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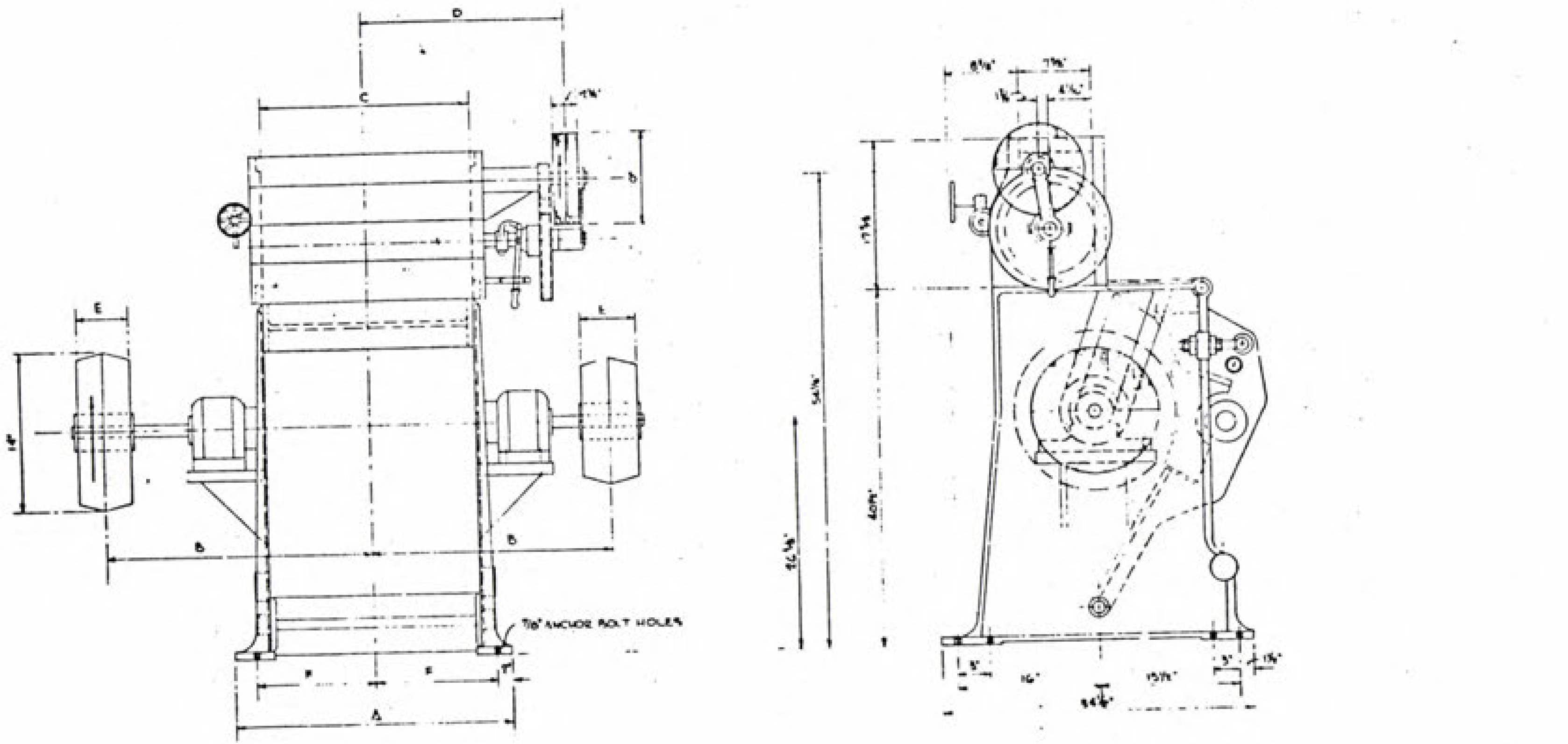


SIZE OF HULLER	DIMENSIONS IN INCHES A	B	C	D	E	F
24"	36 3/4"	27 7/8"	24 3/4"	21 7/16"	5 1/4"	16 3/8"
36"	48 3/4"	33 7/8"	36 3/4"	27 7/16"	6 7/8"	22 3/16"
48"	60 3/4"	41 1/2"	48 3/4"	33 7/16"	8 1/4"	28 3/16"

SHEET IDENTIFICATION
PERFECTION HULLER
PROJECT IDENTIFICATION
FIGURE No 1

PART ONE

THE HULLER

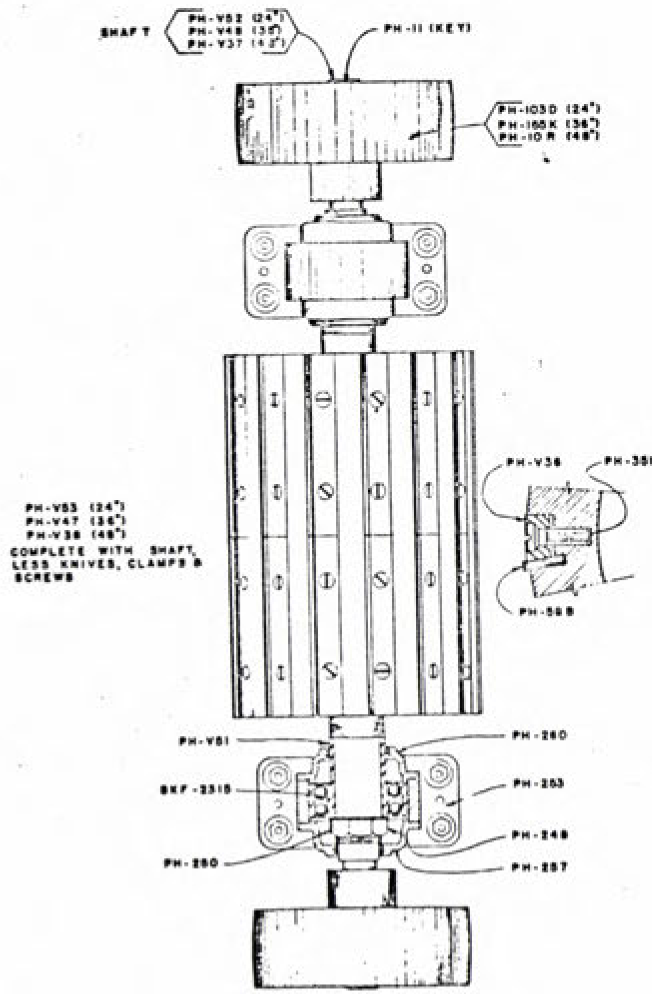
The universally accepted method of hulling, or cracking the seed is with a Bar Huller, illustrated in Figure 1. Details and part numbers are shown on Figures 1a and 1b. Many years experience has convinced oil mill operators and engineers that the bar huller will allow better separation, by producing less oil in hull; less fine hull to interfere with protein control; operate with less power and present less fire hazard than any other type of huller, regardless of the type separating system it is used with.

The setting and adjusting of the huller will be discussed somewhat more in detail under the individual systems, but it might be pointed out here that it is very important that the concave be accurately trammed so as to cut equally at both ends. The latest model single breast huller is rigidly fixed at the bottom and when properly closed at the top should be in proper tram. However, even this type huller should be checked from time-to-time to be sure that the concave knives are equidistant from the cylinder knives at both ends.

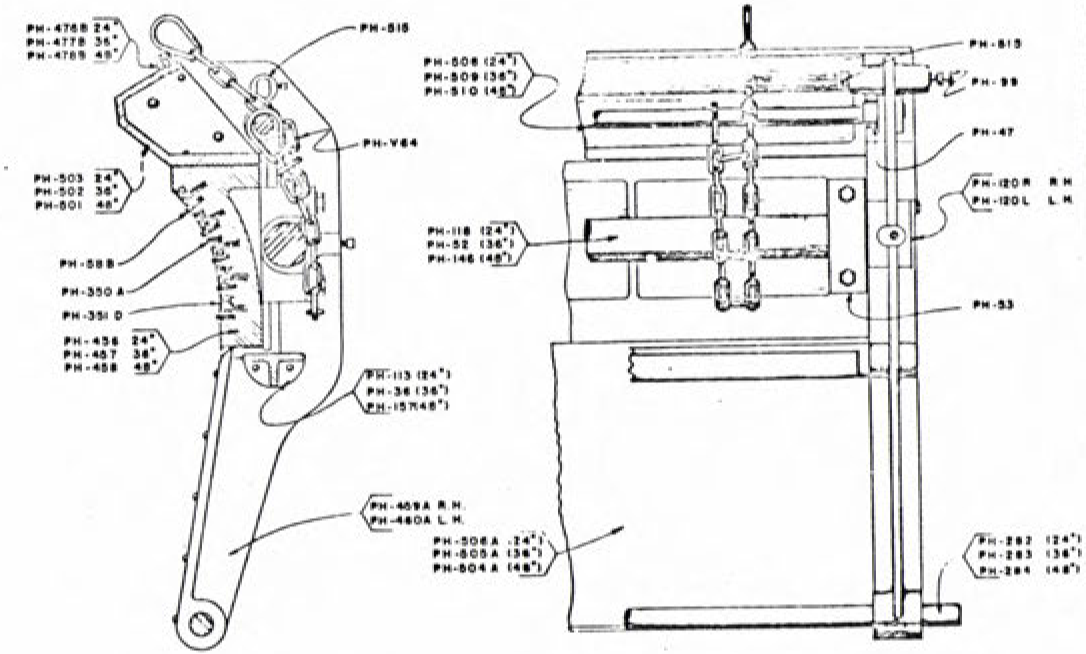
The eccentrics for adjusting the concave to and from the cylinder should be kept lubricated and easily movable, so that the huller can readily be adjusted while operating. The eccentric shaft should be kept free of rust and never painted, to prevent binding and always be free and easily adjustable when the clamping bolt is released. All of the adjustments should be carefully checked each time the knives are changed and it is particularly important that the concave come down against the stop, in the "closed" position before hitting the cylinder knives, so that adjustments may be made with the huller running, with no danger of striking knives and wrecking the huller.

Constant wear on the cylinder and the concave, generally alongside and forward of the knives, eventually results in excessive knife projection, which interferes with efficient hulling. The knife projection should be checked periodically, and corrective measures taken as soon as it is excessive. Proper knife projection on the Carver huller cylinder is approximately 1/8" and on the concave 7/32". On the latest model hullers, both the cylinder and concave knives are held in with special plates, which serve as wear strips. This case hardened material minimizes the above mentioned excess wear alongside the knives and if wear should occur, they may be readily replaced.

The latest type Carver hullers are equipped with a round cylinder rather than the conventional flat areas be-



CYLINDER PARTS

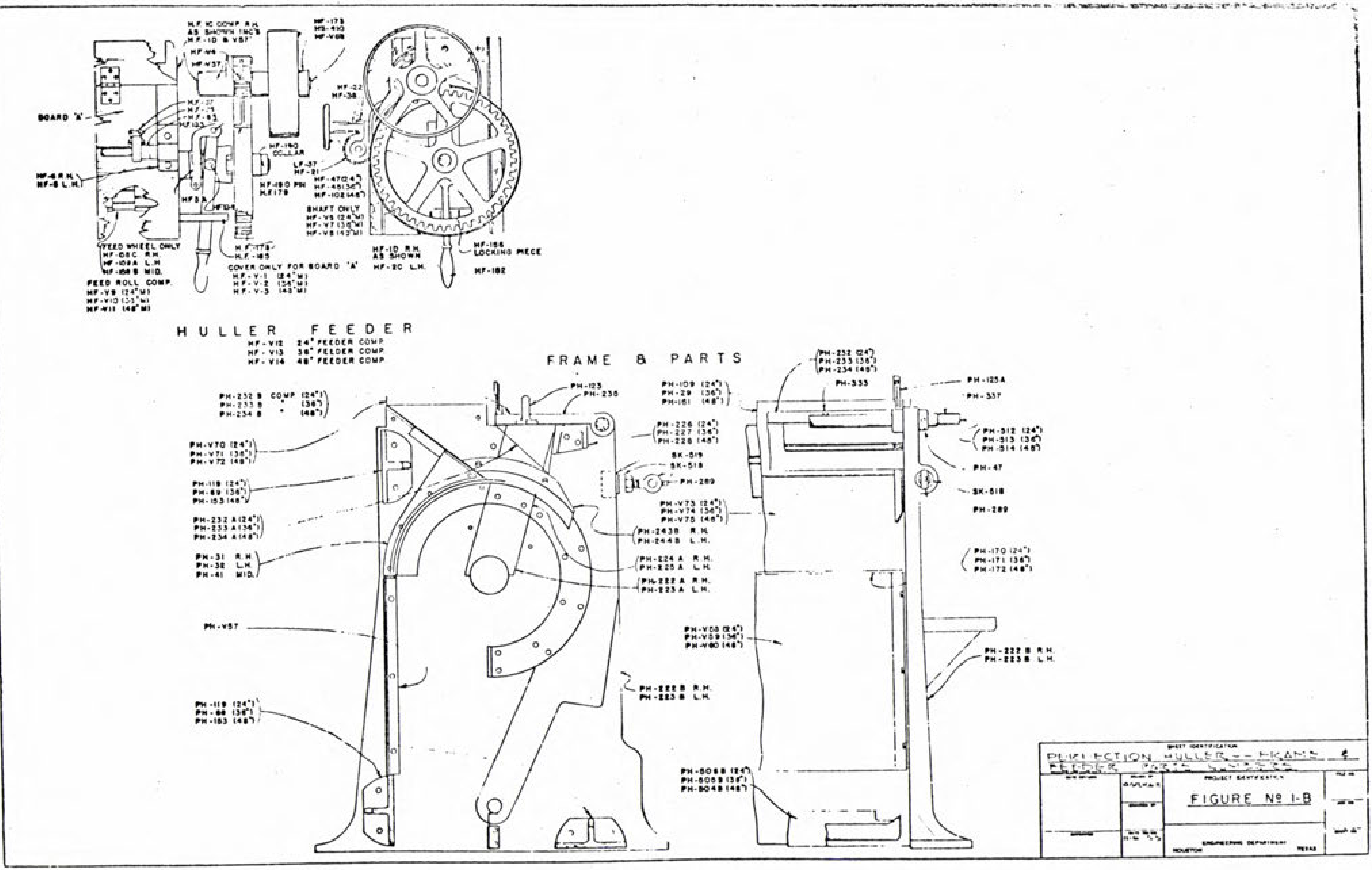


CONCAVE PARTS

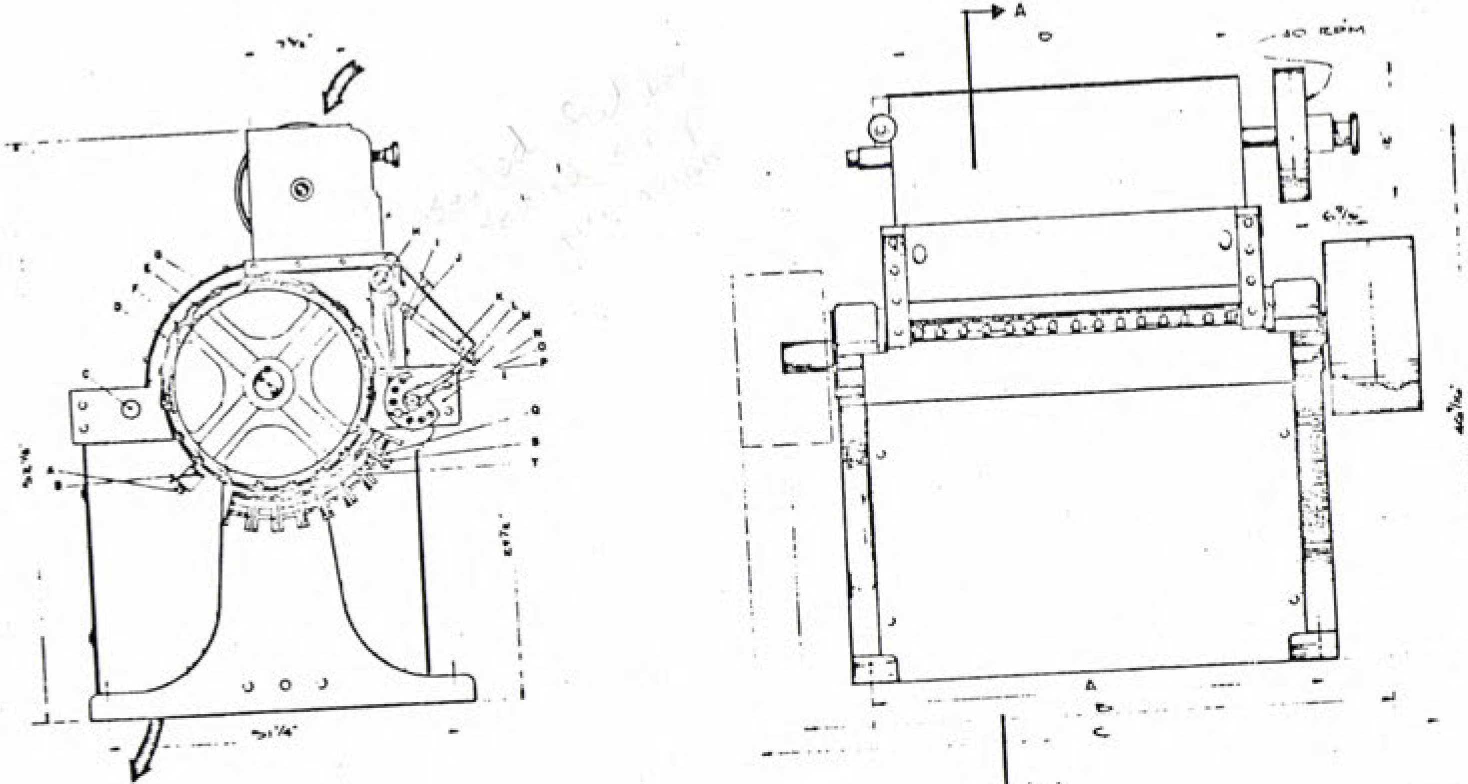
PERFECTION HULLER - PART NUMBERS-
CYLINDER & CONCAVE

FIGURE Nº 1-A

ENGINEERING DEPARTMENT


HULLER FEEDER
HF-V12 24" FEEDER COMP.
HF-V13 36" FEEDER COMP.
HF-V14 48" FEEDER COMP.
FRAME & PARTS
BOARD 'A'
HF-156
LOCKING PIECE
HF-182
HF-10 R.H.
AS SHOWN
HF-20 L.H.
HF-190
COLLAR
SHAFT ONLY
COVER ONLY FOR BOARD 'A'
FEED WHEEL ONLY
FEED ROLL COMP.
PH-123
PH-236
PH-123A
PH-337
PH-333
PH-232 B COMP (24")
PH-233 B " (36")
PH-234 B " (48")
PH-V70 (24")
PH-V71 (36")
PH-V72 (48")
PH-119 (24")
PH-69 (36")
PH-153 (48")
PH-232 A (24")
PH-233 A (36")
PH-234 A (48")
PH-31 R.H.
PH-32 L.H.
PH-41 MID.
PH-V57
PH-109 (24")
PH-29 (36")
PH-161 (48")
PH-226 (24")
PH-227 (36")
PH-228 (48")
SK-519
SK-518
PH-289
PH-V73 (24")
PH-V74 (36")
PH-V75 (48")
PH-224 A R.H.
PH-225 A L.H.
PH-222 A R.H.
PH-223 A L.H.
PH-222 B R.H.
PH-223 B L.H.
PH-232 (24")
PH-233 (36")
PH-234 (48")
PH-512 (24")
PH-513 (36")
PH-514 (48")
PH-47
PH-170 (24")
PH-171 (36")
PH-172 (48")
PH-V58 (24")
PH-V59 (36")
PH-V60 (48")
FIGURE No 1-B
ENGINEERING DEPARTMENT
HOUSTON
TEXAS

A BREAST BOLT TO HOLD BREAST BAR, SCREEN BAR, OR SEED DEFLECTOR BAR
B SEED DEFLECTOR BAR
C BREAST PIVOT SHAFT
D CYLINDER KNIFE
E CYLINDER KNIFE CLAMP
F CYLINDER KNIFE CLAMP SCREW
G CYLINDER COVER
H SAFETY LEVER
I SAFETY LEVER BOLT
J NUT FOR ADJUSTING SAFETY LEVER SPRING
K SAFETY LEVER SPRING
L SAFETY LEVER ADJUSTING NUT
M SAFETY LEVER LOCK NUT
N BREAST END
O ECCENTRIC SHAFT FOR BREAST ADJUSTMENT.
P BREAST ADJUSTING LEVER
Q BREAST BAR
S BREAST KNIFE SCREW
T BREAST KNIFE



SECTION A-A

SIZE	A	B	C	D	SHEAVE PULLEY RPM			HP
1 - 24"	[illegible]	46"	57"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 - 30"	[illegible]	54"	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4 - [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CHANDLER HULLER

FIGURE Nº 2

tween knives and the very oldest type huller cylinders may be completely rebuilt and plated to conform to the latest style. Instructions for this rebuilding work along with instructions for rebuilding old style hullers to the single breast type, or equipping old cylinders or concaves with wear strips, may be obtained from Carver.

The number of knives used in the concave, under different operating conditions, has an important bearing on good hulling. On extremely dry seed, four rows of knives may be sufficient, and give best results. On wet seed, a maximum number of knives is necessary for best results.

Proper huller speed is an important factor in good hulling. Better results have generally been obtained by operating at speeds somewhat slower than indicated in manufacturers' catalogues. On extremely dry seed, very good results have been obtained at speeds around 500 RPM, resulting in less absorbed oil and fine meats in hulls and producing a coarser hull, allowing better protein control. With tonnage approaching maximum and with higher moisture in seed, greater speeds are necessary. For average conditions 700 to 800 RPM is satisfactory, but with extremely high moisture and soft damaged seed, it may be necessary to speed up to 950 or 1000 RPM.

Huller capacity should be given careful consideration as the oil in hulls will increase directly in proportion to the tonnage, and as the tonnage approaches maximum, it is necessary that the huller be adjusted between very close limits to prevent excessive absorption. Also, at maximum tonnages it is necessary to set the concave knives extremely close to the cylinder in order to cut the required percentage of seed, thereby increasing absorption. At lighter capacities, a "wider" setting will cut an equal percentage of seed with less absorption and coarser hull. In other words, better results will be obtained, with less expert supervision, when hullers are not forced to maximum capacity. Two tons per inch of width is maximum. One and one-half tons is safer and better.

Sharp knives are essential for good hulling results. A dull knife fails to cut the desired percentage of seed, requiring extremely close setting which mashes the seed and increases absorption of oil. The preparation of the seed for hulling, and the removal of sand, loose lint, and other foreign matter has much to do with the life and condition of huller knives and will be discussed at length in Part No. 7 of this article. Most mills depend on a visual inspection of huller knives each week to determine when it is necessary to change. Many set up a regular schedule and change the concave knives every week and the cylinder knives every two or three weeks. It is obvious that the above method is haphazard and frequently results in knives being changed before they are actually worn out, or possibly in not changing often enough. On dry seed, what appears to be a dull edge on a knife will actually give good results for several weeks or more but on extremely wet or sandy seed it has actually been found necessary to change knives every three or four days in order to do efficient work. A good method of determining when it is time to change knives is to watch the absorbed oil in the hulls; however, this is not too dependable unless a large number of samples are drawn. A good indication of dull knives is when it becomes necessary to continue closing the concave adjustment in order to maintain the cut. The most dependable method is to take samples each day or two from the shaker tray, and when the absorbed oil exceeds by more than 0.10% the natural oil in hulls, it is time to check the knives. With a good job of coarse hulling, the hulls from the shaker contain very little more oil than the so-called natural oil in hull (obtained by cutting the seed with a razor blade and analyzing the hull for oil).

A uniform feed, or flow of material, through the huller and uniform distribution across its width is essential for good results. Where two or more hullers are operated in a battery, the load should be equally divided. The use of sliding gates and valves to divide the load is no good. The best known method is to first provide a good, properly built spout over the feeder, and then regulate the feeder speed to handle the desired load, with the spouts running full. Slight fluctuation in load may be handled with the feeder cant board adjustment. The load on the end huller of a battery, or a single huller, may fluctuate slightly, but it can be regulated to keep the feeder covered at all times. The most dependable manner of controlling the feed to two or more hullers is to drive all the feeders from one common variable speed countershaft.

A delinted seed surge bin just ahead of the hullers, usually mounted over the safety shaker, is highly desirable. This bin should have a capacity of at least ten minutes production to take care of fluctuations in load from the lint room and to provide a uniform flow of seed to the hullers. It may also serve as an overflow bin from the hullers and makes it possible to handle minor interruptions in the Huller Room without shutting down the linters.

Huller Knife Grinding

The importance of changing huller knives before they become dull and maintaining sharp cutting edges has been pointed out above. Due to the fact that a Carver huller knife has four cutting edges and may be changed and operated in the four different positions, there has not been too much incentive to go to the trouble and expense of regrinding these knives. Due to obvious problems and extra expense, many foreign mills regrind huller knives and have been able to get two or three times the life from them, with a corresponding reduction in knife cost.

The average mill will change concave knives each week and cylinder knives every two weeks and with four edges per knife, will consume or wear out about 96 knives per huller in eight weeks. This is based on 56 knives in the cylinder and 20 in the concave. At $1.40 per knife, this amounts to $134.40 or approximately 3¢ per ton of seed crushed, based on 80 tons per huller per day. Obviously this is nothing to get excited about, but if it can be reduced to one-third this amount by knife grinding, a mill crushing 50,000 tons per year could save perhaps $1000 per annum.

A small mill with a light crush could not afford any sizable investment for knife grinding equipment and should improvise or arrange for grinding with existing tools. Some mills have been able to contract with local machine shops to grind knives in their off time and this makes an attractive arrangement when it can be done for, say, 15¢ or 20¢ per knife. Some foreign mills and large domestic mills are using special knife grinders of their own design while others utilize regular machine shop equipment.

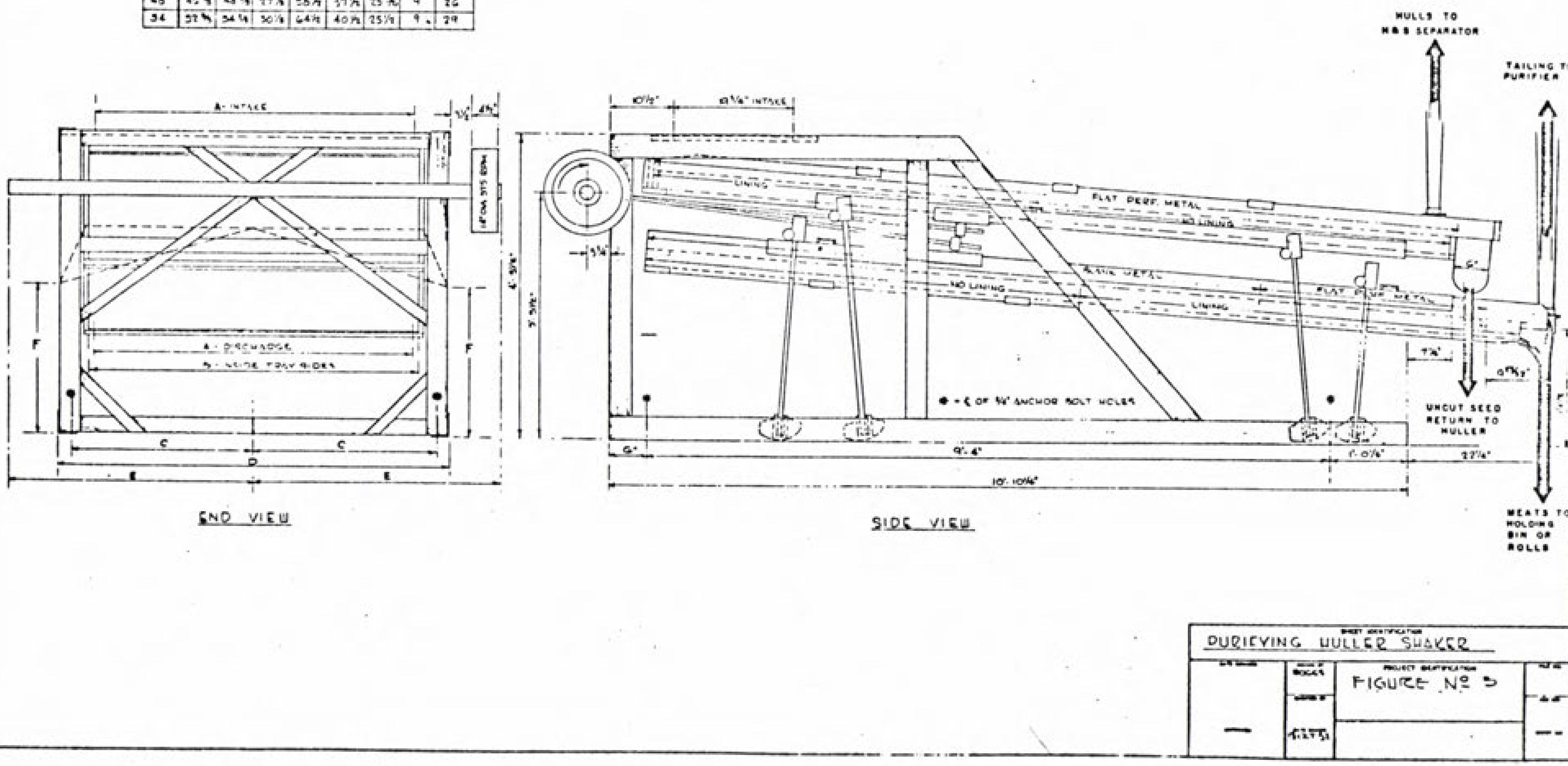
Huller knives are casehardened to a depth of approximately 1/8" below the surface and obviously, if the knife is completely worn down and the cutting edge rounded below this depth, it would not be practical to regrind it. Where the knives are changed as soon as they begin to dull and there is a visible rounding of the cutting edge, it is possible to regrind them two or three times.

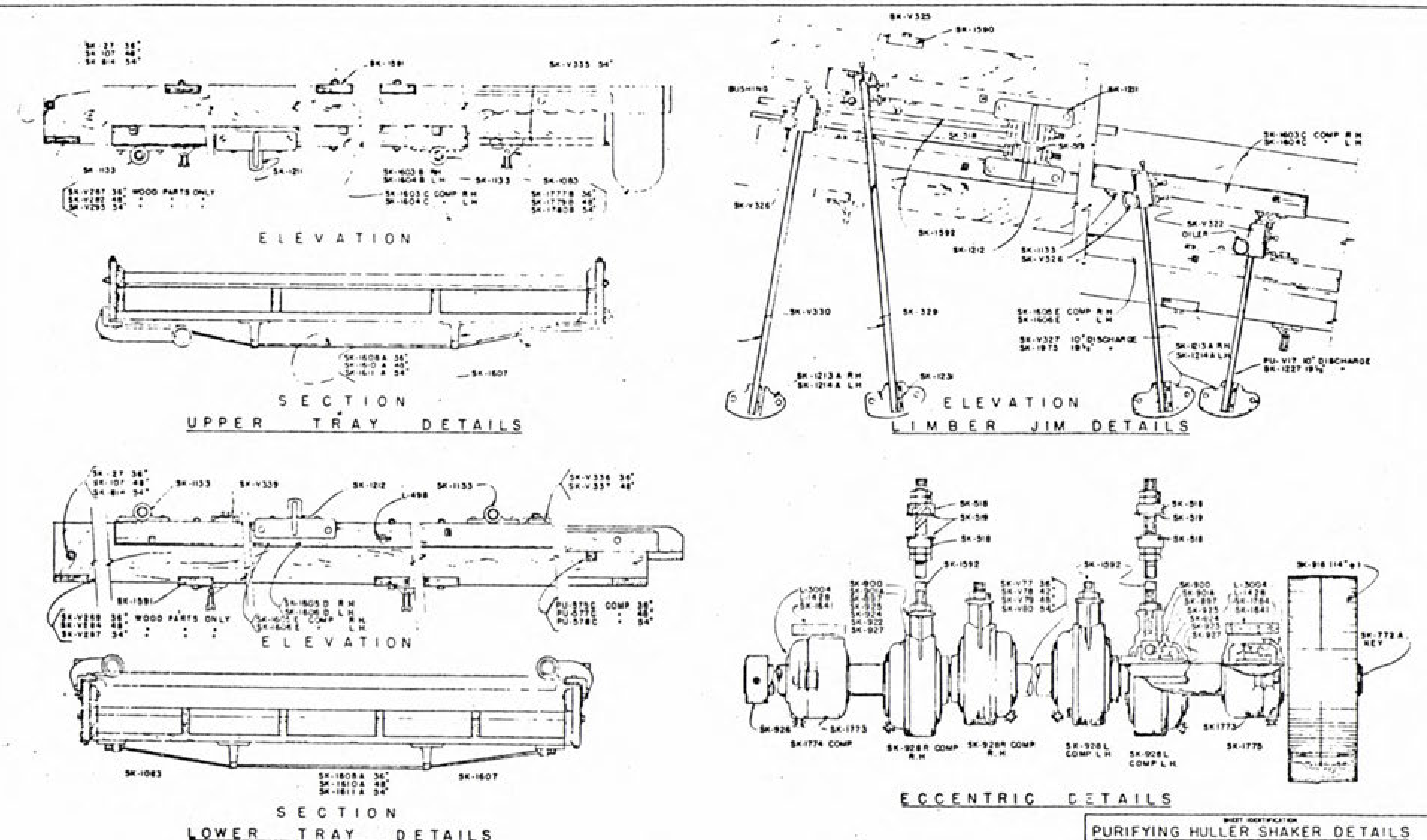
The best way to regrind a huller knife is to take a light grind with a special emery wheel on each of the flat sides of the knife and to a distance of approximately 7/32" below the cutting edge. The depth of the cut or amount of metal ground off will depend on the condition of the cutting edge, but will normally not require more than 1/64 or 1/32 cut on each edge. The special knife grinders built by some mills are provided with two emery wheels and the knife is fed between the two with adjustable spring pressure applying the required tension against the knife. Two or three passes between the emery wheels are generally sufficient to get the job done.

The reason for grinding on the flat sides of the knife, rather than on the top and bottom, is to maintain the original width, and original projection of knife. However, where the grinding is done in a machine shop, it is sometimes more convenient to clamp together 12 or more knives, or the entire set, and grind off the top and then the bottom. When this procedure is followed, each knife must be ground to the exact same width and kept in sets. This method might be helpful where the cylinder and concave wear strips are beginning to wear down alongside the knife and the knife projection was getting excessive. Obviously, very little could be ground from the concave knives on a new huller where the projection is only 1/8". As a further argument for maintaining sharp huller knives, we might compare the cost of changing on the above schedule at a cost of 3¢ per ton of seed with loss of oil in hulls from dull knives. If with dull knives the absorbed oil increases .10%, we stand to lose about 8¢/ton (based on 20¢ oil). It is therefore profitable to check absorbed oil in hulls from shakers, or beaters, and change after several analysis indicate increased absorption. This checking procedure will also avoid changing knives before it becomes necessary as knives will sometimes run satisfactorily for four or five months on dry seed, but absorbed oil must be checked.

SCHEDULE

HULLER SIZE	A	B	C	D	E	F	G	H
36	34¾	35¼	21⅛	40½	31½	24¾	8	20
48	45¾	48¾	27⅞	58¾	37½	25¾	9	26
54	57¾	54¾	30⅞	64¾	40½	25½	9	29





PURIFYING HULLER SHAKER DETAILS

FIGURE Nº 3-A

PART TWO

THE SHAKER

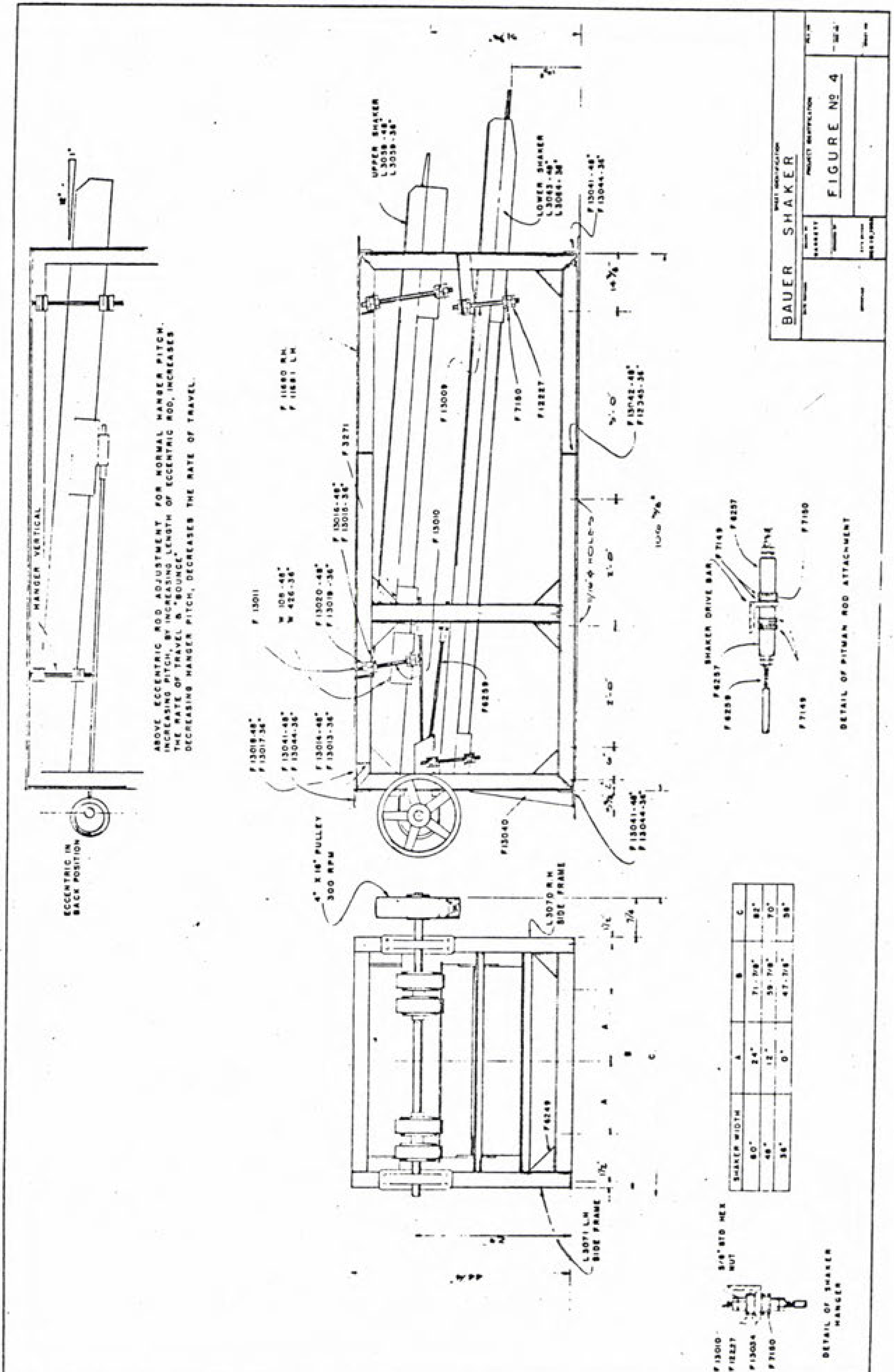
Shakers, or shaker separators, as commonly used in connection with separation of cottonseed hulls and meats, may be classified in two general types, the Bauer-type with long throw eccentrics, and the Carver-type with shorter throw eccentrics. The two types of shakers are illustrated in Figure 3 and Figure 4, respectively. Insofar as operating results are concerned, neither has any advantage over the other. They will both be discussed in order to illustrate theory and operation of shakers in general.

As noted in the illustration, the Bauer-type shaker is designed with the trays suspended from a frame with "hangers", whereas the Carver trays are supported with "limber jims". The latter type construction is more rigid and the limber jim arrangement actually serves as a spring and aids the eccentric in moving the weight of the shaker at the end of the stroke. Either type shaker, as put out by the manufacturer, will be set with the correct shaker and hanger pitch and recommended eccentric speed for most efficient results, but in order to illustrate the theory, these various adjustments will be discussed in detail.

The Carver-type shaker, as used for hulls, was for years equipped with corrugated perforated metal, based on the theory that the corrugations tend to turn the material or cause the hull to ride the top of the ridges, and result in better separation. The resulting action does look good, and is advantageous with wooly hull, but it has its disadvantages in being more difficult to keep clean, particularly on wet seed. The corrugated metal tends to retard the travel of material and greater shaker pitch is required to compensate for it. The pitch of the shaker tray and the limber jims is fixed for best results and should not normally be changed. Likewise, the Bauer type shaker is set by the manufacturer at what they consider the proper pitch, but the hanger pitch illustrated in Figure 4 may be varied by changing the length of the eccentric rods, or by moving the upper hanger brackets fore or aft.

On a properly operating shaker, the material moves uniformly down the tray with a slight vibratory motion but not a decided bounce. It should be uniformly distributed, and the material should run not more than 1/2" thick.

Assuming the material is being fed and discharged uniformly from the huller, it should travel uniformly down the shaker tray provided the following items are in order:



SHAKER WIDTH	A	B	C
60"	24"	71-7/8"	82"
48"	12"	59-7/8"	70"
36"	0"	47-7/8"	58"

a) Eccentrics not slipped on shaft.

b) Eccentric rods same length.

c) Shaker tray level and metal flat and not loose or sagging.

d) Hangers or limber jims set at same pitch and secured in proper location.

If the material is not moving fast enough down the tray, or too fast, corrective measures may be taken as follows:

a) Change the speed of the shaker. It is not recommended to vary more than 10% from standard speeds given below.

b) Increase or decrease the pitch or fall of the shaker tray, by lowering or raising the discharge end. Excessive pitch will cause the material to slide and results in poor shaking or separating action.

c) Increase or decrease the pitch of the hanger or limber jim, by moving the upper end backward (backward refers to the upper or intake end of the shaker and forward refers to the lower or discharge end) or the lower end forward. This may be accomplished, within reasonable limits, by lengthening or shortening the eccentric rods, as illustrated on Figure 4.

The standard pitch of the Bauer shaker tray with flat metal is approximately 1" per foot of length. It is not desirable to increase this pitch in excess of 1-1/4" or a sliding action will result.

The pitch on the Carver-type tray is also approximately 1" per foot of length. On some old Carver shakers, using corrugated perforated metal, the pitch was 2" per foot of length. Likewise, it is not practical to install the corrugated metal on a Bauer-type shaker without redesigning and changing the pitch.

Some operators prefer a flatter pitch to the tray, ranging from 1/2" to 3/4" per foot of length and a greater hanger pitch and/or speed. The increased hanger pitch causes more bouncing of the material but the decreased tray pitch counteracts and slows down its forward movement. It is possible that the resulting action might shake out some additional fine meats dust, but the increased bouncing effect would make it more difficult to separate large meat particles, and therefore, a happy medium is desirable.

Some operators also prefer that hulls should "break away" or increase in velocity as they approach the discharge end of the tray. This is not a bad theory and may readily be accomplished by increasing the pitch of the forward hangers.

As the hanger pitch is reduced and the top of the hanger approaches, or goes forward to the vertical, the material slows down and the bounce decreases. In an extreme reverse setting of the hangers (minus pitch) the material can almost be made to travel backward and uphill. In handling material such as meats on a lower tray, or on a purifier, the hangers should be set approximately vertical or slightly backward to obtain a minimum agitation as the material passes under the suction nozzle, or air lift.

Most shakers, as used in connection with separating or seed cleaning, are designed with two trays, and with the eccentrics for each tray 180° apart on a common shaft. The theory is that the force at the end of each stroke will thus be counter-balanced and the vibration reduced. However, single tray shakers properly designed with a self-contained substantially built frame and a counter-balanced flywheel will operate satisfactorily.

The speed of the shaker, or eccentric shaft, is dependent on the throw of the eccentric. The Bauer-type is usually equipped with a 3/4" throw (1-1/2" stroke) eccentric and requires a speed of 290 to 325 RPM. On the latest model Bauer shakers with 3/8" throw the speed should be about 400 RPM. The Carver-type with 3/8" throw eccentric requires a speed of 400 to 425 RPM. Various vibrators, as used in flour mills, have been installed on shakers to replace the eccentrics, but so far they have shown no appreciable improvement over the conventional eccentric.

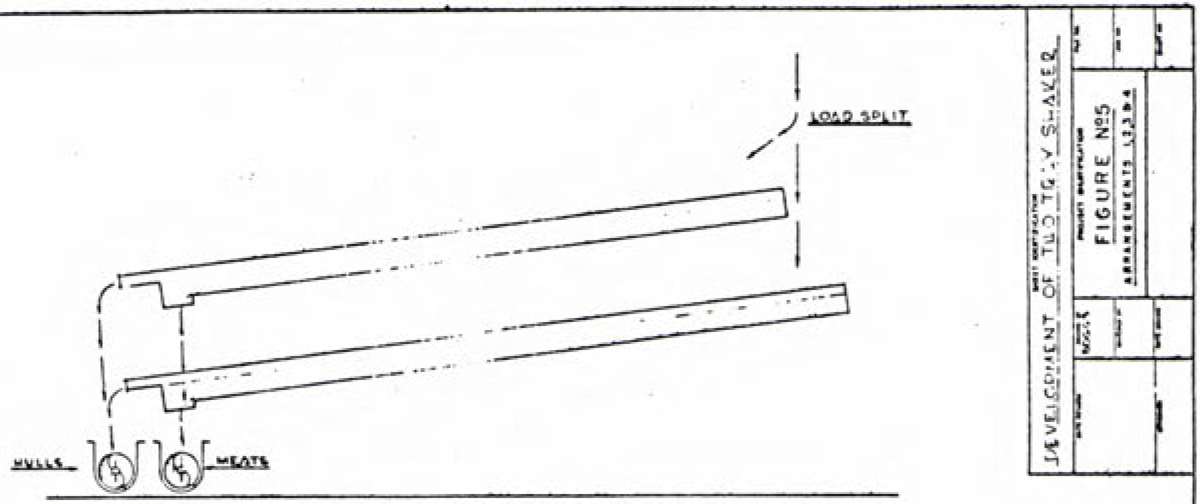
Southland Cotton Oil Company have developed a high speed shaker which they are using successfully in most of their mills. This shaker is of all metal construction and a very neat, compact design, consisting of a single tray with perforated metal double-decked. This shaker is an adaption of the Sutton, Steele & Steele vibrator and has a very flat shaker pitch, practically level, a steep hanger pitch, a very high speed short throw eccentric. One of the advantages claimed by the designer is that the higher speed tends to prevent clogging of the perforated metal, but our experience has been that the maintenance cost is higher and that it does not show any appreciable advantage over conventional shakers.

The clothing of a shaker refers to the perforated metal used thereon. The proper clothing is very important for good results and each operator must study his own problem, as it is dependent on lint cut, moisture, size of seed and meats and other local conditions.

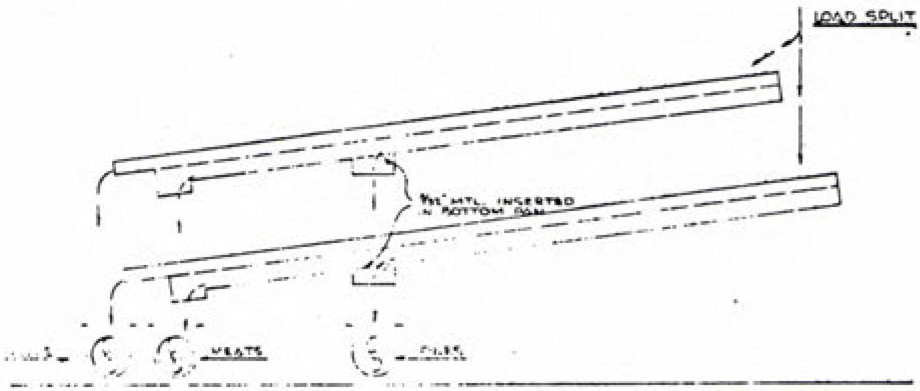
To give exact perforated metal specifications for a huller shaker without being thoroughly familiar with local conditions would be impossible. For average operating conditions, at least one section of 7/32" perforated metal is generally required in order to remove all of the large meat particles and if an overall average condition could be specified, it might call for one section of 5/32" perforations, one section of 3/16" and at the discharge end, one section of 7/32" perforations. In West Texas and other areas where small seed are prevalent, the 7/32" perforation is generally too large and 3/16" might be considered a maximum. On the other hand, in some areas extremely large seed and meats might be encountered which would require a short section of 1/4" perforations. Carver have developed a 13/64" perforated metal which is used successfully by mills that have been encountering trouble with 7/32", but could not use 3/16".

The ideal clothing arrangement is a perforation that will separate all of the meats and pass a minimum amount of hull and seed with the meats. This means using the smallest possible perforations that will pass out all of the meats. If a visual inspection indicates whole meats passing from the tray with the hulls, it will be necessary to install at least one section of larger perforations. After carefully determining if all meats are being separated, and taking the necessary corrective measure as outlined above, a check should be made to find out if excess hull is being passed with the meats. This should be held to a minimum and the method of determining and the practical limits will be dealt with in detail in another part of this article. If it is determined that excess hull or seed is getting into the meats, and if observation or an actual check indicates it is from the shaker tray, a portion of the perforated metal may be reduced. For example, if the clothing consists of three sections of 7/32", one section could be changed to 5/32" and one to 3/16". Each individual case must be carefully worked out on the job.

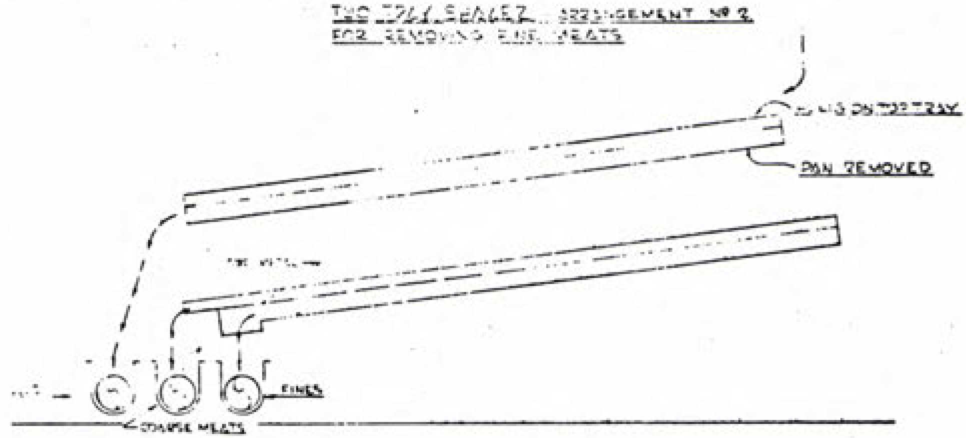
Instead of making a gradual reduction in the perforation of a portion of the screening area, some operators simply blank a part of the upper section of the tray, by replacing perforated metal with sheet metal. This procedure is not recommended, for even where excess screening area is available, it might as well be utilized with 5/32"



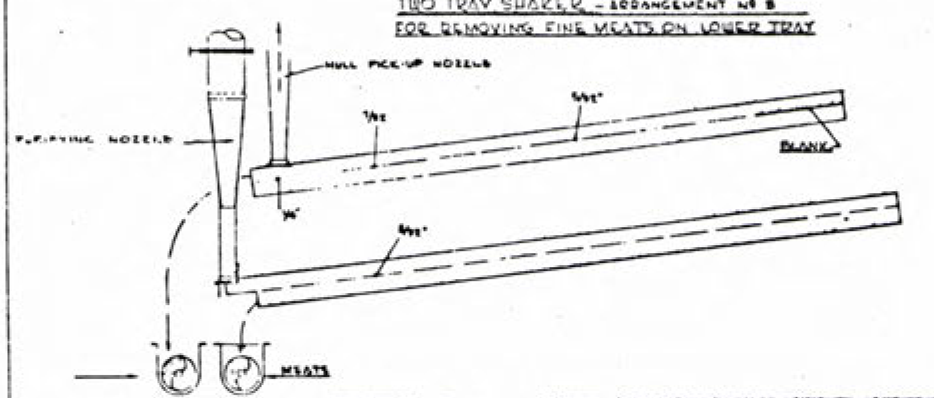
TWO TRAY SHAKER - ARRANGEMENT No 1



TWO TRAY SHAKER - ARRANGEMENT No 2
FOR REMOVING FINE MEATS



TWO TRAY SHAKER - ARRANGEMENT No 3
FOR REMOVING FINE MEATS ON LOWER TRAY



TWO TRAY SHAKER - ARRANGEMENT No 4
FOR PURIFYING MEATS ON LOWER TRAY

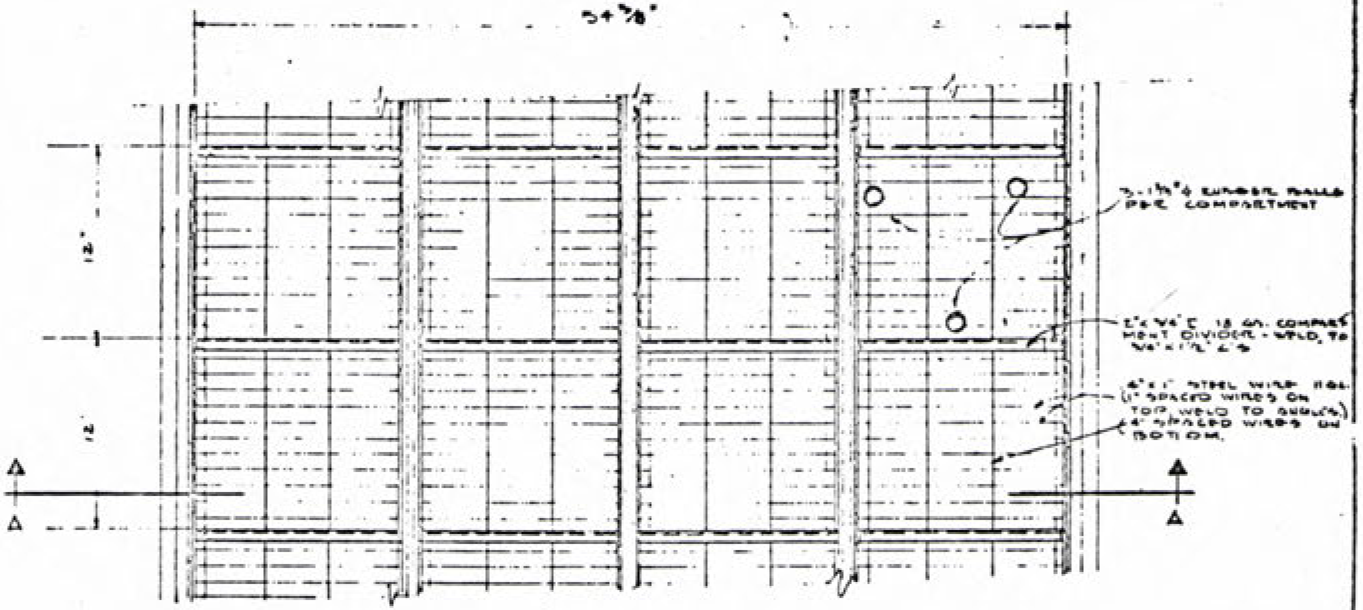
or smaller perforations which will remove some fine meat dust and will not pass any more hull particles than would be passed anyway by the remaining larger metal. It certainly does not hurt anything to utilize this additional area and it probably does some good. It is common practice, and a good idea, to clothe approximately 24" at the inlet end of the tray with blank metal. This allows the material to move forward rapidly as it is discharged from the huller. Some operators have attempted to utilize this additional screening surface, but perforations directly under the huller soon choke up, causing the material to mat and pile up, doing more harm than good. If larger perforations are used at this point, such as 7/32" or 1/4", too much hull drives through with the meats.

On the original or early designs of the two-tray shakers, the load was split and divided over the two trays. The meats dropped through to the pan, which formed the bottom of the trays, and was then discharged at the forward end, into the meats conveyor. This arrangement is illustrated in Figure 5, Arrangement 1. With the advent of meats purifiers, it was found advisable to screen out fine meats on the shaker tray and bypass them around the purifier. Figure 5, Arrangement 2, illustrates a simple means of separating meats on a two-tray shaker, by means of a short section of 3/32" or 1/8" perforated metal in the pan, and a side spout to handle them from the top tray to the fine meats conveyors. Although this arrangement is now seldom used, it might be necessary if we should ever go back to light lint cuts requiring more screening area.

As lint cuts gradually increase, the area of one shaker tray was easily sufficient to handle the load of hulls and another evolution took place in the shaker. Figure 5, Arrangement 3, illustrates how the load is handled on the top tray, with the pan removed, allowing the meats to fall through to the lower tray for screening out the fine meats. This not only gives additional screening area for meats, but makes the metal on both trays more accessible for cleaning.

From Arrangement 3, it was natural to go on to Arrangement 4 and install a suction nozzle to purify meats at the end of the lower shaker tray. This automatically eliminates the necessity of the fine meats conveyor. This arrangement is now standard procedure in connection with "double purifying" systems, to be discussed under another heading.

The final development, also shown on Figure 5, Arrangement 4, has been used in most of the newest installations. This arrangement shown in Arrangement 4, above, calls for a pick up nozzle added to aspirate the hulls from the top



TOP VIEW (TYPICAL)
(WITH PERFORATED METAL REMOVED)

SECTION A-A

NOTES:

1. COMPARTMENTS APPROXIMATELY 12" SQUARE.
2. THREE 1½" RUBBER BALLS PER COMPARTMENT.
3. USUAL LENGTH AS EQUIPPED: COMPLETE UPPER TRAY 59" LOWER TRAY.

CARVER HULLER - SHAKER

SCALE: 3/16" = 1'

SHEET IDENTIFICATION: Application of Ro-ball to Huller - Shaker			
DATE REVISED	DRAWN BY: garrett	PROJECT IDENTIFICATION: FIGURE NO. 5A	FILE NO.
	CHECKED BY		JOB NO.
APPROVED	DATE DRAWN: april 1, 1954		SHEET NO.

tray of the shaker. In this manner, the hull is pneumatically conveyed onto the H & S machines, usually through a vacuum dropper, and at the same time an appreciable percentage of the uncut seed may be separated and returned to the huller. This relieves the load on the H & S machines by greatly reducing the percentage of seed in the hulls going to these machines.

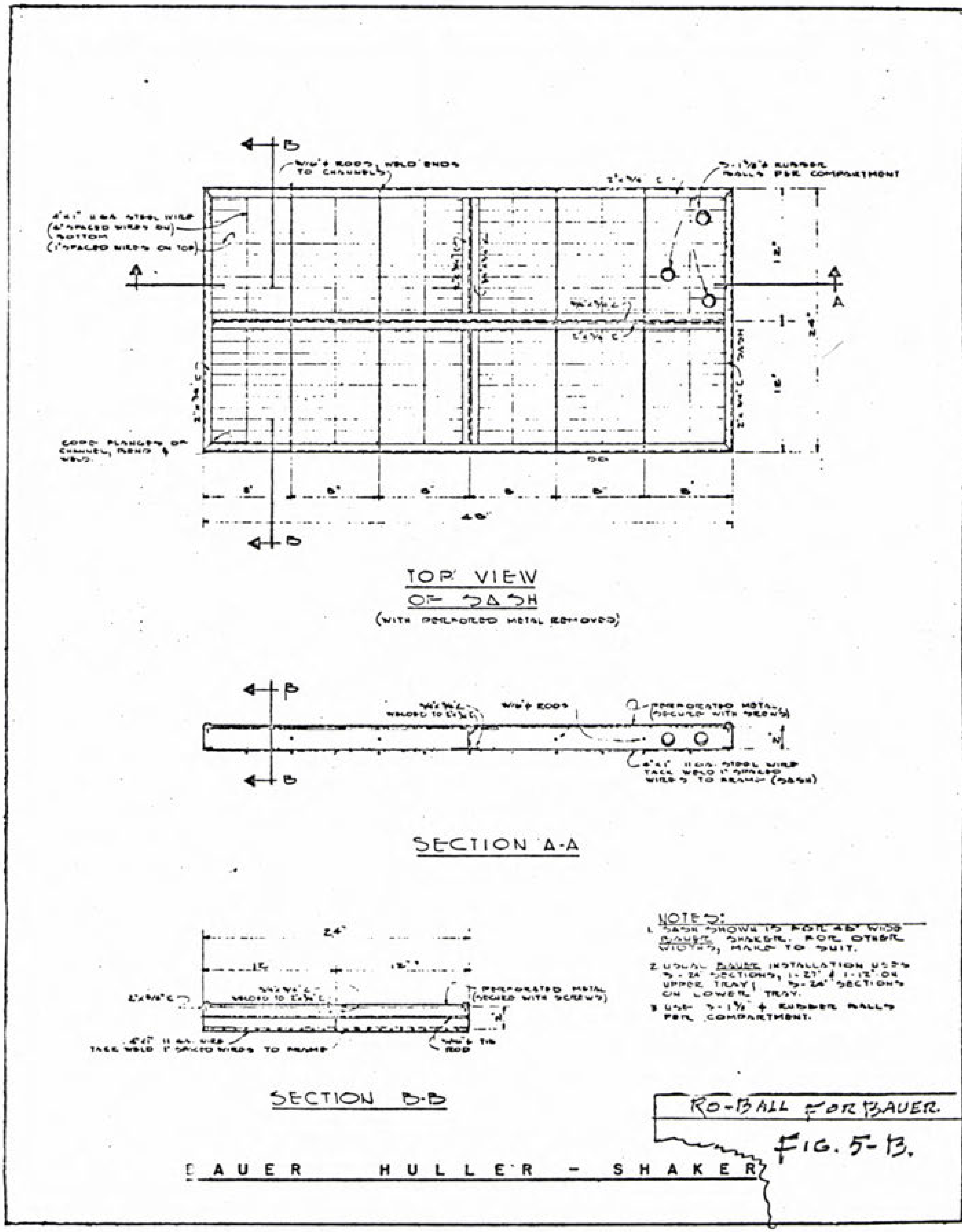
Shaker capacity is not generally given much consideration, as it is originally designed in conjunction with the huller, which is, in most cases, the limiting factor. It is common practice to use a shaker 6" wider than the huller width, i.e., for a 48" huller, a 54" wide shaker, etc. Standard practice is a shaker length of from 10 ft. to 12 ft., regardless of width. With moderate to heavy lint cuts, one tray of a shaker of the above dimensions is sufficient. On light lint cuts, it might be necessary to use both trays. On extremely light lint cuts, leaving 6% or more lint on the seed (not practical in recent years), additional shaker capacity may be secured by using a scalping tray, consisting of a section of 1/2" or 5/8" perforation metal extending 1/2 or 2/3 down the tray and superimposed over the regular metal. This breaks up the wads of hull and allows better separation on the regular metal.

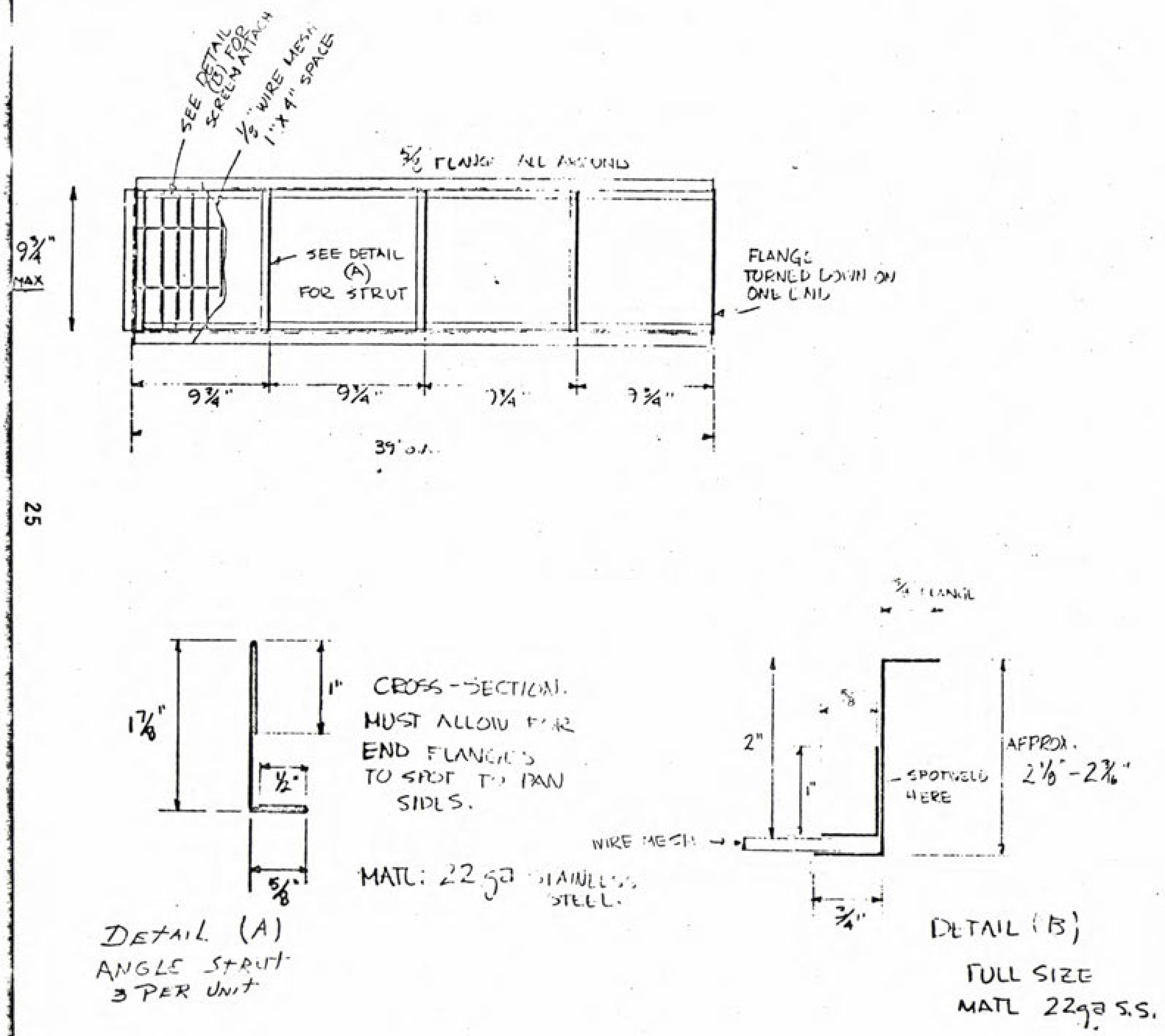
The RoBall Attachment

The necessity of maintaining clean screens on all shakers in the huller room is vital to good separating results, but unless the operators are constantly cleaning the screens they will soon become clogged with meats. A solution to this problem is the installation of the RoBall attachment. As shown on Figure 5A, this device consists of rubber balls supported under each screen. The action of the shaker causes the hard rubber balls to bounce vigorously against the underside of the screen, keeping it cleaner than could be done by hand.

This rubber ball device for maintaining clean screens or perforated metal has been used successfully on various sifters and shakers in flour mills for many years but only recently applied to Carver and Bauer shakers in cottonseed oil mills. Most operators who have used the RoBalls would not be without them, as the clean screens facilitate better separating results.

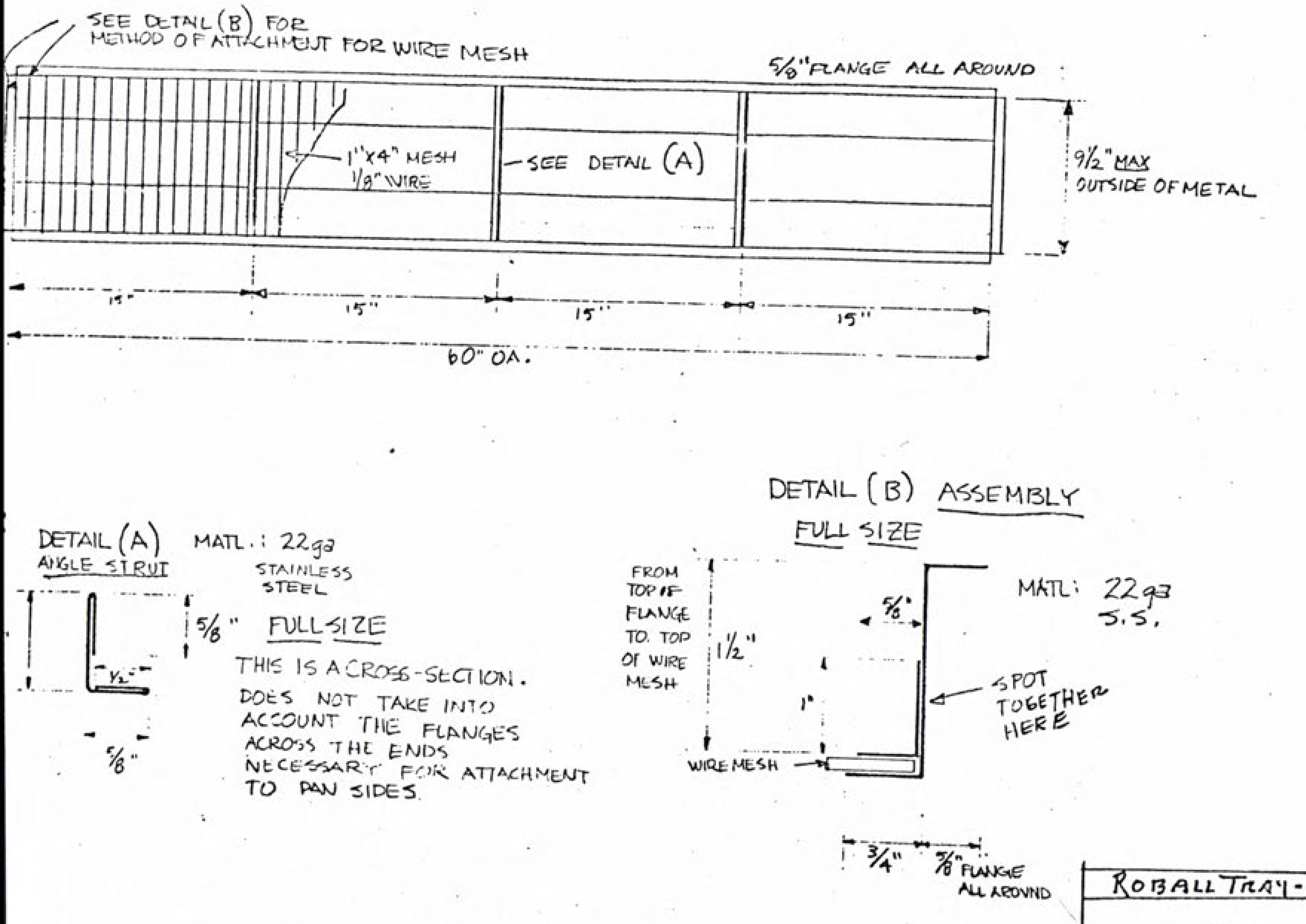
As will be noted from the drawing on Figure 5A, the rubber balls are 1-3/8" diameter. They are usually made of neoprene rubber and may be obtained from several manufacturers. The design used at most oil mills calls for


TOP VIEW
OF SASH
SECTION A-A
SECTION B-B
NOTES:
1. SASH SHOWN IS FOR 48" WIDE BAUER SHAKER. FOR OTHER WIDTHS, MAKE TO SUIT.
2. USUAL BAUER INSTALLATION USES 5-24" SECTIONS, 1-27" & 1-12" ON UPPER TRAY; 5-24" SECTIONS ON LOWER TRAY.
3. USE 3-1½" ϕ RUBBER BALLS FOR COMPARTMENT.
RO-BALL FOR BAUER
FIG. 5-B.
BAUER HULLER - SHAKER



ROBALL TRAY - BOTTOM

FIGURE No 5-C



ROBALL TRAY - TOP.

FIGURE No 5-D

compartments, approximately 12" square, each containing three balls. This results in a total of 36 balls on the lower tray of a 54" shaker and 72" on the top tray.

Cost for the rubber balls is approximately 12.7¢ each or $13.72 for both trays of the huller shaker. Estimated cost for the complete installation, including balls would be about $600 for both trays, based on doing the work with oil mill labor. It could double that figure in some areas with contract labor.

The design shown on Figure 5A and 5B was developed for installation on old shakers by mill labor and has been used satisfactorily for many years. This design calls for bolting 3/4" x 1-1/2" angle irons to the longitudinal ribs of the shaker tray to support the 4" x 1" steel wire that supports the rubber balls; 3/4" perforated metal has been used to support the balls but is heavier and not as good as the steel wire mesh.

It is very important to use the proper rubber balls and well made steel wire mesh or serious troubles will be encountered. Any mill that has not had experience with the RoBall device should consult with Carver or Bauer as to a proper source for this material.

Figure 5C and 5D gives details for a more recent design of a simplified RoBall attachment that may be purchased from Carver or fabricated in any good sheet metal shop.

The advantage of this design is that the standardized 39" x 9-3/4" or 60" x 9-3/4" sections may be prefabricated and are easy to install and extra sections may be stocked to simplify maintenance. To install these sections requires only the removal of the perforated metal and then slipping the sections between the longitudinal ribs of the Carver shaker tray and bolting or screwing in place.

Most operators use 5 sections of 60" on the top tray to cover 60" of length and 5 sections on the lower tray for a length of 39". This is usually sufficient but more sections may be installed to keep all metal clean if desired. Ten sections of the 39" could be used on top if desired.

The prefabricated RoBall attachment for Bauer shakers may be purchased from W. C. Cantrell or fabricated similar to the above for Carver.

So the cost for this installation "ain't" cheap. If the RoBalls are purchased with a new Carver shaker the extra cost per shaker would be about $982.00.

If we assume that clean perforations will result in a saving of .10% oil in hulls, we can estimate each shaker handling 75 tons per day could anticipate a profit of $1800 per year (300 operating days/year). In many cases, the clogged perforations result in even higher losses of oil in hulls and therefore the RoBalls are highly recommended.

PART THREE

THE HULL BEATER

The primary object of the hull beater is to remove fine meats' dust, oily fibers and small meat particles, all of which cling to the hull and cannot be completely separated on the shaker.

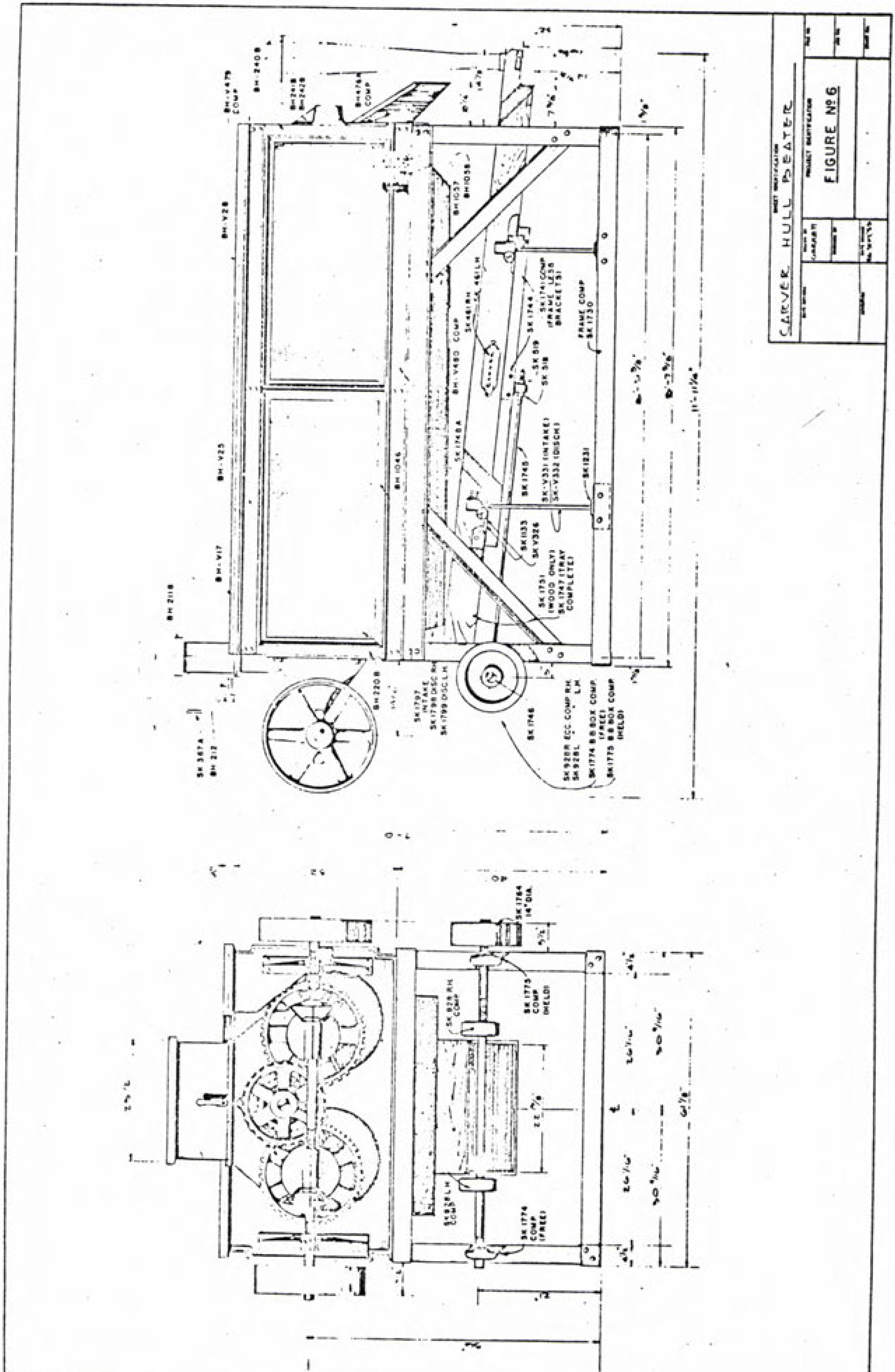
The original hull beaters consisted of a stationary perforated basket, with revolving spikes set to convey the material forward as it was beaten and agitated. It was obvious that the perforations choked rapidly and were difficult to clean, and one early attempt for improvement was a basket designed with a reciprocating action. This made some improvement, but was soon replaced by the revolving drum beater, which gives greater effective screening area, less tendency to clog the perforations, and keeps the mass of material moving away from the screening area. It is also easier to clean while running.

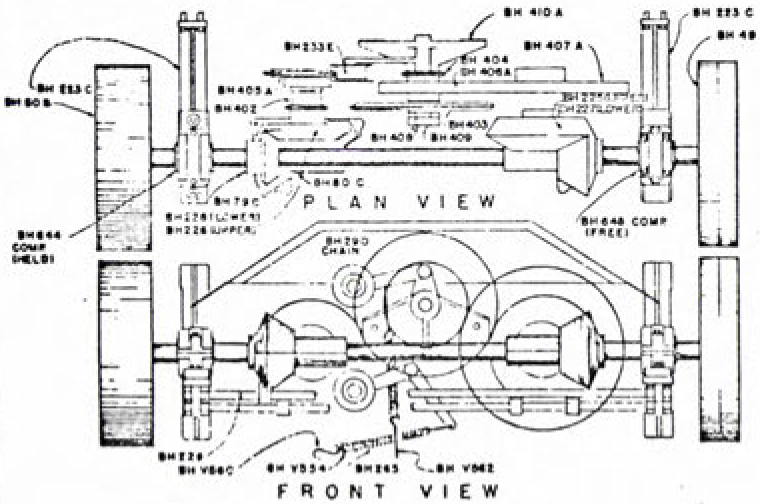
Most mills are now equipped with either the Carver or Bauer double drum revolving beater, illustrated in Figures 6 and 7. Neither has any apparent operating advantage over the other, and the design and general arrangement of both are similar; however, each has its own mechanical advantages. Single drum beaters of either kind may be obtained for lighter loads.

Beater speed as recommended by the manufacturer is generally satisfactory for best results and slight changes one way or the other do not appear to affect the results. The recommended drive shaft speed results in a spike shaft speed of about 150 RPM. The ideal spike speed is one that throws the material over a maximum screen area. Excess speed simply causes spikes to churn and cut through hulls. With heavy lint cuts, it is sometimes advisable to operate at slower speeds, which may be determined by watching the action of the material. This may be done by holding a light on the opposite side of the drum. Minimum speed for the spike shaft is 100 RPM.

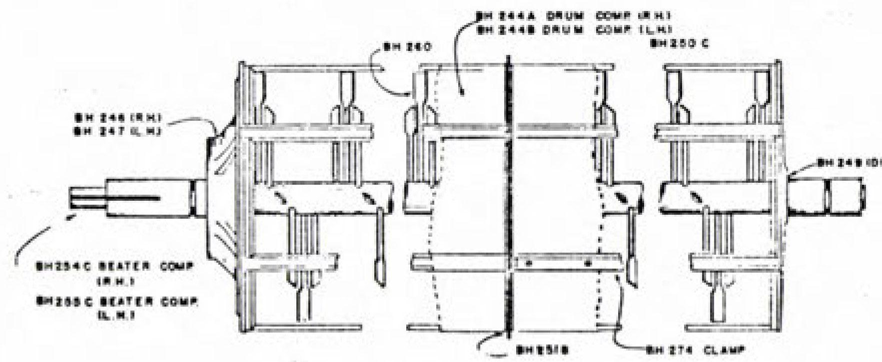
The beater drum is generally driven from the main shaft by gears or chain and sprocket and the speed ratio to the shaft is therefore fixed. Drum speed is not important and has no appreciable effect on results as long as it is sufficiently slow. Speeds in excess of 30 RPM interfere with good separation and a speed of less than 10 RPM is preferable.

There might be some difference of opinion as to whether or not the drum should revolve in the same or opposite direction from the spikes. For many years it was considered


CARVER HULL BEATER
FIGURE № 6
BH-V28
BH-V25
BH-V17
BH 2118
BH-1046
SK 1731 (WOOD ONLY)
SK 1747 (TRAY COMPLETE)
FRAME COMP SK 1730
SK 1231
SK 1746
SK 1784 14" DIA.
SK 1775 COMP (HELD)
SK 1774 COMP (FREE)



D R I V E   P A R T S



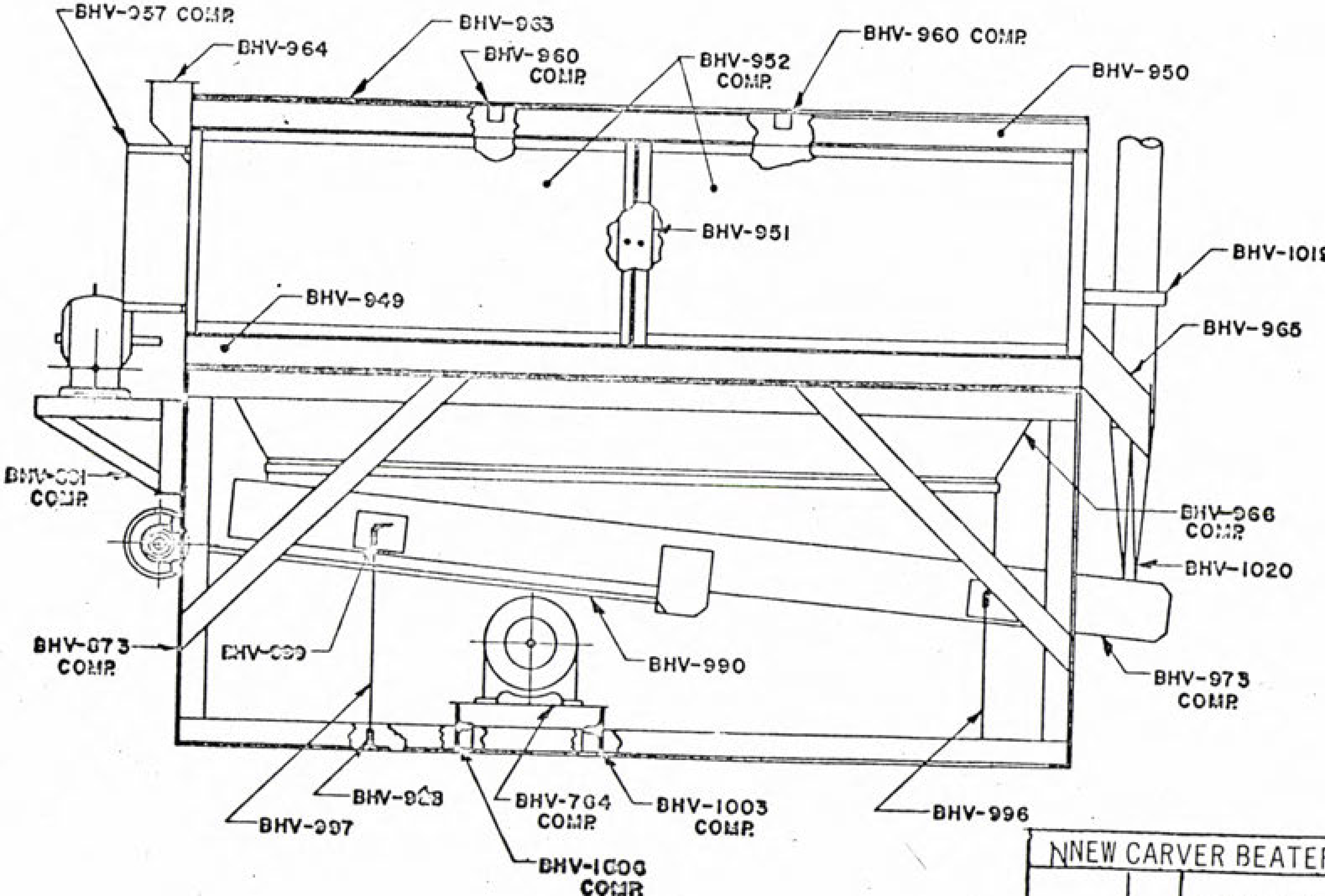
B E A T E R & D R U M   P A R T S

CARVER HULL BEATER - PART NUMBERS

GARRETT

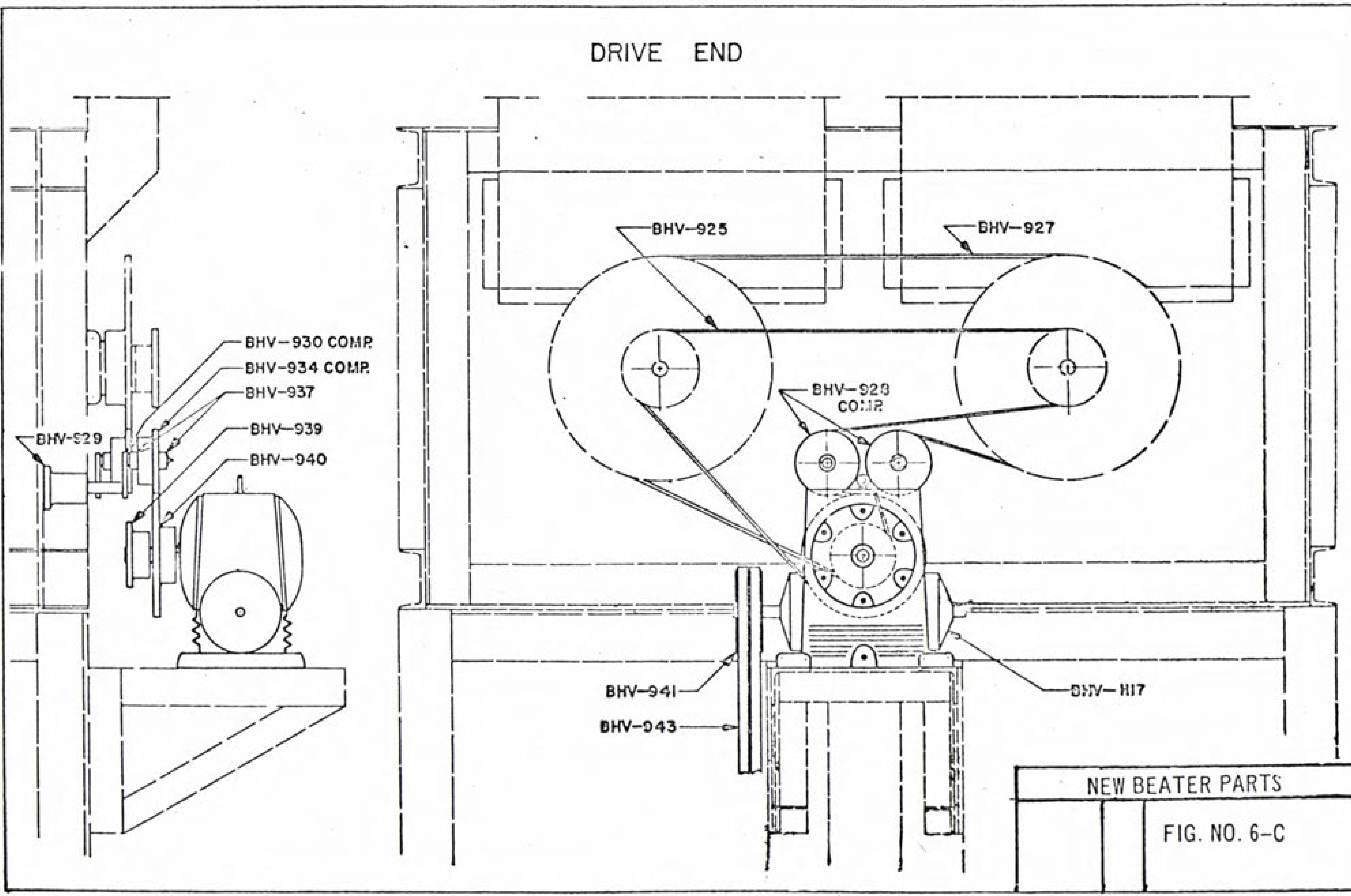
FIGURE Nº 6A

FRAME AND PARTS



NEW CARVER BEATER

FIG. NO. 6-B



NEW BEATER PARTS

FIG. NO. 6-C

best practice to revolve in opposite directions. One manufacturer had one drum running opposite and the other the same, with apparently no difference in results. Careful observation might indicate more clean screening area and less tendency for piling up of material with the drum running in the same direction as the spikes, but results do not warrant making any extensive alterations.

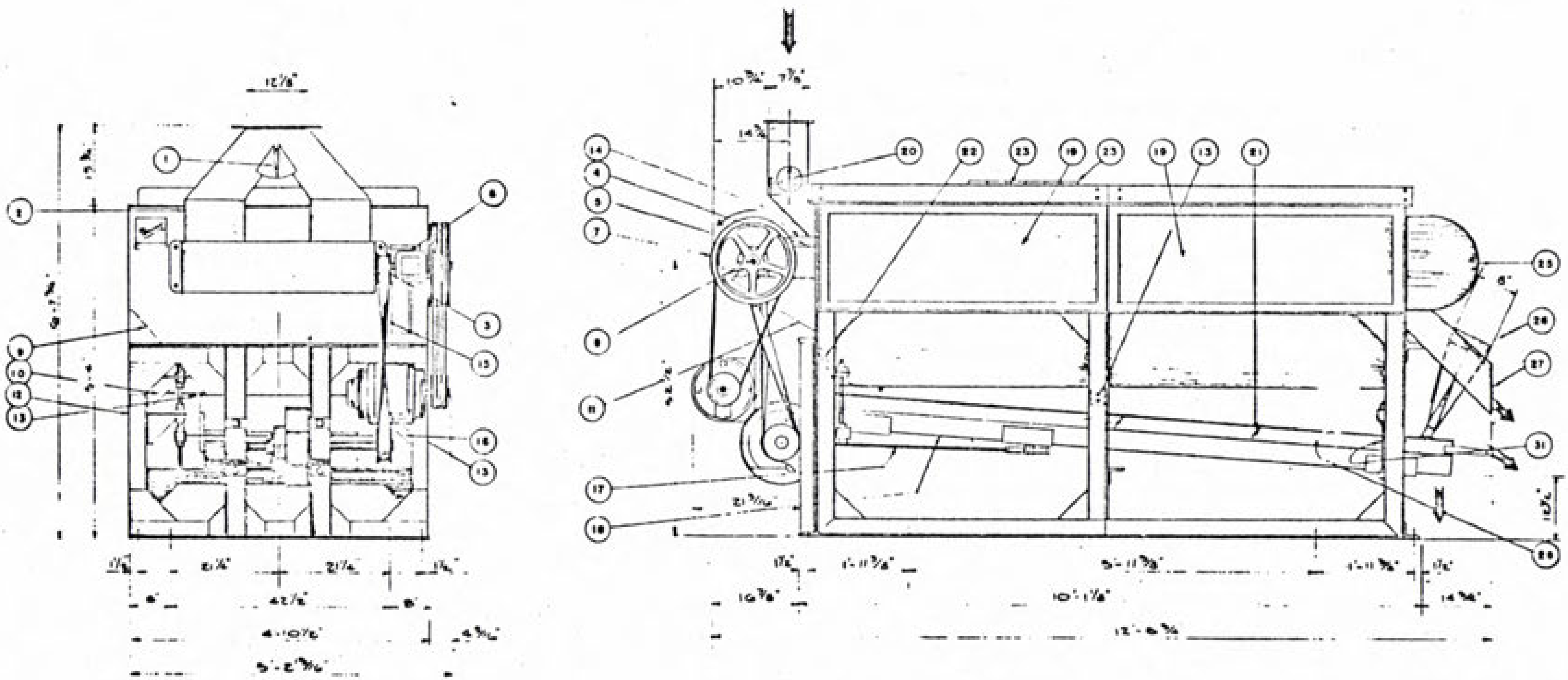
The beater spikes are usually set by the manufacturer, with the flats at an angle of 45°, and this has been found best for average conditions. It is possible to twist the spikes to greater or lesser angles with a wrench, and thereby increase or decrease the agitation. Best opinion is that it is best to leave the spikes set at 45° and obtain change in rate of travel and agitation by varying the spike speed.

Under average operating conditions, one double drum beater is sufficient for a mill crushing 120 tons per 24 hours, but its capacity is dependent on lint cut. With extremely heavy lint cuts, it will handle up to 200 tons (hulls from) and on light cuts, greater than rated beater capacity might be required.

Beater drum clothing and beater shaker arrangement and clothing will be discussed in detail under the individual hulling systems, but several general arrangements might be reviewed briefly at this time. As with the shaker, beater drum clothing should be as small as possible, but should normally have one section of 3/16" or 7/32" perforation at discharge end to remove any remaining whole or half kernels.

The original arrangement of the modern revolving drum beater was essentially the same as in Figures 6 and 7, except that there was no aspirating nozzle and all material passing through the drum screen (tailings) fell to a blank tray which passes it to the upper end of the shaker tray. This tray is clothed with fine metal, generally 3/32" or 1/8" with a short strip of 7/32" near the discharge end for removing large meat particles. The finished tailings from the top of the tray would then join the finished hulls from the drums, and the fine meats and dust screened out going to the meats conveyor.

The above arrangement was used for many years and was fairly satsifactory on moderate lint cuts, but good operators soon detected two serious defects. The first was that in order to screen out large meat particles, it was necessary to insert 8" to 12" of 7/32" perforation at the end of the tray, and this allowed an excessive amount of fine hull or hull bran to pass on through to the meats, seriously interfering with protein control. Secondly, the material



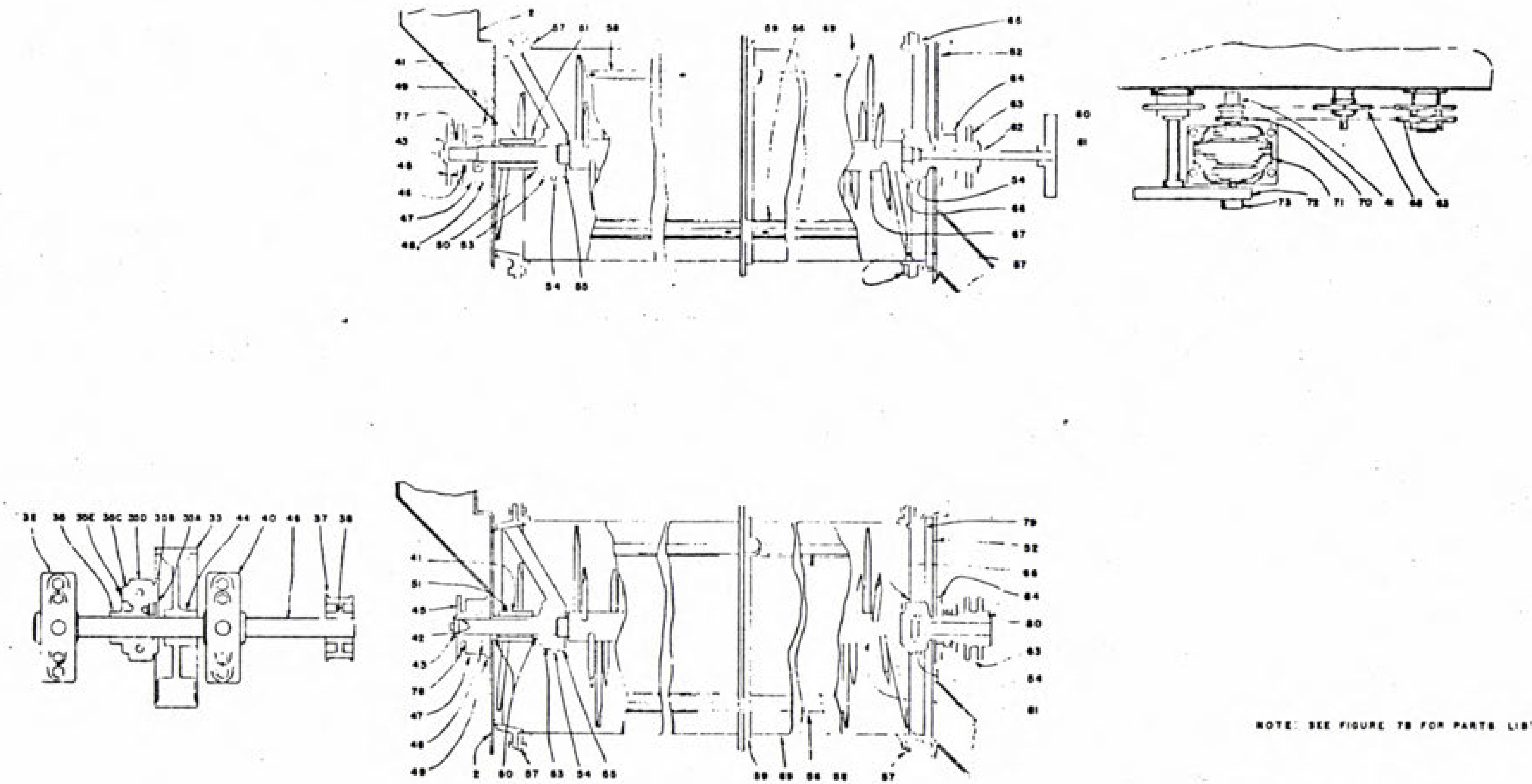
NOTE: SEE FIGURE 7B FOR PARTS LIST

BAUER DOUBLE ROTARY BEATER

FIGURE No. 7

ENGINEERING DEPARTMENT

HOUSTON TEXAS



NOTE: SEE FIGURE 7B FOR PARTS LIST

RAUER DOUBLE ROTARY BEATER-PARTS

FIGURE Nº 7A

passing over the tray, although well screened and containing little or no meat particles, did contain a large quantity of loose lint and fibers running extremely high in absorbed oil and directly affecting the oil content of the finished hulls. Figures 6 and 7 show an arrangement commonly used to overcome the above difficulty. By using a suction nozzle and aspirating the tailings from the end of the tray, the meats are dropped out at this point, thereby eliminating the necessity of the large metal. All tailings thus picked up by the nozzle are then handled through a fan and dust collector and to a small tailings beater for further treatment. This arrangement is now considered standard practice and with slight variations is used by practically all mills. In some cases a vacuum dropper is helpful and this is covered more in detail in Parts 8 and 10.

A further refinement, that is particularly good on extremely dry seed with a high content of fine meats dust, is described as follows. The first section of the beater drum is clothed with 3/32" perforated metal which will remove the bulk of the very fine meat dust and oily fibers. This material is then spouted direct to the pan or under side of the shaker and goes direct to the finished meats. In this manner the rest of the tailings are not contaminated, and are then handled in the usual manner.

It is just as important that the load be equally distributed on a beater as on other machines, but unfortunely they are not designed with very efficient feeding mechanisms. A splitter or adjustable baffle in the inlet spout may be set to approximately divide the load between the two drums, but this is subject to considerable fluctuations. Where more than one beater is operated in parallel, each beater should be provided with a positive feeder, driven from a common countershaft, with variable speed drive.

Care and maintenance for beaters is similar to that covered by general care and maintenance of separating machinery, but attention is invited to a few items pertaining solely to beaters. The operator should make daily inspections of all perforated metal to see if it is properly cleaned. In some cases it may not be necessary to wire brush, scrape, or blow the metal more than once each eight hours, but in extreme cases, with high moisture seed, it might be necessary to set up a cleaning schedule every hour. During routine inspection the operators should look out for loose metal, broken metal, or any defects that might result in leakage of hulls or meats.

At least once each week the beater should be stopped and given a careful inspection. Spikes should be examined to see that there is no accumulation of rags or strings, and that there are no bent or twisted spikes. The underside of the shaker tray should be examined and thoroughly cleaned, as fine meats have a tendency to build up and accumulate in the pan. Access ports are generally provided for scraping between the metal and the pan, but in some cases it might be necessary to remove the metal in order to properly clean the pan.

Since the drawings shown in this book were made there have been changes made on the drive mechanism by both Carver and Bauer. Therefore the parts numbers shown on these drawings should not be used for ordering spare parts without checking with Bauer or Carver.

Figures 6B and 6C indicate the design of drive and part numbers on late model Carver Beaters.

PARTS LIST FOR DRAWINGS #7 & 7a

FIGURE No. 7B

No.	Name	No.	Name	No.	Name
1	Indicator Arm	31	Hanger Rod	56	Cradle Angle
2	Front Plate	32	Bearing Unit (exp.type)	57	Cradle Rib (end)
3	Pulley on Reducer	33	Cntr-Bal. Pulley	58	Cradle Bar
4	Guard	34	Hanger Support-R.H.Rear	59	Cradle Rib (Middle)
5	13 T Sprocket	35	Eccentric (complete)	60	Key (64 T.Gear)
6	Rt.Angle Drive Unit	35A	Retainer	61	Spur Gear(Beater Shaft)
7	Drive Pulley	35B	Cap	62	Key (25T.Sprocket)
8	Key (Drive Pulley)	35C	Housing	63	25 T.Sprocket
9	Side Shield - L.H.	35D	Bearing	64	Bearing Unit
10	Hanger Support-L.H.Frt.	35E	Hub	65	Reel Spider (R.H.Rear)
11	Drive Support	36	Apron	66	Cap (Rear Spider)
12	Frame	37	Pulley(Eccentric Shaft)	67	Beater Shaft-R.H.
13	Brace (Side Shield)	38	Key(Ecc.Shaft Pulley)	68	Idler (complete)
14	Front Guard	39	Hanger Support-L.H.Rear	68A	Tightener Arm
15	Side Shield - R.H.	40	Bearing Unit(non-expn.)	68B	Wheel
16	Hanger Support-R.H.Frt.	41	Key(agitator & 13T Sprt.	68C	Bushing
17	Pitman Rod	42	Key(25T.Sprt.L.H.Shaft)	68D	Clamp Washer
18	Shaker Assembly	43	Clamp Washer	69	Screen(Reel)(spec.perf.)
19	Door	44	Key (Eccentric)	70	13 T. Sprocket
20	Hand Hole Cover	45	25 T. Sprocket	71	Speed Reducer
21	Sash Clamp	46	Eccentric Shaft	72	Key (32 T.Gear)
22	End Shield	47	Cap	73	Spur Gear (Spd.Reducer)
23	Top	48	Bearing	74	Spacer (Pitman Rod)
24	Conn. Spout-Feed Inlet	49	Bearing Housing	75	Cup (Pitman Rod)
25	Rear Guard	50	Sleeve (agitator)	76	Bushing (drive bar)
26	Uptake	51	Agitator Assembly	77	Key (25 T.Sprocket-R.H.Shaft)
27	Discharge Spout	52	Rear Plate	78	Sleeve
28	Sash	53	Cap (Reel Spider-Frt.)	79	Reel Spider (L.H.Rear)
29	Rubber Cushion	54	Bearing(Reel Spider)	80	Key (25 T.Sprockets-L.H.Shaft)
30	Cup (hanger rod)	55	Reel Spider (Front)		
81	Beater Shaft-L.H.	82	Bracket for Speed Reducer(Not shown) (Used only with Dodge Reducer)		

PART FOUR

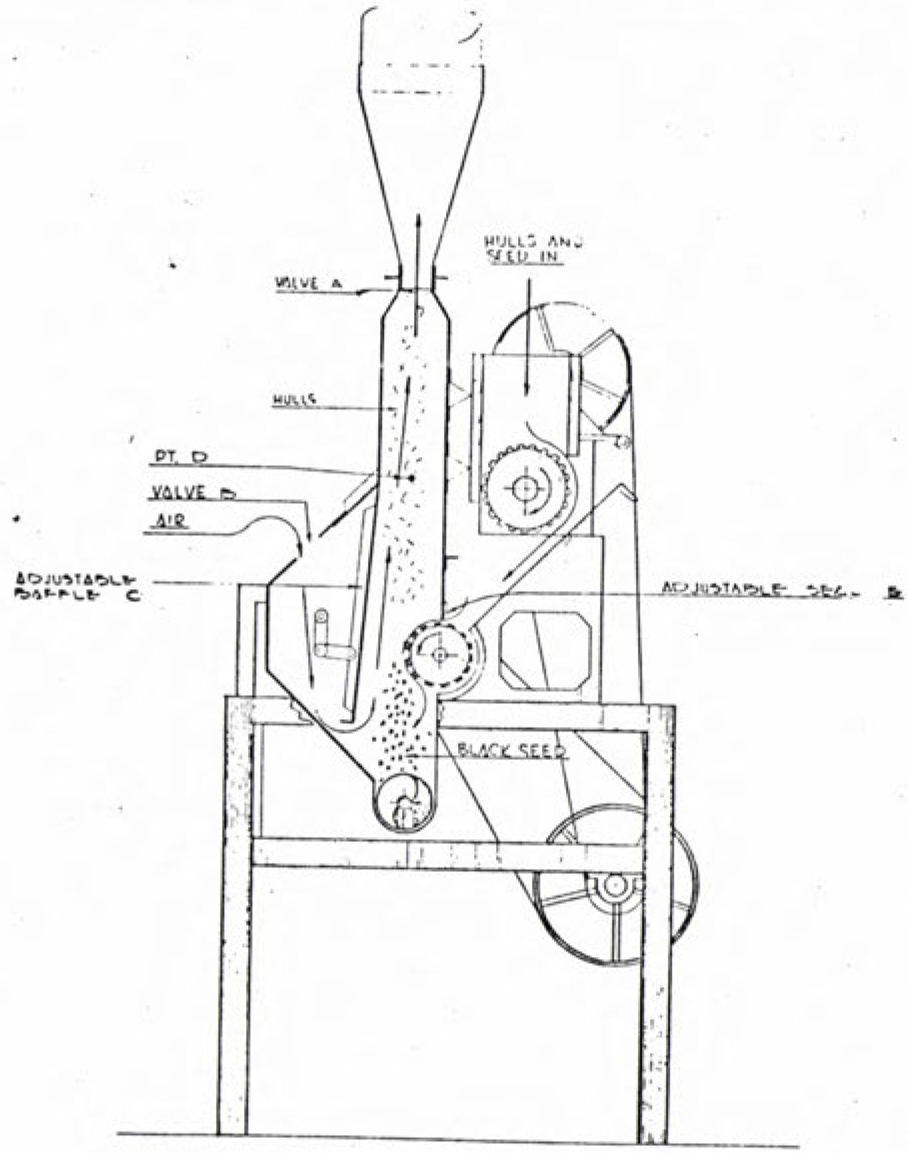
THE HULL and SEED SEPARATOR

The Hull and Seed Separator, shown on Figure 8, is a pneumatic device for separating cottonseed hulls from seed. The principle of its operation is obvious from the above-mentioned cross sectional drawing. This machine, which handles the mixture of hull and uncut seed from the huller, makes possible the several arrangements of Single Huller Systems, which will be discussed in detail under Part Eight. By introducing a thin sheet of the mixture into a "vacuum chamber", with the feed and air properly adjusted, the hull will be picked up and the heavier seed dropped out, to be returned to the huller.

The capacity of this machine is normally estimated at 75 tons of seed (hulls from) but actually is dependent on the percentage of lint left on seed and the type of seed worked. On prime seed with less than 1-1/2% lint on seed, it will handle satisfactorily in excess of 90 tons per 24 hours, but with more than 2-1/2% lint on seed and with large percentages of immature seed, it will not give good results with more than 60 tons. With still higher percentages of lint on seed, the capacity drops even further, and with approximately 4% or more lint, it is not practical to operate a Single Hulling System and it becomes necessary to convert to something entirely different as covered in Part Twelve. In working "bollies", containing a large percentage of small, immature seed, it is necessary to drop a larger percentage of hull with the uncut seed, to prevent picking up these lighter seed, and this results in a proportional reduction in capacity. As with almost any machine, the H & S Separator requires careful, accurate adjustment when crowded to its maximum capacity and at lesser tonnage is not so sensitive and will do good work with less expert supervision.

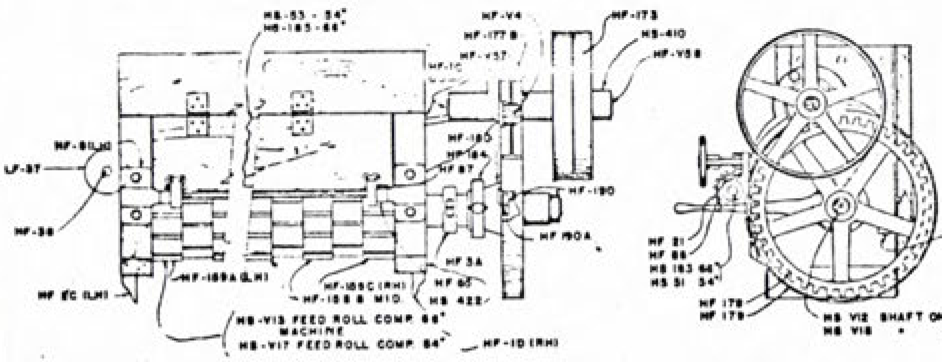
The first step in starting up one of these machines for the first time is to properly adjust the feeders to uniformly distribute the load over all machines. Several combinations of pulleys are furnished with the equipment for driving the feeder from a countershaft and after making any necessary changes and arriving at approximately the correct feeder speed, minor changes and adjustments may be made with the adjustable lip board on the back of the feeder. In large mills using three or more Separators, it is desirable to install a countershaft with variable speed drive for controlling the feeder under varying load conditions.

Full instructions as to the air requirements for this machine will be covered in Part Eleven, and assuming that the pneumatic system is properly designed and adequate air is available, there are three other important adjustments,

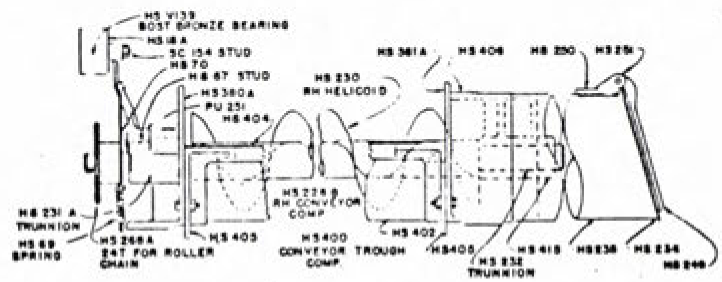


CARVER HULL AND SEED SEPARATOR

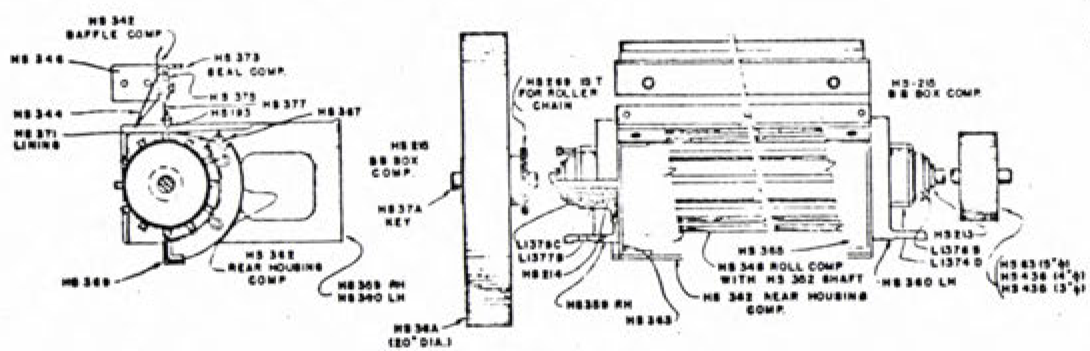
FIGURE No 8



F E E D E R

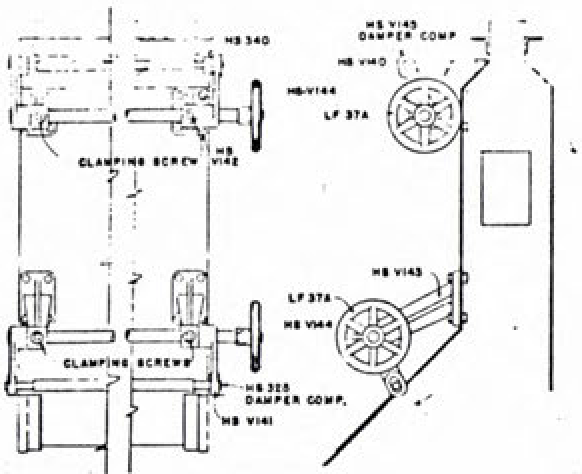


CONVEYOR PARTS

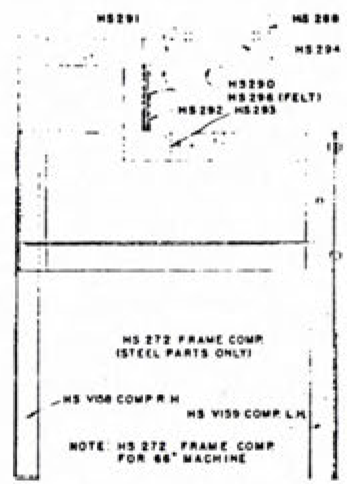


SEPARATOR ROLL

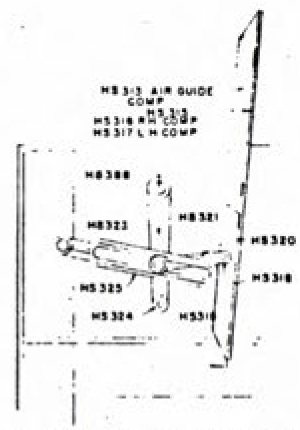
HULL & SEED SEPARATOR - PART NUMBERS
FIGURE Nº 8-A



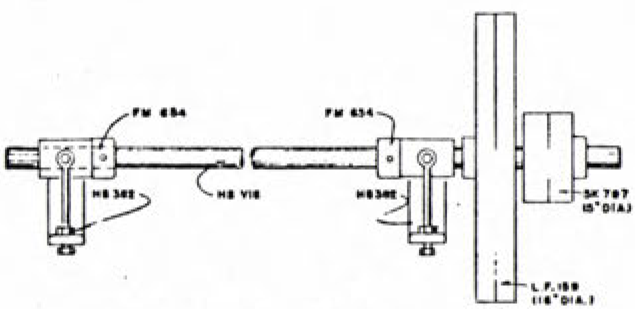
DAMPER PARTS



FRAME PARTS



AIR GUIDE & OPERATING PARTS



COUNTERSHAFT PARTS

HULL & SEED SEPARATOR - PART NUMBERS		
GARRETT	FIGURE 8 B	

indicated on Figure 8, as follows:

a) This adjustable valve or air outlet on the top of the machine should be moved in or out until the negative pressure in the air chamber at Point D is approximately 1.3" of water. This reading may be made by drilling a 1/4" hole in the side of the air chamber as indicated and reading the negative pressure with a manometer. Before making this adjustment, however, the two other adjustments B and C should be made as outlined below. For heavy tonnage and closely linted seed, it might sometimes be necessary to vary this adjustment A and make the negative pressure a little in excess of 1.3" of water and for lighter tonnages it might operate successfully with negative pressures as low as 1.2". However, after once making this adjustment A and determining it to be satisfactory for a particular condition, the valve A should be bolted or locked in place and never moved except under the direction of the mill superintendent.

b) Adjustment B is a sliding valve for controlling the inlet air to the machine. As outlined in A above, it should be first set for an opening of exactly 3/4" before making adjustment A. After starting up the equipment and getting the load regulated, all normal adjustments should be made at this point to control the percentage of hull dropped with the uncut seed. Operators should be cautioned not to tamper with this adjustment, for after it is once properly set, it should not be necessary to change it unless there has been radical change in the tonnage or some variation in linting, moisture, etc.

c) This adjustable baffle board should be set for a clearance of from 3" to 3-3/4" from the roller as indicated in Figure 8 and after determining that this adjustment is satisfactory for a particular operating condition, it should not normally be necessary to alter it. With heavy tonnages or where there might be a shortage of air on the pneumatic system, it will be necessary to operate this baffle board for a minimum clearance, but for normal operating conditions, the wider setting of approximately 3" to 3-1/2" is preferable. From time-to-time, the link mechanism on the baffle board C should be checked to be sure that the clearance is the same at both ends.

Directly above the feed roll, underneath the feeder, there is an adjustable seal strip indicated as adjustment E on Figure 8. This is a metal bar, attached to rubber belt-ing for flexibility, and it should be adjusted for bare clearance from the feed roll, so as to prevent leakage of air. This adjustment should be checked periodically to see that there is no excessive leakage of air in the back of the machine but normally there is very little wear encountered at this point and adjustments are seldom necessary.

In starting up the H & S machine, the adjustable valve B should be opened a little wider than normal so that there will be no danger of excessive dropping of hull with the uncut seed, as this would build up an excessive "run around" of hulls, making it difficult to adjust the feeder or feeder speeds for the normal tonnage. After the feeder speeds have been regulated to uniformly distribute the load, the uncut seed from the Separator should be checked, preferably with a Laboratory Seed and Hull Separator, covered under Part 10, to determine the percentage of hull being dropped with the seed. On prime seed, valve B should be adjusted so that approximately 15% of hull will drop out with the uncut seed. This is necessary to assure that no seed are picked up with the hulls. If the "droppings" contain more than 15% hull, the valve should be opened slightly and vice versa. After arriving at approximately 15% hull in the uncut seed, the finished hulls should be carefully checked to determine if they contain any seed, and if so, it will be necessary to close valve B slightly, dropping a little higher percentage of hull with the uncut seed and then rechecking the finished hull. As mentioned above, where the seed are not uniformly linted or where they contain a large percentage of bollie seed, it might be necessary to drop as much as 45% hulls with the uncut seed to prevent picking up seed with the hulls. However, it is highly desirable not to exceed 20% or 25% hulls with the uncut seed and all operators should be cautioned to watch this carefully, as excess hulls with the uncut seed can easily develop into a big "run around" and eventually overload the Separators as well as the Hullers and Shakers. With reasonably good quality seed, average linting conditions, and with the equipment not overloaded, there is no reason for picking up any uncut seed with the hulls, but on bollie seed it is very difficult not to pick up a few immature seed (which usually contain practically no meats) and sometimes the overall results will be better by letting a few of these immature seed get in the hulls, rather than overloading the system in an effort to drop them out.

The uncut seed from this machine are discharged through a plug with flap gate which forms an air seal. This plug should be carefully checked to see that there is no leakage of air, and sometimes, on closely linted seed, it is necessary to add some additional weight to the flap gate in order to form sufficient plug to seal the air.

PART FIVE

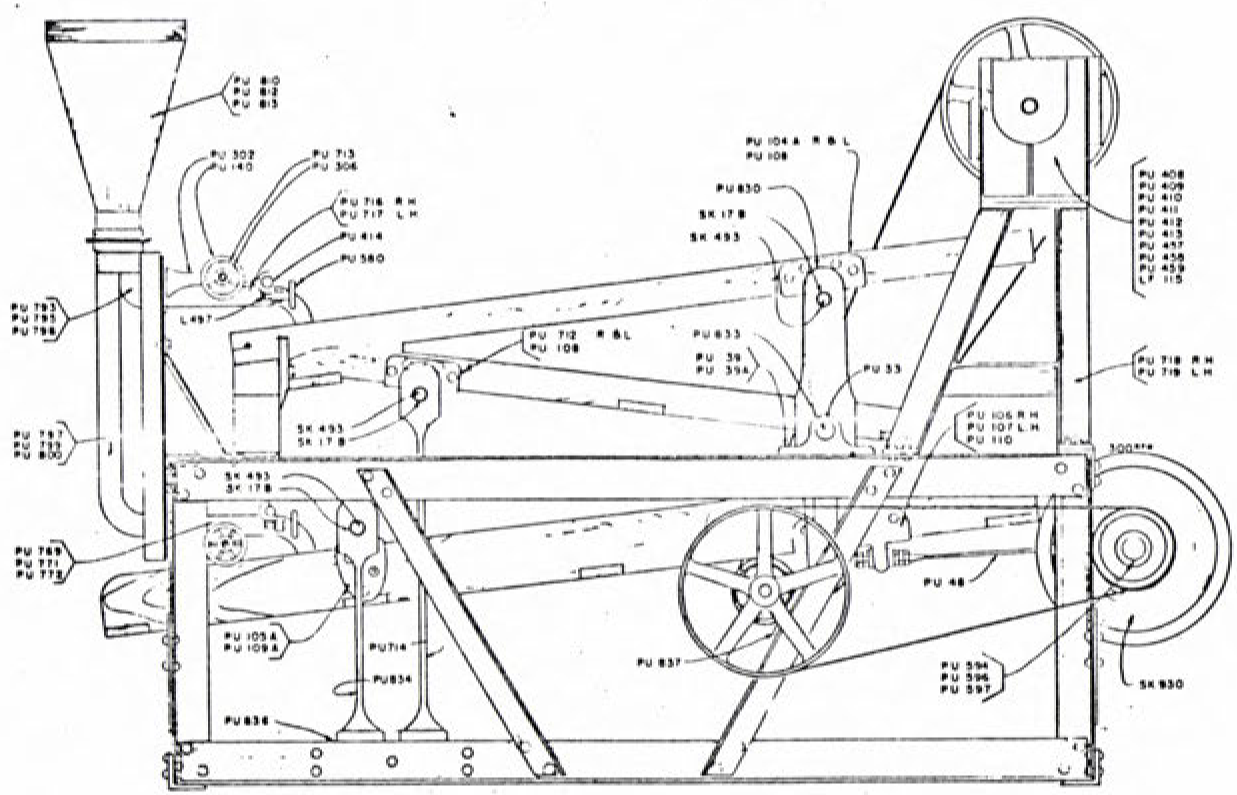
MEATS PURIFIERS

Purifying of cottonseed meats refers to the process of separating excess hull particles from the meats in order to control or produce the desired protein in cake. So long as the protein in seed (or in pure meats) is sufficiently high that 12% or more hull can be left in the meats, the problem is not too difficult, but when low protein seed makes it necessary to lower the hull content to 8% or 10%, then the very best arrangement and supervision are required. Fortunately, the market in this country has adjusted itself to consume cake and meal within the range that the mills can economically produce, but with heavy lint cuts and dry seed, the very best arrangement of separating machinery and close supervision are generally required in order to produce 41% protein, or in some cases, 43%. The protein in seed is subject to considerable variation, which further complicates this problem.

Quite a few mills, where protein in seed will allow, are now producing 45% to 48% protein. This high protein cake or meal is then stored in bins, analyzed and then blended with hull bran to produce the desired protein. This allows more accurate protein control and usually greater capacity through the expellers or extraction plant.

A good meats purifier alone will not control protein. The entire arrangement of separating machinery must be designed with a view of protein control. It must produce coarse hull, no "run around" of material, and handle the finished purifier tailings direct to the hulls. Minimum rehandling of material is essential for efficient protein control, as well as good separation. Improper or inadequate arrangement and design of meats purifying equipment, and handling of tailings, is responsible for more bad separating results than any other single factor. Almost any separating system can produce hulls of low oil content, if the protein or percentage of hulls in meat is disregarded, but efforts to purify the meats frequently result in serious losses of oil and meats in hulls.

With the proper meats purifying arrangements, it is possible to raise or lower the protein within certain limits, but to determine and produce the desired percentage protein in cake, proper sampling and laboratory analysis are essential, and it is here that many mills fall down. Proper sampling procedure will be discussed later, but it is obvious that if insufficient samples are taken or if the analysis is not promptly obtained from the laboratory, the problem of protein control is seriously complicated. Most mills



CARVER PURIFIER		
		FIGURE Nº 9

adjust their protein machine in accordance with the last available analysis, take cake samples at various intervals throughout the day, and then wait 18 to 36 hours for the results. So long as the protein in seed and other factors remain constant, this method is fairly reliable, but unfortunately conditions do vary, and protein in cake is correspondingly irregular.

This chapter will concern itself primarily with equipment for raising or lowering protein by removing more or less hull from the meats. With the Bauer pneumatic system, the protein control is an integral part of the system and will be discussed in connection with that equipment. Most commonly used independent protein machine is the Carver Purifier, illustrated in Figure 9. Some mills use a homemade purifier, most of which embody the same general principle as the Carver, so this discussion will treat with the theory and operation of the Carver Purifier.

The general idea of a Purifier is to pass the meats or tailings over a shaker tray clothed with proper metal to screen out any remaining fine meats dust, and with the two tray purifier, the top tray is clothed with proper perforations to let approximately half the load drop through to the second tray. This generally requires 7/32" metal or a combination of 7/32" and 5/32" on the top tray and smaller metal on the bottom tray. A suction nozzle is mounted at the discharge end of the tray, and by raising or lowering the nozzle, or by increasing or decreasing the volume of air by means of a valve, more or less hull particles may be lifted from the meats. For best results, the shaker must be designed and operated at the proper speed to give a gentle action to the material which will float the hull to the top, allowing the meats to move forward with no appreciable bounce and pass under the nozzle uniformly distributed across the tray. This action is obtained by operating the shaker at minimum speed, generally about 300 RPM, on a 3/8" throw eccentric, and with a hanger pitch of zero (vertical) or slightly forward of the vertical.

It is most important that the meats purifier be kept in good mechanical repair. Shaker metal should be flat and well secured. The nozzle must be rigidly mounted, with the lip of the nozzle equidistant from the surface of the tray on each end. Adjustable mechanism for raising or lowering the nozzle should be free and easy to move. After the nozzle height has been set in accordance with the load, further adjustments should be made by regulating the valve controlling the air, or bleeder valve in line.

For good results, the suction nozzle must be properly designed for a smooth flow of air, and with the effective area corresponding to the pipe size. The fan must be of ample capacity and operate at the proper speed to handle sufficient volume of air, etc. Details in connection with design will be covered in Part Eleven.

The most modern separating systems, designed with a view of producing maximum protein cake, are equipped to purify or scalp the meats on the lower tray of the huller shaker, illustrated in Figure 5, Arrangement 4 on Page 20. With this system, the meats are finished at the huller shaker, and go direct to the rolls, but it is generally necessary to repurify the tailings on the Purifier. All of the "tailings" or "black hull" scalped from the meats, are discharged to the Purifier and any meat particles picked up are then dropped out along with the desired amount of hull to control the protein. This arrangement is referred to as double purifying, and is now considered standard practice.

With the double purifying system, wherein the meats are purified on the lower tray of the huller shaker and the tailings repurified on the Purifier, to separate any meat particles picked up at the huller shaker, it is possible to do a better job of separation and protein control than with the original system of purifying all of the meats on the Purifier. However, it is still not possible to make a complete separation and, particularly on the lower tray of the Purifier it is necessary for some small hull particle to drop out with the smaller meat particles, in order not to pick up meats with tailings.

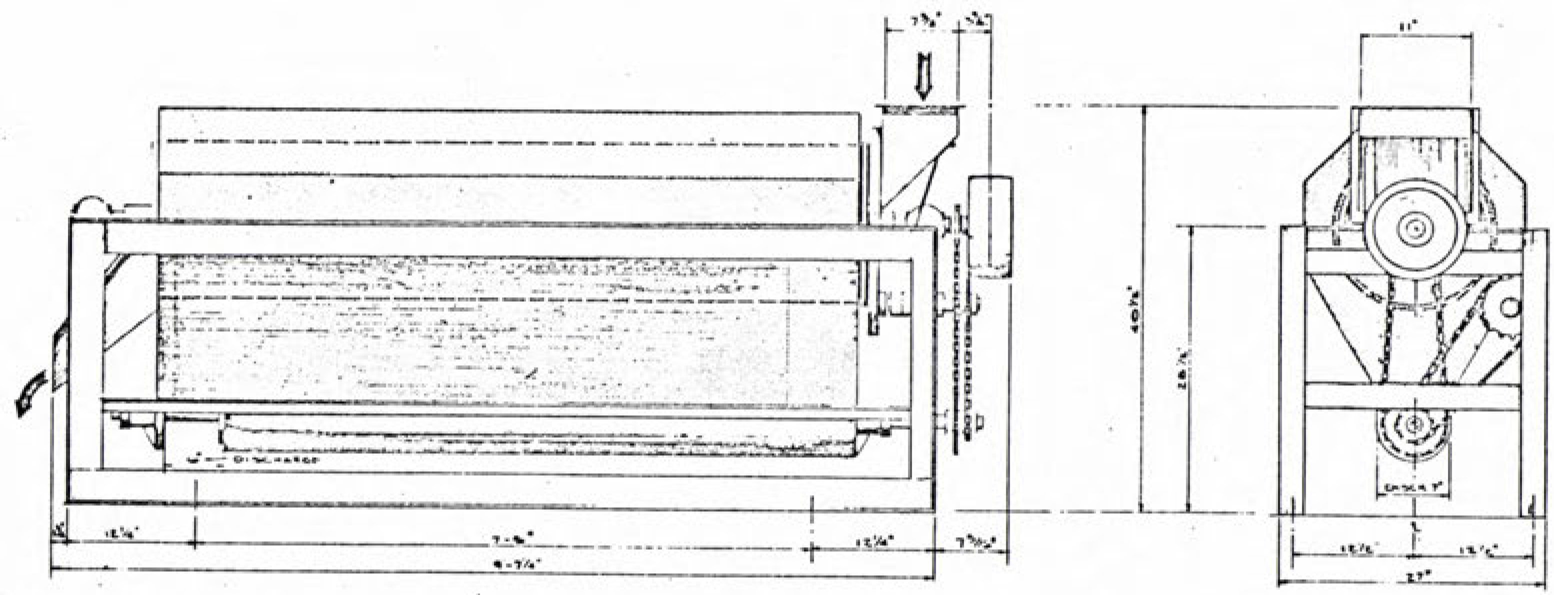
With normal cottonseed the above Double Purifying System will usually allow protein control up to 43%, but on extremely dry or low protein seed, or to produce higher protein cake it is sometimes necessary to resort to other devices. Suggestions for making higher protein are as follows:

a) Install a small aspirating nozzle on the extreme discharge end of the lower tray of the Purifier, to pick up any small hulls not removed by the Purifier Nozzle, illustrated on Figure 13, Arrangement 1, Part Eight. This special nozzle might pickup a few small meats so it should not be connected into the Purifier Pneumatic System. It may be connected into the Pneumatic System handling tailings to the Purifier, and recycled back to the Purifier. Recycling of hull fractions is not usually recommended anywhere in the system, but in this case, and where the Purifier is not overloaded, it is sometimes helpful.

b) If the inexpensive device, in a) above, does not give the desired results and if still higher protein is required, then another Purifier, in series with the first, will make it possible to make a further reduction of hulls in meats. With two Purifiers in series, it becomes easy to remove almost all hulls from the meats with the nozzles on the lower tray of the Huller Shaker. Even though this nozzle picks up 10% to 15% meats with tailings and with the first Purifier removing 90% of the meats, the second Purifier has an easy job with only 1% to 1-1/2% of meats in tailings. If it also removes only 90% there would be a negligable amount of meats in the finished tailings.

An even more efficient device for separating meat particles from tailings, which is now being used at several mills, is the Sutton Gravity Separator. It is believed that this machine will do a better job of purifying tailings, but it does require careful and constant supervision and is not recommended unless the protein control situation with the conventional equipment has been impossible.

The use of the RoBall attachment, covered in detail in Part 2 for the Huller Shaker, is recommended for the lower tray of the Purifier, to prevent the screen from clogging with small meats.



CARVER TAILINGS BEATER

BARRETT

FIGURE No 10

PART SIX

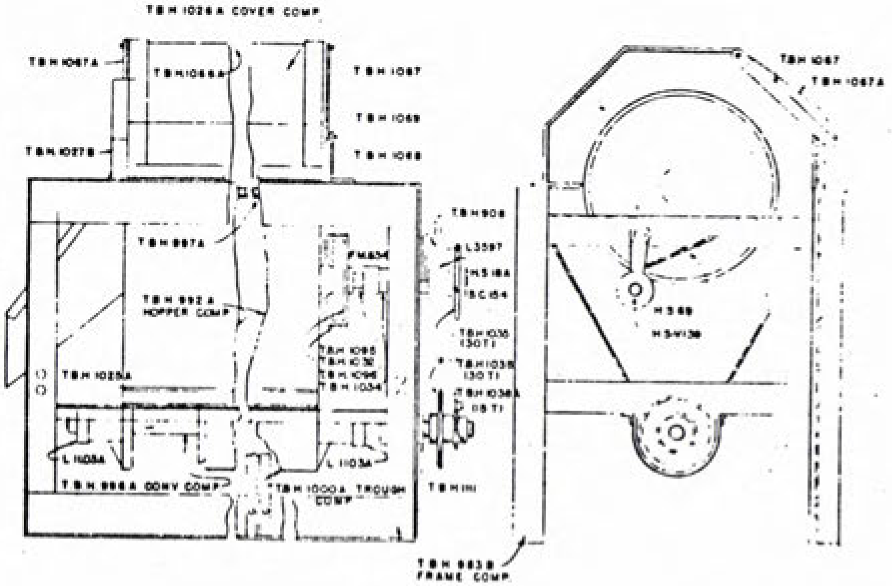
THE TAILINGS BEATER AND HANDLING OF TAILINGS

All hulls from the Purifier will be referred to as Purifier tailings and hulls picked up from the beater shaker as beater tailings, and usually both will be handled and treated together. With a properly designed and operated system, there should be no seed or meat particles in the tailings, but there will be considerable meats dust and oily fibers which require treatment in a beater, or some other device. Figure 10 shows a conventional Carver revolving drum tailings beater, from which it will be noted that all meats dust passing through the metal goes to the finished meats and the finished tailings direct to the finished hulls. Mills handling less than 100 tons of seed per 24 hours sometimes get by with a smaller stationary basket beater, but the revolving drum is preferable. Mills crushing over 150 tons per day should use a single drum hull beater, rather than the tailings beater and for this reason Carver have discontinued the mall tailings beater.

Beater tailings and Purifier tailings require the same treatment and may be handled with the same beater. When the Purifier fan is of sufficient capacity, a 6" pipe may be tapped into its suction side to pick up and carry the tailings from the Hull Beater Tray.

In extreme cases with dry seed and heavy lint cuts, a few meat particles will be picked up by the Purifier nozzles, and where this cannot be corrected by readjusting the nozzles, or other devices mentioned in Part 5, it is sometimes necessary to install a short section of 5/32" or 1/8" perforations at the discharge end of the tailings beater. However, caution should be used in putting larger perforations on a tailings beater, as excessive hull will then pass on to the finished meats, resulting in more harm than good. When a few meat particles are showing up in the tailings, they may be partially eliminated by handling the tailings through a meats dropper. Various arrangements may be improvised for this purpose, such as a "moting chamber" or a simplified small scale model of the Hull and Seed Separator. Arrangements of this kind are easily installed when pneumatic means are already provided for conveying the tailings to the finished hulls.

Under no circumstances should tailings be returned to the Hullers, main Hull Beaters, or Separators, as this simply results in a "run around" of material, with an excessive recycle to the Purifier, and will finally result in excessive fine hulls in the meats, lower protein and excessive oil in hulls. The same is true of perforating the



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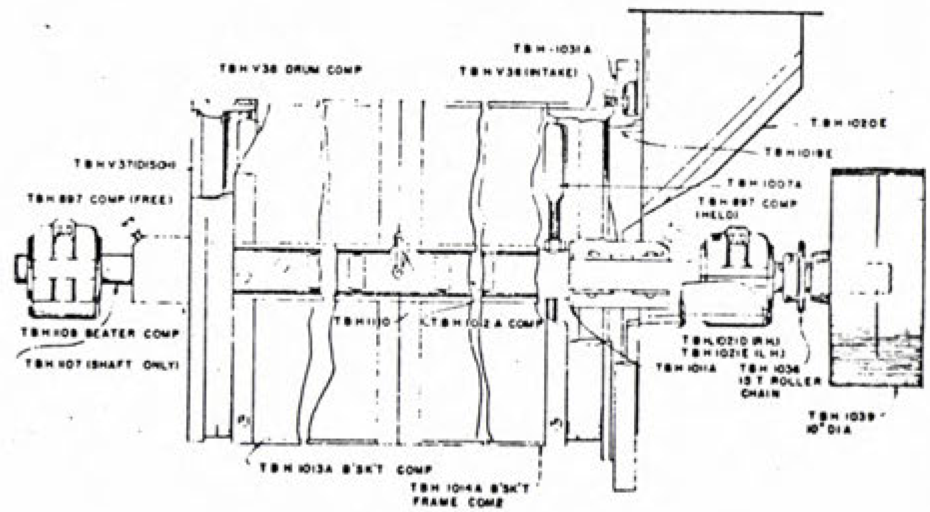
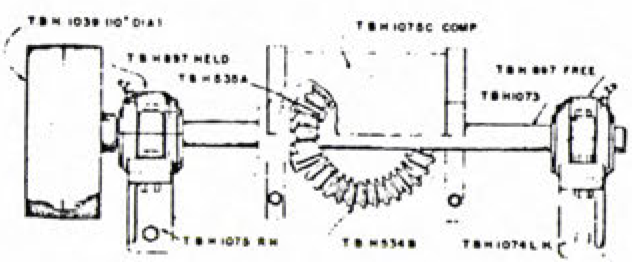


BEATER & DRUM PARTS



RIGHT ANGLE DRIVE

CARVER TAILINGS BEATER-PARTS

FIGURE Nº10A

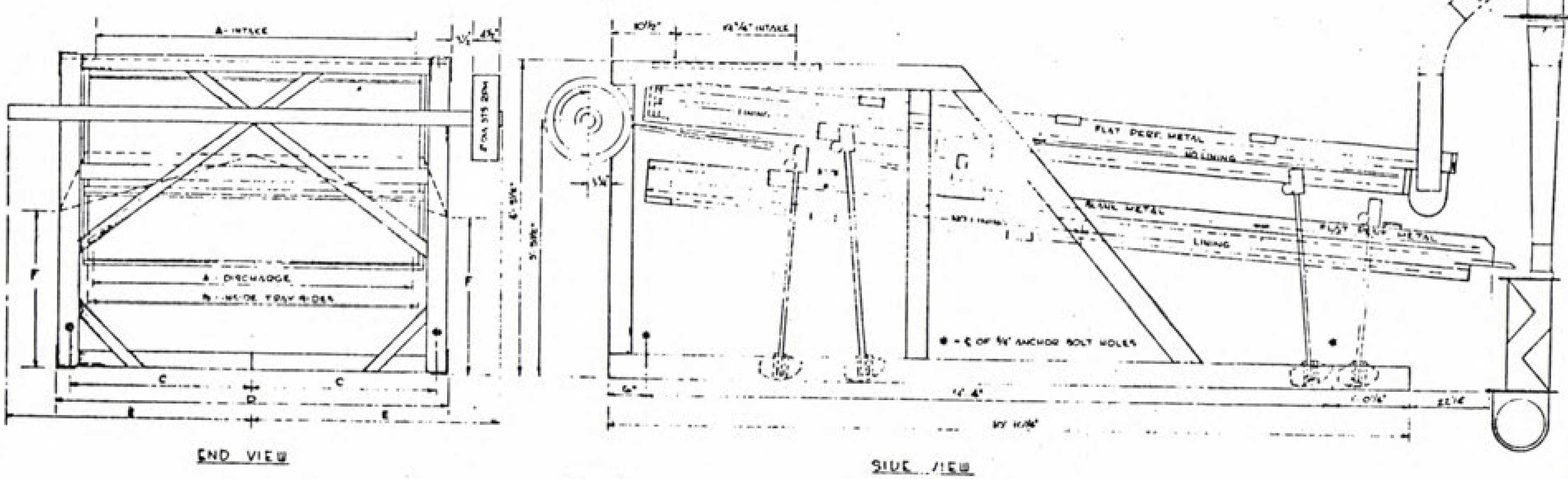
finished hull conveyors in an effort to trap out meats; this also results in a "run around" of material. Seed or meats in the hulls is due to improper operation or inadequate equipment, and proper corrective measures should be taken at the source of the trouble.

Where the tailings beater is used as intended, with small perforations, i.e., not exceeding 1/8", it serves a useful purpose in removing oily fibers and meats dust, but where larger perforations are installed, with the intention of removing larger meat particles which may be due to improper operation of the Purifier, it may result in serious trouble. Larger perforations for removing meat particles will remove a much larger percentage of hulls in order to take out just a few meats. This immediately lowers the protein, making it necessary to "pull harder" on the Purifier, putting more meats in the tailings. Detailed operating and trouble shooting suggestions will be made in Parts 8 and 10, and the purpose of mentioning this problem here is to point out that under certain conditions, the tailings beater might be more harm than good.

With extremely dry hulls, there is considerable shattering and breakage of hulls, in every handling operation, which produces hull bran and increases the percentage of hulls in meats and in some cases, makes it very difficult to produce the desired protein without excessive oil or meats in hulls. It is therefore highly desirable to minimize such breakage of hulls and one of the best places to do so is where the pneumatic systems are handling hulls and tailings through fans. Many of the modern systems now incorporate vacuum droppers ahead of all fans to bypass the material around the fans. Due to the importance of the vacuum dropper arrangements in connection with pneumatic systems in the Huller Room, their application will be covered at length under Parts 8 and 11.

SCHEDULE

MESH SIZE	A	B	C	D	E	F	G	H
24	34⅜	36¾	21⅛	46½	31½	24⅝	5	20
45	45⅜	41¾	27½	56½	37½	29¾	7	26
54	52⅞	54¾	30⅞	64½	40½	35½	9	29



SAFETY SHAKER

FIGURE No 11

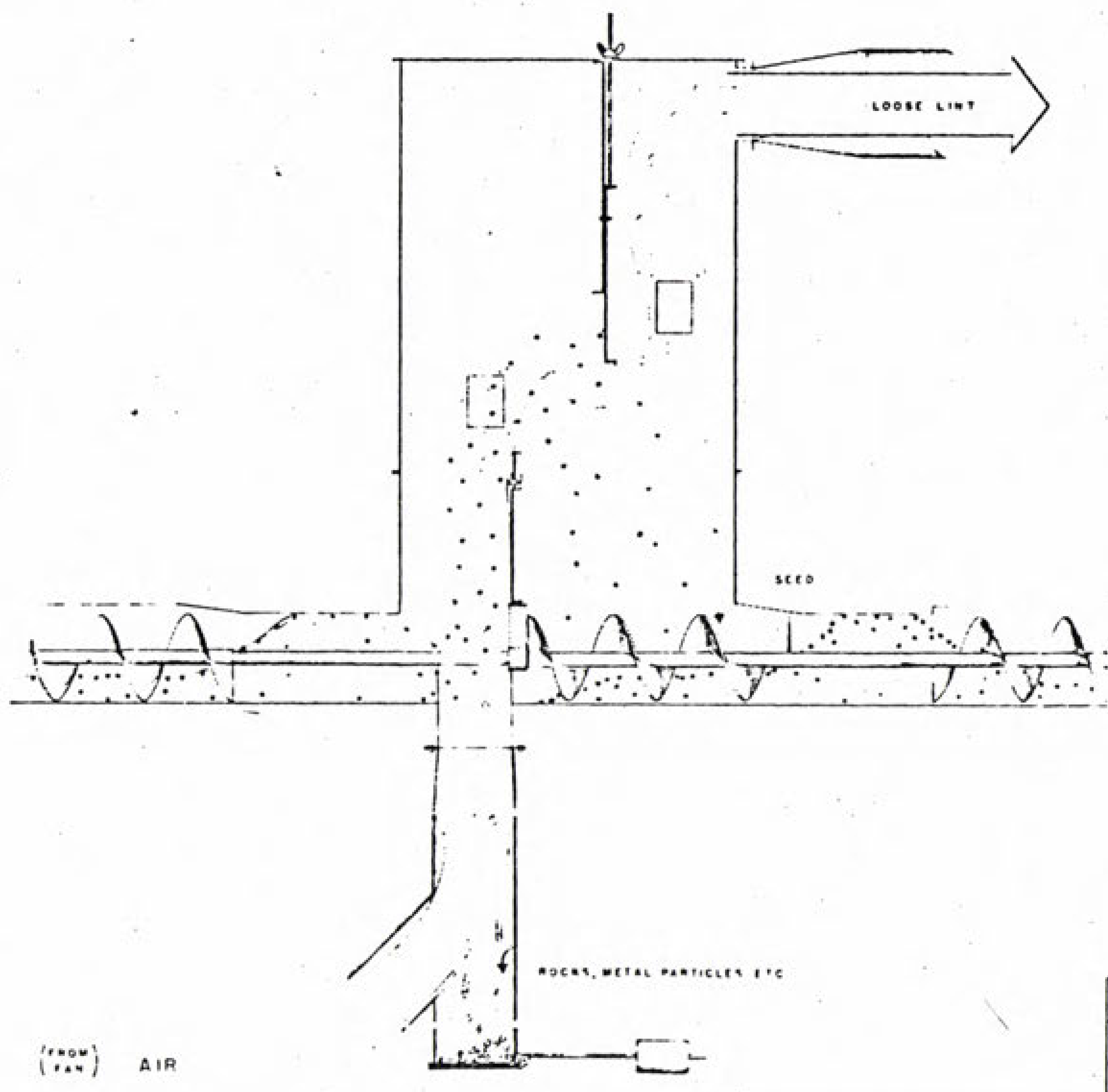
PART SEVEN

THE SAFETY SHAKER

Seed going to the Hullers from the Lint Room will contain various quantities of loose lint, foreign matter, sand and fine meats; however, when the Lint Room is properly operated and equipped with independent mote handling conveyors, this material, particularly lint, will be kept to a minimum. Some means of protecting the Huller from foreign matter such as nuts, bolts, etc., is absolutely essential and this may be done by means of a Safety Shaker or pneumatic trap or a magnet, or a combination. In deciding on the best means of protecting the Huller, it is well to bear in mind the importance of also removing loose lint, sand and fine meats dust which wear out huller knives and adversely affect separating results, and to incorporate this into the system.

The most popular method of protecting the Huller and preparing the seed, probably because it is easy and fairly economical, is with a Safety Shaker. Various designs may be used, but one incorporating several features is illustrated in Figure 11. Although many mills spout the material direct from the overhead conveyor to the Shaker, with no feeder, a feeder is strongly recommended. With a feeder properly speeded and with adjustments to take care of load fluctuations, a much better distribution of material may be obtained allowing smaller perforated metal on the Shaker and better scalping. The feeder also reduces the amount of dust and lint fly. As will be noted on the illustration, the top deck of the tray is clothed with 3/8" or 1/2" perforations, depending on the load and lint cut. This screens out any large foreign matter and loose lint. A suction nozzle at the end of the tray picks up the loose lint, generally conveying it by air to the mote beater. The nozzle design shown on the sketch removes practically all loose lint by passing the seed through the air current, and is much more effective than a simple nozzle on top of the tray. The lower deck of the tray is clothed with 3/32" or 1/8" perforations to screen out fine meats and sand. Where the seed are well cleaned and there is no appreciable quantity of sand, the fines may be spouted to the meats conveyor, but if the sand is excessive, the material must be disposed of, as there is no known method of separating sand from fine meats.

The above scalping Shaker arrangement has been used successfully for many years in most oil mills, although the early adaptations used a conventional nozzle on top of the tray, which allowed some loose lint to pass through the large perforations of the top deck along with the seed and go on to the Huller. With this arrangement, the Huller is not protected from small metal particles or ball bearings



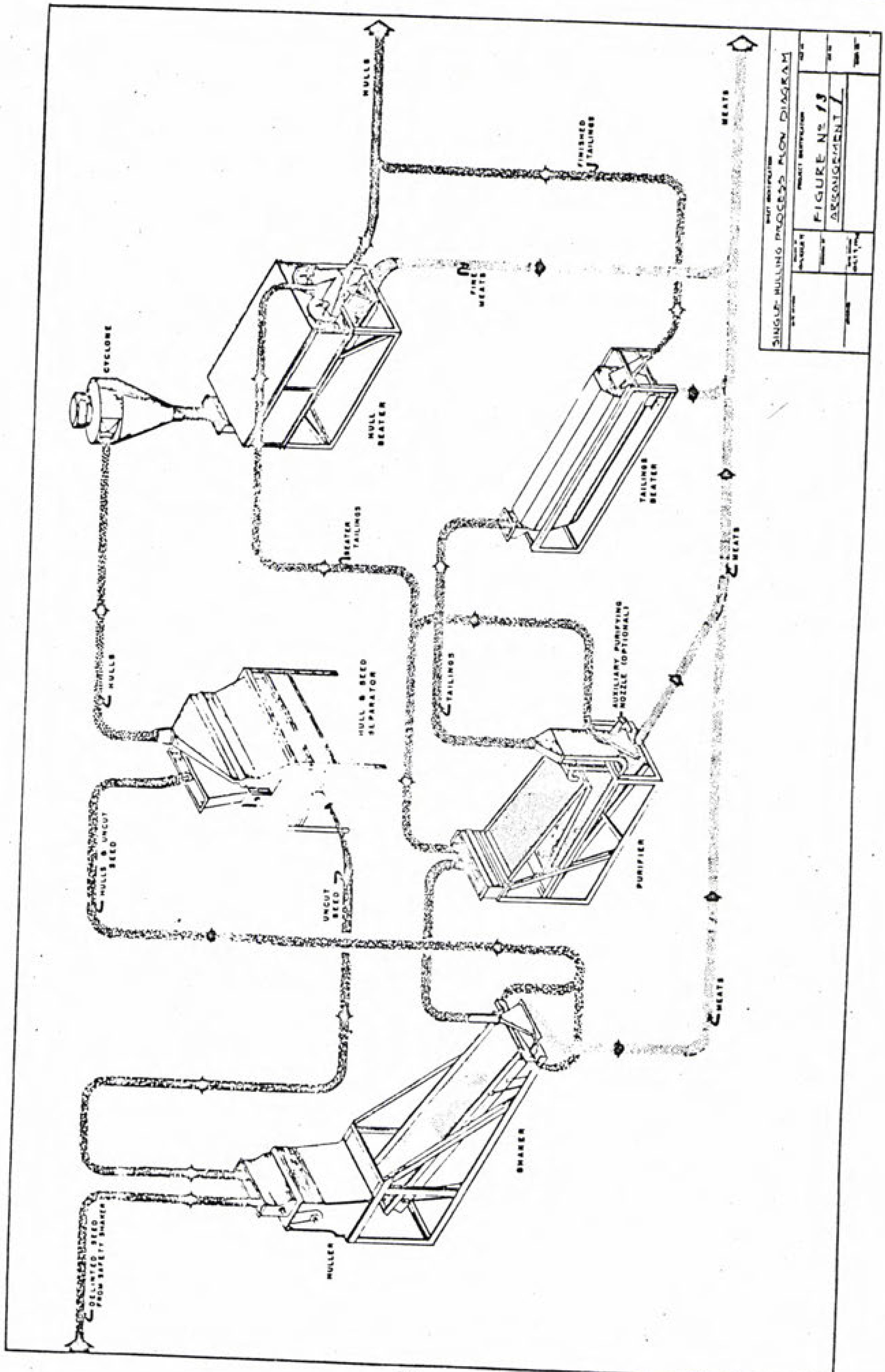
SHALE B ROCK TRAP

FIGURE No.

that will pass through the 3/8" perforations, but this may be overcome by using a magnet on the huller.

Another method of protecting the Huller, which is operating successfully in a few modern mills, particularly where there is not space for a Shaker, is with a pneumatic trap, commonly referred to as a Shale and Rock remover, and illustrated in Figure 12. This device requires about 5 HP to operate the fan, but eliminates one elevator and costs less than the scalping Shaker. The rock trap, when properly adjusted, will drop out the very smallest particles of rocks and metal and blows out to the dust collector practically all of the loose lint. It does not remove any fine meats or sand, but this may be handled by installing a section of perforated bottom conveyor between the Lint Room and the Rock trap. The present design of the rock trap is satisfactory, but normally the scalping Shaker is preferable for protecting the Huller.

The use of magnetic belts for Huller protection is hardly justified. Permanent magnets installed in elevator spouts, or under the Huller feeders are good insurance. It is not practical to install a magnet in the spout over a Huller feeder, which must run full of seed. Permanent magnets are now furnished as standard equipment directly under the Huller feeder.


SINGLE-HULLING PROCESS FLOW DIAGRAM
FIGURE No 13
ARRANGEMENT 1
DELINTED SEED FROM SAFETY SHAKER
HULLER
SHAKER
HULLS & UNCUT SEED
UNCUT SEED
HULL & SEED SEPARATOR
HULLS
CYCLONE
HULL BEATER
HULLS
FINE MEATS
FINISHED TAILINGS
BEATER TAILINGS
TAILINGS
TAILINGS BEATER
AUXILIARY PURIFYING NOZZLE (OPTIONAL)
PURIFIER
MEATS
MEATS
MEATS

PART EIGHT

SINGLE HULLING SYSTEMS

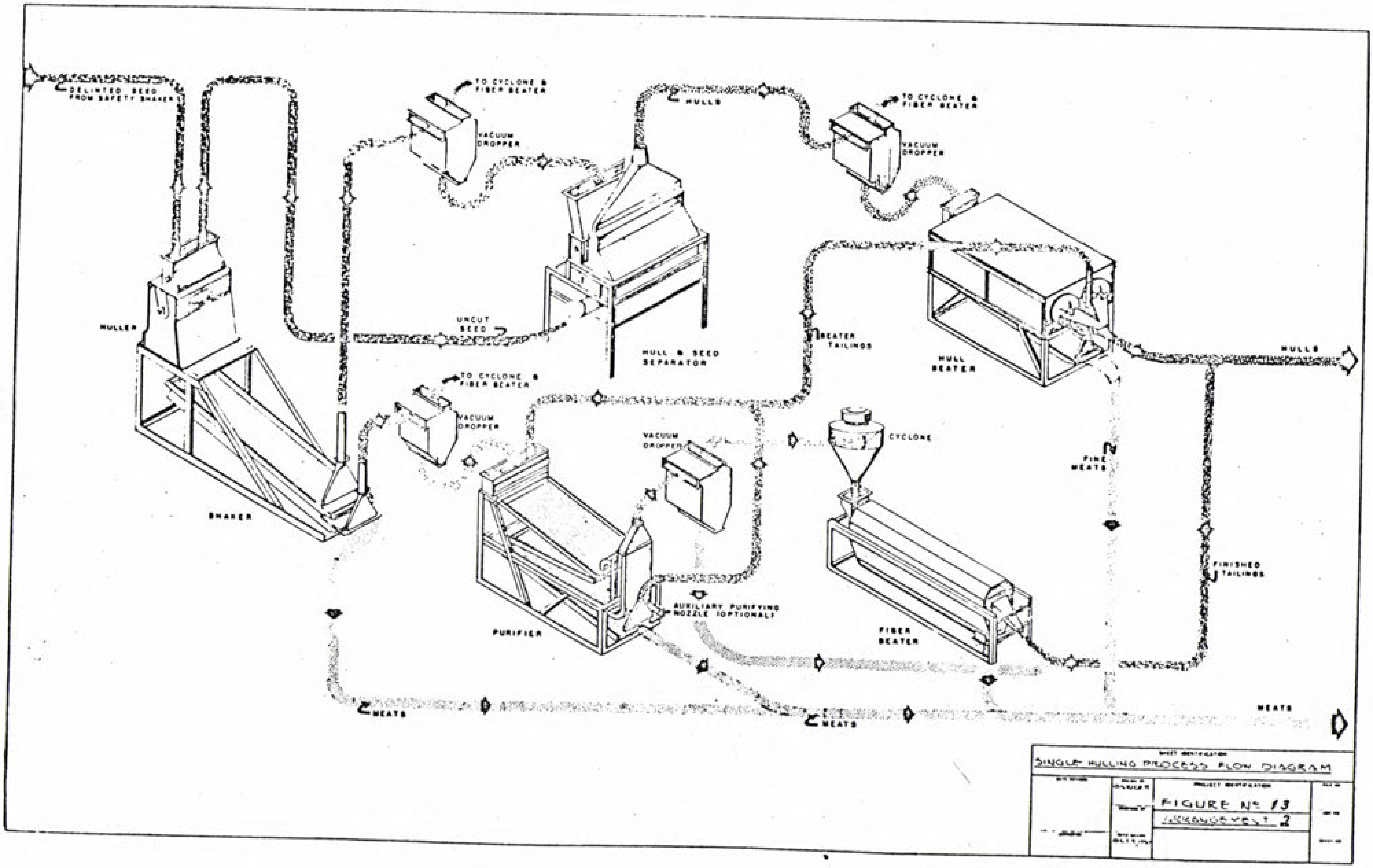
The foregoing descriptions and discussions of the individual pieces of machinery used in practically all hulling and separating systems have just about covered the general arrangement of a conventional single hulling system and it will only be necessary to discuss here the three or more deviations from the conventional arrangement along with the advantages and disadvantages of each.

Almost any arrangement of a single hulling system would call for a Safety Shaker, Huller, Shaker, Hull and Seed Separator and a final treatment in the Hull Beater. It might be mentioned here that for several years after the development of the Carver Hull and Seed Separator, this machine was located so as to handle the mixture of hulls and seed from the beater, rather than ahead of the beater. This was based on the theory that it would be preferable to remove meats dust from the hulls by means of the beater before passing them to the H & S machine. However, it has since been found best to locate the Separator ahead of the beater as this traps out the uncut seed and eliminates the necessity of passing this volume of seed through the beater, and also, with the beater for a final treatment, it will separate some small seed and meats that might accidentally be picked up by the Separators.

Figure 13, Arrangement 1, is a flow chart showing the simplest conventional arrangement of a single hulling system in which the material from the Huller Shakers is conveyed and elevated to the H & S machines, uncut seed returned to the Hullers, hulls pneumatically handled through the fan and discharged to a cyclone and then to the beaters.

A deviation and improvement to this system, shown on Figure 13, Arrangement 2, is to aspirate the hulls from the top tray of the Huller Shaker, with a pick-up nozzle, and handle them pneumatically to the H & S machines. The principal advantage of this pneumatic handling is that with a proper "pick-up nozzle" approximately 50% of the uncut seed may be dropped out at this point, thereby relieving the load on the H & S machines, and making it possible for them to do a better job of separation.

This proposed Arrangement #2 on Figure 13 also indicates Vacuum Droppers on all four pneumatic systems. A Vacuum Dropper is essential on the system handling hulls from the top tray of Huller Shaker as this material contains some seed that would be broken by the fan. It is also highly desirable on the system handling tailings from


DELINTED SEED FROM SAFETY SHAKER
HULLER
SHAKER
TO CYCLONE & FIBER BEATER
VACUUM DROPPER
UNCUT SEED
HULL & SEED SEPARATOR
HULLS
TO CYCLONE & FIBER BEATER
VACUUM DROPPER
BEATER TAILINGS
HULL BEATER
HULLS
TO CYCLONE & FIBER BEATER
VACUUM DROPPER
VACUUM DROPPER
CYCLONE
FINE MEATS
PURIFIER
AUXILIARY PURIFYING NOZZLE (OPTIONAL)
FIBER BEATER
FINISHED TAILINGS
MEATS
MEATS
MEATS
SINGLE HULLING PROCESS FLOW DIAGRAM
FIGURE No 13
ATTACHMENT 2

the lower tray of Huller Shakers to the Purifier to prevent breakage of meats and hulls passing through the fan. Vacuum Droppers on the two remaining systems will minimize breakage of hulls and make it easier to control protein. This proposed Arrangement #2 is the best and most complete system available today.

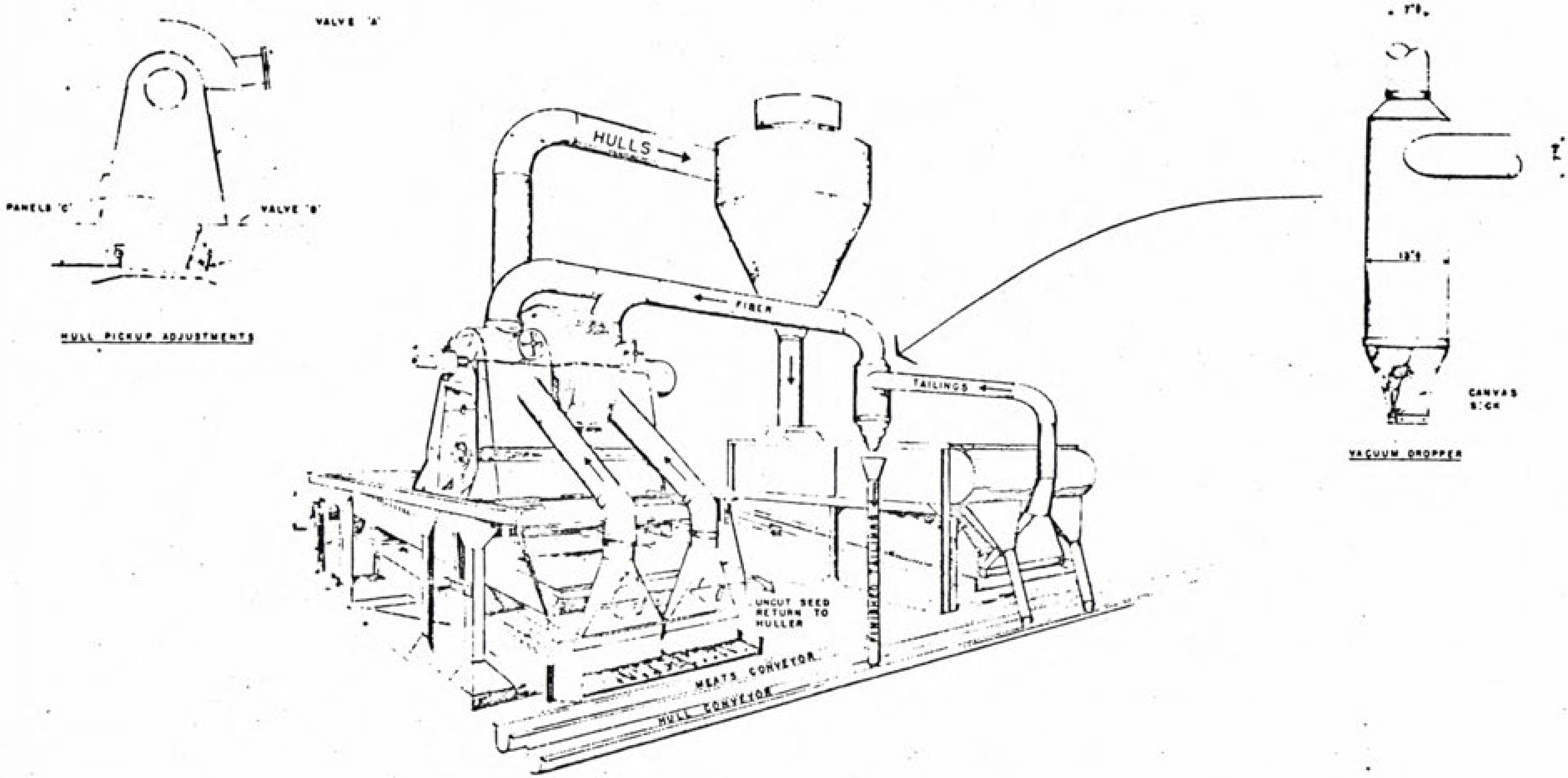
Details, and further discussion of Vacuum Droppers will be covered in Part 11.

There are, of course, quite a few additional deviations and combinations of the above arrangements in connection with single hulling systems, but fundamentally the flow of material will be essentially the same as outlined above. One interesting arrangement that is applicable in connection with the use of vacuum droppers is a common pneumatic system and a single fan, with branch lines to the vacuum droppers on the various systems. An arrangement of this kind is in some cases more economical, in that it eliminates five or six or more small fans, cyclones, motors, etc., and replaces them with one large fan and cyclone. A system of this kind is more difficult to operate, and requires accurate adjustment of valves to obtain the required volume of air to each machine.

To summarize on the use of Vacuum Droppers:

a) Where a Pneumatic system is used to handle hulls from shakers to H & S machines, they are essential.

b) Highly desirable ahead of the H & S machine fans and the tailings handling systems to and from the Purifier, to prevent breakage of dry hulls, but not essential with high moisture seed, light lint cuts and where high protein is no problem.



BAUER UNIT

FIGURE Nº 14

PART NINE

THE BAUER UNIT

The Bauer No. 153 or 403 Separator-Purifier used in conjunction with the Bauer Double Drum Beater, makes up a complete unit and is more compact, easier to install, and probably less expensive than any other single hulling arrangement.

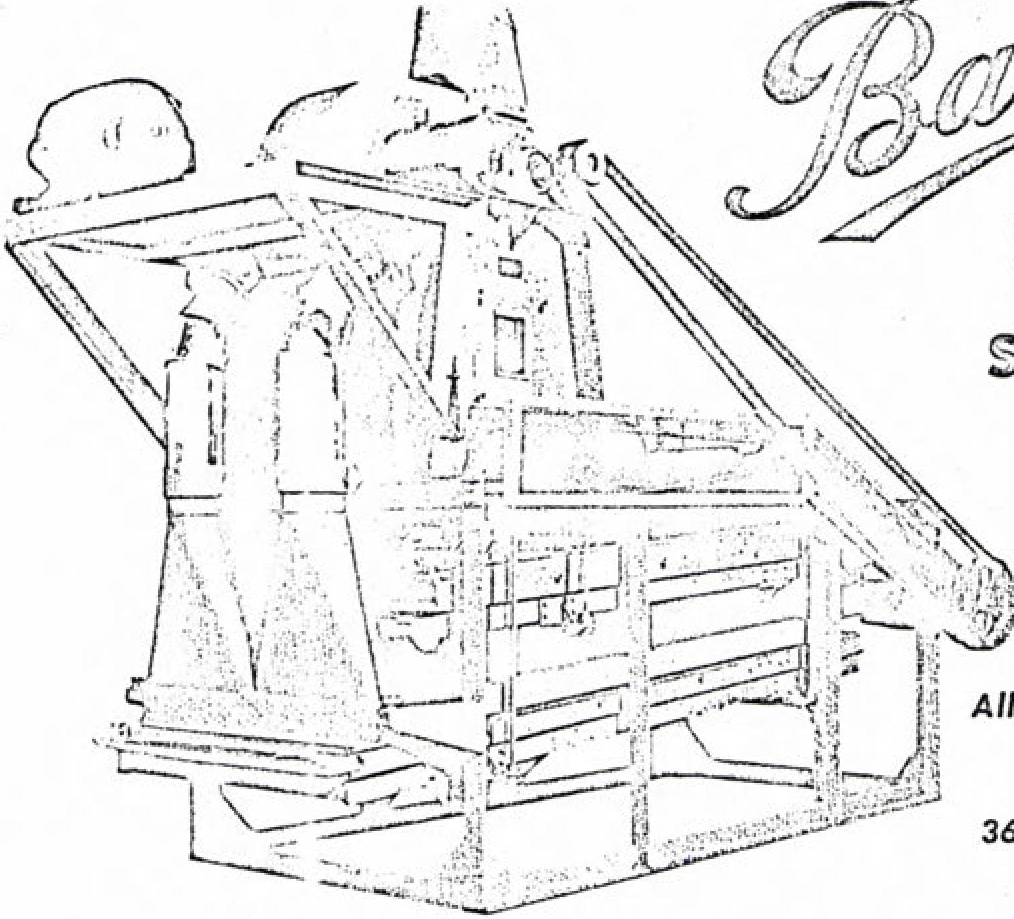
The Bauer System is essentially the same as the Carver Single Hulling System with the No. 153 Separator serving the same purpose as the Carver H & S machine and separating the uncut seed from the hulls and then handling the hulls to the beater and returning the uncut seed to the Huller. However, these systems are radically different as to the procedure for purifying the meats and particularly for the treatment of the tailings.

The drawing shown on Figure 14 will serve to illustrate the principle of the No. 153 Separator and indicate the various control adjustments. The No. 403 is shown on Figure 14A but as the adjustments and operating instructions are essentially the same the following instructions may apply to either.

> "Valves in upper and lower sections of Expansion Chamber permit regulation of volume and velocity of air passing up and through it. If, when Fan is speeded 1200 RPM, whole seeds are lifted with hulls, upper valves "A" should be opened to reduce volume of air through bottom, or, if too many hulls pass beyond the Chamber, reduce area of bottom intake by manipulation of lower valve "B". If, with these adjustments, the suction is too high or low, speed of Fan should be changed.
>
> "The thickness of the hulls traveling on the lower shaker varies with the lint cut. Panels "C" have been made adjustable so that the space between the aspirating chamber and the shaker may be adjusted to suit these conditions. These panels may also be adjusted to regulate the strength of the air currents.
>
> "To aid separation, Decorticator should be set to cut not more than from 80% to 85% of the seed, uncut seeds are delivered over end of upper tray for return to Decorticator. Permit some coarse hulls to return with uncut seed rather than have whole seed lifted by suction."

Bauer

No. 403 Separator Purifier



All Steel Construction

Two Sizes
36" and 48" Widths

FOR EFFECTIVE REMOVAL OF HULLS FROM OIL BEARING SEEDS AND NUTS

BAUER No. 403 SEPARATORS COMBINE MECHANICAL AND PNEUMATIC FORCES TO EFFICIENTLY REMOVE HULLS FROM DECORTICATED OIL BEARING SEEDS AND NUTS, INCLUDING COTTONSEED, TUNG NUTS, SUNFLOWER SEED, SAFFLOWER, TANGUIS SEED, AND OTHERS. THE No. 403 SEPARATORS ARE AVAILABLE WITH EITHER 36 INCH OR 48 INCH WIDE SHAKERS.

Usually the huller is mounted on the frame of the No. 403 Separator, so that the seeds or nuts fall directly to the upper tray of the machine. The upper tray is clothed to first sift out the fine particles, then the whole meats which drop to lower tray.

Hulls are precisely separated by air currents near end of upper tray, and are conveyed to a cyclone-collector. Uncut seeds or nuts are delivered from the side spout at end of upper tray to an elevator for return to the huller. Meats are purified by additional sifting and aspiration on the lower tray, and are discharged free of lint, linty hulls, or loose hulls. Upper and lower trays are clothed with all steel perforated screens and are readily interchangeable for different screening classifications needed to control protein content of seed residue (oil mill cake) after oil extraction. Extra screens for this purpose are included with each machine.

Valves in Fan hood regulate volume of air so precise separation of hulls is controllable. All controls are easily accessible from sides of machine.

FIG. NO. 14 A

THE BAUER BROS. CO.
SPRINGFIELD, OHIO

All protein control adjustments are made by raising or lowering the aspirating nozzles on the end of the lower tray and the tailings scalped off at this point pass through the fan of the No. 153 Separator, along with the main load of hulls, to be treated in the double drum beater. All of the tailings from the beater shaker tray are then aspirated with a nozzle, returned to the separator fan, and recycled to the beater.

The above arrangement is compact and simple, and for moderate lint cuts and where relatively high ammonia in seed makes protein control relatively easy, it will do an excellent job. With extremely dry seed, where protein control is difficult, this recycle of tailings through the hull beater will result in a "run around" of material which will seriously affect the separation results.

A simple and inexpensive way to minimize this fault in the system is to install a vacuum dropper in the air line between the suction nozzle on the beater tray and the fan of the No. 153 Separator, as illustrated on Figure 14. This vacuum dropper will entirely eliminate the recycle of tailings and if properly designed, will do a reasonably good job of "air washing" the tailings, and if no meat particles are picked up by the aspirating nozzle, very good separation results will be obtained.

The above-mentioned vacuum dropper arrangement to prevent "run around" of tailings in a Bauer System is being used successfully in many No. 153 Separator installations. It will make some improvement in separation and allows the production of slightly higher protein, but under extreme conditions it will not produce maximum protein. Also, with this vacuum dropper system, there is a recycle of oily fibers which eventually affects oil in hulls but it does make a slight improvement, and is inexpensive. Excessive oil in hulls will be encountered in an effort to produce high protein. This is entirely understandable, in that the meats purifying device is nothing more than the aspirating nozzle at the end of the Huller Shaker of a Carver Single Hulling System and no auxiliary Purifier is provided for double purifying or tailings beater for treatment of the tailings. It is obvious that this problem is identical with that encountered with a Carver Single Hulling System with no meats Purifier, and that better protein control and overall efficiency would be obtained by using a standard Double Purifying System in connection with the Bauer Unit.

Several Brazil mills have had excellent success with the Bauer Units, but it must be pointed out that they have not had any protein control problem, in that the protein and moisture in seed has been relatively high, and they have not found it necessary to produce maximum protein. In the future, if they should desire to make higher protein, with less percentage of hulls in meats, a double purifying system in connection with their Bauer Units would be recommended.

1) The above mentioned Brazil mills, with which the writer is familiar, all utilize the little vacuum dropper, illustrated on Figure 14, to prevent beater tailings from recycling back to the beater. It will make a slight improvement in results where protein control is no serious problem.

2) The obvious fault with the above No. 1 solution is that any meats lifted by the nozzle will go to the finished hulls and all oily fibers are recycled to the beater. This problem could be avoided by installing a small fan and cyclone, aspirating the beater tailings and discharging them to a tailings beater. This will make a substantial improvement but still does not allow maximum protein control.

3) A further improvement to 2) above would be to install a Purifier ahead of the tailings beater. The Separate Pneumatic System would then convey the tailings from the beater shaker to the Purifier for removal of meat particles and allow use of smaller perforations on the tailings beater.

4) The best auxiliary meats purifying for a Bauer system would be a complete Double Purifying System, same as shown on Figure 13, Arrangement 1. This would call for a separate Pneumatic System to handle all tailings from the lower tray of Huller Shakers and Beater Shakers to the Purifier and then to tailings beater. Without a complete system of this kind, and when working dry seed with low protein, too many meats will be lifted by the nozzles and carried with tailings to the big Hull Beaters. For best results, tailing from meats should never be recyled to the Hull Beaters and mixed with the main stream of hulls. Full information on this proposed Double Purifying System is given in Part 8, and many such systems are operating successfully with Bauer equipment.

5) On extremely dry seed, a further improvement can be made by using vacuum boxes on the Pneumatic Systems handling tailings to the Purifier and to the Tailing Beater. This

is illustrated on Figure 13, Arrangement 2 and also discussed in Part 8.

Most of the general instructions covered under Part 10 for the Carver Single Hulling System and the comments on the Huller, Shaker and Beater, will be applicable to the Bauer System. Many of the suggestions in connection with the H & S Separator, covered under Part 4, will be applicable to the No. 153 Separator, which is designed to accomplish the same results. This applies particularly to the air adjustments which should be made so as to drop a minimum of hull with the uncut seed, but at the same time not to pick up any seed with the hull. It is also as important with this system that the huller be carefully adjusted at all times to cut approximately 85%, with possible variations as outlined in Part 1.

The capacity of the No. 153 Separator is approximately 60 tons of seed per 24 hours. With closely linted prime seed, it may be operated at slightly higher capacities, but on seed with 3% or more lint left on, or with immature seed, its capacity will be less. The capacity of the shaker and the double drum beater is somewhat greater as outlined in Parts 2 and 3, and therefore the limitation in capacity of this unit is in the air separator.

On several foreign installations, the 48" Bauer Shaker and the No. 153 Unit have been widened to 60" which allows some increase in capacity. On cottonseed this increase will be limited by huller capacity, but the increased shaker width is helpful when working sunflower seed. W. C. Cantrell Company of Fort Worth, Texas is now the exclusive manufacturer of Bauer Oil Mill Equipment and parts.

Mr. Cantrell points out that the No. 403 Separator has many improvements over the old No. 153, including Steel Shaker Trays with interchangable screens and 3/8" throw eccentrics. Cantrell also advises that the No. 403 is more efficient and that the revolving reel in the bottom of the air head will facilitate separation of seed where the seed are delinted to at least 3%.

HELPFUL ACCESSORIES

All Huller Room Operators and Personnel working with this area should be provided with a Dust Mask. One of the most popular is the Martindale Dust Mask, manufactured by Martindale Electric Company, Box 617, Cleveland, Ohio, 44107. This mask has a disposable cotton gauze pad that fits over the nose and mouth. There are other disposable-type masks on the market.

The Mill Superintendent and his key supervisory personnel should have a "Perforated Metal Gauge" for checking the size of perforated metal on Shakers and Beaters. This device can be turned out on a lathe, starting out with 1/16" and going on up to steps of 1/32" to 1/4".

Each mill should have a good speed indicator for checking the RPM of all machinery. One that has been very popular for many years is the JAGABI indicator that reads directly without a watch. It is distributed by Jas. G. Biddle Co. of Philadelphia.

PART TEN

OPERATING AND TROUBLE SHOOTING SUGGESTIONS

Maintenance and Cleanliness

Before attempting to regulate or adjust a Separating System for most efficient results, it is essential that all of the equipment be in good mechanical condition and certainly preferable that every possible effort be exerted to maintain cleanliness and good housekeeping. Good results can hardly be expected in a department that is dusty, dirty, and where poor working conditions exist.

Some mention of specific maintenance problems has been made in the foregoing Parts covering individual equipment, but to a good superintendent or operator, it should not be necessary to give detailed maintenance instructions. However, a few check list items will be tabulated, as follows:

a) Perforated metal on all shaker trays must be absolutely flat and well secured. No walking on metal should be tolerated. Repair or replace any bent, broken or sagging metal.

b) Maintain the adjustments on the eccentrics, eccentric rods, limber jims or hangers of all shaker trays so that the material flows uniformly.

c) Periodic checks should be made on the underside of all screens, particularly the lower tray, to determine if fine meats are building up or accumulating in the pan.

Cleanliness in the Huller Room is perhaps more difficult than in any other department of the mill, but it can be accomplished by perseverence, ingenuity and by working out each individual case on the job. One of the principal sources of dust is the blow from under the Hullers. This can be greatly improved by completely enclosing the space between the underside of the Huller and providing adequate canvas or rubber belt seals. It may then be further improved by pulling a slight negative pressure on this enclosed space under the Huller, by means of a 4" or 5" suction line connected to the hull pick-up system or one of the other pneumatic systems, or, if necessary, with an auxiliary clean-up system.

Other sources of dust in the Huller Room may be eliminated by properly enclosing spouts, conveyors and elevators and by making them all as dust-tight as possible.

The discharge spout from the hull beater is a frequent offender, but this can also be completely eliminated by properly enclosing and sealing.

Meats and hull particles bouncing out between the top and bottom shaker trays are a frequent source of untidiness in the Huller Room. This can be almost completely eliminated by installing a section of lining or pan at the upper end of the top tray, so that the meats falling through to the lower tray will not strike on the eccentric rods. The new Carver shakers are now equipped in this manner and all old shakers should be arranged in a similar manner. Canvas flaps to seal the opening between the shaker trays will prevent this spillage of meats but do not make a very attractive installation, and interfere with inspection and cleaning of perforated metal. The canvas flaps between the shaker trays are not recommended except as a last resort.

The discharge from the several Dust Collectors on the Huller Room Pneumatic System, usually on the roof, makes this area one of the dirtiest and dustiest areas in the mill, and the most difficult to keep clean. Quite a bit of improvement can be made by using the high velosity collectors, shown in Part 11, but it will still be far short of meeting O.S.A. standards.

Several mills are now successfully using various types of sock filters to handle the air discharged from lint handling collectors, and some will soon be experimenting with sock filters for Huller Room Collectors. Some types of sock filters are more adaptable to handling the fine, oily fibers from the Huller Room, and research is now being carried out at several mills to find which type will be best. Most reliable manufacturers will be able to advise you if they have a design suitable for handling this material.

Sock filters on all dust collector discharges will clean up the outside of the building and the above suggestions will make a big improvement in the Huller Room area, but so far, there has been no solution to the exposed Huller Shakers. It has been suggested that the entire shaker and the beater shaker and purifier might be completely enclosed to eliminate this source of dust. This proposed enclosure would have to be designed with lightweight easily removable frames for maintenance and screen cleaning. This enclosure would be equipped with many glass inspection openings for inspection. The existing aspirating nozzles would result in a constant flow of air into the enclosure and prevent dust blowing out.

Distribution of Loads

One of the first things to look for in attempting to adjust and regulate the Hulling & Separating System is to see that the load is equally distributed on all machines. The feeder on the safety shaker (sometimes referred to as scalping shaker) should be equipped with some type of variable speed control so as to feed the load uniformly to the Hullers and at the same time spread it uniformly over the safety shaker. Where the system is equipped with a delinted seed bin or tank ahead of the safety shaker, and this is certainly preferable, the overflow from the Hullers is usually returned to this bin. With an arrangement of this kind it is desirable to set the feeder speed for a slight surplus, i.e., 3% to 5%, which will be recycled over the Hullers and returned to the bin, and in this manner, assure a full feed to the Hullers. With an overflow return system of this type, the operator should make frequent inspections to see that the feeder is not running too fast with a resulting build up in seed recycled to the bin, which would throw an unnecessary load on the conveying and elevating equipment.

It is even more important to carefully regulate the Huller feeder speeds to accurately divide the load to the Hullers and where two or more Hullers are used, it is preferable to drive the feeders from a common countershaft equipped with variable speed drive for convenience in regulating.

Neither the Bauer nor the Carver Hull Beater is equipped with a feeder and where two or more beaters are used, it is necessary to install some type of controlled feed to divide the load. The standard procedure for spouting the material into the hull beater and attempting to divide the load by means of the "adjustable splitter", provided with the machine, is not at all satisfactory or accurate, and therefore a vane type feeder or screw feeder, mounted directly over the beater inlet is highly desirable for dividing the load between two or more beaters and also for the purpose of equally dividing the load between the two beater drums. Where two or more beaters are used it is, of course, desirable to provide a variable speed drive mechanism to the vane or screw feeders.

Adjustment of Huller

The proper adjustment of the Huller to cut the desired percentage of seed and the maintaining of the proper cut is a very important factor in connection with separation.

Most operators attempt to set the Huller by observation or by feeling the hulls on the shaker tray and estimating the percentage of uncut seed. This is a very crude and inaccurate method and is subject to quite a bit of variation which will result in inefficient operation.

Actual experience and many experiments have determined that for average operating conditions, minimum oil in hulls will be obtained with the Huller adjusted to cut approximately 85% of the seed going to the Huller, which means that the hulls from the discharge end of the shaker tray would contain approximately 28% uncut seed. The formula for determining the percentage of seed cut by a Huller will be discussed below, in connection with the Laboratory Hull & Seed Separator, which will also include a table showing the percentage of cut for various percentages of seed in hulls. Every Huller Room should be equipped with a Laboratory H & S Separator for accurately checking the percentage of cut on the Hullers as well as for checking other hull fractions to be discussed below.

This proposed 85% cut will give best results under average conditions, but local conditions might justify minor deviations up or down. For example, on extremely dry seed and particularly where the Hullers are not overloaded, it might be possible to produce a coarser hull, with less breakage of meats, by setting the Huller to cut in the neighborhood of 80%. However, if the Huller is being operated near maximum capacity, say 90 tons per machine, the resulting "run around" or build up material will more than offset the advantage of the lesser cut. Where the Hullers are loaded to maximum capacity, it is recommended that the cut be maintained between 85% and 90%, and where the Huller is lightly loaded, somewhere between 80% and 85%.

In order to maintain the desired Huller cut, the hulls from the discharge end of the shaker tray should be checked with the Laboratory H & S machine at least once each day. This procedure will be described in detail under that heading. The Huller cut will vary with different types of seed and will decrease as the knives begin to wear. After closing the Huller breast to the full extent of the adjustment, and assuming the Huller to be in good condition and properly trammed, if it is not possible to maintain at least 85% cut, it is a good indication that the knives have become dull, or else the cylinder is running too slow.

Whenever it is necessary to replace a broken safety lug and after the Huller is closed back up and put in operation, it should be rechecked to determine if it is cutting the proper percentage of seed. If the Huller feeder has been stopped and the concave and adjacent parts of the Huller carefully cleaned by blowing with compressed air, there should be no difficulty in closing the Huller, putting in the new lug, and setting it back to its original position. It should not be necessary to open or make any change in the position of the concave. However, in this connection, whenever a change is made in the adjustment of a concave, to obtain the desired cut, the eccentric shaft should be clearly marked with a pencil at this new setting and at the time the setting is made, all old marks should be erased. This makes it possible to reset the concave adjusting shaft back to its original setting. With a proper marking of this kind it is also possible for the operator or superintendent to see if anyone has made any change in the setting of the Huller.

H & S Separator

The various adjustments to the H & S machine have been covered in detail under Part 4 and at this point it will be assumed that the machine has been adjusted properly and therefore this discussion will deal primarily with the minor operating adjustments which tie in directly with the overall operation of the Separating System. As previously explained, the inlet air valve which controls the volume of air to this machine will directly control the percentage of hull dropped with the uncut seed. This particular adjustment is almost as important as the Huller setting, and here again, it is practically impossible to determine within reasonable limits the percentage of hull being dropped with the uncut seed by simply looking at and feeling the material being discharged from the bottom of the Separator. It is not too difficult to look at the uncut seed from the Separators and see when they are "too clean" and not enough of the hull being dropped, in which case uncut seed will be lifted with the hulls, but it is a difficult problem to estimate if the machine is dropping 15%, 30% or 100%. It is highly desirable to maintain a minimum of hull with the uncut seed from the Separators, as excess hull at this point will overload the system and result in excessive oil in hulls and, by unnecessary recycling of hulls, the protein will be adversely affected. Under ideal conditions and with uniformly delinted prime seed, the Separator will operate efficiently with not more than 15% hulls in the uncut seed. With bollie seed containing a large percentage of small lightweight immature seed, it is necessary to reduce the volume of air through the H & S machine to a minimum and drop a larger percentage of hull in order to avoid picking up some of these immature seed. With normal West Texas bollies, it is usually possible to get by with about 30% of hull with the uncut seed, but in extreme cases it might be necessary to drop as much as 50%. With the Huller passing 15% of the seed and on a standard system with the Separators dropping 50% hulls, the entire system is having to take an added load of at least 5% over and above normal conditions. Where the shaker trays are equipped with hull pickup nozzles, and where these nozzles can drop out and return approximately half of the uncut seed, the Separators will be relieved accordingly, and even with 50% hulls in the Separator droppings, the overload would amount to only 2-1/2%. This is one of the advantages of the pneumatic hull pickup system in connection with Single Hulling.

Protein Control Equipment and Treatment of Tailings

With a modern Single Hulling System as outlined in Part 8 and with the several types of meats purifying arrangements covered in Part 5, the percentage of hulls left in meats, which directly control the protein in finished meal or cake, may be controlled or adjusted at three principal points as follows:

a) The meats purifying pickup nozzles at the end of the lower tray of the huller shaker. These nozzles should be adjusted to pick up, or scalp out, as much of the "tailings" or black hull particle as possible from the meats and at the same time pick up a minimum of meats. This adjustment may be made by raising or lowering the nozzle or by increasing or decreasing the volume of air. After the nozzle has been set in its most efficient position, usually about 1/2" above the top of the material on the tray, it should not normally be necessary to move it. The exact distance between the bottom of the nozzle and the shaker tray will be dependent upon the load and the air velocity at its inlet. After it is finally adjusted for best results any minor adjustments may be accomplished by regulating the air.

With a properly designed aspirating nozzle, it should be possible to remove practically all large hull particles, say down to anything that would not pass through 1/8" perforations, and at the same time not pick up more than 10% of meat particles with the tailings. Where the protein and moisture in seed is relatively high and protein control is no serious problem, this purifying nozzle should be adjusted to "scalp lightly" and pick up a lesser percentage of meats. On the other hand, where it is difficult to produce the required protein, it will be necessary to "scalp heavy" and this will naturally pick up a larger percentage of meats, which of course will have to be reclaimed with the subsequent purifying equipment as outlined in b) below.

After properly adjusting the purifying nozzles to scalp off a slight surplus of tailings, so that final control may be made with the protein machine, no further adjustments should be necessary. If, from day to day, the protein is consistently low and difficulty is being encountered in controlling it with the Purifier, then these nozzles should be adjusted to "scalp heavier" and pick up a larger percentage of tailings. On the other hand, if the protein is consistently high and no trouble is being encountered at the Purifier, then these pickup nozzles should be regulated to pick up a slightly lesser percentage of hulls, which will mean that fewer meats will be picked up with the tailings.

b) The Protein Control Machine. This might be a Carver Purifier or a homemade version of the Purifier. Unfortunately, the protein and moisture in seed will vary from day to day, making it impossible to accurately control the protein in the finished product, regardless of the type of purifying equipment used or the amount of supervision applied to same. Most mills do not receive protein analyses of the meal within 24 hours after it is produced and by this time it is likely that normal variations in seed would have affected the results, and therefore, all that we can expect from the conventional protein control equipment is to strike a happy medium and attempt to produce something that will average approximately 41% protein meal or whatever else is required. Actually, the only way to accurately control protein in meal is to produce something higher than the actual requirements, store it in bins or tanks until accurate analysis can be obtained, and then produce exactly what is desired by blending the required quantity of hull bran.

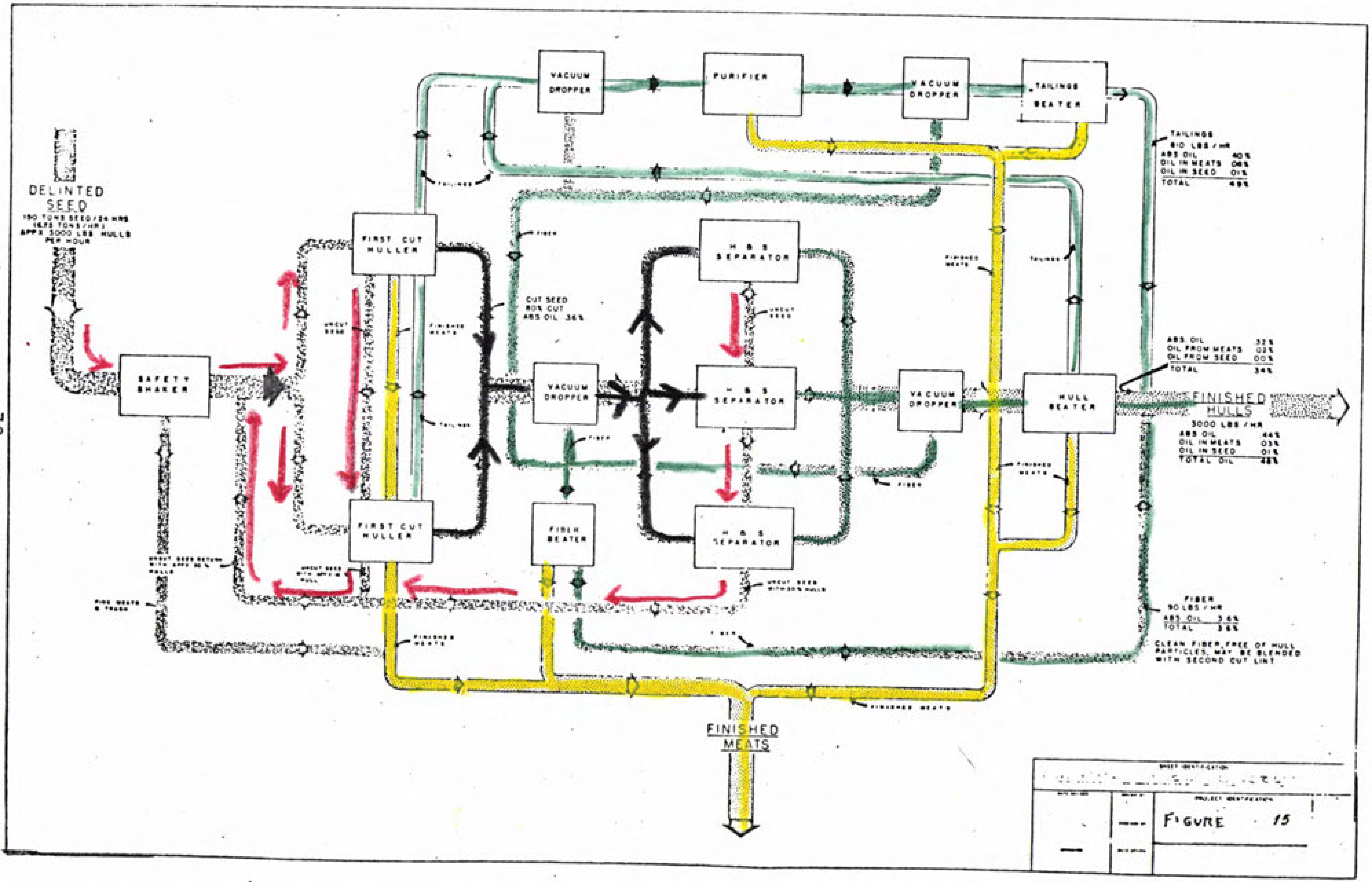
In spite of the above-mentioned handicaps, most mills do accomplish an amazingly good job of controlling protein. With either of these machines, and in connection with the "Double Purifying System", the final control of the protein is made with this machine which pneumatically separates the tailings from any meats or seed that may have been picked up with them as outlined in a) above. In making the pneumatic adjustment on the Purifier, the desired quantity of hull particle will be picked up or dropped out with the meats, in order to give the required percentage of hulls in meats. It is here and with this machine that all protein adjustments should be made, which are usually required from day to day. Where the protein control situation is not critical and no difficulty is encountered in producing the required 41% or 43% protein in the finished product, it is simply a matter of raising or lowering the nozzles on the Purifier, or opening or closing air valves to drop more or less hull particle into the meats stream along with the meats being reclaimed from the tailings. With dry, low protein seed, and in connection with maximum lint cuts, the protein control problem will be more critical. In this latter case, the purifying nozzles, discussed in a) above, will already have been adjusted for maximum scalping and somewhere between 10% and 20% meats might have been picked up with the tailings. In this case, a very careful adjustment of the Purifier, will be necessary to prevent picking up meats with the finished tailings in this final separation, and it is here that very close supervision is required and only a very competent person should be allowed to make this most important adjustment.

It is here with this final adjustment for protein control that the total oil in hulls will be seriously affected. For example, if the protein has been running low, the operator will naturally attempt to lift practically all of the hull particle but as none of the conventional pneumatic separating devices are one hundred percent efficient, a point will ultimately be reached where the machine will begin to pick up meat particles with the tailings. With the Carver Purifier it will be necessary that a small percentage of hull particle pass under the aspirating nozzle and drop out with the meats in order to prevent lifting some of the meats. This is particularly true in connection with the nozzle on the lower tray, which handles the finer, lighter weight material. In extreme cases, where it is necessary to remove a maximum of hull particles from the meats, an auxiliary nozzle may be installed at the discharge end of the lower tray, to scalp off some of these hull particles that pass out with the meats. This arrangement is described in detail under Part 5 and shown schematically in Figure 13, Arrangements 1 and 2, and calls for recycling the material picked up by this auxiliary nozzle back to the Purifier. This final adjustment is very sensitive and should be made by a competent supervisor who can also check and see that all other adjustments have been properly made. After adjusting the protein machine to the limit of its efficiency, and if excessive hull particles are still getting into the meats, the other two adjusting points, i.e., a) above and c) below, should be rechecked, but normally these adjustments will already have been made and it is emphasized again that the day to day control should be made with the Purifier.

c) <u>The Aspirating Nozzle at the discharge end of the Beater Shaker Tray</u>. The primary purpose of this aspirating nozzle is outlined and explained in Part 3. Normally this nozzle should be adjusted to lift practically all of the beater tailings and drop out any meat particles. Where there is no particular strain or difficulty in producing the desired protein, it is preferable to adjust this nozzle, with a factor of safety, to drop out a slight excess of hull particle with the meats particles, but as all of this tailing material is usually handled to the Purifier, for repurifying, and as the quantity of meats encountered at this point should be relatively light, the usual practice is to scalp heavy at this point, drop a minimum of hull particle into the meats and then accomplish the final separation and protein control with the Purifier, as outlined in b) above.

Some operators actually attempt to control the protein with the nozzle on the beater tray and, of course, it is possible to add or take out hull particles at this point, but under normal conditions this procedure is not recommended. The protein may easily be lowered by means of this adjustment but in a standard system, to scalp heavier at this point might not necessarily increase the protein. The material picked up by this nozzle on the beater tray will be given the final treatment on the Purifier and therefore the final adjustment for accurately controlling the amount of hulls in meats should be made at the Purifier. The same reasoning applies to the scalping nozzles on the Huller shakers, as outlined in a) above and, of course, these nozzles as well as the beater tray nozzle must necessarily "scalp heavy" and drop a minimum of hulls into the meats in order to produce maximum protein in meal, but this will not be accomplished unless the proper and final adjustment is made at the Purifier.

As emphasized above, the meats purifying, handling and treatment of tailings will have more effect on the separation results than any other single factor. After making the adjustments as outlined in a), b), and c) above, and if difficulty is still encountered in reducing the percentage of hulls in meats, to produce the desired protein in cake, a careful check should be made to determine the exact quantity of tailings being produced and an analysis made of the various fractions. An excessive quantity of tailings will make it difficult to control protein and will usually result in excessive oil in finished hulls.


DELINTED
SEED
150 TONS SEED/24 HRS
(6.25 TONS/HR)
APPX 3000 LBS HULLS
PER HOUR
SAFETY
SHAKER
FIRST CUT
HULLER
FIRST CUT
HULLER
CUT SEED
80% CUT
ABS OIL 36%
VACUUM
DROPPER
FIBER
BEATER
H & S
SEPARATOR
H & S
SEPARATOR
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SEPARATOR
VACUUM
DROPPER
HULL
BEATER
PURIFIER
VACUUM
DROPPER
TAILINGS
BEATER
TAILINGS
610 LBS / HR
ABS OIL 40%
OIL IN MEATS 08%
OIL IN SEED 01%
TOTAL 49%
ABS. OIL 32%
OIL FROM MEATS 02%
OIL FROM SEED 00%
TOTAL 34%
FINISHED
HULLS
3000 LBS / HR
ABS OIL 44%
OIL IN MEATS 03%
OIL IN SEED 01%
TOTAL OIL 48%
FIBER
90 LBS / HR
ABS OIL 3.6%
TOTAL 3.6%
CLEAN FIBER, FREE OF HULL
PARTICLES, MAY BE BLENDED
WITH SECOND CUT LINT
FINISHED
MEATS
FIGURE 15

The total percentage of finished tailings will, of course, depend upon local conditions and particularly upon the ammonia in seed or meats but under no conditions should the finished tailings exceed 30% of the weight of finished hulls. For example, if a mill is producing 3000 lbs. of hulls per hour, the total weight of finished tailings should not exceed 900 lbs. per hour. By making a 10-minute test of the finished tailings, the hourly production may be calculated, and if it should exceed the above mentioned quantity, the shakers and beaters should be checked and very likely smaller perforations will be indicated.

A complete analysis of tailings, as outlined above, along with analysis and weight determinations of fiber and other fractions, and of course analysis of hulls from shakers and beaters, would develop all information needed to work out an oil balance and make a complete analytical flow chart as shown on Figure 15. Balancing the total oil in the various fractions, which go to make up the finished hulls, against the total oil in the finished hulls, will pinpoint the trouble spots and determine the source of any excessive losses. The source of excess meats or seed may easily be located by sampling and checking the products from each machine, but when the absorbed oil or meats dust in finished hulls is above normal, complete analysis of all products to develop an analytical flow chart is often helpful and is recommended.

The flow diagram shown in Figure 15 was made from actual results from a Texas Oil Mill and is typical for many mills. In this case, as shown on the chart, the weight of tailings ran 21% of total finished hulls, which is satisfactory, and oil in tailings .49% as compared to .38% oil in hulls from beater, also satisfactory. In the case the fiber from vacuum droppers at 90 lbs. per hour, figures only 3% of total hulls and oil in fiber 3.6%. This low percentage of fiber indicates very little loose lint in the delinted seed to hullers and also, that the vacuum droppers had been generously sized so very little hull particle was being pulled over with the fiber.

Where the percentage of fiber exceeds 5%, and does not contain excessive hull particles, corrective measures should be taken to reduce excess loose lint going to Hullers. If excess hull is being pulled over with the fiber, the velocity of air from vacuum droppers must be reduced.

By combining the total oil in beater hulls, tailings, and fiber, on a weighted basis, as shown on the diagram, we arrive at the total oil of .48% in finished hulls which should check with the actual analysis of finished hulls.

Where only three items go to make up the finished hulls, as outlined above, it is a simple matter to pinpoint any trouble points but the solution to the problem is not always easy. Where vacuum droppers are not used there are only two fractions to work with.

In many cases high oil in hulls is due to oily fibers, trash and other fractions from Lint Beaters, mote Beaters and sometimes from Seed Cleaners, being combined with the finished hulls after they leave the Huller Room. For purposes of accounting and for products yields the total oil in the hulls going to the hull storage must be reported. In many cases hull samples will be taken in the Huller Room or even from the Hull Beater, showing less than .50% oil, but after adding various trashy fractions as mentioned above, the oil in finished hulls may run as high as 3.0% oil. This is misleading and false economy and any representative finished hull sample should be representative of the hulls in storage or hulls shipped.

It is true that excess oil in hulls, due to the addition of these trashy fractions is not due to any inefficiency of the Huller Room equipment, but where it results in excess oil in hulls it is the mill superintendent's responsibility to find out what is responsible and make every effort to correct it.

If trash from Seed Cleaners is being added to hulls, and if it contains seed and meats, this trash should first be passed over a "reclaim shaker" or some device to remove the seed and meats before it goes to the hulls. The same applies to trashy fractions from the Lint and Mote Beaters. In a few rare cases hull bran or pepper from Lint Beaters has been mixed with hulls and this practice can easily add .25% oil to finished hulls. Where management considers it necessary to add hull pepper and other trash fractions to finished hulls they should be appraised of the final results by showing the total oil in hulls as it really is. They should also realize that the appearance after adding trashy, linty fractions will not be that of a prime cottonseed hull.

Treatment of Fiber from Vacuum Droppers

The advantages and disadvantages of vacuum droppers in connection with Single Hulling Systems have been discussed in Part 8 and Part 11. This discussion will deal primarily with the proper treatment of the fiber which is pulled or separated from the heavier hull particles and passed on through the fan. It is not necessarily the purpose of the vacuum dropper to separate fibrous material from the hull but as this separation does take place and as this material contains a relatively high percentage of oil, consisting of both absorbed oil and fine meats dust, it becomes necessary to provide adequate means of treating and recovering this material.

With a properly designed system in which the delinted seed are passed through a suitable air chamber on the Scalping Shaker, there will be a minimum of lint and fiber in the seed going to the Hullers but even under these conditions, the fibrous material collected from a complete vacuum dropper system will range anywhere from 15 to 25 lbs. per ton of seed, or somewhere in the neighborhood of 5% of the hull production. On some old systems not adequately arranged to remove lint from the delinted seed, this fibrous material might run as high as 10% of the hull production.

This fiber from the vacuum droppers will contain up to 18% oil and actually accounts for a large percentage of the total oil in hulls. Therefore, it is highly desirable to separate such material from the main stream of hulls and recover as much of this oil as possible.

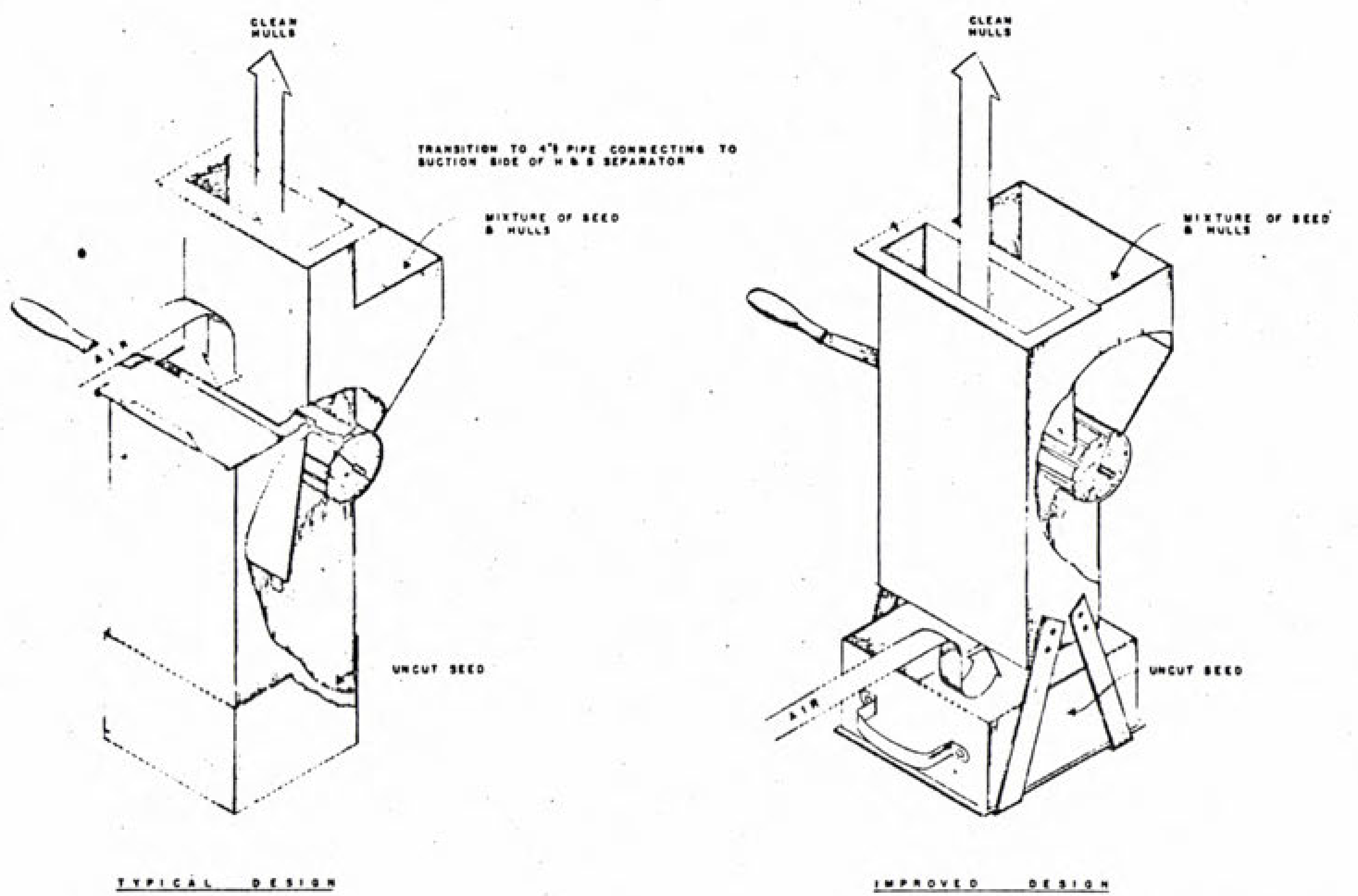
On a system not equipped with vacuum droppers, this fibrous material will remain in the hulls going to the hull beater and in the tailings to the tailings beater and eventually some of it will be removed and go on to the meats and some of it will remain in the finished hulls. Various means of treating this material are as follows:

a) The first and most obvious procedure would be to treat this material in a tailings beater, either a single drum revolving tailings beater as covered under Part 6, or for larger tonnages a single drum hull beater, or a lint beater. Either one, in this case, would be referred to as a Fiber Beater. Normally, in handling this type material, the beater drum should be clothed with relatively small perforations, say approximately 1/8", but in some cases it might be desirable to use 3/16" or even 1/4". All of the material that beats through the drum may be handled directly to the finished meats and therefore no shaker tray is needed in connection with this beater. This fine material that beats through the drums will consist of short fibers and meats dust and although some operators would prefer not to put it into meats, it will usually run 15% to 20% oil and the obvious place to put it is into the meat stream. The material from the beater drum may then be returned to the finished hulls, where it originally came from, and where it would remain on systems not equipped with vacuum droppers. This fibrous material, even after treatment through the beater, will usually contain anywhere from 3% to 8% oil and naturally will increase the total oil in hulls, but in many cases there is nothing to do with it but handle in this manner. If the vacuum droppers are properly designed and adjusted, this fibrous material should not contain very much hull particle and in some cases is being treated and returned to the second cut lint or motes. If at all possible, and where the hull particles can be removed, the best solution to this problem is to return it to the second cut lint system. In spite of its relatively high oil content, it is not detrimental to chemical linters. Even under the best operating conditions there will usually be some hull particles in this fiber and special treatment through a hammer mill or pneumatic cleaner might be necessary before introducing it back to the second cut lint system.

b) For a relatively small mill, where the tailings beater is not overloaded, it is possible to treat the vacuum dropper fiber along with the Purifier tailings through the regular tailings beater. This procedure is being followed at several mills with reasonably good results, but is not recommended where high oil in tailings is encountered. In all cases, the fine fibers and meats dust which pass through the beater drum screen should go directly to the meats stream.

c) Where the total amount of fiber from the vacuum droppers can be minimized, to say less than 2-1/2% of the hull load, and particularly in connection with solvent extraction plants or Expellers, the entire mass of fibers may sometimes successfully be introduced to the meats with no detrimental effects, and of course with a substantial improvement in overall separation results.

Regardless of how this fibrous material from the vacuum droppers is handled, it will have a direct effect on the total oil in hulls and the best separation results will be obtained when very little, if any, of this oil-bearing material goes into the finished hulls. One of the first places to look for trouble in a Huller Room is in connection with this material and a good huller room supervisor should always know the percentage of fiber being produced from the vacuum droppers, total oil in the material, oil in the finished fiber from the

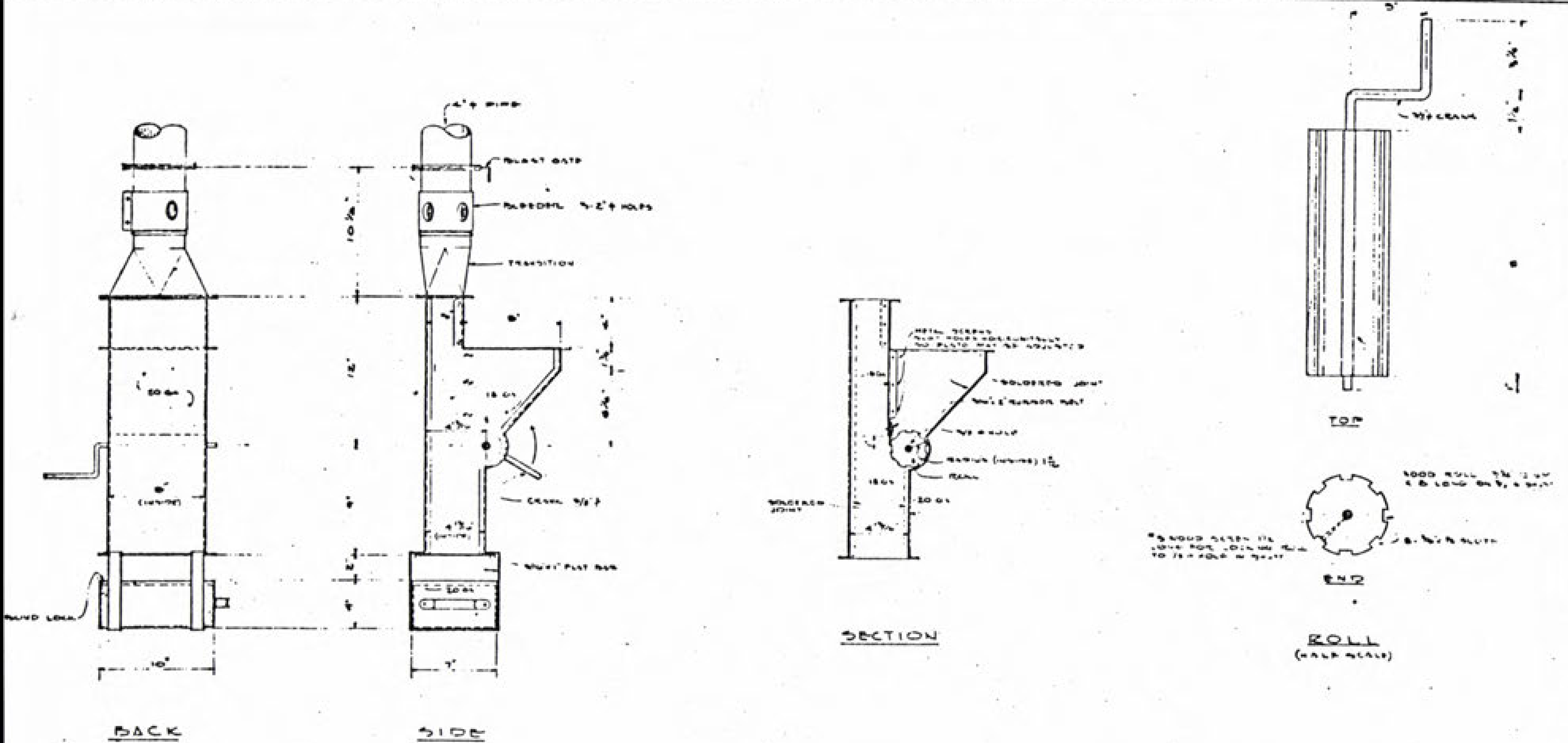


NOTE: DETAIL DRAWINGS OF THESE MACHINES MAY BE OBTAINED FROM THE HOUSTON ACCO OFFICE.

LABORATORY HULL & SEED SEPARATOR

GARRETT

FIGURE Nº 16



SCALE: 3"=1'-0"
(EXCEPT AS NOTED)

NOTES:
1. THIS DEVICE BASED ON 4" ø PIPE APPROX 10' LONG CONNECTED TO SIDE OF DUCT IN WHICH A NEGATIVE STATIC PRESSURE OF 1½" OR MORE IS MAINTAINED.
2. WITH A STATIC PRESSURE UP TO [illegible] BLAST GATE MAY BE OPENED WIDE & COMPENSATING ADJUSTMENT MADE AT PLENUM, WHICH MAY THEN BE [illegible]. FOR SUBSEQUENT RUNS, BLAST GATE ONLY NEED BE MANIPULATED.
3. PRELIMINARY ADJUSTMENTS MAY BE MADE BY RUNNING THROUGH [illegible] SAMPLES OR SMALL SEED ALONE & HULL ALONE.
4. FOR TEST PROCEDURE SEE [illegible] "HULLER ROOM OPERATING INSTRUCTIONS".

DETAILS OF LABORATORY HULL & SEED SEPARATOR

FIG. NO. 16A

HOUSTON TEXAS

beater, and the percentage of the fiber passing the beater to the meats. With this information, the fibrous material may be handled to the best advantage.

Laboratory Hull & Seed Separator

This little device for separating seed and meats from hull samples is indispensable in a properly operated Huller Room. Figure 16 illustrates two very simple but effective designs of a Laboratory Separator being used extensively. It can be built in any good sheet metal shop from the sketch shown on Figure 16A. One of the features of this design is that it requires no motive power and its source of air may be obtained by tapping into the suction side of one of the H & S Separator fans. The volume of air required is hardly sufficient to affect the operation of the H & S machine, but a valve may be installed to cut off the air to the Laboratory Separator when it is not in use.

Carver manufacture and sell a Laboratory Separator, using an electric fan as a source of air. Buckeye Cotton Oil Company use a Laboratory Separator of their own design with a small blower as the source of air.

A small, preferably rugged, scale or balance with a capacity up to 500 grams should be provided in the Huller Room for use with the Laboratory Separator. It is not necessary for this scale to accurately weigh small quantities, such as one or two seed, but it should be accurate to within 1% in weighing, say 25 grams of seed in checking Huller cuts and uncut seed from the Separators.

The principal use of the Laboratory Separator is for checking samples from the Huller Shaker, to determine the percentage of seed in hulls so as to calculate the percentage cut by the Huller, but there are several other important uses, as follows:

a) Checking percentage of hulls in the uncut seed from H & S Separators or Bauer Units and, where hull pick up nozzles are used, in the seed from the top shaker tray.

b) Checking samples of finished hulls from Hull Beater to determine if seed or meats are being picked up by the H & S machines.

FIGURE 17

TABLES OF % CUT

TABLE #1 BASED ON 100 GM. SAMPLE		TABLE #2 BASED ON 250 GM. SAMPLE		TABLE #3 BASED ON 500 GM. SAMPLE	
Wt. of Un-Cut Seed	% Cut	Wt. of Un-Cut Seed	% Cut	Wt. of Un-Cut Seed	% Cut
48	70	121	70	242	70
47	71	117	71	235	71
46	72	114	72	229	72
45	73	111	73	223	73
43	74	108	74	216	74
42	75	105	75	210	75
41	76	102	76	204	76
39	77	98	77	197	77
38	78	95	78	190	78
37	79	91	79	183	79
35	80	88	80	176	80
34	81	84	81	169	81
32	82	81	82	162	82
31	83	77	83	154	83
29	84	73	84	147	84
28	85	69	85	139	85
26	86	65	86	131	86
24	87	61	87	123	87
23	88	57	88	114	88
21	89	53	89	106	89
19	90	48	90	97	90
18	91	44	91	89	91
16	92	40	92	80	92
14	93	35	93	70	93
12	94	30	94	60	94
10	95	25	95	50	95
8	96	20	96	40	96
6	97	15	97	30	97
4	98	10	98	20	98
2	99	5	99	10	99

c) Checking samples of tailings from the Tailings Beater or vacuum droppers, to determine if meats are being picked up by the Purifier.

d) Checking finished hulls for seed or meats.

To determine the percent seed cut by a Huller, an accurate sample of hulls (mixture of hulls and seed) should be drawn from the discharge end of the shaker tray or when a hull pick up nozzle or Bauer Unit is used, just before it reaches the nozzle. Grab samples should be drawn at three or more points across the width of the shaker, then mixed, quartered down, and the 100-gram sample accurately weighed. More accurate results, for very close control work, may be obtained with a 200-gram or even 500-gram sample, but for normal control and setting of Hullers, the 100-gram sample is usually satisfactory. After weighing out the 100-gram sample, it is fed through the Laboratory Separator, which removes the hulls and drops the seed. In order to be sure that no seed are picked up with the hulls, the Laboratory Separator should be adjusted to drop a few hull with the seed and it is sometimes desirable to rerun these seed to remove as much as possible of the remaining hull. It is then advisable to carefully check the remaining uncut seed and remove any excess hull particle by hand. Some operators, after practice with this machine, find it possible to adjust the Laboratory Separator to drop very few hulls and although picking up a few light seed, they find by experience that the amount of seed picked up will be offset by the hulls dropped with the seed. In that manner, it is possible to speed up this procedure by eliminating the rerunning of the sample and the hand picking. A procedure of this kind requires practice and experience and is not recommended for inexperienced operators. This machine is admittedly not 100% accurate, but if operated each day in the same manner, any errors will at least be consistent and if checked each day against the oil in hulls, it will soon be possible to determine the most effective Huller setting and maintain it.

After determining the weight of seed in the 100-gram sample as outlined above, refer to the No. 1 Table on Figure 17 on the adjacent page, which will give the percent cut by the Huller. Tables No. 2 and No. 3 give this information based on 250- and 500-gram samples.

The table shown on Figure 17 is based on a simple algebraic calculation, in which it is assumed that the original seed to the Huller contain 46% hulls. The calculation is as follows:

wt. of sample - wt. of uncut seed = wt. of hulls in sample.
wt. of hulls ÷ .46 = equivalent wt. of seed.
equivalent wt. of seed = seed cut by Huller.
equivalent wt. of seed ÷ (uncut seed + equivalent wt. of seed) = % cut.

This formula, or the assumption as to the percent of hulls in the seed, will not necessarily apply to all mills, but this is not too important, so long as each mill determines just what percent cut (as determined by these tables) is best for their particular conditions, and sticks to it. Adjusting and setting the Huller is covered in the first part of Part 10.

It is true that many mills have obtained good separating results for many years and never heard of a Laboratory Separator, but by using this device to determine the percent cut and accurately setting the Hullers for most efficient results, better results will be obtained. No man can consistently tell by observation and feel the exact percent cut or even guess within 10%. Any good superintendent or operator who has ever properly used this device will never want to be without it in the Huller Room.

The next most important use for this device is for checking samples of uncut seed from the H & S Separators or Bauer Unit to determine the percentage of hulls dropped with the uncut seed. Here again, it is difficult, if not impossible, to estimate within 15% or 20% and the use of the Laboratory Separator for setting and adjusting the H & S machine, as outlined in the early part of this chapter, is indispensable. In this case, no table is required and where a 100-gram sample is used, it is a simple matter of deducting the weight of seed from the 100-gram sample and the difference is both the weight and percentage of hulls in the sample.

The use of the Laboratory Separator for checking finished hulls, beater hulls, tailings, and other fractions is not intended to determine any exact percentage by weight, as the scale used in the Huller Room is usually not sufficiently accurate for weighing these relatively small quantities of seed or meats. It is intended to facilitate checking the various products and to save time in determining the presence of seed or meats and it is quicker and more accurate than hand picking. It is, however, desirable to weigh the check sample, usually 100 grams, and by using this exact quantity each time, any variation in the seed or meat content is readily detectable. When an operator is constantly finding, say, one or two seed or meats in a 100-gram sample of finished hulls, he may wish to have these seed and meats weighed on a laboratory balance and then translate this percentage to determine how it will affect his total oil in hulls.

A good standard checking procedure is for the Huller Room operator or supervisor to check the percent cut by each Huller each morning or whenever any change or adjustment is made to the Huller and then make any adjustments as required, and recheck. Then check each H & S Separator for percent of hulls in "droppings" or uncut seed and adjust as required. Also, check a sample of finished hulls and if no seed or meats are found in a 100-gram sample, no further checking is required. If seed or meats are detected in the finished hull sample, it will then be necessary to check both the hulls from the beater and the finished tailings to determine the source of this loss. If seed or meats are found in the hulls from the beater, a further check and adjustment of the H & S Separators will be required, and if found in the tailings, the adjustment and setting of the Purifier should be checked. Each time the Purifier is adjusted or changed to control protein, a sample of finished tailings should be checked by passing through the Laboratory Separator to see if any meats are being picked up.

Hulling Performance Standards

To establish hulling performance standars for expected oil in hulls is something that would have to be done for each individual mill in order to arrive at accurate results. Natural oil in hulls will vary from .20 to .50% across the cotton belt so naturally the total oil will also vary accordingly. Oil in hulls will also be directly affected by F.F.A. in seed, and moisture in seed. The ideal moisture for good hulling is around 11% and oil in hulls will increase as the moisture goes up or down.

Several groups of mills have established standards based on their average result, over a period of years, and adjusted for moisture and F.F.A. This system is reasonably accurate for comparative purposes but does not take into account any variation in natural oil in hulls. An example of this method of comparison is listed in Figure 17A. (pg.94)

To apply the Table for, say 30 days operation, first calculate average seed moisture and F.F.A. for that period. If moisture averages 8.5% the Table (page 94) gives the expected oil in hulls as .62%. If this mill averaged 2.5% F.F.A. in seed worked for this period, the Table indicates .03 should be added to expected oil in hulls making the expected total oil .65%. If, for example this mill actually averaged .60%, they have obviously done a good job by bettering the expected standard by .05%. On the other hand if they failed to equal the expected they could start looking for trouble.

A general 'rule of thumb' estimate for expected total oil in hulls would be .50% but where natural oil in hulls runs .30% to .35% then the oil in hulls should be correspondingly lower. On the other hand, in rare cases, with high moisture and F.F.A., then the expected total oil will run .75% to 1.00% and there is nothing can be done about it.

The expected oil in hulls (Figure 17A) is based on the actual production of hulls from the Huller Room and would not include any discarded trashy fractions from Lint Beaters, Motes or Seed Cleaning. Where it is practical or profitable to add such fractions to the hulls, any added oil should be accounted for separately. Large volumes of oily hull pepper and fiberous fractions can very easily double the total oil in hulls.

An aggressive superintendent should be able to establish his own standards, based on the type and quality cottonseed being worked. This proposed actual "standard" in all cases reverts back to the "natural oil" in hulls.

"Natural oil" in hulls consists primarily of gums and waxes and will usually range from .20% to .50% as indicated by laboratory analyses. There is nothing that can be done to reduce this oil which is fixed in the hull and therefore the total oil will invariably consist of this "natural oil" plus oil picked up in the hulling and separating process, which will consist of absorbed oil, meats dust, seed and meats.

With a properly designed and operated Huller Room and with reasonably prime seed, there is really little, if any, actual absorption or blotting up of oil by the hull, particularly closely linted or black hull. Practically all of this absorption occurs in the loose lint, or fiber, remaining in the hulls, and it is therefore extremely important that all traces of loose lint be removed from the delinted seed before hulling. It is likely that a large part of this socalled absorbed oil consists of meats dust which is difficult to remove from lint or fiber.

"Natural oil" in hulls may be determined by cutting a representative sample of delinted seed with a razor blade, hand picking to remove the meats, and then extract-ing the cleaned hulls for oil determination in the usual manner. It is assumed that a clean cutting of the seed with a sharp razor blade will remove the hull without wiping or mashing any oil from the kernel. An even safer method that has been used is to clamp the razor blade between two pieces of keystock or flat metal, with approximately 1/16" of the blade protruding and then roll the seed across the blade. This procedure will cut a circle around the circumference of the seed and allow the hull to fall off in two pieces, without penetrating the kernel.

It is the writer's opinion that under normal conditions, the expected total oil in hulls should not exceed by more than .12% the "natural oil" in hulls. In other words, if the "natural oil" in hulls is .30%, the total oil in the finished hulls should not exceed .42% oil. There are several factors which will make it difficult to obtain the above mentioned expected standard. On extremely wet seed, there will be considerable mashing of seed in the Huller and the absorbed oil increase at this point will very likely be more than the above mentioned .12%. A good operator will check the "natural oil" in hulls and then determine the percentage of absorption in the Huller by checking samples of hulls from the discharge end of the Huller Shaker. To determine the absorbed oil in hulls from the shaker, the sample should first be hand picked to remove all uncut seed and meat particles and then remove meats dust by beating the sample in an ordinary flour sifter, clothed with approimately 16-mesh screen. It is recommended that the sifter be filled approximately two-thirds full of hulls, covered with a piece of paper held down by hand and then thoroughly dusted by turning the hand crank vigorously, approximately 100 turns. The hull samples should then be rechecked by hand picking to see that all seed and meat particles have been removed and then analyzed in the laboratory for absorbed oil. The difference between this absorbed oil and the "natural oil" in hulls will indicate the absorption taking place in the Huller. With prime seed and with seed moisture not exceeding 12%, the absorbed oil in the hull from the shaker should not exceed the "natural oil" by more than .10%. With a properly operated hull beater, the clean hulls from the beater should contain approximately the same absorbed oil as the hulls from the shaker, but in this case it should not be necessary to beat the sample with the flour sifter, as it is assumed that the beater removes all of the fine meats dust.

A third, and very important, source of absorbed oil and meats dust is from the fiber from vacuum droppers which has been covered in the preceding portions of this article.

The above, in connection with expected oil in hulls, may be summarized by stating that the first and most important thing to be determined is the "natural oil" in hulls and the absorbed oil in the hulls from shakers or beaters. Under normal conditions, the rise or increase in oil within the Huller should not be more than .10%. Except under unusual and difficult protein control conditions, the oil in finished tailings should not exceed the total oil in hulls and, therefore, the total oil in finished hulls should not be more than .12% in excess of the "natural oil" in hulls.

In some cases, where it is profitable to produce extra high protein in cake or meal, and where protein in seed is low and/or moisture is low and seed closely delinted, it might be necessary to sacrifice some extra oil in hulls. For example, a mill that could maintain .50% oil in hulls when producing .41% protein might run up to 1.00% in hulls when producing .46% or .48% protein. This, with oil at 20¢ per pound, would mean a loss of about 50¢ per ton of seed. In most cases this would be more than offseted by increased tonnage through the mill, more uniform protein in finished meal or perhaps greater products revenue for the higher protein. Before going to the higher protein operation the increased oil in hulls should be determined and the economics of the high protein operation evaluated.

There might be other cases where oil in hulls could not be maintained at the .50% oil level mentioned above. In Peru and Egypt, when working the black, lintless Pima-type cotton seed, and maintaining .41% protein, the oil will run .50% higher than with normal cottonseed and under these conditions 1.00% oil in hulls will be a good figure to shoot at. In fact, it takes a well designed huller room and good supervision to maintain 1.00% oil in hulls and .41% protein, with these Pima-type black seed.

Sampling

Proper hull sampling to obtain representative samples, is essential in order to know just what results are being obtained in the Huller Room.

The only really accurate method of obtaining samples is with a properly designed and installed automatic sampler, which will periodically draw a true sample 24 hours per day, and discharge it to a dust-tight container. Unfortunately, very few mills are equipped with a device of this kind, but a sampler similar to those being used extensively for sampling seed and cake would be entirely satisfactory and is definitely recommended for cottonseed hulls.

Where the automatic sampler is not available, the operator should be carefully instructed to draw a representative sample of finished hulls, at least each hour, and place same in a dust-tight can. At the end of each shift, this complete sample should be riffled or quartered down to sample size, placed in a container, marked, and forwarded to the laboratory.

To obtain a fair representative hull sample in most Huller Rooms is easier said than done and will simply have to be worked out for each individual mill. In practically all cases, beater hulls and finished tailings will be discharged into a common screw conveyor along with any other fractions going into the finished hull stream and in some cases, it is difficult if not impossible to get a good sample. Where the mixture of the various fractions which make up the finished hulls are handled in a rotor lift, a very good arrangement is to provide a sliding gate in the housing of the rotor lift from which a reasonably representative sample can be drawn at regular intervals. Where the screw conveyor handling this material pushes directly into a pneumatic blower plug, the sample must be drawn from the screw conveyor before the material reaches the plug and this is usually difficult, as well as dangerous. Where it is impossible to draw a representative sample in the Huller Room, it should be taken at the collector discharge in the hull house, and this requires drawing a relatively large sample to include the entire discharge from the collector and then quartering it down. Every superintendent should give this matter serious consideration and make adequate provisions for conveniently taking representative samples.

Even where reasonably good hull samples are being taken in the Huller Room they should be checked about once a week against hull storage or shipment samples. By probing into the hull pile or in cars or trucks, a representative sample will be obtained. If the storage samples are higher than the Huller Room samples then they should be used for accounting purposes.

In sampling of cake or meal for the purpose of protein control is even more important, and greater care should be exercised than in the sampling of hulls. Some of the suggestions outlined above for hull sampling will also apply to cake sampling and this matter should be carefully studied. A summary of some of the general points in connection with sampling of any product is outlined as follows:

a) In order for samples to be of value, they must be truly representative of the materials being sampled and where grab samples are being taken, the chances of having a representative sample are increased as the frequency of sampling is increased.

b) It is very important that the samples be carefully and accurately reduced in size by means of proper mixing, quartering, or riffling.

c) It is essential that all equipment, such as grinders, riffles, sample cans, etc., be thoroughly cleaned.

d) Samples to be used for moisture determinations should be placed in moisture-tight containers as quickly as possible.

FIGURE 17A

EXPECTED OIL IN HULLS

Seed Moist.	Expected Oil in Hulls
Below 7.0%	.80
7.0 - 7.4	.77
7.5 - 7.9	.71
8.0 - 8.4	.66
8.5 - 8.9	.62
9.0 - 9.4	.59
9.5 - 9.9	.56
10.0 -10.4	.55
10.5 -11.4	.54
11.5 -11.9	.56
12.0 -12.4	.58
12.5 -12.9	.62
13.0 and above	.70

FFA Corection

FFA in Seed	Add
2.0	0
2.5	.03
3.0	.06
3.5 & above	.09

PART ELEVEN

TECHNICAL DATA AND GENERAL DESIGN INFORMATION

Introduction

The principles and flow of material in screening the various fractions by means of shakers, beaters, or combinations of the two, and the application of pneumatic devices to insure a more nearly perfect separation in the process have been discussed elsewhere. In this section, some of the technical aspects of selective lifting and conveying of Huller Room fractions by air will be discussed.

In discussions of pneumatic separation, the terms "lighter particles", "heavier particles" and "density" are generally used. These terms can be misleading, in that the floating velocity of particles of any one material and therefore of fixed density, will vary widely with their size and shape. To illustrate this point, assume that a kernel of meat of spherical shape has a diameter of 0.16" and a weight of 0.028 grams; the projected area on which the impact of a stream of air will apply is the area of a great circle of the sphere, or 0.0201 square inches; based on the given weight and projected area, this particle will float in a stream of air having a velocity of 1170 fee per minute; now assume that this meat is cleanly cut in half so that its weight is now 0.014 grams; the projected area on which the stream of air will apply is the same as before, or 0.0201 square inches. Based on this, the floating velocity for this particle will be only 825 feet per minute.

From this illustration it may be stated that the floating velocity of any particle depends not on its weight or density, but on its <u>weight per square inch of projected area</u>, the area in this case being normal, or at right angles, to the direction of the air stream, when the particle is in its floating attitude or position.

To continue with this phase, note that a spherical particle of one-half the diameter of the first example given above will have a weight of one-eighth as much, and a projected area of only one-fourth as much; the corresponding weight per square inch of projected area of this particle would be one-half as much and would require an air velocity of 825 feet per minute. Now consider a spherical particle of one-fourth the diameter, which will weigh one sixty-fourth as much and have a projected area of one-sixteenth as much; the weight per square inch of projected area in this case would be one-fourth as much and the floating velocity 585 feet per minute. Similarly, it may be

FIGURE 18

FLOATING VELOCITIES OF HULL AND OTHER PARTICLES

HULL PICK-UP NOZZLE		PURIFYING NOZZLE	
(1) Hulls	(2) Meats	(3) Hulls	(4) Meats
1100	1360	675	1360
955	1170	597	1170
885	1125	447	1125
754	825	392	825
675	700		700
			580
			460

NOTES:

(a) Hulls in column (1), because of size or matting, will normally pass over 3/16" round perforations. Meats in column (2), above the dividing line, may occasionally be found passing over the same screen. If the screen is permitted to blind, particles of meats below the line will be exposed to the aspirating nozzle.

(b) In columns (3) and (4), hull and meat particles above the line will normally be found passing over 1/8" round perforations. A blinded screen will force meat particles below the line to pass under the aspirating nozzle.

(c) Floating velocities of seed will vary widely with conditions of moisture, maturity, weather damage, lint, etc. A few observed velocities follow.

West Texas seed with Lint	1600 - 1800
Delinted	1800 - 2000
Red "Pops"	800 - 900

(The floating velocities given are not to be confused with conveying velocities, which consist of floating velocities plus a large margin for transportation.)

demonstrated that cubical or spherical particles of the same material will require lower and lower air velocities to float as their size decreases down to the dust or micron sizes.

Limitations or Selective Aspiration

The foregoing discussion has been devoted specifically to the floating velocities of meats and meat particles, because these constitute the most valuable material in process and a clear understanding of the physical limitations of any given pneumatic system, no matter how perfectly designed, is needed to realize the importance of proper screening of materials ahead of a pick-up point, so that only the intended particle sizes will come within the zone of influence of the aspirating nozzle. For example, consider the bottom tray of a hulling shaker, which is clothed with, say, 1/8" round perforated metal, and a purifying nozzle is used over the discharge lip of the shaker. Obviously, it is intended that only meat and hull particles larger than 1/8" pass over the screen and continue on to the end of the tray, where the stream of air induced by the nozzle will act on them. On the opposite page will be found Figure 18 on floating velocities of hull and other particles, but at this point it may be said that there is sufficient difference in the floating velocities of hull and meat particles in this range of sizes that the hulls may be floated and conveyed upward, while the meats are dropped. This will not apply, however, if the screen is allowed to blank and very small particles of meats pass under the purifying nozzle, since the floating and conveying velocity being used to lift off hulls will surely lift all the smaller particles of meats and meat dust.

In single-hulling systems, where a pneumatic pick-up is used at the discharge end of the top huller shaker to remove the hulls and convey them to the Hull and Seed Separators, the pick-up nozzle, as in other similar applications, is called upon to do a difficult job of selective lifting under somewhat adverse conditions; the density of individual particles varies with moisture or lint content, the thickness of the blanket of hulls and seed fluctuates, and even the temperature and humidity of the air will vary widely throughout a 24-hour period. All of these variables tend to have an effect on the degree of exactness that might otherwise be expected in making this type of separation or selective lifting.

In addition to unavoidable fluctuations and variables discussed before, there are always present varying amounts

FIGURE 19

TYPICAL DESIGN DATA FOR PNEUMATIC SYSTEMS

1. Volume of air required to convey one pound of material and recommended conveying velocity -

	Cu. Ft. per Lb.	Ft. per Min.
Delinted Seed	40	5000
Meats	40	4500
Hulls (wooly)	70	3000
Hulls (black, bran)	50	4500
Hulls (black, pepper)	40	4000
Meats Dust (fiber)	80	2500

2. Friction of air in smooth, round metal pipes.-

		Friction, Inches Water per 100'			
Pipe Size	Area, sq. ft.	2000 FM	3000 FM	4000 FM	5000 FM
5	.1364	1.4	2.9	4.8	7.0
6	.1964	1.0	2.1	3.8	5.6
7	.2673	.85	1.9	3.0	4.6
8	.3491	.70	1.6	2.6	3.8
9	.4418	.60	1.4	2.2	3.4
10	.5454	.54	1.2	2.0	3.0
12	..7854	.40	.90	1.6	2.2
14	1.069	.34	.70	1.3	1.9
16	1.396	.30	.60	1.0	1.6
18	1.767	.26	.52	.90	1.4
20	2,182	.22	.48	.80	1.2
22	2,640	.20	.40	.70	1.0
24	3,142	.18	.36	.60	.90

3. Air Velocities corresponding with various velocity heads -

In. H_2O	Velocity	In. H_2O	Velocity
.2	1780.	1.1	4200
.3	2190	1.2	4380
.4	2530	1.3	4560
.5	2830	1.4	4750
.6	3100	1.5	4900
.7	3350	1.6	5050
.8	3580	1.7	5220
.9	3800	1.8	5370
1.0	4000	1.9	5500

of fine lint fiber with entrained meat dust in the fractions exposed to aspirating nozzles. This would explain why the aspirating nozzle itself cannot be depended upon to do an exact and finished separation, without the aid of vacuum droppers, which may be designed to drop all but the fiber and dust to be treated separately, and Hull and Seed Separators and Purifiers, which under normal conditions are better suited to do the finishing job on mixtures of seed and hulls, and meats and hulls, prior to final beating.

Design of Single-Line Pick-Up System

The principal objectives of the design of pneumatic systems, as in the design of any machine or structure, are 1) to produce the intended effect, 2) to obtain a reasonable life expectancy, 3) to obtain economy in construction, 4) to obtain economy in maintenance, attention and power, 5) to provide convenience and safety in adjustment and operation, 6) to arrange and place component parts logically and in an orderly manner. In the design of pneumatic systems as applied to the Separating Room, certain rules and data have been evolved through study and experience and these are helpful in providing the basis for calculations of complete systems. The table shown in Figure 19 gives volumes of air required to accomplish various jobs and other useful information.

In the planning of a single-line separating pick-up system as applied to the end of a shaker, the amount of material to be picked up must first be determined or estimated, based on observation and experience. The amount of air required to convey the material should then be calculated from the table in Figure 19, "Cubic Feet of Air Required to Convey One Pound of Material"; this should then be divided by the velocity required to convey the material as indicated by the tables. The result will be the area of the pipe, in square feet, which may be readily converted to square inches and the corresponding pipe diameter determined. The design of aspirating nozzles will be discussed later on in this chapter, but to continue, the aspirating nozzle must then be proportioned to suit the lifting velocity required, when the mouth of the nozzle is a predetermined distance above the bed of moving material, usually 1", which means for adjusting from, say, 1/2" to 2". This velocity, divided into the volume of air required to convey the material, as determined early in this paragraph, would give the area of the nozzle mouth, in square feet; this should be converted to square inches for convenience. The width of the nozzle should then be established by choice; that is, it must be somewhat less than the width of the shaker, possibly one inch on each side, or it may be made narrower if the bed of material can be deflected at both sides so as to come fully under the influence of the nozzle. This procedure is nor normally recommended. The area determined immediately above, divided by the width selected, will equal the depth of the nozzle mouth. If this gives too narrow an opening for free passage of any expected material, such as balls of lint, the nozzle should be made deeper and the entire system enlarged correspondingly.

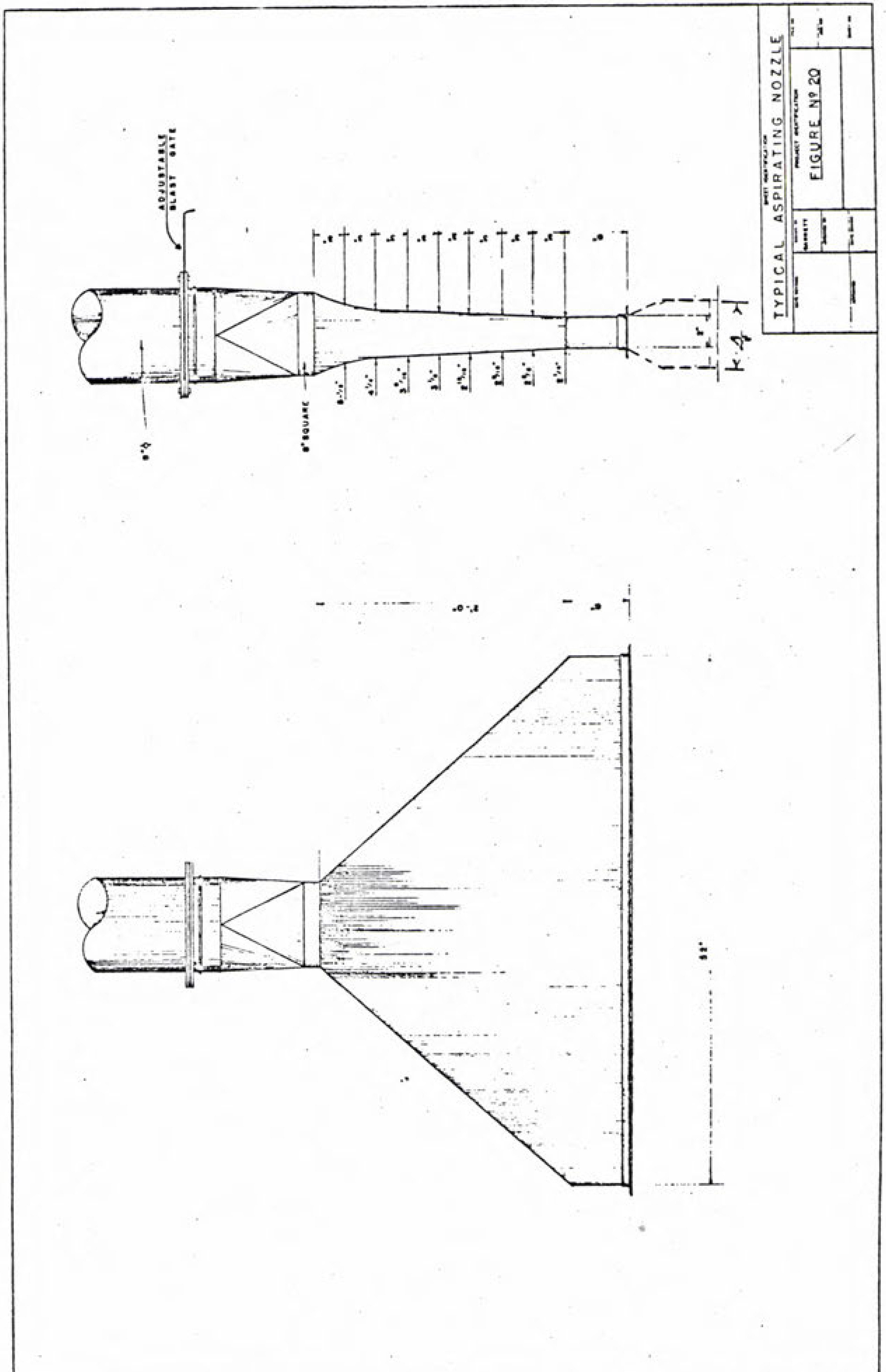
After this part of the problem is solved, the friction in the conveying pipe must be determined from tables, a sample of which is presented in the table in Figure 19. To this frictional resistance must be added the expected entrance loss at the nozzle, which usually amounts to about two or three times the velocity head, based on the velocity of entrance to the nozzle. This will vary with smoothness of the entrance, temperature, etc., but for the usual pick up velocities encountered, it may be assumed to be 1-1/2" just under the blast gate. If the line so far represents a branch of a larger system, the sum just obtained will be the negative static pressure required at the junction, to draw the required volume of air at the desired conveying velocity.

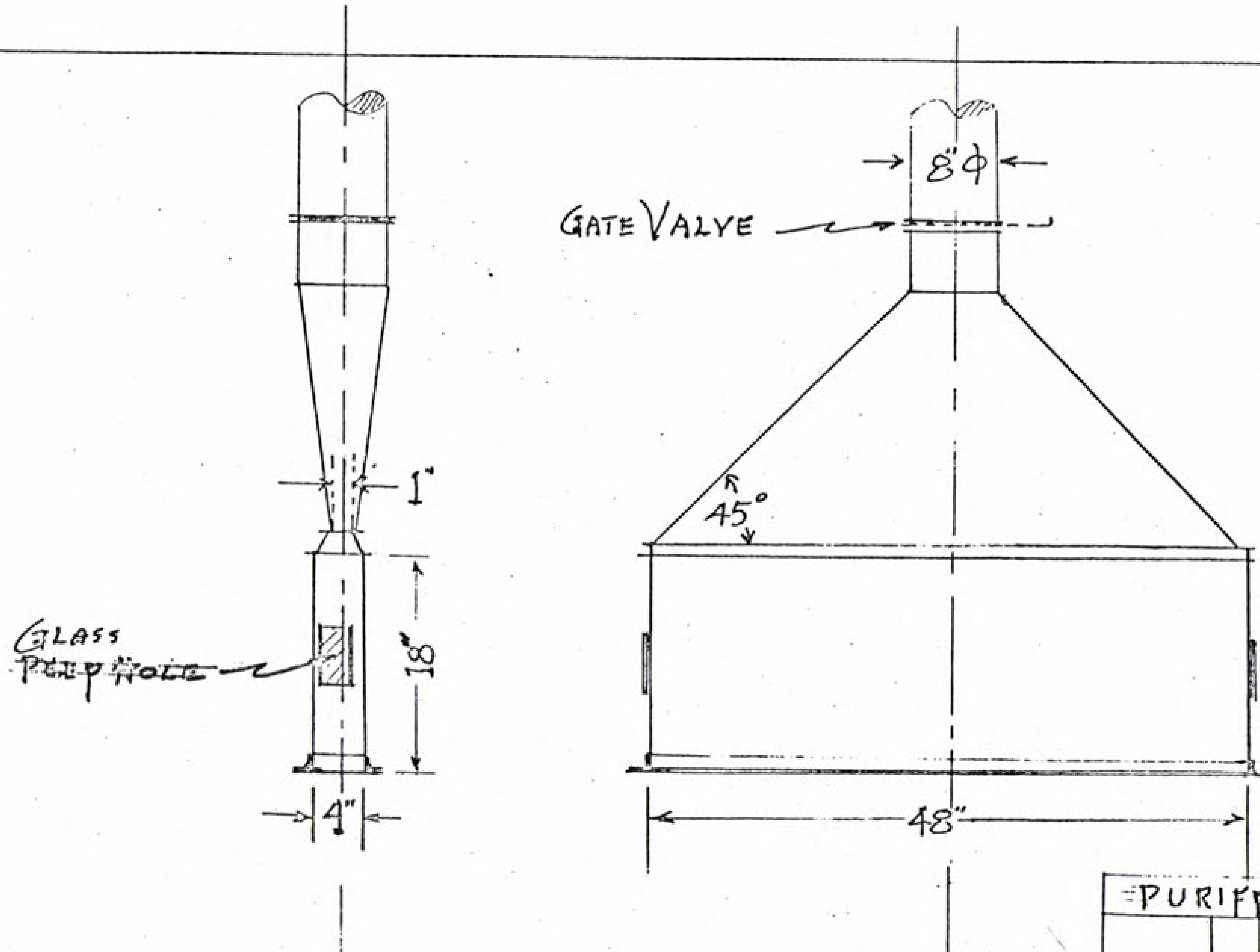
In the design of a multiple system, where a trunk line is used with several branches, it is necessary to determine the combination of branch and trunk that requires the highest static pressure to operate, and base system on this loss. Losses through droppers and finally the cyclone back pressure must all be taken into account and the fan size, speed and horsepower requirement determined, to complete the design.

For large, complex pneumatic systems, it is best to obtain assistance from people who have had considerable experience in their design; however, in the case of simple systems or the improvement of existing components of old systems, the scope of this chapter should be sufficient to assist in their determination.

The Aspirating Nozzle

One very common component of a pneumatic system is the suction or aspirating nozzle. Years ago, these were made in the form of an ordinary transition from the rectangular nozzle intake to the round conveying pipe. People who have used this type of nozzle in the past may remember


ADJUSTABLE BLAST GATE
8" SQUARE
TYPICAL ASPIRATING NOZZLE
FIGURE Nº 20



PURIFYING NOZZLE

FIG. No. 20A

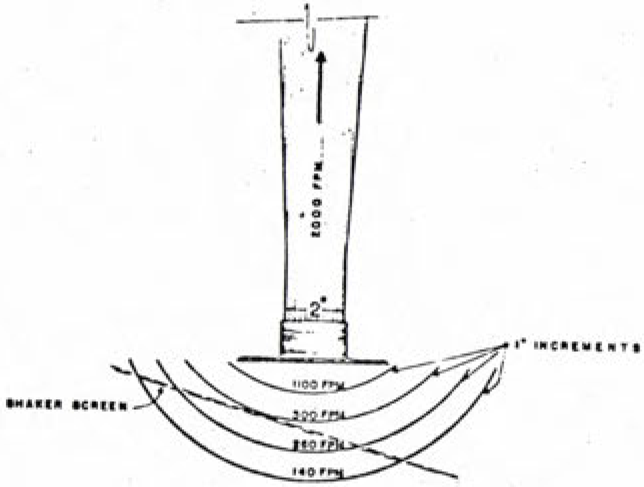
that frequently balls of hulls and fiber would form in the middle and bounce around until enough of them formed to choke the nozzle. This peculiar phenomena is caused by the fact that in the common transition the cross-sectional area is larger at a point near the middle than at either the mouth end or the pipe end; the velocity at this point is lower, and therefore some material that is floated and conveyed at the mouth will only float when it reaches the lower velocity area, and remain there. In the modern designs, the shape of the nozzle is such that velocity increases constantly and uniformly from pick up velocity to pipe conveying velocity, so that any material that enters the mouth will accelerate uniformly and reach conveying velocity without interruption. A typical nozzle of this type appears in Figure 20.

Recent observations of nozzles giving good results in operation have led to the belief that larger volumes of air, that is, larger nozzles using the same entrance velocity, may be desirable. A theoretical analysis of the action that takes place in the region surrounding the entrance to a nozzle seems to bear this out.

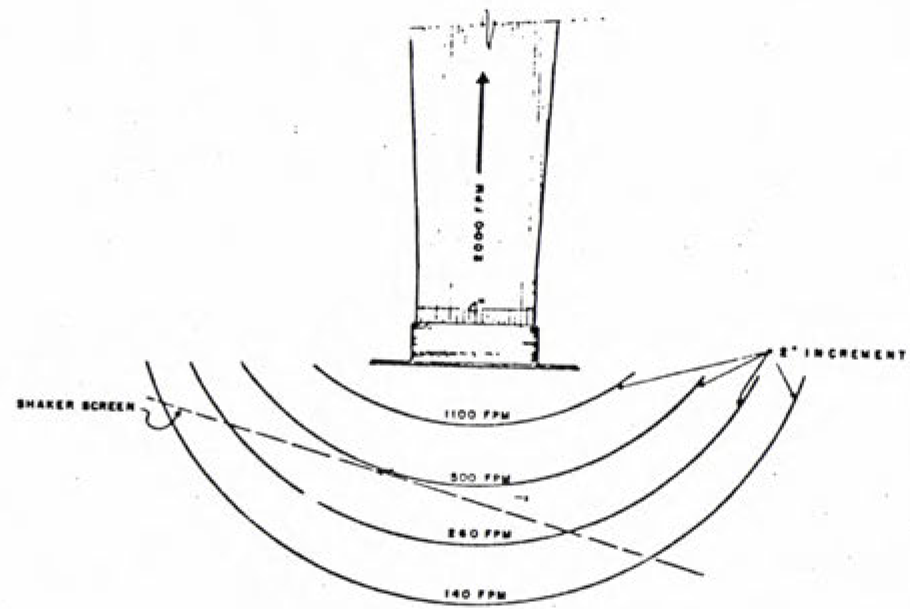
Referring to Figure 21(a) note the velocity of air at various points as it is forced toward the low pressure region surrounding the nozzle. With the nozzle at 1" above the shaker, it may be seen that in a space of approximately 1/2", velocities will range from 500 feet per minute to 1100; a slight variation in the thickness of the bed of material or a very slight adjustment of the nozzle will cause considerable change in air velocity that acts on the material; also, with a 1/2" thick bed of material, the particles on the bottom are acted upon by air moving at 500 fm, whereas the particles on top are acted upon by air moving at 1100 fm.

Referring to Figure 21(b) note that this nozzle may be located 2" above the shaker and still obtain a velocity of 500 fm at the bottom of the bed of material. The particles at the top of a 1/2" thick bed of material would be acted upon by a current of air at 750 fm; slight variations in nozzle adjustment or in thickness of bed would make little difference in the desired effect.

The use of larger nozzles will call for handling larger volumes of air and larger piping, but friction losses will be reduced and the power required may be expected to increase only moderately, possibly between 10% and 20%. The idea of overcoming this by making a nozzle narrower and deeper with the intention of deflecting material from the sides of the shaker so as to pass under the mouth of the



(a)



(b)

THEORICAL ANALYSIS OF NOZZLE ENTRANCE DESIGN

FIGURE Nº 21

nozzle, has the fallacy that the bed of material will be thicker, and slight variations in hulling rate would be multiplied into large variations in bed thickness, so that the advantages of a deeper nozzle are nullified. An optional method to obtain the 4" deep nozzle inlet is to simply widen the inlet as shown in dotted lines in Figure 20, or redesign the bottom 6" of the nozzle accordingly.

Summary

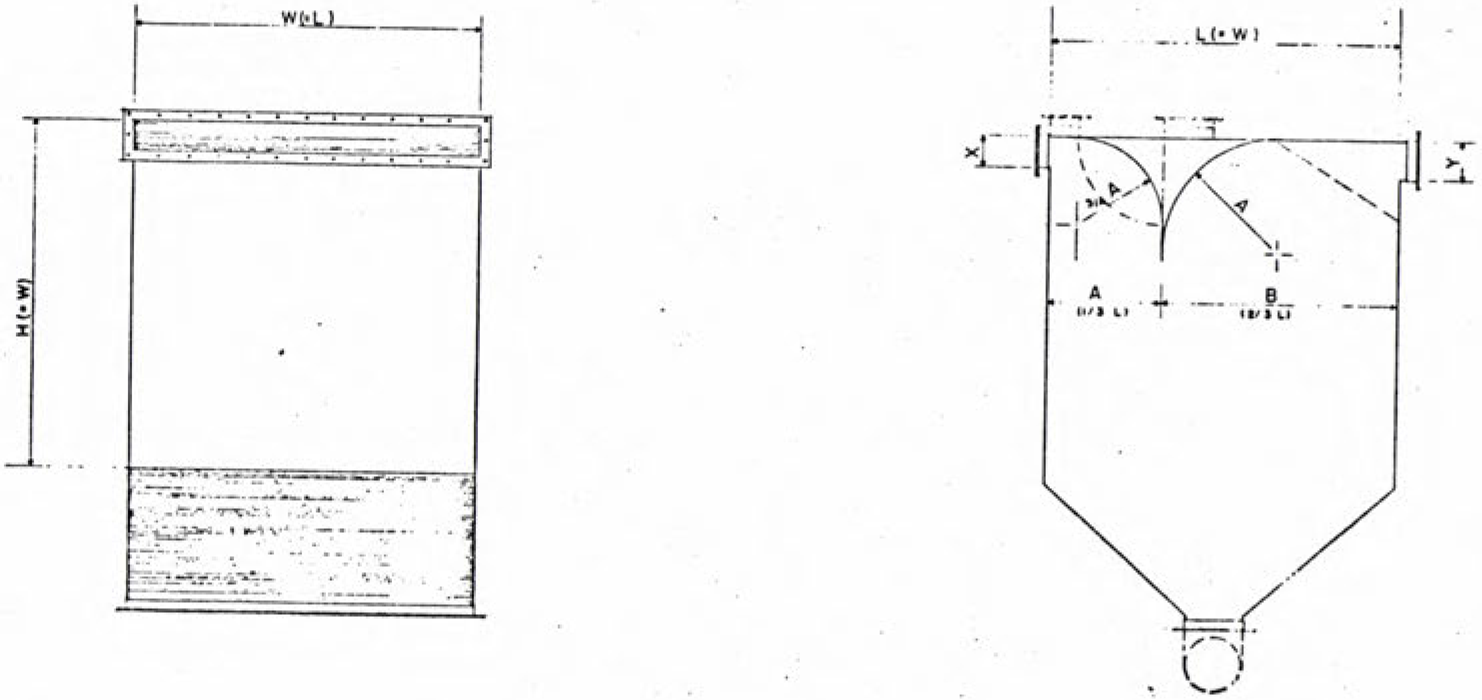
The preceding discussions of floating velocities, selective aspiration, design of pick up system and nozzles, is intended to give a smattering of technical information for what it may be worth but for the average Huller Room the whole thing may be summarized as follows.

For the Aspirating Nozzle on the lower tray of the Huller Shaker, use a design similar to that on Figure 20. The 4" deep nozzle is preferable and the 8" pipe to each nozzle, handling about 1570 cfm of air each at 4500 fpm velocity in the pipe, is satisfactory. Another nozzle design shown in Figure 20A has also been used successfully, but in all cases the 4" deep nozzle inlet is recommended, for reasons illustrated in Figure 21.

For the Aspirating Nozzle on the top tray of the Huller Shaker a 10" pipe is required to handle about 55% more air for the larger volume of hulls. This requires a proportionally larger nozzle design with 4" deep inlet and 55% greater cross sectional area than shown on Figure 20.

To design a pneumatic system to handle two aspirating nozzles, each with 8" pipes and one 6" pipe to the Hull Beater Nozzle, would require a 13" pipe to the fan suction and from fan to cyclone. The information on Figure 19 allows a simple calculation friction loss in pipes, which at 4500 fpm would total 2.25". Adding 1" static required at nozzle and 3" for pressure drop through a H.V. Collector we arrive at a total of 6.25" water column on the system. With the required cfm and static, it is then a simple matter to refer to any manufacturer's fan table and select the proper fan. If a Fort Worth fan table is used the standard No. S2 exhaust fan meets the requirements. The table requires interpolating to get the exact static and would indicate a speed of 2200 rpm and horsepower about 3.6. This would require a 5 HP motor.

After the installation is completed the static should be checked and balanced at each nozzle. This may be done by drilling a 1/4" hole in the pipe, just above the nozzle



$W = \sqrt{CFM \times .436}$ INCHES

$X = \frac{\text{AREA OF CONVEYING PIPE, (SQ. IN)}}{W}$ INCHES

$Y = \frac{CFM \times .06}{W}$ INCHES

TYPICAL HULL DROPPER

FIGURE Nº 22

and taking a manometer reading. Static at the top of each nozzle should be 1" to 1-1/2" and after adjusting blast gates or values to equalize and if static is less than 1", the fan may have to be speeded up slightly. If static exceeds 1-1/2" it may be lowered by adjusting blast gates but, if convenient, it would be better to reduce fan speed.

The Vacuum Dropper

For many years it has been known that the separation of Huller Room fiber from hulls traveling in an air stream would be advantageous in that the fiber could be treated separately from the hulls, preventing "run around", reducing the total oil left in hulls and in recent times, even making the cleaned fiber salvageable as lint. Another important advantage of the vacuum dropper is that the hulls do not pass through the fan, where they are subject to breakage. Various devices have been employed that will accomplish this kind of separation with varying degrees of success, but the present design meets most requirements and has come to be adopted by many mills. A sketch of a typical unit may be seen in Figure 22. There are also disadvantages to vacuum droppers and they should not be used unless necessary.

In selecting the proper size dropper to use for a system, first the volume of air to be handled must be known or determined. Since the design is based on an average upward velocity of 500 fm, dividing the volume of air by 500 will equal the area in square feet of an horizontal across-section of the upward stream; this would be equal to the product of the width of the dropper, in feet, and dimension B, also in feet. From this, all dimensions may be developed. It will be noticed that the cross-sectional area of the downward stream is 1/2 that of the upward stream. This permits simplifying the complete calculation as follows: 1) multiply the total CFM to be handled by .436; 2) take the square root of this product, and the answer will be W, in inches. As long as the area of the upward stream will correspond with the 500 fm velocity, the proportions of the device may be varied somewhat without hampering its operation; for example, the width may be increased and dimensions A and B decreased proportionately or vice versa; or the dropper may be made taller, but preferably not shorter.

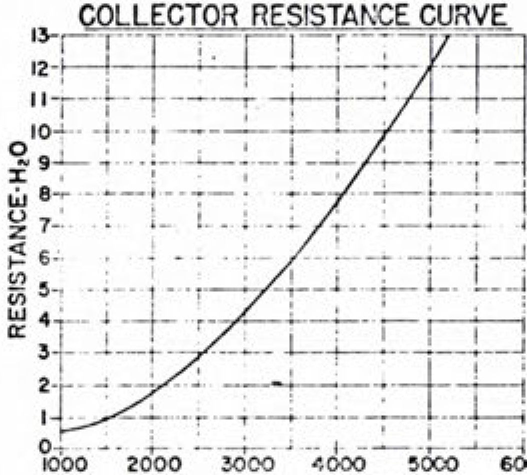
An example of the calculation mentioned above and shown on Figure 22, for a system handling 3000 cfm incates a width of 36.17", or in round figures 36". This

HIGH VELOCITY (H.V.) COLLECTOR

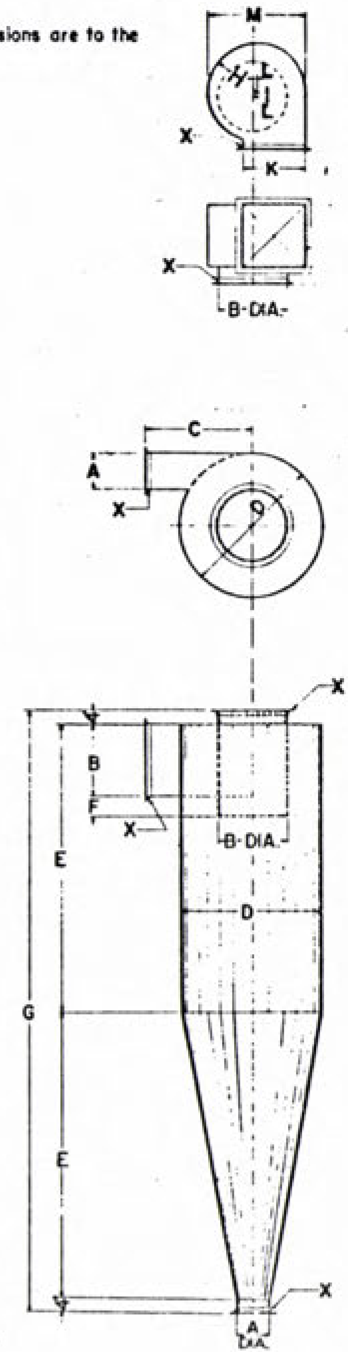
FIGURE NO. 23

STANDARDS

SIZE	INLET AREA SQ.FT.	CAPACITY C.F.M.	SIZE	INLET AREA SQ.FT.	CAPACITY C.F.M.
1	.052	121 - 175	11	.656	1532-2202
2	.067	155 - 223	12	.917	2140-3080
3	.087	203 - 292	13	1.188	2775-3990
4	.115	268 - 386	14	1.566	3660-5260
5	.147	342 - 493	15	2.00	4675-6720
6	.189	441 - 634	16	2.623	6130-8825
7	.244	568-813	17	3.415	7970-11470
8	.322	751 -1030	18	4.430	10370-14900
9	.420	980-1410	19	5.770	13460-19370
10	.543	1268-1825	20	7.510	17510-25200



NOTE: All dimensions are to the inside.



DIMENSIONS

SIZE	A	B	C	D	E	F	G	H	J	K	L	M	X	HEAVY SERVICE GA.	HEAVY SERVICE WT.	MEDIUM SERVICE GA.	MEDIUM SERVICE WT.	LIGHT SERVICE GA.	LIGHT SERVICE WT.
1	1 15/16"	3 7/8"	5 13/16"	7 3/4"	1'-3 1/2"	1"	3'-3"	2 11/16"	4"	3 7/16"	1/4"	5 3/8"	1"x1/8"	14	20	16	17	20	11
2	2 3/16"	4 3/8"	6 9/16"	8 3/4"	1'-5 1/2"	1 1/8"	3'-7"	3"	4"	3 11/16"	1/4"	6"	1"x1/8"	14	25	16	21	20	14
3	2 1/2"	5"	7 1/2"	10"	1'-8"	1 1/4"	4'-0"	3 7/16"	4 1/2"	4 7/16"	5/16"	6 7/8"	1"x1/8"	14	32	16	27	20	17
4	2 7/8"	5 3/4"	8 5/8"	11 1/2"	1'-11"	1 7/16"	4'-6"	3 15/16"	5"	5 1/8"	3/8"	7 7/8"	1"x1/8"	14	42	16	34	20	22
5	3 1/4"	6 1/2"	9 3/4"	1'-1"	2'-2"	1 5/8"	5'-0"	4 1/2"	5 1/2"	5 13/16"	7/16"	9"	1"x1/8"	14	53	16	43	20	27
6	3 11/16"	7 3/8"	11 1/16"	1'-2 3/4"	2'-5 1/2"	1 7/8"	5'-7"	5 1/16"	6"	6 9/16"	7/16"	10 1/8"	1"x1/8"	14	67	16	54	20	34
7	4 3/16"	8 3/8"	1'-0 9/16"	1'-4 3/4"	2'-9 1/2"	2 1/8"	6'-3"	5 3/4"	6 3/4"	7 7/16"	1/2"	11 1/2"	1"x1/8"	14	85	16	69	20	43
8	4 13/16"	9 5/8"	1'-2 7/16"	1'-7 1/4"	3'-2 1/2"	2 7/16"	7'-1"	6 5/8"	8"	8 9/16"	5/8"	13 1/4"	1 1/2"x1/8"	12	156	14	113	18	76
9	5 1/2"	11"	1'-4 1/2"	1'-10"	3'-8"	2 3/4"	8'-0"	7 1/16"	8 1/2"	9 13/16"	11/16"	14 1/8"	1 1/2"x1/8"	12	201	14	146	18	97
10	6 1/4"	1'-0 1/2"	1'-6 3/4"	2'-1"	4'-2"	3 1/8"	9'-0"	8 1/16"	9 1/2"	11 1/8"	3/4"	16 1/8"	1 1/2"x1/8"	12	257	14	187	18	123
11	7 1/8"	1'-2 1/4"	1'-9 3/8"	2'-4 1/2"	4'-9"	3 9/16"	10'-2"	9 13/16"	10 3/4"	12 11/16"	7/8"	19 5/8"	1 1/2"x3/16"	12	336	14	245	18	163
12	8 1/8"	1'-4 1/4"	2'-0 3/8"	2'-8 1/2"	5'-5"	4 1/16"	11'-6"	11 3/16"	12 1/4"	14 7/16"	1"	22 3/8"	1 1/2"x3/16"	12	432	14	314	18	208
13	9 1/4"	1'-6 1/2"	2'-3 3/4"	3'-1"	6'-2"	4 5/8"	13'-0"	12 1/2"	14"	16 7/16"	1 1/8"	25"	1 1/2"x3/16"	10	709	12	556	16	327
14	10 5/8"	1'-9 1/4"	2'-7 7/8"	3'-6 1/2"	7'-1"	5 5/16"	14'-10"	14 5/8"	16"	18 7/8"	1 3/8"	29 1/4"	1 1/2"x3/16"	10	928	12	726	16	427
15	1'-0"	2'-0"	3'-0"	4'-0"	8'-0"	6"	16'-8"	16 1/2"	18"	19 5/8"	1 1/2"	33"	1 1/2"x3/16"	10	1175	12	928	16	539
16	1'-1 3/4"	2'-3 1/2"	3'-5 1/4"	4'-7"	9'-2"	6 7/8"	19'-0"	18 15/16"	21"	24 1/2"	1 11/16"	37 7/8"	1 1/2"x3/16"	10	1534	12	1202	16	700
17	1'-3 11/16"	2'-7 3/[illegible]"	3'-11 [illegible]"	5'-2 3/4"	10'-5 1/2"	7 7/8"	21'-7"	22 15/[illegible]"	23 1/[illegible]"	27 15/[illegible]"	1 5/16"	45 7/8"	1 1/2"x3/16"	10	1987	12	1557	16	905
18	1'-5 7/8"	2'-11 3/4"	4'-5 5/8"	5'-11 1/2"	11'-11"	8 15/16"	24'-6"	24 5/8"	27"	31 13/16"	2 1/4"	49 1/4"	2"x3/16"	3/16"	3507	10	2587	14	1467
19	1'-8 3/8"	3'-4 3/4"	5'-1 1/8"	6'-9 1/2"	13'-7"	10 3/16"	27'-10"	28"	30"	36 1/4"	2 9/16"	56"	2"x3/16"	3/16"	4534	10	3344	14	1891
20	1'-11 1/4"	3'-10 1/2"	5'-9 3/4"	7'-9"	15'-6"	11 5/8"	31'-8"	32"	35"	41 3/8"	2 15/16"	64"	2"x3/16"	3/16"	5908	10	4353	14	2460

makes the inlet dimension A, 1 foot, and the outlet dimension B, 2 feet, based on an outlet velocity of 500 FPM. Most operators prefer a slightly lower velocity to avoid hull particles in the fiber when it can be blended with second cut lint. If a velocity of 350 FPM is desired simply divide the 2 ft. dimension by 350 and multiply by 500 and arrive at the outlet dimension of 2.85 ft.

The rectangular inlet should be the full width of the dropper with an area approximately equal to that of the conveying pipe, and a common transition is used to connect these two. The outlet is also full width and usually has a greater area, so that a velocity of approximately 2500 fm is obtained. This has a tendency to reduce the friction loss and fiber drawn from the dropper can be conveyed easily at this velocity.

The bottom of the dropper should be hoppered so that the material may be discharged to a rotary-vane or preferably a screw-plug feeder. The latter, at 90° to the direction of air flow, is undoubtedly the best arrangement, as it provides a smoother turn for the air stream; in all cases, the slope of the hopper sides should be 45° or steeper. It is desirable that the material discharge be fairly large to prevent possible bridging and that the plug or seal run fast enough to prevent any possibility of a build-up of material in the hopper. A vane feeder of at least 10" x 10" inlet, at three or four times the theoretical displacement required, will give good results; a 9" conveyor screw plug at 60 to 80 RPM will do for most sizes, and it is usually easier to provide a drive for it.

Where the primary objective of the Vacuum Dropper is to avoid passing hull particles through a fan, and when it is not considered helpful to separate the linty fibers, then a conventional pull-through collector may be subsituted for the Vacuum Dropper. Drawings of the high velosity collectors recommended for Huller Room Pneumatic Systems are shown on Figure 23 at the end of this Chapter and would be satisfactory or even better, a low velocity collector could be used. A screw plug or vane feeder would be required to seal the cyclone discharge.

It may be noted from Figure 23 that the inlet or the outlet or both may be located vertically to best suit installation requirements.

Pneumatic Conveying of Huller Room Fractions

The equipment and principles so far discussed fall in the category of "low-pressure, high-volume" pneumatic systems. In this type of work the volume of air per pound of material is generally high, or, to put it another way, the pounds of material per pound of air is low. In calculating such a system, it is not necessary to take into account the additional friction created by the material being conveyed, since it is small and may add to or be offset by other minor variables, such as relative pipe smoothness, air density and others not ordinarily considered; however, especially where material is to travel through a fan, it is customary to provide a little extra motor horsepower to take care of the mechanical reacceleration of the material; this may range from 5% to 15%.

In conveying pneumatically within the Huller Room, the systems are characterized by large piping, large droppers, large cyclone collectors, short conveying distances and large centrifugal fans. The sum of suction and discharge pressures at the fans seldom exceeds 6" or 7" of water column. Where the high velocity collector is used to minimize dust, the static pressure will increase 2" or 3".

For conveying longer distances, as in the case of hull bran to the meal room, the amount of material is relatively small and so is the pipe size corresponding with this amount and the higher velocity required for this material. The smaller pipe, longer distance and higher velocity combine to increase pipe friction so that the static head against which the fan must operate is high, although the volume is low. For best efficiency and stable performance, this will call for a smaller fan at a higher speed. A system of this type may be classified as an "intermediate-pressure, high-volume"; it is characterized by small pipe, small dust collector, moderate conveying distance, small centrifugal fan, high static pressure and low ratio of material-to-air. Static pressures encountered may range up to 10" or more. Material is usually picked up by the suction pipe or spouted into it, and generally travels through the fan. A system of this kind may also be designed with the information on Figure 19.

The third type of pneumatic conveying may be callsified as "high-Pressure, low-volume." Here, the pressures involved are beyond the limits of the ordinary centrifugal fan and semi-positive displacement blowers or compressors are used, although there are multi-state centrifugal blowers on the market as yet untried in many oil mills which may prove dependable and more quiet in operation. As indicated by the "low-volume" classification, the ratio of pounds of material to pounds of air is high. Conveying distances can be quite long, and are limited only by the maximum pressure rating of the blower. These are available in the low-pressure range, up to 3 pounds per square inch, the medium-pressure range to 6 psi, and the high-pressure up to 10 psi. In our work, the pressures encountered seldom exceed 3 psi sufficiently to require heavier blowers.

This type of conveying is characterized by high material capacity, small piping, small collector, long distances, pressure blower, and since material cannot be handled through the blower, an injection feeder for "blow-through" arrangement or ejection feeder for "draw-through" arrangement. Unlike the high-volume systems, since the ratio of material to air is very high, the friction of material must be taken into account in the design of a high-pressure system; this will vary from 150% to 300% or more of the friction calculated for air alone. While a low pressure conveying system may be calculated from the discussion and data so far presented, the design of a high pressure system is beyond the scope of this section and may best be left to those experienced in this type of work.

Without going into the many details necessary to calculate and design a pressure blower system some general information and specifications will be given for a typical system to handle hulls from the mill to storage. For this illustration it is assumed the mill is crushing 200 tons of seed and producing 100,000 lbs. of hulls per day (24 hrs.). This would amount to about 70 lbs. of hulls per minute to be conveyed a distance of 500 ft., and with 3 long radius elbows, and discharging into a low velocity collector. The calculations call for a 5" pipe handling 46 lbs. of air per minute or 614 cfm at a velocity of 4500 fpm. Further calculations indicated a static pressure of 59.2" water column or 2.14 lbs. With the above information a Sudibilt 6L Blower was selected to operate at 710 rpm. Horsepower required was indicated at 7.75 which called for a 10 HP motor. A Roots Blower could be selected from the same design information.

In this case the blower was on the large side but a size smaller was not sufficient. Therefore, this blower has surplus capacity for the job and should last a long time.

<u>The Hull & Seed Separator</u>

Operating instructions and the principles employed in this machine have been covered in Part 4. This section will be confined to the actual air requirements and some explanation and discussion as to velocities and pressures at various points and under different control and adjustment conditions.

Referring again to Figure 8 and the instructions in Part 4, a static pressure of -1.2" at "D" would indicate that air enters at "B" at approximately 4,400 feet per minute. Based on a 3/4" opening, the volume entering would be 1510 cfm. With an opening of 3-1/2" at "C", the velocity of the stream at this point would be 945 feet per minute, which is normally sufficient to float hulls. Reducing the opening at "C" to 3" would increase the velocity of the stream to 1100 fm; the operating range, then, might well fall within the limits of 3" and 3-3/4". It would be best to make running adjustments here, since moving adjustment "B" 1/2" would increase the velocity at "C" to 1575 fm and at the same time admit more volume of air into the machine, possibly upsetting the adjustment of other machines if more than one machine is connected to the same pneumatic system.

The fact that the machine is estimated to require about 2000 cfm, while the air entering "B" is only 1510 cfm, may be explained by assuming an average of 1/4" of continuous opening at the roll seal, which at -1.2" pressure would permit leakage of 500 cfm; inspection of the roll and seal in operation will easily justify this assumption.

It should be pointed out that adjustments at "A" and "B" and available "suction" over point "A" must combine to create an entrance of air through slot "B" of at least 1500 cfm. If less than this amount enters, baffle "C" may have to be brought so close to the roll that the upward stream widens too much above point "C" and some material picked up at point "C" will only float or drop back down in this region, making the operation of the machine erratic. On the other hand, if the 1500 cfm is exceeded too much, in order to drop seed, baffle "C" may need to be opened wider than good practice would dictate. It would be safe to recommend that to meet most conditions best, a volume of 1600 cfm should enter at "B", so that the best range may be expected at adjustment "C".

Since it is not always convenient in practice to vary fan speeds and otherwise exactly duplicate the data given earlier, following is a table which will serve as a guide in determining the combination of adjustments "A" and "B" to obtain the optimum condition at "C":

Static Pressure at Point D	Opening at Slot B	Static Pressure at Point D	Opening at Slot B
-1.2"	0.80"	-0.8"	0.98"
-1.1"	0.84"	-0.7"	1.05"
-1.0"	0.88"	-0.6"	1.13"
-0.9"	0.92"	-0.5"	1.24"

While the above table is carried out to -0.5", it is believed that satisfactory operation will be obtained only at the higher vacuums, because the size of the stack of the machine is such that considerable leakage at the seal above the roll is required to maintain conveying velocity. On the other hand, carrying the vacuum to extremes (higher than 1.2"), may create such an inrush at the seal that severe turbulence would take place where this current merges with the useful air stream.

The Meats Purifier

The Meats Purifier generally consists of two superimposed parallel shaker screens, the upper having a backward sloping blank bottom that conveys the fines back to the receiving end of the lower. A feeder is used to distribute the load over the width of the top ahaker and at the discharge end of each shaker an adjustable aspirating nozzle is employed to pick up hulls.

The advantage of this machine lies in the accessibility of the screens for cleaning and the fact that the material can be sized in two stages before it comes within the influence of the aspirating nozzles. As long as these screens are kept clean, occasional blanking of the lower trays of the Huller shakers is not too serious, since particles conveyed to the machine may then be segregated and only coarse hulls and larger meat particles exposed to the aspirating nozzles. The RoBall attachment is recommended for the lower tray.

The 36" wide purifying machine requires a minimum of 2700 cfm for proper conveying of hulls past the 13" diameter exit of the transition, and for the 54" machine, around 3100 cfm would be advisable in order that the months of the aspirating nozzles need not be placed too close to the bed of material, as this would make the operation less selective (see chapter on aspirating nozzles).

Negative static pressures at the transition exit in the neighborhood of 1.0" for the 54" machine to 1.5" for the 36" machine may be expected. In the case of the smaller machines, some small saving in power may be expected by replacing the transition with one having an exit of 11" diameter and reducing the volume of air handled to around 2000 cfm.

. Huller Room Power Requirements

While no set rules can be laid down as to exact horsepower required to operate Huller Room equipment, certain values have evolved through experience with individually motorized units, and although conditions may vary at different mills, or even in the same mill from time to time, the power required can be estimated with reasonable accuracy and values assigned that will not normally be exceeded.

Generally, it is advantageous from a standpoint of maintenance and power-saving to operate equipment at no higher speed than necessary to accomplish the purpose. The tendency to over-power must also be guarded against, as otherwise a low power factor will result.

Following is a tabulation of the sizes of motors installed in a Huller Room handling 150 tons of seed per day, including the total horsepower assigned to conveyors and elevators.

			Total HP
1	54" Scalping Shaker	1 HP	1 or 2 HP
2	48" Hullers & Shakers	10 HP	20
3	66" Hull & Seed Separators	1 HP	3
1	Double Drum Hull Beater	3 HP	3
1	Single Drum Tailings Beater	2 HP	2
1	Pneumatic System Fan	25 HP	25
	Conveyors & Elevators		19
	Hull Blower	5 HP	5
	TOTAL		78

Although the above HP estimates have proved satisfactory in several small mills there will be cases where larger motors would be required. For example, the Scalping Shaker might require a 2 HP motor for tonnages over 150 tons per day or even 3 HP for greater tonnages. Although the 10 HP motor for a 48" Huller is satisfactory for normal seed and tonnages, and a recent check indicated 9 HP on Hullers handling 90 tons each, there are many operators who prefer a 15 HP motor on each Huller. Local conditions should be checked and machinery manufacturers consulted on the matter of proper motors.

In the case of individually motorized Huller Room equipment and conveyors, it is unusual if not practically impossible to attain an overall ratio of horsepower load to connected horsepower of more than 0.85. This is largely due to the fact that within certain ranges, standard motors are sized approximately in accordance with the geometric series of preferred numbers. For example, a 1-1/2 HP motor has 1-1/2 times the power of a 1; a 2 HP, approximately 1-1/2 times the 1-1/2; a 3 HP, 1-1/2 times the 2; a 5 HP, approximately 1-1/2 times the 3; a 7-1/2 HP, 1-1/2 times the 5, and so on. Obviously, where a machine or conveyor to operate under planned conditions requires a horsepower input falling between two motor sizes, the larger motor must be selected. Taking the mean of increase from one size motor to the next as the required input horsepower, the best condition to expect would be a ratio of input horsepower to connected horsepower of 1.25/1.50 = 0.83. This ratio can be approached only through very careful calculation and grouping of drives wherever practical.

From the foregoing and from spot-checks made during operation, it may be estimated that the net horsepower load of the hulling and separating system used previously as an example is 65 HP. Based on the daily tonnage of 150, the horsepower-hours per ton of seed would be 10.4; assuming 15% induction, windage and friction losses in small motors, the electrical energy required would be 9.1 KWH per ton.

Special Note: The above HP requirements are based on separate feeder drives for the Hullers and H&S Separator. About 1/2 HP would be required for each feeder drive.

PART TWELVE

UNIVERSAL HULLING SYSTEM

If and when it should ever become necessary or profitable to drastically reduce lint cuts, or even discontinue producing second cut linters, which a few years ago was not altogether inconceivable, and thus leave from 6% to 8% lint on seed, the conventional Single Hulling System, as outlined in Parts 8, 9 and 10 would not do a satisfactory job of hulling and separating. This is due primarily to the fact that a pneumatic separator, either the Carver H & S Machine or Bauer Unit will not effectively separate seed from linty hulls. Extremely linty hulls are bulky and not only overload the machine, but also mat together, causing seed to be picked up with wads of hull.

The old Double Hulling Systems, used extensively before the development of the H & S Separator, will do a reasonably good job with linty hulls, but in order to convert most of our Single Hulling Systems an additional Huller would be required for the second cut operation.

Much greater screening area is required on the Huller shaker in connection with hulls of this type and this could be accomplished by installing a pan under the top tray of the Huller shaker and splitting the load over the two trays, as outlined in Part 2 and illustrated in Figure 5. Almost twice as much hull beater capacity is required with extremely linty hulls, and most of the existing installations would require another hull beater. Larger perforations would be indicated on shakers and beaters.

Over a period of many years several mills have found it profitable to leave substantially higher percentages of lint on the seed and operate correspondingly fewer linters, then hull and separate the linty hull and remove the remaining lint from the hulls with Defibrators. This discussion will not deal with the advantages or disadvantages of this procedure, but will attempt to offer suggestions as to how the partially delinted seed may be satisfactorily hulled and separated.

As mentioned above, a Double Hulling System, with ample shaker and beater capacity, will do a very good job on linty hulls, although best separating results will always be obtained when the seed are closely linted, except under extreme conditions which involve purifying problems in connection with protein control. Where a large percentage of lint is left on the seed, there will alwys be more absorbed oil in the finished hull and greater quantities of loose fiber to contend with in the hulling procedure. However, with greater percentages of lint left on the seed there is practically no protein control problem and very little, if any, purifying of meats is necessary. Frequently it is necessary to add hulls or hull bran to the meats, in order to lower the protein.

As most mills are now equipped with single hulling and have H & S machines available, they could be used in conjunction with double hulling and make some improvement over the original process. Several systems of this kind have been installed, in which a Huller and Shaker are installed to follow up a regular Single Hulling System. By passing all of the hulls from the original system through an additional Huller, any seed picked up by the H & S machine will be hulled and separated. The H & S machine will separate perhaps 50% to 75% of the uncut seed, returning them to the first cut Huller and thereby passing a much smaller percentage to the second cut Huller than would be the case in a regular Double Hulling System. Systems of this kind have been referred to as Universal Hulling in that they provide a flexible arrangement which may be quickly converted from single to double hulling whenever it should be necessary to make drastic changes in lint cuts.

An even better adaptation of the Universal Hulling System was used several years ago in Matamoros when they found it profitable to drastically reduce lint cuts and were leaving about 7% to 8% lint on seed. Their Single Hulling System consisted of four hullers and shakers, five H & S machines, two double drum beaters, and a conventional double purifying system, handling approximately 270 tons of seed per day. With the Universal System the load was split over three hullers, handled pneumatically to the H & S machines, then through the remaining huller (to cut any seed picked up by the separators) and last, to the beaters. It was found necessary to add another beater, making a total of three, handling the hulls from 90 tons of seed each. Under these conditions, the beaters were fully loaded. With the entire load of hulls from the H & S Separators containing approximately 5% seed going to one second cut huller, it was handling about 90 tons of hulls and five tons of seed per 24 hours. The Huller handled this load very nicely and satisfactorily cut the remaining seed but with this very linty material, the single tray shaker was badly overloaded. However, with this arrangement in which the hulls from this last shaker were given another treatment in the beaters, it was possible to remove practically all of the meat particles and the problems with this overloaded shaker were primarily mechanical. Had it been possible to convert to a two-tray double pass shaker and split the load, the results would have been much better. With a properly arranged double pass shaker it is believed that the second cut Huller for a finishing operation of this kind would be able to handle the hulls from approximately 250 tons of seed per 24 hours.

One interesting observation in connection with the special Universal Hulling System at Matamoros was that the pickup nozzles at the end of the shaker tray separated practically no seed from the wooly hulls, but did drop out an appreciable quantity of whole meats which had not been separated on the shaker screen. Therefore, instead of spouting these whole meats into the conveyor which originally returned the uncut seed to the Hullers, they were simply spouted into the meats conveyor. By raising or lowering the hull pickup nozzle, it was possible to also discharge a small quantity of broken hull particles into the meats and control the protein at this point. It was not necessary to use the meats purifying system at all and it was usually necessary to drop a considerable quantity of hull particle into the meats, as outlined above, in order to lower the protein.

As the Universal Hulling System has been described above in detail, no flow charts will be included at this time, and at present chemical linter prices, it is not likely any such drastic changes will be required.

TABLE SHOWING PERCENTAGE OF HULLS IN MEATS FOR 43% PROTEIN

MOISTURE IN COTTONSEED	AMMONIA IN SEED																		
	3.30	3.35	3.40	3.45	3.50	3.55	3.60	3.65	3.70	3.75	3.80	3.85	3.90	3.95	4.00	4.05	4.10	4.15	4.20
7.0	4.8	5.3	5.8	6.3	6.8	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8
7.2	4.9	5.4	5.9	6.4	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9
7.4	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0
7.6	5.1	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1
7.8	5.2	5.7	6.2	6.7	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2
8.0	5.3	5.8	6.3	6.8	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3
8.2	5.4	5.9	6.4	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.4
8.4	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5
8.6	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6
8.8	5.7	6.2	6.7	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7
9.0	5.8	6.3	6.8	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.8
9.2	5.9	6.4	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.4	14.9
9.4	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
9.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6	15.1
9.8	6.2	6.7	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2
10.0	6.3	6.8	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.8	15.3
10.2	6.4	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.4	14.9	15.4
10.4	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5
10.6	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6	15.1	15.6
10.8	6.7	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2	15.7
11.0	6.8	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.8	15.3	15.8
11.2	6.9	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.4	14.9	15.4	15.9
11.4	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0
11.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6	15.1	15.6	16.1
11.8	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2	15.7	16.2
12.0	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.8	15.3	15.8	16.3
12.2	7.4	7.9	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.9	12.4	12.9	13.4	13.9	14.4	14.9	15.4	15.9	16.4
12.4	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5
12.6	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	11.6	12.1	12.6	13.1	13.6	14.1	14.6	15.1	15.6	16.1	16.6
12.8	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2	15.7	16.2	16.7
13.0	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.8	15.3	15.8	16.3	16.8

NOTE: Determine percentage of hulls in rolled meats by rubbing gently with finger tips through 20 mesh screen.

FIGURE No. 23A

PART THIRTEEN

PROTEIN CONTROL

Parts 5 and 8, covering protein control, referred to the procedure for removing hull particles from the meats in the Huller Room by means of aspirating nozzles and purifiers. Many mills depend all together on this control with a Purifier to regulate the protein in the finished cake or meal but due to variances of ammonia and moisture in seed or changes in lint on seed, it is difficult, if not impossible, to consistently control it within reasonable limits.

The only way to get any reasonable accuracy of protein control with cottonseed meal is to regulate the Purifying equipment to remove an excess of hull so that the protein in finished meal will be higher than necessary. Then by storing the meal in bins or tanks until analysis of protein can be obtained, hull bran may be blended in the necessary proportion to obtain the required protein in meal. There are many ways of adding hull bran and producing bran from highly technical well designed systems on down to simple, inexpensive make-shift arrangements. Several practical arrangements under the heading "Producing and Blending Hull Bran" will be discussed below but first a few suggestions where hull bran blending is not practical or not available.

1) Protein Control without Hull Bran

There are many oil mills that do all their protein control by adjusting the Purifier in the Huller Room to raise or lower the percentage of hulls in meats. In many cases they sell a large percentage of their production in the form of expeller flakes and in this case the protein must be controlled from the Huller Room. Most of the smaller mills do not have their own laboratories and must depend on a commercial laboratory for their cake analysis. This usually involves a lapse of 12 to 24 hours before the results can be obtained and adjustments made. Obviously, better results will be obtained with more frequent sampling and analysis and even when a complete laboratory cannot be afforded, some mills have installed the necessary equipment and train one operator in the mill to make the Kjeldahl analysis. Where a sample can be drawn and analyzed at the end of each 8-hour shift it is much more accurate than the 24-hour sample.

Where the cake or meal can be stored in bags or bins until the protein analysis can be obtained there are several possible solutions. For example at the end of a 24-hour run, the analysis indicates the first 8 hours protein was low, the second shift was about right and the third shift ran high. By blending or mixing the first and third shift production a reasonable average may be obtained. Where the material has been sacked and where the three shifts have been stacked separately, they may be mixed proportionally when loaded in trucks to get the desired protein. In this case there will be a difference between bags but the average for the shipment may be brought in line.

Over the years many oil mills have devised various methods of approximating protein in cake. One little procedure that has been practiced with some success is to have the crushing roll operator screen a sample of rolled meats approximately each hour and determine the percentage of hulls in meats. This calls for a small balance to weigh a 100-gram sample and of sufficient accuracy to weigh down to 4 grams of hulls to within 1/10 of 1%. After checking the percent hulls in meats for several days, and comparing with the actual analysis of protein in cake, the hull content of meats for the desired protein is arrived at.

To determine the percentage of hull in the rolled meats, the sample is passed through a 20-mesh screen by rubbing gently with the finger tips. The meats break up and pass through the screen while the tougher hull is retained on the screen. This method is obviously not accurate but it is better than no check and when the hull content is higher or lower than normal, based on actual experience at each mill, an adjustment can be made in the Huller Room.

A more sophisticated adaption of the above procedure for checking percent hulls in meats, to avoid changes of moisture and ammonia in seed, is to sample and analyze a composite sample of seed being worked. Where the seed are stored in large mill supply bins or tanks the sampling is easy but where seed are being worked direct from storage the sampling is more difficult. However, it can be done by approximating where the seed will be worked from the following day, and probing into the pile at this point to get representative samples. In this manner the moisture and ammonia in seed being worked is known each morning. By checking the percentage of hulls in meats and referring to the table shown in Figure 23A to determine the required percentage of hulls, the necessary corrections may then be made on the Purifier.

This particular table is based on producing 43% protein in cake but could easily be adjusted for 41% or whatever protein is desired. For example, if the moisture in seed ran 10% and the ammonia 3.50% the table indicates 8.3% hulls in meats to produce 43% protein. This particular method and the table was used successfully at mills in the Mississippi Valley for many years. The table may have to be adjusted for seed in other areas but this approach is certainly better than guessing and shooting in the dark when protein control with hull bran is not available.

2) Protein control with Hull Bran

There are many reasons for producing high protein through the mill and then cutting it back to the desired protein in meal by blending with hull bran. With proper equipment, it is the only way to control the protein within reasonable limits. But, even more important, high protein substantially increases the tonnage through the mill and also allows better extraction with screw presses or hydraulic presses. In most cases the higher protein contributes to better results with solvent extraction. Each mill must "put the pencil" to the economics of protein control to suit their particular conditions. Almost any mill will profit from closer control and knowing what is being produced. If protein runs too high they are throwing money down the drain but when too low are subject to penalties. In many cases even greater profits will be made by running maximum protein through the mill and then cutting it back to the desired protein by blending hull bran.

Various methods and procedures for blending hull bran will be outlined and discussed below, from the simplest on up to the most efficient.

a) One of the simplest and least expensive methods is to simply add bran at a predetermined rate to the cake or flakes being conveyed from the mill to the meal room for grinding. In this manner the protein in the cake can be maintained at say 42% or 43% and sufficient bran added to cut it back to 41% or whatever might be required. This procedure calls for a small bin or hopper and a varible speed feeder to control the flow of cake from the press room and if this flow is changed or interrupted, then the flow of bran must be changed accordingly. This method of control depends on accurate protein control in the Huller Room, but is just about as accurate as trying to control 41% through the Press Room and has the advantage of higher protein through the mill.

b) A more conventional method of protein control would be to provide bins or tanks to store the cake or expeller flakes. Accurate samples of the material are taken and then analyzed by the laboratory for protein. If the mill has its own lab and can get prompt analysis, they might get by with 24 or 16 hours holding capacity, but where samples have to be sent out to a commercial laboratory, they might need 30 to 48 hours holding capacity.

All of the cake bins are equipped with variable speed feeders and a hull bran bin or tank, also with feed control is located along side to feed bran into the conveyor handling cake to the meal grinder or pellet mill.

As the protein in the cake from the mill will often vary from hour-to-hour, it is not unusual to find a variation of 1% or more between the top and bottom strata of a large tank or with several small tanks even more variation from the first to the last tank. This variance can be minimized by feeding from all tanks simultaneously, rather than from one at a time. For this reason, it is much better to have six or more small tanks or bins, rather than one or two large ones.

c) Another method of blending bran is with automatic scales for weighing the cake and hull bran. With this type scale the larger cake scale weighs and dumps at a constant rate. The smaller bran scale is tied in to dump simultaneously and preset to dump the desired amount of bran. This system of proportioning the bran might be a little more accurate, but the scales are more expensive and the same amount of storage capacity is required. Most mills feel that the bins with variable speed feeders is satisfactory.

3. Calculating the Bran Requirements

Before calculating the amount of bran to be added to each ton of cake to obtain the desired protein in meal, it is necessary to obtain representative samples. A properly built automatic sampler is best, but if not, then carefully drawn hand samples taken at least each hour and composited in an air tight can. This sample should then be carefully mixed and quartered or riffled to laboratory size of about one pound. After getting results from the lab and determining the protein in the cake to be blended, the actual calculation can be made as follows: for example, to reduce 43% to 41%;

Protein in cake - 43%
Protein desired in meal - 41%
Protein in Bran - 4%
X = Amount Bran per Ton Meal
Protein in 1 ton 43% = .41 (2000 + X) - .04X
860 = 820 - .37X
.37X = 40
X = 108 lbs. Bran.

The above calculation is based on 4% protein in bran. The following table indicates the amount of bran to be added to 1 ton of meal ranging from 41.25 to 44% protein and with three different proteins in bran to produce 41% meal.

Bran Addition for Protein Control at 41% Meal

For 1 Ton Meal in which Protein is:	Pounds of Bran to Add to 1 Ton of Meal		
	4.00% Bran	4.25% Bran	4.50% Bran
44.00%	162#	163#	165#
43.75%	149#	149#	150#
43.50%	135#	136#	137#
43.25%	122#	122#	123#
43.00%	108#	109#	110#
42.75%	95#	95#	96#
42.50%	81#	81#	82#
42.25%	68#	68#	69#
42.00%	54#	55#	55#
41.75%	41#	41#	41#
41.50%	27#	27#	27#
41.25%	13#	13#	14#

In order to use the above calculation or table, it is of course necessary to determine the rate of flow of meal from the bin feeders and correlate with the flow of bran. First determine how many minutes is required to feed 2000 lbs. of meal. If the meal is flowing, say, at a rate of 2000 lbs. in three minutes then the bran feeder should be set to feed 108 lbs. in three minutes to reduce 43% protein to 41%.

The Production of Hull Bran

Where a mill is not attempting to produce maximum protein in cake thru the press room and holding it at slightly over 41% only a small quantity of hull bran would be required for control purposes. In this case they could utilize hull pepper from the lint beaters. Most mills will produce from 15 lbs. to 20 lbs. of pepper per ton of seed which should be sufficient to reduce protein from 41.50% back to 41%. Where a little more bran is required it is sometimes obtained by screening from the hull conveyor with a 1/8" perforated bottom. Therefore, where a mill is content to produce protein not exceeding 41.75% or perhaps up to 42.00% they can get by without special equipment for producing bran.

Where a mill has found it profitable to produce high protein due to increased thruput in the Press Room and higher oil recovery, then special equipment will be required to produce the required quantity of bran.

The best machine available today is the old Reynall Ware fiber machine which completely grinds and pulverizes the hull to something less than 1/8" and removes the remaining lint fibers. The mixture of bran and fiber falls into a chamber below the grinder and the fiber is pulled out with air. This machine makes a good quality hull bran with a minimum of loose lint and with proper lint beaters, the fiber can be baled separately or blended with second or third cut linters. At today's prices the fiber operation should be profitable in removing the lint left on seed but this discussion will deal primarily with hull bran. If there is any profit from the fiber it may be applied to the cost of producing bran.

The Reynall Ware fiber machine has for several years been manufactured by Bauer Bros. It is now made by W. C. Cantrell and is designated as the Bauer 404 Defibrator. The latest model machine, equipped with 100 HP motor should handle between 10 and 15 tons of hulls per day, depending on the amount of lint on hulls and the moisture.

One of the Bauer Defibrators should produce 8 or 10 tons of bran per day which should be sufficient for a mill working up to 200 tons of seed per day on a high protein basis or proportionally more for lower protein.

There is not usually a ready market for hull bran but some mills who produce more than they require, have been able to sell it to nearby mills who do not have hull bran equipment.

The above Bauer Defibrator sells for about $17,000 and a complete installation with lint beater and installation cost would run $25,000 to $30,000.

A less expensive installation for making hull bran, but not recovering the fiber, may be accomplished with a Hammermill, a shaker screen and the necessary conveying equipment. With this proposed arrangement a portion of the finished hulls are passed through the Hammermill and then to a shaker to screen out the bran. The overs from the shaker, consisting of hull and fiber, is returned and mixed with the finished hulls. With this system it would be desirable to utilize the finished tailings from the Purifier which usually contain less lint.

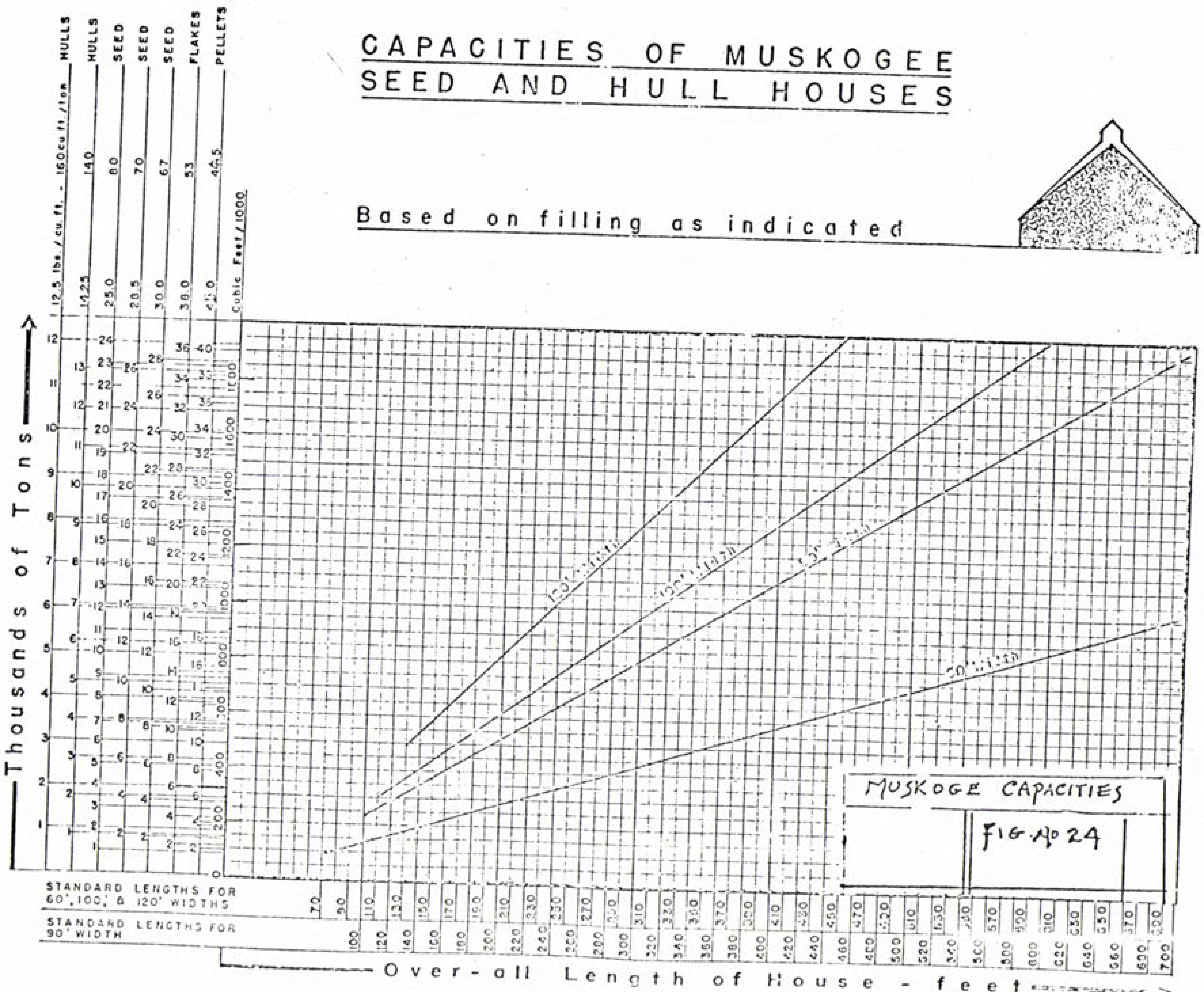
A typical installation of this kind utilizes a Williams 1518 Mill, directly connected to a 40 HP motor running 3600 RPM, and dressed with 1/16" screen. The 48" shaker is dressed with 9-mesh screen on a top deck and 16-mesh on the lower deck where the bran passes out.

The above arrangement will produce about 1300 lbs. of good quality bran per hour. With larger mesh screen on the Hammermill and shaker the capacity can be more than doubled, but the coarser bran is more noticable in the meal.

There are other ways of controlling protein and producing hull bran but the above is typical and some of the suggestions may be helpful. Each must work out the economics and determine what is best for their own particular conditions. A careful study will usually reveal that high protein through the mill is profitable.

CAPACITIES OF MUSKOGEE SEED AND HULL HOUSES

Based on filling as indicated



PART FOURTEEN

THE STORAGE & HANDLING OF HULLS

Storage

Cottonseed hulls are usually at the bottom of the list when storage facilities are considered for oil mills. This is understandable in that they are the lowest price product.

Most mills provide storage for only a small percentage of their hull production and therefore they must be kept moving at whatever price they will bring in order not to overflow the hull house.

Most small or medium sized mills crushing, say, 30,000 tons of seed per year will usually not be provided with more than 1000 to 1500 tons hull storage and some even less.

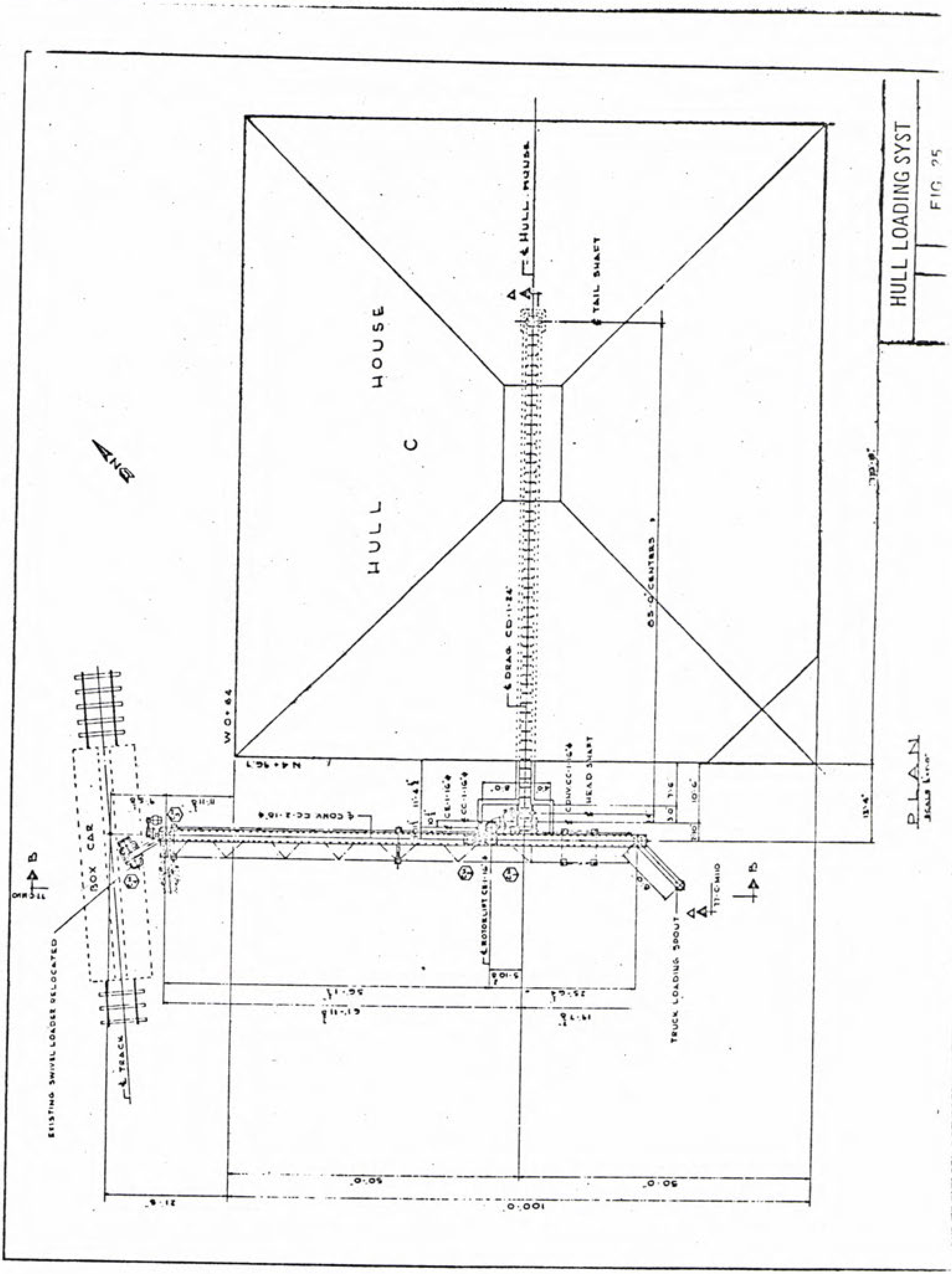
A popular type hull storage house is the Muskogee-type Seed House usually about 100 feet wide and 110 feet long. The attached chart on Figure 24 indicates that this 110' house will store about 2000 tons. With some shoveling back in the corners and filling a little above the lower truss cord, it may store up to 2500 tons.

Due to their low density the cost per ton for hull storage is approximately twice that of cottonseed and, no doubt, that is the reason most mills cannot afford more capacity. Almost any type storage would be satisfactory for hulls but it should be self-filling and usually the Muskogee-type is the most economical on a cost per cubic foot basis.

In areas where annual rainfall is less than 10" hulls may be safely stored in the open with no cover. This uncovered storage is practiced in the Western part of the United States and other countries on both seed and hulls.

The proposed open storage area should be located on high ground where there is no danger of drainage of rainwater. As a further precaution, it is best to build up the storage area to about 18" above ground level and slope it to each side, so the outer edges are at least 6" above ground level. If the soil is well packed and hard, paving is not necessary for hulls, but for cleaning up the site and to recover all the hulls, a concrete or asphalt slab is certainly preferable, if it can be afforded.

Hulls are usually conveyed to the storage area pneumatically, with a pressure blower, and the pile may be formed by simply allowing the pipe to discharge to the desired location. This procedure for blowing both seed and hulls to temporary storage was used for many years.


HULL LOADING SYST
FIG. 25
HULL HOUSE C
PLAN
BOX CAR
TRUCK LOADING SPOUT
EXISTING SWIVEL LOADER RELOCATED
TAIL SHAFT
HEAD SHAFT
HULL HOUSE
DRAG CD-1-24
65'-0" CENTERS
TRACK
100'-0"
50'-0"
50'-0"

but as it blows lint and dust all over the surrounding property, has just about been discontinued.

To avoid the dust problem the hull blower line may be discharged into a cyclone, suitably supported on top of a telephone pole or pipe of the desired height.

A better solution, where the storage facility is of a permanent nature, is to provide an overhead conveyor, supported on pipes or fabricated structual supports, with a cat walk alongside the conveyor for servicing. This proposed conveyor may be provided with a conveyor box and suitable outlet openings, although it can be an open conveyor that conveys along the top of the pile as it fills.

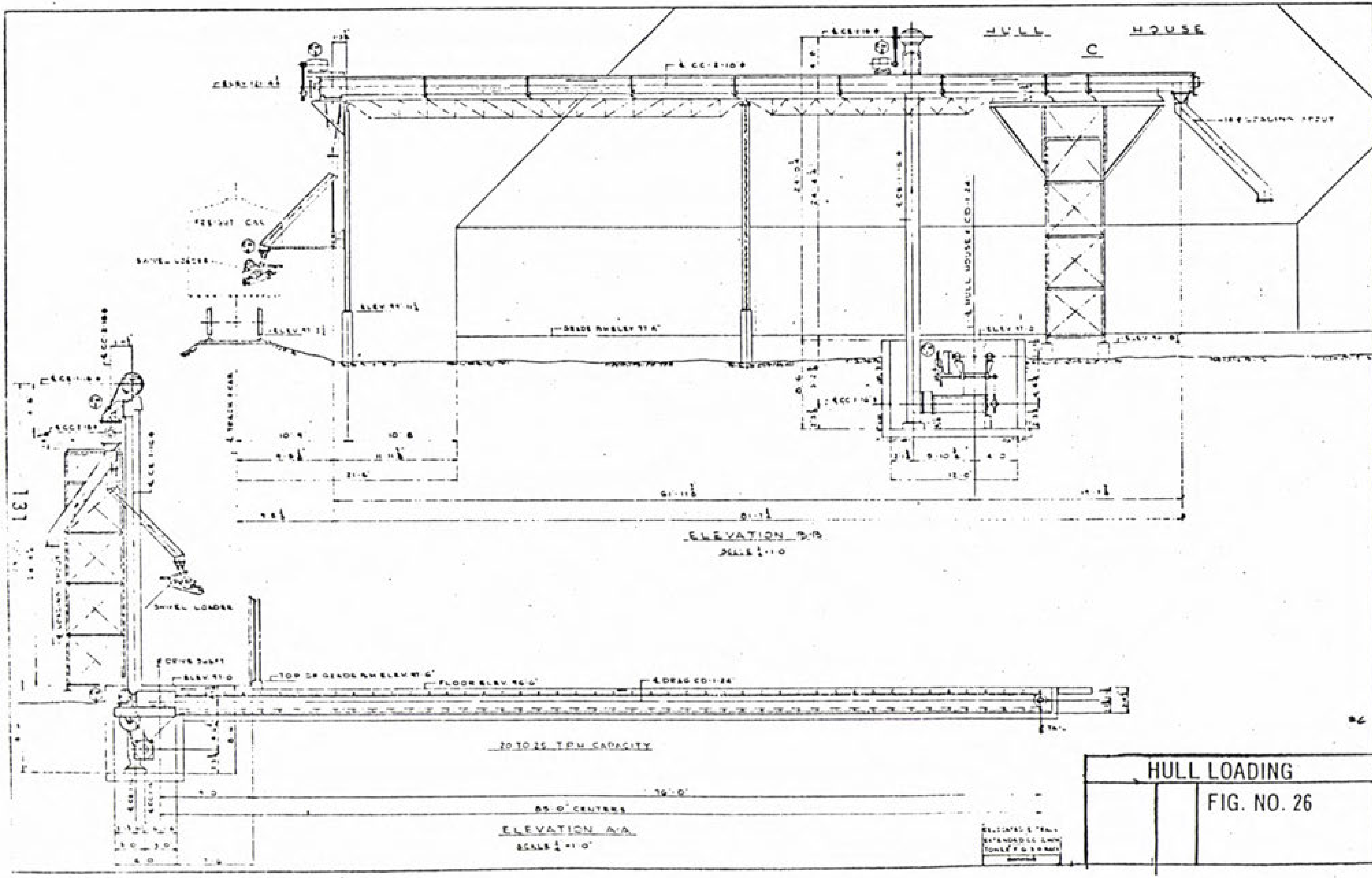
The hulls may be elevated with the blower system by locating the cyclone over one end of the conveyor. Or, the cyclone may be located near ground level and a chain drage elevator provided to elevate to the conveyor. This latter arrangement has the advantage of being able to start forming the pile a few feet above the ground by means of discharge openings on the under side of the inclined elevator. Where the hulls are discharged from the overhead conveyor to start forming the pile, particularly with the conveyor 40' to 60' above the ground, a strong wind will blow hulls all over the property.

So much for outside or uncovered stoage. Naturally, a good hull house is better but sometimes it just cannot be justified and under these conditions the information outlined above might be helpful.

There might be certain unusual market conditions that will sometimes warrant the installation of more than normal hull storage. For example, where there is practically no market for hulls during the early part of the season and they have to be dumped at ridiculously low prices, and when the prices are consistently better during the winter months. Under these conditions, if 5000 tons of $8.00 hulls could be stored and held for six months until the market reaches $30.00, it goes a long way toward amortizing the investment in one year.

Hull Cooling

Whether or not hulls are stored in houses or uncovered storage they seldom cause trouble from hot spots like cottonseed in storage. Even with seed moistures up to 12% it is seldom that hot spots are encountered in hulls. However, with seed moisture up to 20%, hot spots in hulls will some-



HULL LOADING

FIG. NO. 26

times be encountered and must be carefully watched. Where the moistures are high and there is any history of hot hulls, it is desirable to install thermometers and know what the temperatures are at all times.

It is seldom that a conventional seed cooling system can be justified for hulls. Where a few hot spots are encountered at rare intervals, they can usually be handled with a portable fan. After locating the hot spot with thermometers, bore a hole into the pile from the outside. This may be done by screwing a section of 9" conveyor into the hulls then pulling out. Then attach to a pipe and again screw into the hulls until the hot spot is reached. Then push a 8" pipe into the hole, attach to a portable fan and blow air until the temperature is reduced. For this portable cooling system, a No. 25 fan and 5 HP motor is usually satisfactory but a 10 HP motor and proportionally more air will do the job quicker.

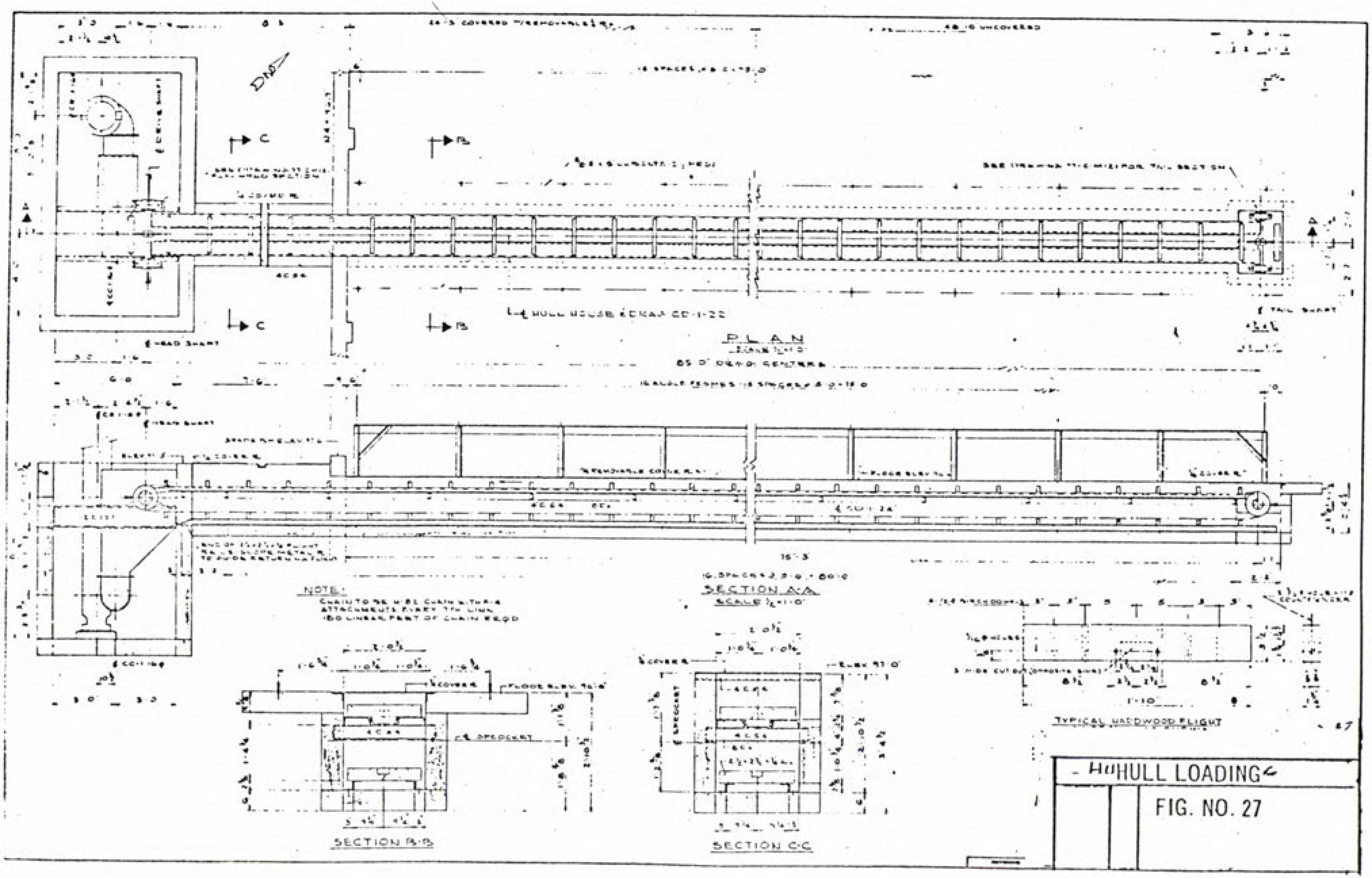
Where the situation can be controlled with the proposed portable cooler and where it does not happen too often, the above procedure is okay. Even with the hot spot extending over a wider area it may be controlled by inserting four or more pipes, connected to a trunk line and a larger fan and motor. However, where the hot spots continue and where they are hard to control, then a conventional seed cooling system should be considered for the Hull House.

Loading Hulls

Few oil mills are equipped to mechanically or automatically load hulls from storage to railroad cars or trucks, but with increasing labor rates there are more automated devices being developed.

For many years the conventional procedure was for the customers' trucks to back into the Hull House and simply fork the hulls with his own labor. Some more progressive mills would install large overhead bins or hoppers that could fill automatically from the conveyor handling hulls to storage. The truck could then drive under the bin, pull a slide gate and fill automatically. Other mills have improvised long, shallow enclosures under the Hull House roof and supported from the trusses. These slides extend all the way down to the eves of the House. They fill by gravity from the overhead conveyor. Trucks drive along the side of the House, open a slide gate and fill automatically.

The above, and similar bins and hoppers, that fill automatically from the hull conveyor, are excellent for handling a few trucks but with a rush of hull loading,


PLAN
SECTION A-A
SECTION B-B
SECTION C-C
NOTE:
HULL LOADING
FIG. NO. 27

a few bins are soon depleted, and the trucks must then load only at the rate of flow from the mill.

Most mills load railroad cars by blowing hull production from the Huller Room direct to cars. This is usually accomplished with a "Y" valve in the line handling the hulls to storage. If this rate of flow is not sufficient or if the mill is not operating, a portable conveyor may be used and the hulls manually loaded.

Although the above or similar devices will be satisfactory for most small mills, many mills are now providing more efficient arrangements to save labor and give better customer service for handling hulls.

Most of these systems call for a conveyor in the bottom of the Hull House to provide a fixed feed at a rate up to the capacity of the elevator and conveyor handling the hulls on to the truck or rail car. With a properly designed system, no labor is required. The truck driver pulls under the spout, pushes a starter button, and then moves the truck forward as it fills. The drawings shown in Figures 25, 26 and 27 give details of a system of this kind that has been used successfully for several years. This system handles about 25 tons per hour and will load the average truck in 30 minutes. As shown on the drawing it may also be used for loading box cars.

Where the hulls spout into the door of the box car, a flinger is used to fill the ends of the car. Some operators prefer a suspended movable screw conveyor to fill the ends of the car and others do it manually.

PART FIFTEEN

OTHER USES FOR COTTONSEED HULLS

For many years the principal use for Hulls has been as a cattle feed or as a supplement or filler. A conventional mixture would call for about 80% hulls and 20% cottonseed meal, resulting in about 12% protein in the mix. Sometimes higher proteins mixtures are used. By adding some form of grain to supply carbohydrates and energy along with minerals, salt and, perhaps, vitamins, a balanced diet may be arrived at.

Although cottonseed hulls are usually considered primarily a filler, with little food value, the nutritionists tell us that there is a small amount of protein and considerable cellulose which is digestible by ruminants and, therefore, does contribute to the ration.

Over the years the demand for hulls will fluctuate up and down, possibly in proportion to the cattle market and availability of grass and hay.

During the times when hulls are not moving, even at a reduced price, the mills become overstocked. It is then that a great interest always developes as to "other uses for hulls".

One last resort that has been used to a limited extent, is to burn hulls in the boiler. In several foreign countries where there was no demand for hulls, the boiler and the mills were designed with this in mind. With an efficient boiler and turbine, the hulls produced will furnish sufficient fuel to provide the power requirements for the mill. With less efficient Corliss engines, the hulls might provide up to 50% of the power. Where the plant operates on purchased power, about 25% of the hull production will provide process steam for cookers.

With most boilers equipped to burn natural gas or fuel oil, the furnaces are not usually large enough to efficiently burn hulls. An old "rule of thumb" estimate was a figure of $5 per ton to justify burning under a boiler, but with higher fuel prices and a proper designed furnace, this figure could be higher. Unfortunately, by the time a mill spends the money for a proper boiler furnace, the price of hulls goes back up and the burning cannot be justified. Most of the foreign mills that once burned all their hulls in the boilers, have now developed a market for cattle feed and can no longer afford the luxury of producing their own fuel, and it is doubtful if this wasteful practice will ever again become profitable.

In attempting to develop some new use for hulls, the thinking was for something dramatic that would produce a much more valuable product and further increase the product revenue from the seed. One suggestion that has been investigated several times was to extract furfural from hulls or hull bran. This might be profitable with extremely low priced hulls, but as they would be competing with wood chips and corn cobs, it was not profitable as the hull price rose above $5/ton. One mill in the Argentine did produce furfural from hull bran on a commercial scale for many years, but it is not known if they are still operating.

One of the problems with hulls is that their low density, i.e., 12-1/2 lbs./cu./ft. makes them very expensive to ship any great distance and also requires twice as much storage capacity as seed. Several mills have minimized this problem by pelleting the hulls and this can be done by making minor alterations to the dies on a conventional pellet machine. However, the wear on dies is excessive.

A similar procedure was checked and tested on a machine that presses sawdust into "logs". This device produced a very nice "log" from hulls, but unfortunately, its primary use was for fuel and the investment for the machine could not be justified when the price of hulls exceed $5/ton.

Other similar uses, such as pressing hulls into wall board, has been studied but again we compete with low-priced sawdust or wood chips.

Hulls have been used extensively as an additive to drilling mud on oil wells, but here again, only low-priced hulls and they must be available near the oil well to avoid high shipping costs.

Research effort with hulls has been devoted to the preparation of sweeping compounds, production of activated carbon and furfural, dextrose and lignin, use of hulls as a soil conditioner, litter material for domestic animals, and a filler for phenolic moulding compounds.

However, in 1948, it was calculated that cottonseed hulls would have to be available in annual amounts of 100,000 tons in localized areas at a price of approximately $5 per ton to be a likely industrial material. At that time, all information indicated that the cattle feeding industry was the most remunerative outlet for cottonseed hulls, approximately 85% of the hulls being consumed by that market. During the past 30 years, little has been done to change that conclusion.

New research efforts are now underway by Cotton, Inc. at Raleigh, North Carolina. This approach is to determine by modern methods any new components that might be economically extracted. They have already detected something that might possibly be utilized in birth control pills and the possibility of applications in paper finishing. Next step will be to determine the economic feasibility of recovering such components.

HULLER ROOM MACHINERY MANUFACTURERS & SUPPLIERS

Carver Cotton Gin Company
East Bridgewater, Mass. 02333
or
P. O. Box 26200, Dallas, Texas
75226

Bauer Machinery
W. C. Cantrell Company
P. O. Box 11216
Fort Worth, Texas 76109

SEED AND HULL STORAGE

Muskogee Iron Works
P. O. Box 188
Muskogee, Oklahoma 74401

HULLER KNIVES

Egon Keller OHG.
563 Remscheid 14
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