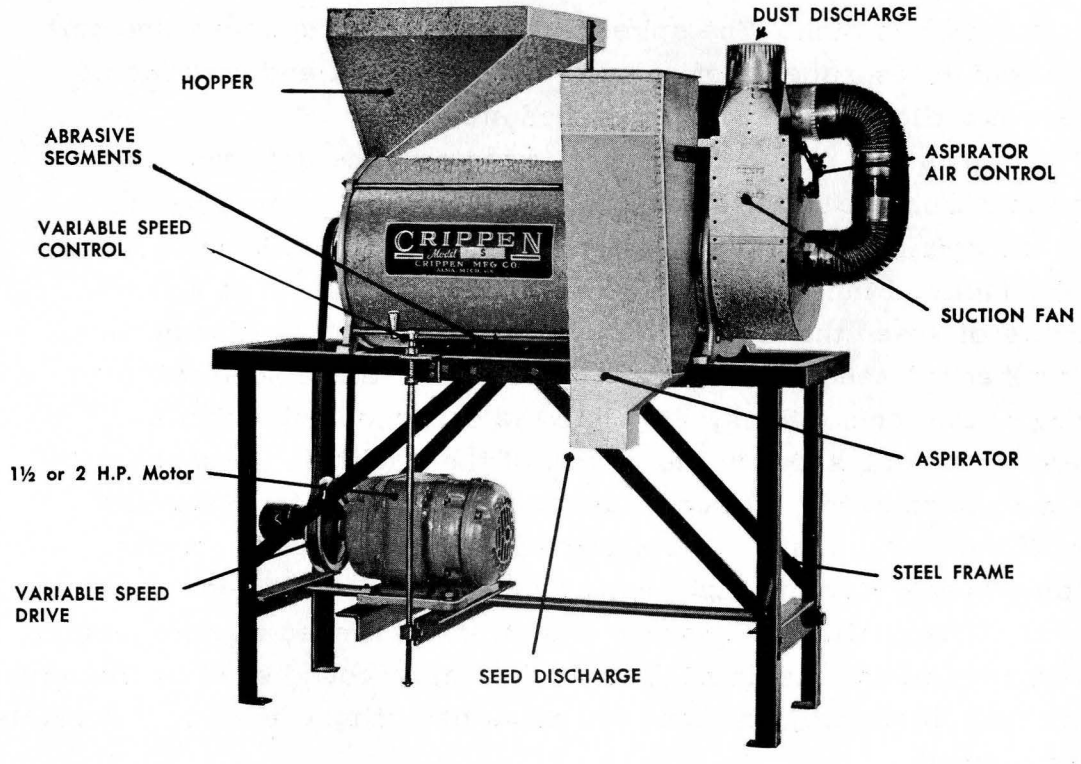


Figure 7. Crippen Model S Scarifier

broken vetch from whole vetch, and, rape and mustard from crimson clover.

A spiral separator (Figure 8), which in appearance resembles a vertically positioned open screw conveyor, is extremely simple to operate. It has relatively few parts, all of which are stationary, and only one significant adjustment, namely, rate of feed. Gravity and centrifugal force provides all the motive power required to make it work.

Basically, this separator consists of a feed hopper, a cone divider (one for each spiral), and one or two spirals. Usually one feed hopper is provided for all spirals grouped into a single unit. The cone divider which is located at the top of the spiral, directly under the opening of the feed hopper, disperses the feed evenly over all the flights of the inner spiral section. The spiral, which is the main separating part of the machine, is made up of an outer housing flight and a series of smaller inner flights onto which the seed are fed.

In operation, the seed mixture is fed onto the uppermost inner spiral flight from the feed hopper. Rate of feed is regulated by the size of the opening in the disc fastened under the feed hopper. Moving down the inclined inner flights, the spherical seed travel at a much faster rate of speed than non-spherical seed. The momentum of the rolling spherical seed increases to the point that these seed roll over the edge of the inner flights, drop into the outer housing flight and discharge through a spout in the bottom of the machine. In contrast, the less rounded seed continue sliding down the inner flights to the bottom of the machine and are discharged through a separate spout. Some spirals will have multiple inner flights arranged in order of increasing size. These units will produce gradations of a seed mixture ranging from flat seed on the inside flight to high-density round seed on the larger outer flight. Therefore, on these machines each flight leads to a separate discharge spout.

The need for spirals is diminishing however, because of machines such as the disk and cylinder separators, that will perform many of the same separations more efficiently. Although very economical, that is, simple to operate and requires no source of power to make a separation, spirals have two major disadvantages, lack of flexibility in adjustment and very low capacities. For example, a spiral designed for use with small seed cannot be used effectively with large seed because the angle of bank and the size of the flights are fixed by the manufacturer. Also, capacities run in the range of 200 to 700 pounds an hour, depending on

the seed being separated and the percentage of round seed in the mixture.

Spirals do, however, offer certain advantages to a seedsman. In addition to being economical to install and operate they are light-weight. Consequently, easy to move. This can be a distinct advantage in that when it is not being used it can be stored out of the way. Also, it can be shifted from one location to another within the plant easily and quickly. Furthermore, it is sometimes more convenient to move a machine than it is to move several hundred bushels of seed.

The inclined draper, like the spiral, separates seed on the basis of a difference in ability to roll. However, it offers more flexability and is more sensitive to differences in seed-coat texture than the spiral. It is very useful when there is a need to separate smooth or round seed from rough, flat or elongated seed. For example, the removal of vetch from oats, or crimson clover from fescue or ryegrass seed.

A draper machine (Figure 9) has four component parts, a feed hopper, one or more inclined draper belts, a tilt mechanism and a variable speed control mechanism. As in the case with all cleaning machines, a single feed hopper is provided for all draper belts in a single machine. From the feed hopper, seeds are fed into metering devices that distribute them uniformly to each belt for cleaning.

The draper belts are the separating parts of the machine. They are mounted in an inclined position and move, or travel, in an up-hill direction. Each draper is a specially made endless belt usually of plastic or canvas, but available in materials with varying degrees of surface roughness. Numbers and size of belts can be expected to vary from machine to machine. In a commercial operation usually more than one belt is used in a single machine. However, each belt is a separate cleaning unit. An increase in draper belts will not increase efficiency, it merely increases capacity. The tilt, and variable speed, mechanisms provide a means by which the pitch, or slope, and speed of the drapers can be adjusted to match the characteristics of the seed being cleaned. All drapers in a single machine will have the same pitch and will travel at the same rate of speed.

In operation, the seed mixture is fed from the feed hopper to the metering device that distributes it in a narrow band in the middle, and across the width of, the moving inclined draper belt. The non-rolling or non-sliding seeds (upper fraction) are carried to the top of the slope and discharged from the belt into a spout. In contrast, the round or sliding seed (lower fraction) roll or slide down the face of the inclined plane and are discharged from the belt into a separate spout at the opposite end of the machine (Figure 9).

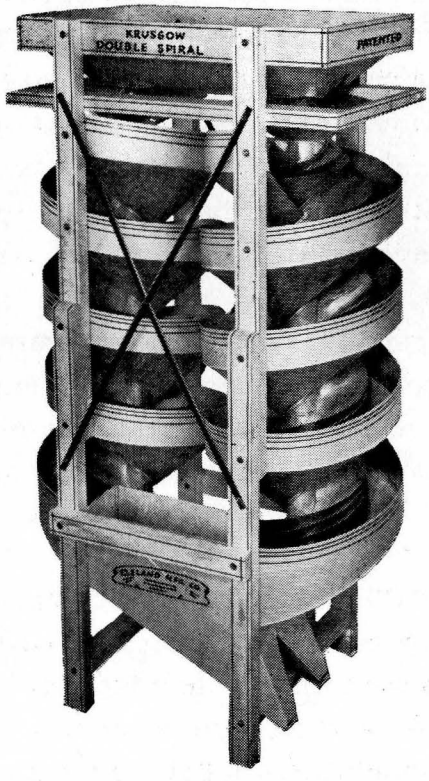


Figure 8. Krussow Double Spiral Separator

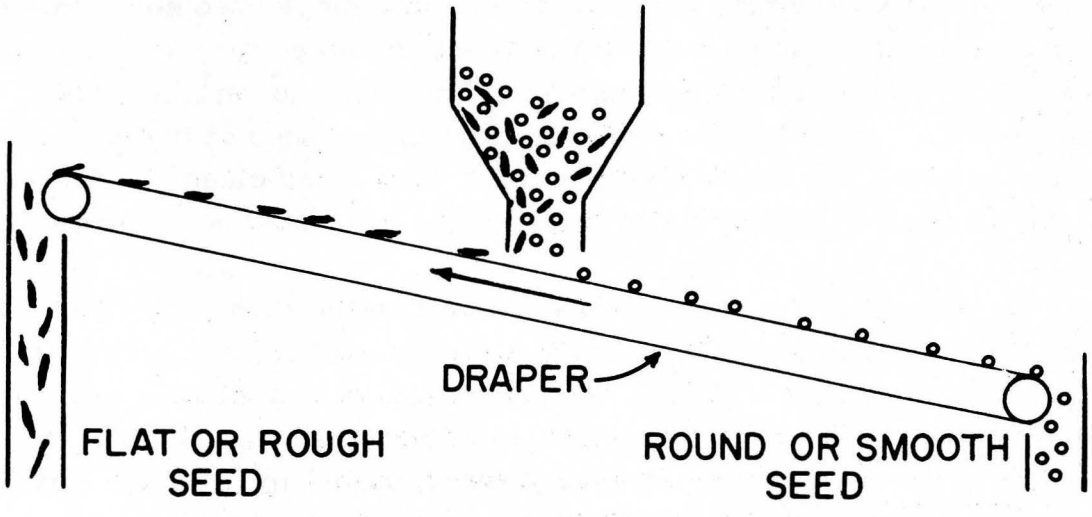


Figure 9. Inclined Draper, Section View

The draper is a finishing machine. It should always be used after the seed mixture has been over the basic cleaning machines in the processing line. Preferably, after the mixture has been reduced to a single contaminant. Some helpful pointers on adjusting a draper follow:

1. Feeding:

   Uniform feeding is essential for best cleaning results. The rate of feed should be such that each seed on the belt is allowed to act individually. That is, round and smooth surface textured seed should not be restricted from rolling or sliding down the inclined plane by the immobile rough textured seed. Likewise, the rough textured seed should not be forced to move down the inclined plane by the rolling or sliding seed.

2. Draper Belts:

   Belts with varying degrees of surface roughness are available. The correct belt for any particular separation will depend on the characteristics of the seed mixture. Smooth plastic belts will usually permit a more precise separation and should be used if a sliding action is desired for the lower fraction. Use a rough surfaced belt, such as canvas, when rolling tendencies predominate in the lower fraction.

3. Angle of Inclination:

   The angle of inclination, or slope, of the draper belt can be varied and it should be adjusted to match the characteristics of the seed in the mixture. When properly adjusted none of the rolling or sliding seed in the mixture (lower fraction) should be carried to the top of the slope.

4. Speed:

   The speed of the draper belt can be varied. When properly adjusted, none of the flat or elongated seed (upper fraction) should be discharged off the lower end of the belt.

A more recently developed machine, one that makes a separation roughly similar to that of the draper, is the vibrator seed separator. Like the draper it is also a finishing machine. Some examples of separations that have been made with the vibrator cleaner are: Johnsongrass from alfalfa, curley dock from crimson clover, dogfennel from timothy, sweet vernal grass from ryegrass and lambsquarter from carrot seed.

In its simplest form, the vibrator separator consists of a single inclined

rectangular deck mounted crosswise on top of an electromagnetic vibrator. The deck, which may have a smooth or a rough textured surface, can be tilted both sideways and endwise. The intensity with which the deck vibrates is regulated by a rheostat controller in the electrical circuit.

In operation, the seed mixture is fed onto the center of the upper end of the deck. As the mixture moves across the vibrating deck toward the discharge end, the rough surfaced and flat seed "crawl" up toward the high side of the deck. In contrast, the more spherical or smooth seed, lacking the traction of the rougher and flatter particles, slip, slide and roll down toward the lower side of the deck. Adjustable dividers positioned along the discharge end of the deck keep the various fractions separated as they are discharged.

The vibrator separator has been used experimentally to make some very difficult separations. However, its high cost and low capacity severly limits its use in the seed industry at the present time.

The three auxiliary machines discussed so far in this session have separated seeds on the basis of difference in shape, or shape and surface texture. Seeds, however, differ from one another in several other ways. For instance, seeds will differ in terminal velocity if they differ in size, shape, surface texture or specific gravity. Air separators, such as aspirators and pneumatic separators use the movement of controlled air currents to classify seed according to their terminal velocity.

Terminal velocity is the air velocity that will suspend a seed in a confined rising column of air. When seed fall through a column of rising air they encounter a restraining force. The strength of this force, which is an air resistance force, will be influenced by such seed characteristics as shape, size, surface texture and specific gravity. As the air velocity is increased the air resistance force increases until an air velocity is reached that just suspends the seed in the air column. This speed is known as the terminal velocity.

The terms "aspirator" and "pneumatic separator" are not synonymous. Both aspirators and pneumatic separators utilize the same principle to separate seed but there is one primary difference in these two machines, namely, the location of the air source. Aspirators will always have a fan at the discharge or exhaust end of the air column, whereas pneumatic separators have a fan at the intake end of the air column.

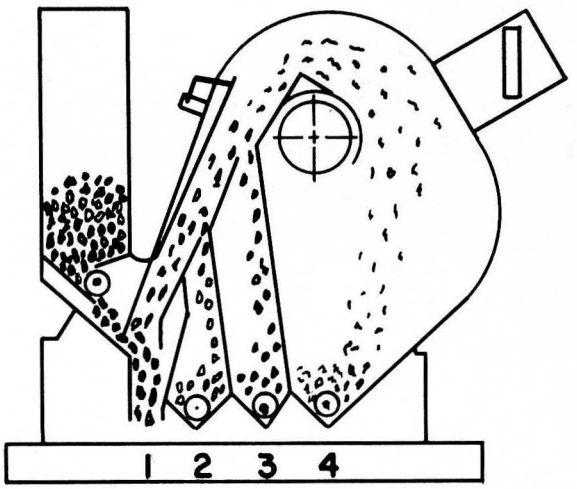
Air separators can be classified into three general types, scalping aspirators, fractionating aspirators and duo-aspirators, and pneumatic separators.

Scalping aspirators are precleaning machines. They are used to separate sticks, straw, weed seeds, dust, etc. from the seed-lot. In operation, the seeds are fed from the hopper through a rotating cylinder-like scalping screen. This removes the sticks, straw and large coarse material. Seeds smaller than the openings in the rotating screen fall into the aspirating chamber through which air is drawn. As the seeds fall into this air stream, the light trash, shriveled crop and weed seeds are separated from the heavy plump seed. The light seed and trash have a terminal velocity less than the velocity of the air stream. This enables them to be separated. The air velocity through the aspirating chamber is controlled with an adjustable gate.

The fractionating aspirator (figure 10) and the duo-aspirator are finishing machines. They have many uses. For example, they are used to separate low-test-weight seed from high germinating seed, after the seed has been uniformly sized. Used in this manner the aspirator is generally the last machine used in the processing line. Aspirators will also be found installed ahead of spirals and color sorters to remove dust and light trash. The fractionating aspirator is so named because different fractions of a seed lot corresponding to seeds with different terminal velocities may be obtained. In operation, the seed are fed from the hopper into an air column. The heavy seed fall against the air flow and out the air inlet. The lighter seed, chaff, weed seed, etc. are lifted by the air column. The air column is constructed at an ever widening angle. Therefore the velocity of the air is constantly decreasing. When a point is reached where the terminal velocity of the seed is greater than the velocity of the air, the seed fall into different outlets. The duo-aspirator operates essentially the same as the fractionating aspirator except that only two products can be obtained, a light fraction and a heavy fraction.

The pneumatic separator (figure 11), like the duo-aspirator gives only two fractions, a light product and a heavy product. In operation, the seed are fed into the machine through a feed chute into a vertical column of air. The air stream is created in a different manner than on the previously mentioned aspirators. With the pneumatic separator a fan at the bottom of the air column creates an air blast which forces air up through the column. As the seed to be cleaned fall from the feed chute into the air stream the light material, possessing a lower terminal velocity than the heavy material, is forced to the top of the air column. The heavy material falls against the air stream until it is deflected by an inclined wire mesh screen into the heavy seed discharge spout.

Seed equipment manufacturers have done an outstanding job of providing the seed industry with the equipment needed to condition and clean seed-lots to a very high level of quality. During this session we have considered only a few of them.



KEY

1. HEAVY SEED DISCHARGE
2. HEAVY LIFTINGS
3. LIGHT LIFTINGS
4. LIGHT WASTE

Figure 10. Fractionating Aspirator, Cross-Section View

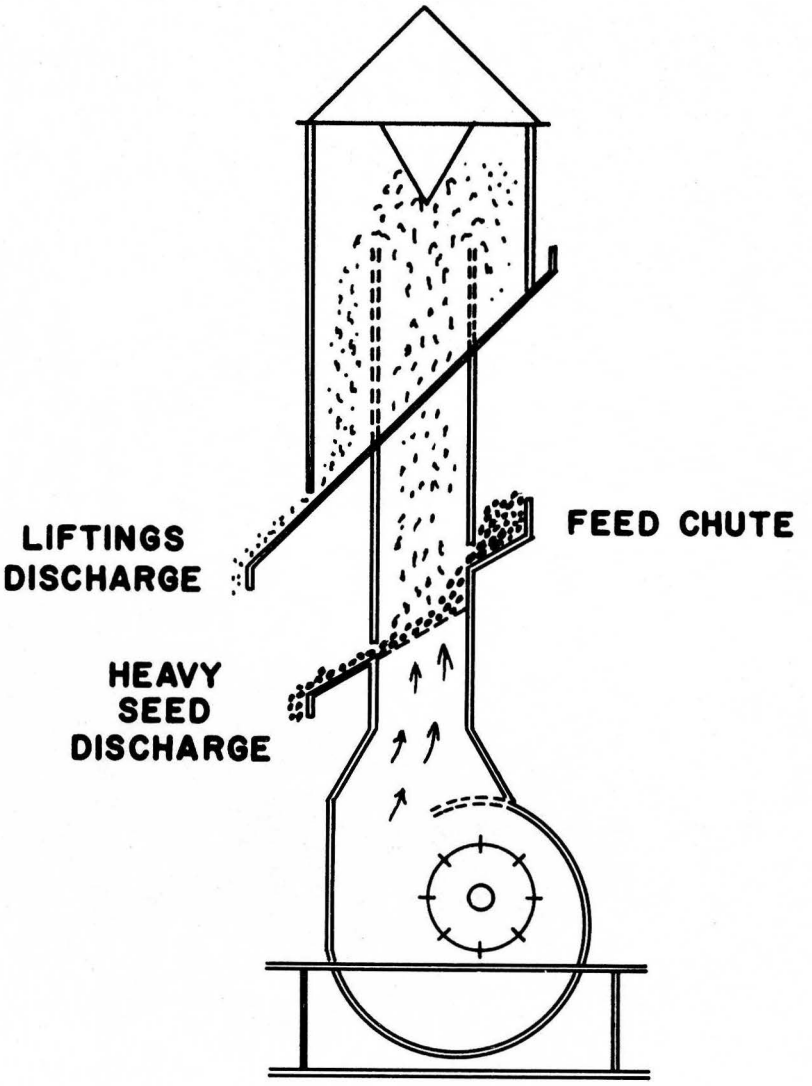


Figure 11. Pneumatic Separator, Cross-Section View