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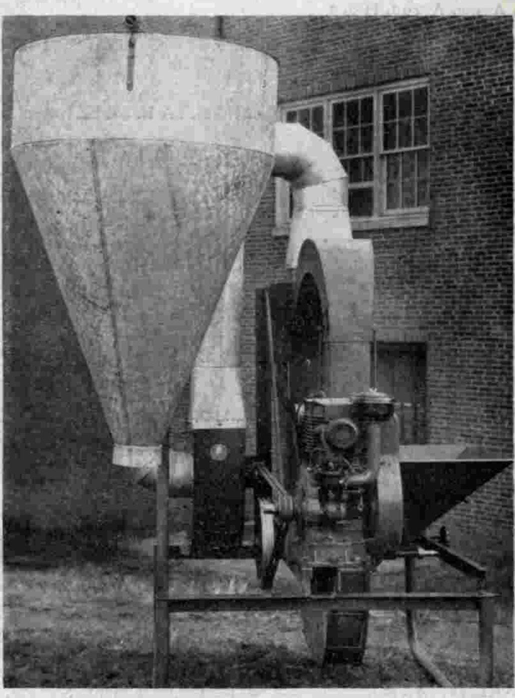

End view of improved castor-bean sheller.

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INTRODUCTION

A castor-bean sheller, incorporating new shelling principles, but of small capacity, is described in Bulletin No. 179, issued by this Station in May, 1942. The present bulletin describes a larger, improved machine, adapted for commercial use, and gives field results and shelling capacities. The developments were made possible by a cooperative arrangement between the University of Tennessee Agricultural Experiment Station and the Tennessee Valley Authority. This grew out of an effort to enhance the program of the U. S. Department of Agriculture for expanding the production of castor beans in American countries so as to insure a supply of castor oil, an allocated material.

Aside from the increased industrial demand for castor oil, especially as a fluid in control equipment, such as hydraulic brakes, shock absorbers, and retractable landing gears on planes, new but essential uses are taxing the supply. Sebacic acid from castor oil is one of the ingredients of nylon, used for parachutes. Dehydrated castor oil is used in quality paints, varnishes, and linoleums, displacing tung and perrilla oils. Its industrial importance now is well known, as in the production of cutting oils, capryl alcohol, rubber substitutes, and synthetic resins for bonding high-speed abrasives; as an organic coating to replace tin; and as a lubricant or a lubricant additive for use in extreme cold, as at high altitudes.

DESCRIPTION OF SHELLER

This machine, because of its capacity, is termed the "commercial" size. It has 24-inch-diameter shelling disks and an hourly capacity of 20 to 30 bushels, or 900 to 1400 pounds, of shelled beans. It requires a 3-h.p. electric motor or a 5-h.p. gasoline engine. Besides shelling the beans, it separates the hulls and trash from the seed. It was designed with a view to the use of substitute materials in its manufacture wherever feasible. Five machines were requisitioned by the U. S. Department of Agriculture and used under various conditions in six states last season. They proved satisfactory except where plywood was substituted for sheet metal. Some of the plywood had to be renewed during the season because of wear. In shelling percentage, portability, and preference of the operators, they were unequaled.

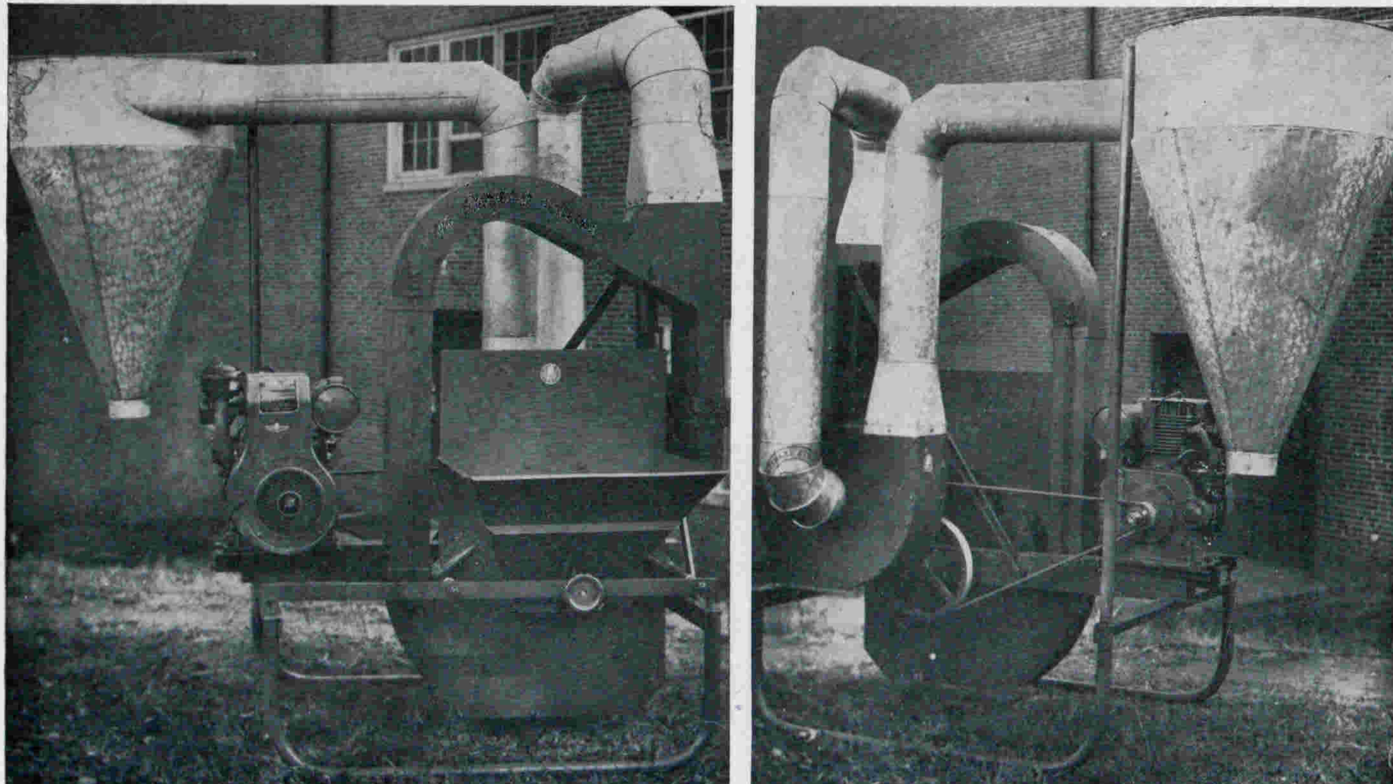


Fig. 1—Hopper side (left) and rear, or drive, side of 24-inch sheller.

This machine, in shelling principle, is the same as the earlier models, but the separator is a combination of pneumatic elevator and cleaner parts incorporated as an integral unit, as illustrated in figures 1, 2, 3, and 4. A fan elevates the seed, by suction, to sacking height and removes the hulls, or shells, as the seed drop through a cleaning duct into a bagger. The dust is drawn away from the operator and discharged into a cyclone collector, which may be located outside the building. This unit is illustrated diagrammatically in figure 5. No sieves or screens are used. The fan and one disk are the only moving parts. The disk type of sheller was selected because of the simplicity of construction, safety from damage by foreign objects, "self-feeding" characteristics, and minimum injury to the beans. In normal operation, the spacing between the disks is greater than the length of the shelled bean, but less than the bean in the shell. Thus the shells are removed by pressure on the ends, and the beans cannot be injured unless two or more are wedged together. The feeding of the beans centrally between the disks causes the layer to spread or become thin as the beans move outward, thus reducing the chances of wedging.

The compactness of the machine, its relative lightness, and the mounting on steel runners or gliders which fit into a pick-up truck facilitate portability. Only two rotating shafts are used, and these are mounted in ball bearings provided with large lubricant reservoirs. The larger shelling disk permits the mounting of a 4-bushel hopper, which eliminates the need for a feeding table. One man can operate the machine, keep the hopper filled, bag the shelled beans, and check adjustments. The spacing between the shelling disks is spring-tensioned. If a large object gets between the disks and holds them apart, they are forced back into position by springs after the object is discharged.

Under ordinary conditions, the machine should shell from 95 to 98 percent of the beans and crack less than 2 percent. Similar machines shelled over 98 percent in nearly all cases if the beans were dry. With Kansas Common, U. S. No. 4, Arlington, Miller, and Stokes, including several lots of each, as harvested at this Station, shelling percentages varied from 96.8 to 99.8, with 1.8 to .04 percent crackage. Out of one lot of Miller castor beans, well dried and ranging in length from .565 to .778 inch in the shell and from .56 to .705 inch after shelling, 99.4 percent were shelled, .05 percent remained in the shell, and .55 percent were injured. With certain lots of Arlington, Stokes, and Miller, shelling percentages over 99.8 were obtained; the percent remaining in the shell varying from .08 to .14 and crackage from .04 to .19.

As accuracy and skill are required in construction, it is recommended that the machines be obtained from reliable manufacturers.

OPERATION OF THE MACHINE

After being dumped or shoveled into the hopper, the beans in the shell flow through the opening in the center of the stationary disk and against the rotary disk. The rotation automatically feeds and circumfuses the beans between the disk faces, breaks up the capsules, removes the

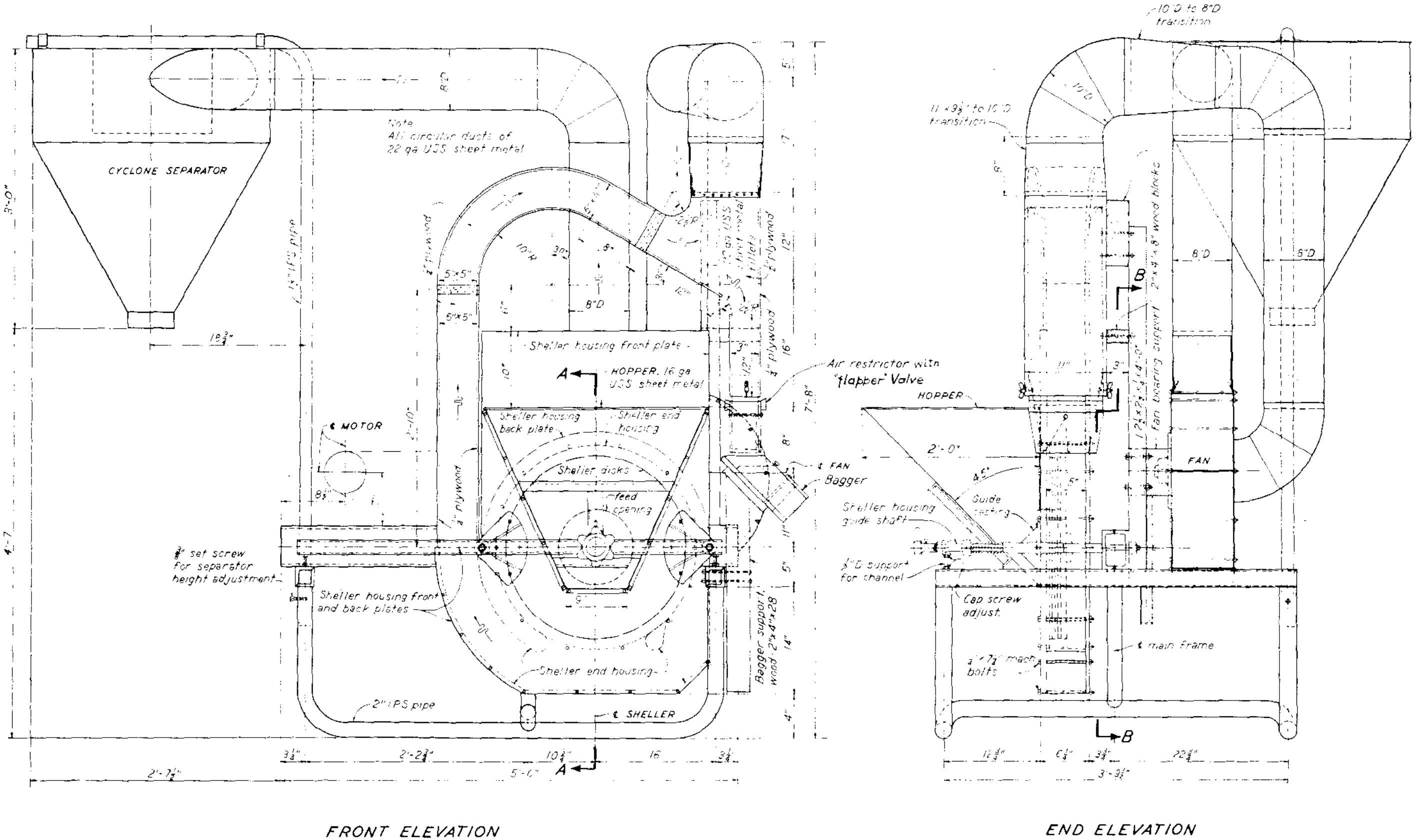


Fig. 2—Assembly layout.

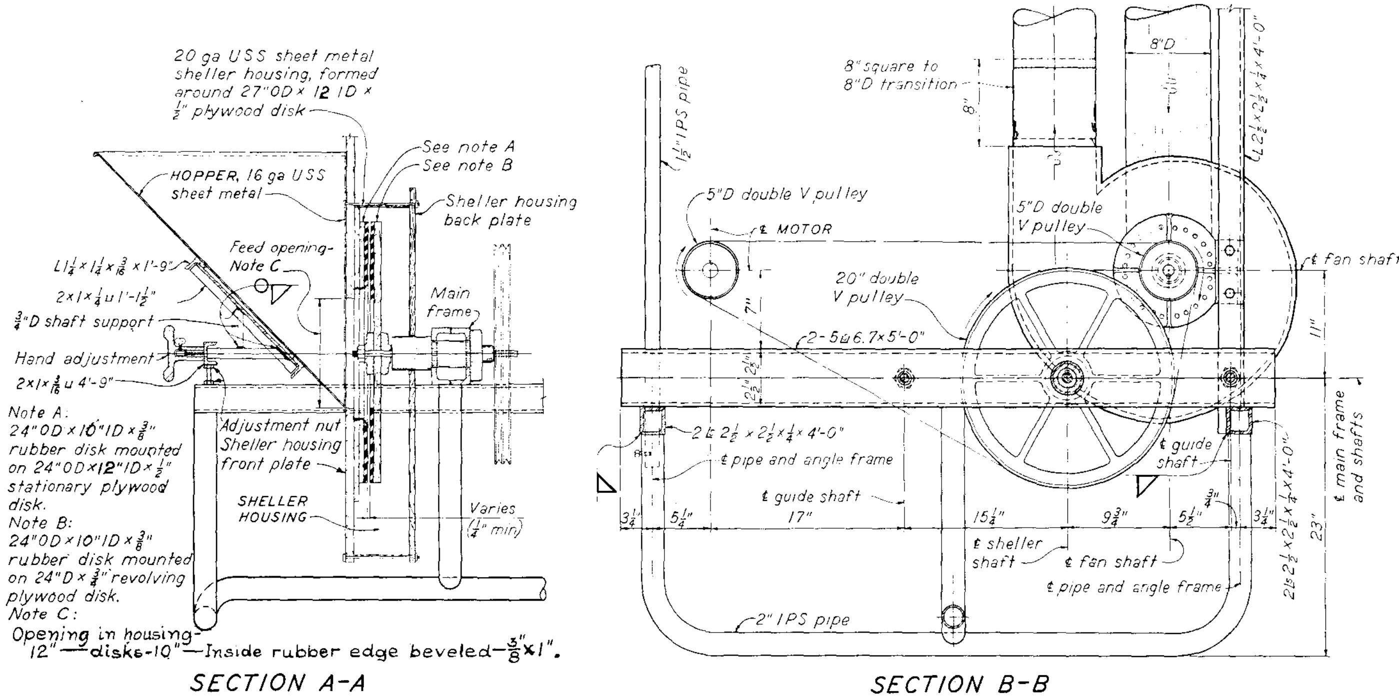


Fig. 3—Sectional views showing shelling disks and drive arrangement.

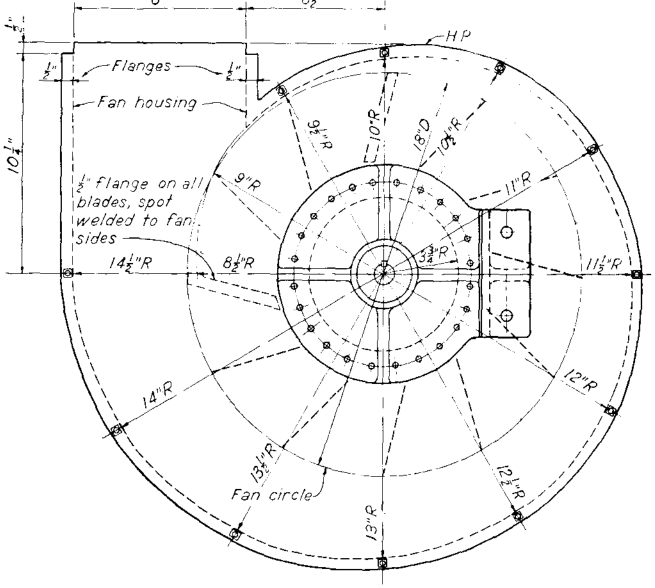
shells, and discharges the shells and beans at the periphery. These drop into the intake of the elevator duct for delivery to the separator part, where the shelled beans drop down through the cleaner and bagger. The larger cross-section area reduces the air velocity from about 3400 feet per minute in the elevator duct to about 2000 f.p.m. in the separator part, which permits the beans to drop out. The shells, dust, and light seed are carried up with the air through the fan and delivered to the cyclone collector, where they drop out by gravity. The cleaner duct is long and narrow in cross section, and an inverted V-shaped "flapper" valve at the lower end further restricts the air inlet but permits the sound shelled beans to drop down through the cleaner against the upward air stream, for the removal of remaining trash, and then into the bagger.

The shelling disks are faced with a ⅜-inch thickness of soft abrasive-resistant rubber, similar to inner-tube tire rubber in resilience, having a specific gravity of about 1.22 and composed of about 40 percent pure gum. The rubber was cemented to the plywood disks with a good grade of rubber-tire patching cement. The process is the same as that used in patching inner tubes, except that extra coats of cement must be applied to the absorbent wood surface. Numerous light blows with a hammer are required to tap the rubber on the wood for a good bond. The stationary rubber-disk facing is provided with a 1-inch bevel at the center opening. The beveling, the speed, and the size of feed opening through the disk affect the shelling rate. The bevel is essential, not only to guide the beans between the disks, but to break up clusters or capsules into single beans small enough to enter the shelling space. Beveling the rotary-disk rubber also increases the shelling rate, or capacity. Too much bevel will overload the shelling disks, increase seed crackage, and permit large stones or other objects to get between the disks.

The spacing between the disks is adjustable for varieties of castor beans of varying size. Such varieties should not be mixed for shelling. If mixed beans are to be shelled, they may be graded with rotary screens—or thicker and more resilient rubber may be used on the disk faces. Batches containing many shelled and cracked beans make the rubber surfaces oily, so that the disks fail to turn the beans lengthwise across the space for shelling. Such batches should be mixed with other lots—or specially grooved rubber disks may be used.

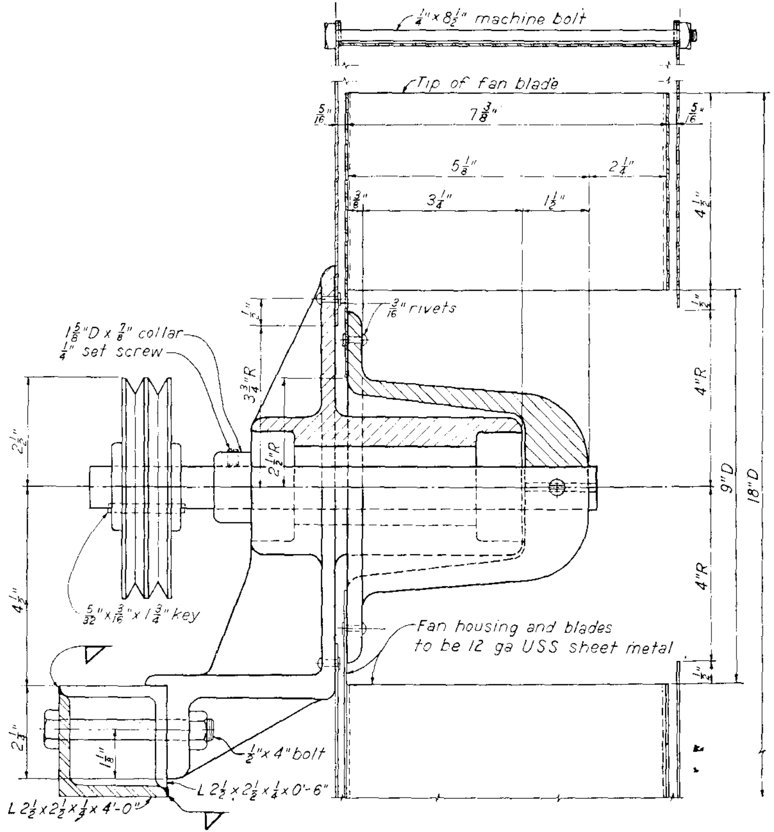
ADJUSTMENTS

Parts requiring adjustments are the shelling disks, separator, and cleaner. The shelling disks are adjustable in alignment and spacing. The spacing is adjustable by means of a hand wheel on the front of the hopper, which slides the stationary disk, including the disk housing and hopper, as an assembly, on two supporting shafts. Springs press the assembly toward the rotary disk, while the threaded hand wheel limits the action of the springs. The compression of the springs should be ample to hold the stationary shelling disk in position except when foreign objects get between the disks. The speed of the 24-inch rotary shelling disk should be about 380 r.p.m.



FRONT ELEVATION-FAN HOUSING

REAR ELEVATION SIMILAR EXCEPT OPPOSITE HAND



SECTIONAL PLAN-FAN ASSEMBLY

Fig. 4—Fan details.

The spacing between the disks is adjusted to the approximate length of the shelled beans. If too many beans remain in the shell after the machine is started, decrease the spacing by turning the hand wheel to the left. If too many are cracked, turn the wheel to the right. The accuracy should be within one-fourth turn.

If the machine, after adjustment, fails to shell sound dry beans without crackage, the disks may be out of alignment. This may be due to careless handling, uneven floor, unequal spring tension, or sticking of the sleeves and failure of the disks to slide on the guide bars, especially after large objects are discharged. One way to check the disk alignment is to remove the sheet-metal band around the shelling-disk housing, adjust the disks until they touch, and note where they fail to meet. Instead, the spacing may be checked with a round rod or dowel, about ½ inch in diameter and about 9 inches long, placed radially between the disks through the feed inlet, or opening. Adjust the disks so that both barely touch the dowel. Rotate the disk, and hold the dowel lightly to note the place where it stops rolling or is loose. If it is loose at the top when in a vertical position, raise the outer ends of the guide shafts with the ½-inch bolts on the channel support ends. If it is loose at the bottom, lower the channel. If looser on one side than the other, change the distance between the channel and main frame by adjusting the guide shaft. Increasing the distance between the channel and frame increases the spacing between the disks on that side. Spacing washers may be used on the guide-shaft ends to change their effective length.

The separator is proportioned so as not to require any adjustment under ordinary conditions. The fan should be run at about 1900 r.p.m. If it runs too slow it will not elevate the seed; if too fast it will carry the seed over with the hulls. When the elevation of the seed is good but hulls and light seed are not removed, even with the cleaner properly adjusted, an opening may be cut in the lower part of the separator duct near the cleaner to provide additional air velocity to carry off the hulls. Making the cross-section area of the upper duct smaller by placing 1″ x 10″ x 12″ wood blocks on one side in the duct may be equally effective without requiring an increase in fan speed.

The air inlet into the cleaner duct is adjusted by raising or lowering of the "flapper" valve housing, or air restrictor, below the cleaner. This air inlet should be as small as possible without letting light seeds and shells come down with sound seed. Too much air entering through the cleaner causes poor elevation unless the fan speed is high.

The lubrication of the fan-shaft and shelling-disk-shaft bearings needs to be checked seasonally and some semi-fluid ball-bearing lubricant added. Although the bearings are provided with good seals and large reservoirs, a thin lubricant may leak out when the machine is being moved or transported. A heavy grease results in poor lubrication, especially in cold weather. Occasionally a few drops of oil may be applied to the wood bearing of the flapper valve pivot.

Where ducts are of plywood, parts may wear out before the end of a season and need to be repaired or replaced. Lining with sheet metal or rubber prevents such wear. Air leaks result in poor operation.

The machine should not be run with the rubber disks touching each other or with the air inlet of the sheller housing clogged and filled with beans, because the heating ruins the rubber or causes it to peel from the disk plates. For the operation of the power unit, the manufacturer's instructions should be observed. After a seasonal run, the machine should be cleaned for inspection, repairs, and storage.

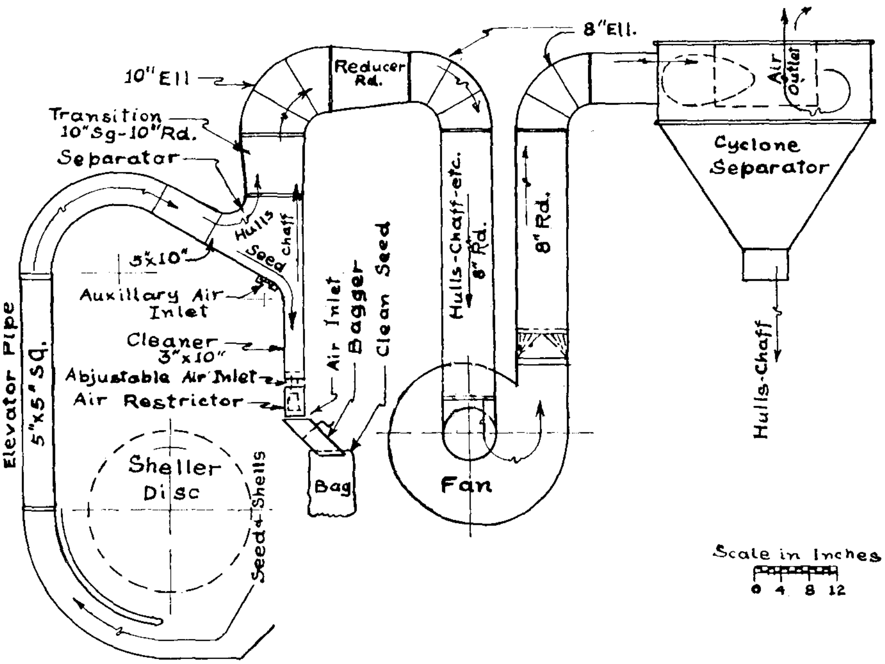


Fig. 5—Diagrammatic layout of elevator-separator-cleaner unit.