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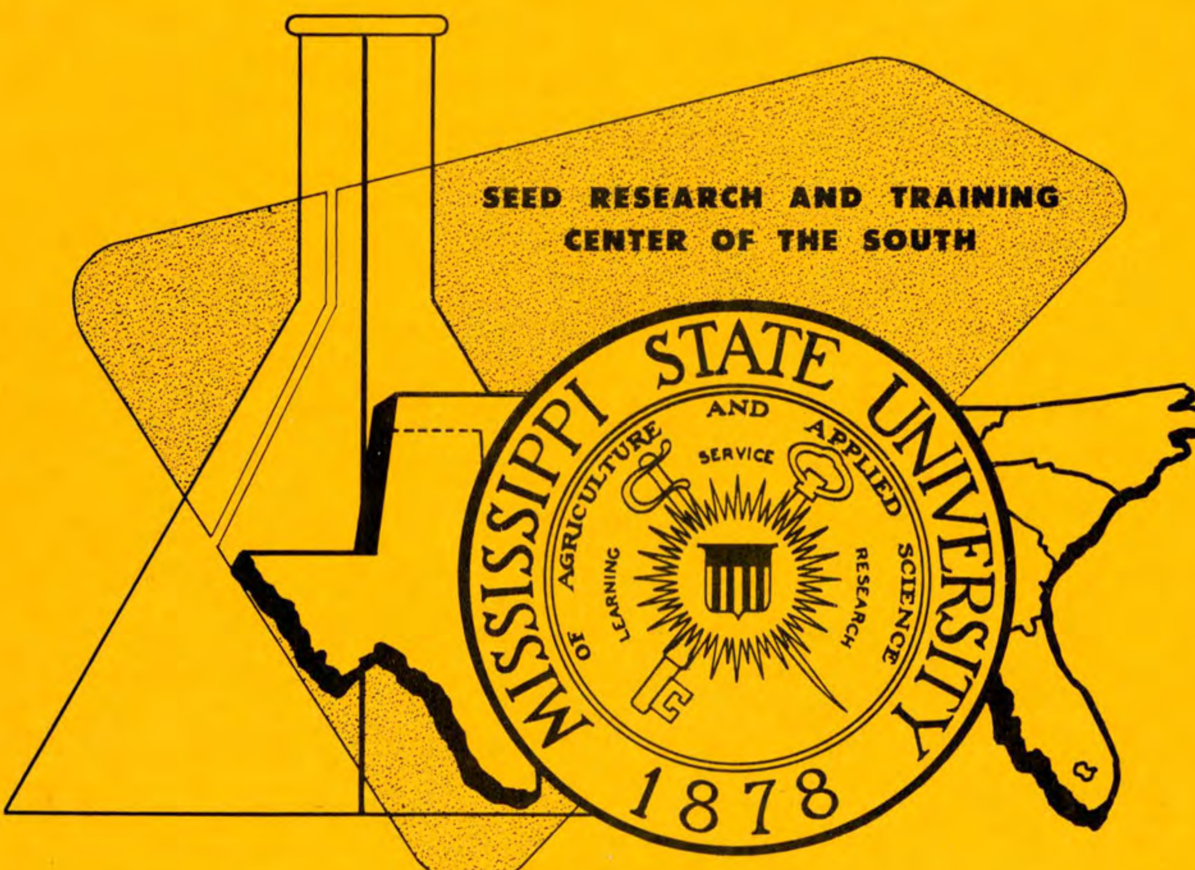
Proceedings: 1964 Short Course for Seedsmen (Full Document)

Proceedings

1964 SHORT COURSE

for

SEEDSMEN



APRIL 27-30, 1964

SEED TECHNOLOGY LABORATORY

STATE COLLEGE *MISSISSIPPI*

Sponsored By The Mississippi Seedsmen's Association

PROCEEDINGS
SEEDSMEN'S SHORT COURSE
APRIL 27 - APRIL 30, 1964

Seed Technology Laboratory
Mississippi Agricultural Experiment Station
Mississippi State University
State College, Mississippi

COVER PHOTOGRAPH

TWIN TOWERS, home of the Seed Technology Laboratory and site of the annual Seedsmen's Short Course. Built in 1900 as a Textile Engineering Building, it later housed the Agricultural Engineering Department. At the present time the University Plant Maintenance Department and the Seed Technology Laboratory share the building.

This structure has become a landmark for seedsmen from all segments of the trade. In addition to the 2500 seedsmen and other interested persons who have attended Short Course Programs, over 50 students graduating from the Seed Technology Laboratory curriculum have made this old building their headquarters for study.

Some day this proud building will have to give way to one roomy enough to accomodate the expanding Seed Technology Laboratory. But for the present, interesting things are happening within these walls and inquisitive people are passing through her portals. It is hoped that her 3 foot walls and 12" x 16" pine beams continue to support the equipment and cosmopolitan traffic until she is finally retired.

TABLE OF CONTENTS

*Article prepared for Proceedings by person other than Program speaker.

CANDID
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1


2

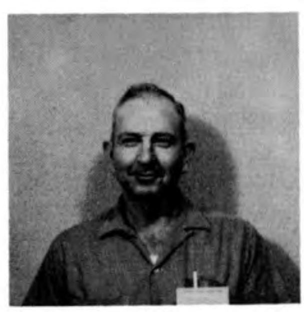

3


4


5


7


9


10


11


12


13


14


15


16


17

STAFF

SEED TECHNOLOGY LABORATORY

STATE COLLEGE, MISSISSIPPI

1. Dr. C. Dale Hoover .... Head, Agronomy Department
2. Dr. James C. Delouche .... In Charge, Seed Technology Laboratory
3. C. Hunter Andrews...Assistant Agronomist and Manager Foundation Seeds
4. George M. Dougherty .... Assistant Agronomist
5. James D. Helmer .... Assistant Agronomist
6. Dumont Souleyrette .... Assistant Agronomist
7. T. Wayne Still .... Assistant Agronomist
8. G. Burns Welch .... Associate Agricultural Engineer
9. James M. Beck .... Engineering Technician
10. Dero Kinard .... Research Assistant
11. Travis Rushing .... Research Assistant
12. Kaye McCrory .... Laboratory Technician
13. William Haughton .... Technical Aide
14. Nonia Hurst .... Secretary
15. Faye Osborne .... Secretary

AID/M.S.U. - Brazil Contract

Campinas, Brazil

16. Dr. H. Dean Bunch .... Chief of Party
17. Charles E. Vaughan .... Assistant Agronomist


2


3


5


4


6


8


7


9


10


11


12

GRADUATE

AND

UNDERGRADUATE STUDENTS

1. Lewis A. Busby .... Mississippi
2. Catherine Feng .... Free China
3. Lee E. Huey .... Illinois
4. James E. Johnson .... Mississippi
5. Mrs. Pil Ju Joo .... Korea
6. Parviz Maleki .... Iran
7. Paul R. Mezynski .... Michigan
8. Franklin Nichols .... Mississippi
9. Mrs. Mabel W. Raspet .... Mississippi
10. Kyle W. Rushing .... Kentucky
11. C. Allen Spragins, Jr. .... Mississippi
12. Ismu Sukanto Suwelo .... Indonesia

PROGRAM SCHEDULE

MONDAY, APRIL 27

8:00 - 12:00	REGISTRATION - SEED TECHNOLOGY LABORATORY COFFEE, COKES, DOUGHNUTS - Furnished all week, courtesy of equipment manufacturers and their representatives.
10:00 - 12:00	GUIDED TOURS OF NEW FACILITIES Boll Weevil Research Laboratory Raspet Flight Research Laboratory
10:00 - 12:00	MOVIES
1:30 - 2:15	WELCOME AND INTRODUCTIONS
2:15 - 2:45	FIRST THE SEED James C. Delouche
2:45 - 3:00	MEN, SEED AND MACHINES Charles E. Vaughan
3:00 - 3:30	COFFEE, COKES, DOUGHNUTS
3:30 - 5:00	Your Choice: PROCESSING DEMONSTRATIONS Continuous and simultaneous demonstrations of different makes and models of air-screen cleaners, disc and cylinder separators, gravity separators, electrostatic separators, color sorters, elevators, seed treaters and other equipment used in seed processing plants. TESTING DEMONSTRATIONS Germination tests - evaluation. Special tests - fluorescence, phenol, vigor. Discussion of problems.
6:30 - 7:30	Hospitality Hour, Courtesy Morton Chemical Company (Panogen)
7:30 - 'til	Barbecued Chicken Dinner - Entertainment Courtesy of Mississippi Seed Improvement Association, Mississippi Seedsmen's Association, and Seedsmen's Short Course.

TUESDAY, APRIL 28

8:30 - 9:15	AIR AND SCREEN CLEANERS James Henderson
9:15 - 10:00	DIMENSIONAL SIZING EQUIPMENT George Durkot
10:00 - 10:30	COFFEE, COKES, AND DOUGHNUTS
10:30 - 11:15	GRAVITY SEPARATORS James Moore
11:15 - 12:00	MAGNETIC CLEANERS ROLL (DODDER) MILLS Henry Brummel
1:30 - 2:15	OTHER USEFUL EQUIPMENT Bill Gregg
2:15 - 3:00	THE TETRAZOLIUM TEST James C. Delouche
3:00 - 3:30	COFFEE, COKES, DOUGHNUTS
3:30 - 5:00	PROCESSING DEMONSTRATIONS
3:30 - 5:00	SEED TESTING METHODS

WEDNESDAY, APRIL 29

8:30 - 9:15	COLOR SORTERS Francis J. Mayer
8:30 - 9:15	ELECTROSTATIC SEPARATORS T. Wayne Still
9:15 - 10:00	SEED TREATMENT Earl D. Hansing
10:00 - 10:30	COFFEE, COKES, DOUGHNUTS
10:30 - 11:15	SEED DETERIORATION James C. Delouche
11:15 - 12:00	SEED STORAGE James D. Helmer Ernest N. May, Jr.
1:30 - 2:00	DRAWING FOR PRIZES
2:00 - 5:00	PROCESSING DEMONSTRATIONS All equipment in operation. Individual practice in operating machines if you wish. Special attention to specific cleaning problems.
2:00 - 5:00	TETRAZOLIUM WORKSHOP Learn the fundamentals or the fine points of tetrazolium testing.
7:00 - 'til	Mississippi Style Barbecue Courtesy of Sawan, Inc.

THURSDAY, APRIL 30

8:30 - 9:15	STRUCTURES FOR MODERN PLANTS Earl W. Terrell
9:15 - 10:00	SAFETY IN PROCESSING PLANTS Tom A. Adler
10:00 - 10:30	COFFEE, COKES, AND DOUGHNUTS
10:30 - 11:15	MATERIALS HANDLING Richard Marsh
11:15 - 12:00	AUTOMATION James Henderson
1:30 - 3:00	TWO SESSIONS FOR SOUTHERNERS COTTONSEED AND COCKLEBURS H. Dean Bunch SOYBEANS John W. McKie
3:00 - 3:30	COFFEE , COKES, AND DOUGHNUTS
3:30 - 5:00	THE WINDUP PERIOD Discussions and equipment operation.

DEMONSTRATIONS

The following industry representatives assisted in the various demonstrations of equipment and techniques for seed processing, conveying, treating and storage, but did not appear on the program.

W. S. Acheson .... Gustafson Manufacturing Co.

Ira Anoot .... Mandrel Industries

Robert Chapman .... Mandrel Industries

Vergil Frevert .... Crippen Manufacturing Co.

William D. Munroe .... Oliver Manufacturing Co.

Don Ouzts .... Wallace Equipment Co.

Vincent Palau .... Mercator Corporation

Winston K. Pendleton ....Universal Dynamics Corp.

T. C. Ryker............................ E. I. DuPont de Nemours Co.

Raymond P. Seven .... Morton Chemical Co.

Norman Twisdale ....Uveyor

Don Vanderveen .... Sortex Company of North America

Bill Wallace .... Wallace Equipment Co.

William L. Warren............................. Morton Chemical Co.

FIRST THE SEED

James C. Delouche [1]

It is appropriate - at the beginning of this 1964 Short Course - to pause for a few minutes before considering the more germane aspects of seed technology and consider the seed itself. For the seed is one of nature's truly marvelous inventions. An incredible example of miniaturization, a vital link in the unbroken thread of life - the importance of the seed was early recognized by man.

Two of the most critical turns in man's long struggle toward civilization involved seeds. Early man came to understand that allowing some of the wild-growing grains he collected to fall to the ground increased the probability of a crop of grain at that spot the following year. Whether man then understood the function of seed is debatable - he may have only been appeasing the spirit of the grain or the soil with an offering. The next giant stride toward civilization came with the discovery that collected seed under favorable conditions could produce plants and grain far from the area in which they naturally occurred. Perhaps a grain crop produced from seed spilled by a hunter around a camp site clued in the discovery. These discoveries had a powerful influence on the course of human history. By collecting seed of desirable plants, storing them and at the proper time sowing them in soil of his choice - man overcame the shackles of a nomadic existance, settled down and developed the concepts of the village, division of labor, and the dim outlines of our modern agricultural-industrial economy.

Man and seeds have long been inseparable. Among the important supplies carried by the Pilgrims to the New World were seeds. Ben Franklin always brought back seeds from his many trips abroad. Thomas Jefferson took time from his studies of Italian art to smuggle rice seed out of Italy - such an act being illegal under Italian law at that time. A curious but illuminating example of the "togetherness" of man and seeds is found in the name given to a common weed by the Indians. They called it "white man's foot print" because it flourished everywhere the white man had been - scattered over the land.

Over 60 percent of the food consumed by mankind is seed or seed products such as flour, meal, oil, etc. If we stretch the definition of "seeds" to include vegetative reproductive structures such as tubers, then the portion of man's food from "seed" is over 75 percent. Stored in seed are three important nutrients: carbohydrates, fats and oils, and proteins. Americans get much of their proteins from meat, but in many countries the principal source of proteins is seed.

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[1] Dr. Delouche is Associate Agronomist, In Charge, Seed Technology Laboratory, Mississippi State University, State College, Mississippi.

The essential role of seed lies in its generative function - the capacity to reproduce (or produce) that from which it came - the grain and fibers, the grass and the trees.

There is a point in the life cycle of every plant when the balance of physiological processes shift from growth to reproduction - and therein lies the genesis of the seed. Flowers are produced in their myriad of shapes, colors, sizes and fragrances. As the male and female organs mature, the nuclei of certain cells undergo reduction-division, i. e., the paired chromosomes of one cell are equally distributed to two daughter cells. The pollen is released, lights on a stigma, germinates, and the tube grows down the style. The reduced nuclei of the male and female elements fuse and develop into an embryo with a normal chromosome complement. The fusion of the male and female elements combines hereditary traits from the male and female parents and determines the characteristics of the offspring. Plant breeders apply their particular efforts at this stage. In an associated phenomenon (double fertilization), one reduced male nucleus fuses with two reduced female nuclei giving rise to the endosperm - the starchy part of a wheat or corn grain.

After fusion of the male and female nuclei, the cells continue to divide and the embryo takes on a characteristic form - differentiates into various organs. The ovule and the enclosed embryo (and endosperm) are gradually transformed into the seed. There are several distinct phases in this transformation: a time when some of the "seeds" develop the capacity to germinate, a time when all seeds are capable of germination, a time when maximum seed size is attained, a time when the maximum amount of dry matter has accumulated in each seed, and a time when the seed has dried sufficiently to naturally fall from the plant (except in fleshy fruits).

The mature seed is a thing of beauty - with a symmetry, a hue, an elegance of form and sculpturing, unmatched in nature.

A parachuted dandelion seed floats in the wind, a bird drops a tree seed in flight, a cocklebur floats in the run-off of a fall rain - somewhere they come to rest. And the cycle begins again.

MEN, SEED, AND MACHINES

Charles E. Vaughan [1]

Dr. Delouche has introduced us to the basic item of agriculture we call seeds. Without them our agriculture would be vastly different. In fact, our survival depends upon them. But more important to us today is the fact that we are all engaged in occupations that are directly related to seeds. Whether we are farmers, processors, manufacturers, salesmen, educators, control officials or bankers, we are all interested in seeing the quality of seed improved. This affects us in terms of dollars and cents.

Seed as it comes from the field is never pure. Neither is it in the best condition for replanting. In fact there are many processors through which the seed should go from the time it leaves the field until it is ready for market, if the quality is to be improved. These are things about which the general public has little understanding, but about which each of us should be quite familiar. Our objective this week is to discuss the things which can be of greatest benefit in improving seed quality and efficiency of plant operation.

Seed processing is becoming more important each year. Our agricultural experiment stations and commercial plant breeders are spending vast sums in the development of new and superior crop varieties. These new varieties will be of benefit to the farmers only when the seed stocks are kept free or recleaned to be free of noxious weeds, are varietally pure, and are available to them at a reasonable price. Therefore, this year, as always, our emphasis is on seed processing; however, not to the exclusion of other important areas of seed improvement, which will also be discussed this week.

Many types of machines have been put on the market by manufacturing companies during the last half-century. Great strides have been made by them in trying to meet the problems of increasing demand for high quality seed. However, prior to any discussion we may have later this week about the operation of seed processing machinery, we must outline several basic facts. First, there is no all-purpose machine that will remove all the objectionable material from the different kinds of seed. Secondly, seeds show a definite lack of uniformity which makes constant supervision of the cleaning process necessary.

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[1] Mr. Vaughan is Assistant Agronomist, Seed Technology Laboratory, Mississippi Agricultural Experiment Station, State College, Mississippi.

There are many other factors which enter into the operation of successful seed cleaning plants. Prominent among them is the need for skilled operators who have a basic mechanical knowledge of the equipment and a good fundamental knowledge of seeds and the problems to be solved in their processing. Therefore, we feel that all who are concerned with seed processing can surely benefit this week because of the nature of our emphasis.

1. First we hope to emphasize the seed characteristics that make various separations possible while others are not. Seeds of any crop must differ sufficiently from its contaminants in one or more characteristics for it to be successfully cleaned and processed. These characteristics include, among others, a difference in width, thickness, length, specific gravity, texture of seed coat, degree of roundness and color.
2. We plan to spend much time emphasizing basic principles of operation. We plan to do this with class-room discussions and equipment demonstrations. Our speakers this week represent years of experience, not only in working with the machinery, but also in discussing and explaining the techniques of operation.
3. For the more experienced seedsmen we hope our speakers will go beyond these basic principles and also discuss the fine points of operation and explain how techniques may be improved.
4. We realize, however, that there are several of you who have already acquired even the fine points of operation, but we still feel that we have something for you. We hope that by providing the background and ideal atmosphere that you will benefit from the conversations and associations with others who are attending. Maybe you can pick up some "Smart Tricks" like the Eskimo who made a visit to New York. When he returned home, he took with him a long length of pipe, which he set up in his igloo so it protruded through the roof. His wife asked what it was for. The Eskimo replied, "Smart trick I learned in New York. When you want more heat, you just bang on this pipe."

ADJUSTMENTS FOR EFFICIENT AND PRECISION SEED CLEANING

James Henderson [1/]

One of the recent developments that has contributed to more efficient and exact seed cleaning is the metering hopper for screen and air cleaners. The fluted roll with extended flights feeds a metered quantity of seed into the air leg and onto the screen. While the gate is adjustable for large changes of rate of feed, the basic adjustment is made by increasing or decreasing the speed at which the fluted roll turns and thereby increasing or decreasing the number of measured quantities fed into the air stream.

Spiked fingers on a shaft turning in the mass of seed in the hopper eliminate bridging of trashy seed across the hopper and tend to force the seed down to the fluted roll so that the flutes can pull the seed through into the air leg.

A variable drive mechanism is required for accurate control of feed with this hopper. If you have occasion to clean very trashy seeds with your seed cleaner, which is equipped with another type of hopper, you can change the speed of your hopper roll by simply switching the two outside gears on your hopper drive. The normal arrangement has a 15-tooth gear driving a 60-tooth gear. These are reversible so that you can have the 60-tooth gear driving the 15-tooth gear. This will cause a regular roll-feed hopper or a roll-feed brush hopper to feed very trashy seeds regularly and evenly to the screens. However, if the seed are not extremely trashy, you may find that the extra high speed you obtain by this reversing of gears will make it impossible for you to control the quantity fed onto the screen. For that reason, we offer an intermediate set of gears having 30 and 36 teeth, respectively, which you can substitute for the 15 and 60 tooth gears to give you two intermediate speeds and accomplish results similar to those obtained with the metering hopper.

Possibly you have observed the action of seed on a hand screen when you tap or jar the hand screen with your fingers. It causes seeds to be turned and tumbled so that they present themselves to the openings of the screen and go through faster. You can have a similar action on top screens of your cleaner by simply installing knockers that are adjustable to lightly tap the screens or to strike the knocker pads on the screens a sharp blow for heavy vibration. This serves a dual purpose of enabling you to vibrate the screens so that seeds will pass through very close and small openings and to jar loose any long weed seeds that become up-ended and wedged so tightly into perforations that brushes cannot remove them.

[1/] Mr. Henderson is Sales Manager, A. T. Ferrell & Company, Saginaw, Michigan; Manufacturers of Clipper grain, seed and bean cleaners and Randolph grain driers.

When you attempt to make a very close and accurate separation with a perforated metal bottom screen and at the same time attempt to put a heavy layer of seed over that screen, there is always the danger that some of the seed you must separate will be carried over the top of the screen without contacting the perforations and will not be separated. Screen dams can be fastened across the top of the screen to interrupt the smooth flow of the seed down the screen and cause them to be turned, tumbled and heavily sifted. These screen dams, if properly placed, will permit you to put a heavier layer of seed on that bottom screen with assurance that the separation will be correctly made.

Round seed, such as soybeans, have a tendency to bounce and roll over the top of a screen so that some of the beans never contact a perforation but pass over the top of the screen with the screenings. A scalper apron made of canvas can be draped over the upper half of the screen to cause these beans to stop their bouncing, settle and contact the perforations that go through. The apron should not be so long and heavy that pods and trash will be held up in its movement down the screen, but can serve as a baffle to make the bouncing seed settle to the screen and be passed through.

At other times you will be faced with the problem of long stems or weed seeds turning on end to go through a top screen when they could be separated if they would lie flat and slide over. If you drape oil cloth with the slick side down over the top screen, these long pieces of stem or weed seeds cannot turn up on end to go through the round hole top screen but will slide down the screen underneath the smooth oil cloth and be screened over.

You can assure a better separation of these long stems and weed seeds by blanking off the lower section of a top screen. After your good seed have gone through the screen, there is no reason to leave the rest of the perforations down the length of that screen open for trash and weed seeds to find their way through. A temporary blank-off section can be accomplished by putting masking tape and brown paper over the lower section. Permanent blanking off can be accomplished by simply making the screen with a blank metal lower section.

One of the most useful controls on a precision seed cleaner is the variable screen shake adjustment mechanism. This permits the operator to adjust the speed at which the screens are shaken from a very slow speed to a very fast speed. The variable shoe shake mechanism should be operated to accomplish a desired action of the seeds on the screen, not to attempt to get more capacity by shaking the screens faster. For example, if you are putting fescue seed through a small round hole screen, it will be necessary for you to shake the screens rapidly in order to cause the fescue seed to turn on end and go through the round screen. If you shake the screen slowly, they will lie flat and float over the top of that screen. Also, if you're putting bluegrass seed or canary grass seed through a small square wire mesh screen, it is necessary for you to shake the screen rapidly or the seeds will not travel down the wire mesh screen but will pile up on top of the screen and lie dead and will eventually be flooded over with the dirt and weed seed. On the other hand, if you are attempting to make a very accurate and close separation of a small round seed through a small round screen, either top or bottom, you must shake the screen slowly to allow the seed to come in exact contact with the opening and pass through. Soybeans on a top screen without the apron will bounce if you shake the screen rapidly, therefore, a slow speed is required. Examples of cleaning operations requiring slow speed are a separation of dodder from Korean lespedeza with a 1/16 round hole bottom screen and cleaning of timothy using 1/23 or 1/25 round hole top screen.

Each screen in a precision seed cleaner must be adjustable for different degrees of pitch. Common ranges of pitch adjustment in seed cleaners range from four to twelve degrees. High capacity grain receiving separators may have greater screen pitch in order to move the grain over the screens rapidly but in a precision seed cleaner, these pitches are sufficient to give adequate cleaning capacity while remaining able to make the exact separations required in seed cleaning.

Screen pitch has a much greater effect on the speed at which seed moves through the machine than does shaker shaft speed. The latter can be increased with little effect on capacity, but seed will pass over a screen in the steep position almost twice as fast as over the screen in the flat position at the same shaker shaft speed. The speed at which the seeds pass over the screen has to be considered from the angles of the desired capacity and the desired separation. If the separation is a difficult one, and capacity is secondary, you will naturally want to leave the seed on the screen as long as possible in order to give every possible opportunity to make the separation. If capacity is the important thing and the separation is secondary, then a steep pitch is in order to accomplish a greater capacity. If the separation is quickly made and you wish to move the material separated over the top of the screen quickly, you will want to use steep pitch.

Since it is possible that you will have a different requirement of speed of travel over and through every screen in your cleaner, it is mandatory that every screen be adjustable for pitch and independent of any other screen, and of course, the best time to make a screen pitch adjustment is while the cleaner is operating so that you can observe the results that the changes of the pitch adjustment cause.

For the convenience of those seed processors who do not have multi-screen cleaners but who on occasion need to make more than one type of separation as the seed are passing over the bottom screen, we offer what we call combination screens. These will have two or more different perforations or meshes on one screen frame; for example, if you are attempting to separate hulled oats and wild buckwheat from oats and have only one botton screen, you may be able to make this separation by using a combination screen that has one section of slotted screen material to drop the hulled oats and another section of triangular perforations to drop the wild buckwheat. There is one very popular combination screen used as a bottom screen for fescue which has four different sections covered by different meshes or perforations and designed to accomplish a specific combination of separations that a processor requires.

When a manufacturer knows that the seed cleaner he is shipping will be used for cleaning one kind of seed it is easy enough to prescribe a fan speed that will give optimum results and maximum adjustability when cleaning only that kind of seed; however, seed cleaners are generally intended for cleaning several different kinds of seed and it is not unusual to see a cleaner being used in season for cleaning the seed of soybeans and the seed of red top. If the machine is shipped with the proper drive for the fans to supply enough air for cleaning soybeans, then the air adjustment when it is used for cleaning red top will be in the lowest portion of the adjustment and will be rather sensitive. On the other hand, if it is shipped with the fans adjusted for red top, there will not be enough air to make a good separation when heavy seeds such as soybeans are being cleaned. Since precision seed cleaners are equipped with a variable shoe shake mechanism and since the fan speed may be varied over a wide range and the variable shoe shake mechanism permits all other drives to be driven at normal speed, it is possible to furnish a dual drive for a cleaner that will be used for cleaning both heavy and light seed. This dual drive permits the operator to change the fan speed from a high speed supplying plenty of air for heavy seeds to a low speed offering wide range of adjustment for small and light seeds. To make it possible to accomplish this change of speeds quickly and easily, the motor pulley furnished can have double the usual number of grooves and the driven pulleys on the fan shaft be side by side of two different sizes. With different belts, it is possible just to change belts in order to change the fan speeds and this quick changeover assures that the cleaner will offer the best possible air separation for all weights of seeds.

Some of the things that can be built into a seed plant to give efficiency of operation are not necessarily a part of a cleaner but are part of the design of the equipment used in that plant. For example:

1. Every bin used should be self-cleaning with no ledges or flat slopes that will hold up seed, necessitating clean up by hand when changing over from one kind of seed to another.

2. Every elevator should be provided with clean-out slides at the bottom to permit quick and perfect removal of small, residual quantities of seed left in the bottom of the elevator when changing to another kind of seed.

3. Elevator buckets should be held away from the elevator belt by spacers between the bucket and belt to permit the easy and quick blowing out of seeds lodged between the bucket and belt. It is impossible to prevent seeds from getting behind the bucket no matter how tightly you may bolt the bucket to the belt, so the best solution to this problem is to give them room to be removed by a blast of compressed air.

4. Every spout leading from an elevator into a bin should be at a pitch that will insure that it is self-cleaning. Every feed from an elevator to a bin or cleaner should be equipped with an overflow device which could be a pressure sensitive device or an overflow spout. The installation of an alarm system or an overflow spout in a spout between an elevator in a bin or cleaner will prevent backing up of seed into the elevator and stopping and jamming the elevator full to stop its operation.

5. A seed cleaning plant that receives seed in bulk from trucks should be equipped with a receiving pit having a vibro-pit that is self cleaning so there are no requirements for an operator to sweep out the truck dump between lots.

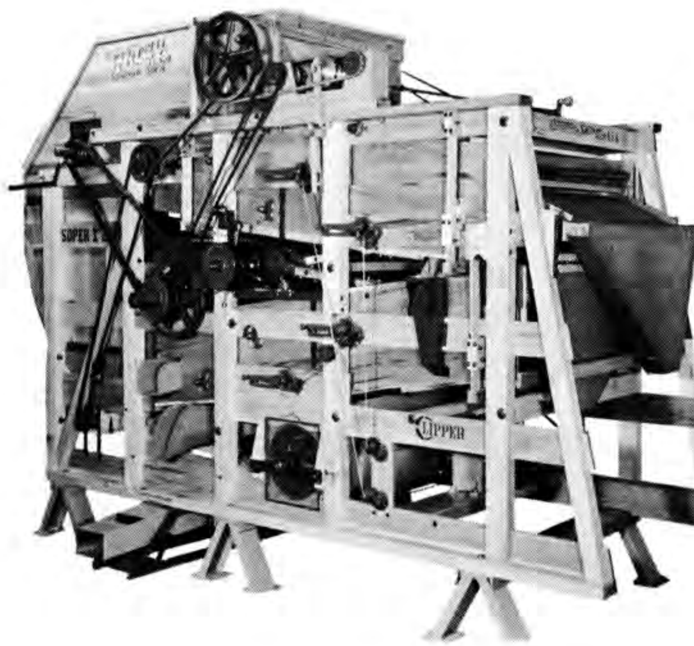
6. The pit which houses elevator boots must be large so that an operator can get into it and have free access to the clean out slide and room for vacuum equipment for cleaning up between lots.

7. A vibrating conveyor mounted beneath the cleaner to convey the cleaned seed from one side to the other cleans itself perfectly between lots so that there is no residue for the operator to sweep out and offers the advantage of an installation above floor level with plenty of room beneath the cleaner so that spilled seeds may be quickly and easily cleaned from the floor.

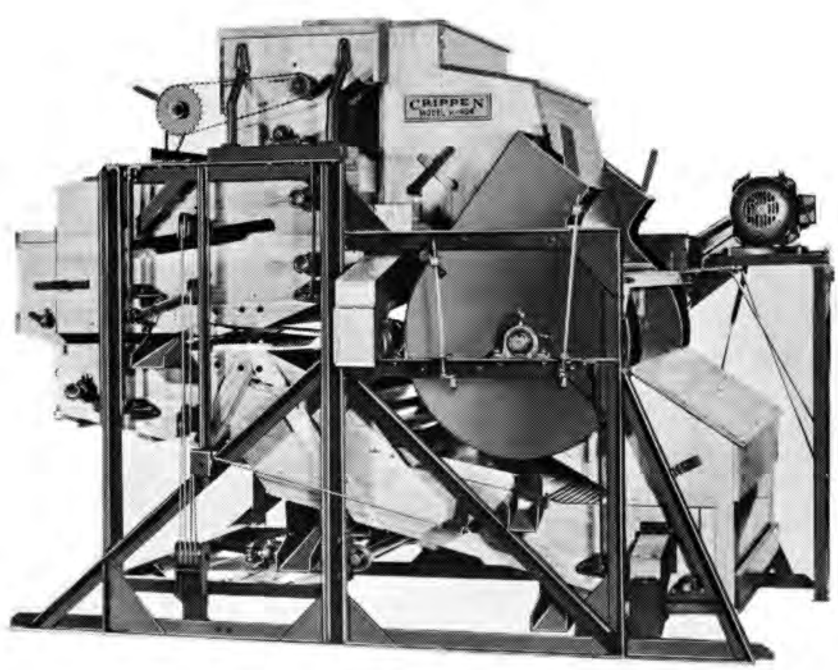
8. Pneumatic unloading installation eliminate the clean-up problem and add great efficiency to plants which must maintain identity without mixtures of lots of seeds coming in one after another.

Following some of these suggestions will assist you to increase the efficiency of your seed cleaning plant and properly adjust your machines for precision cleaning.

Editor's Note: The air-screen cleaner is basic equipment in nearly every type of seed cleaning installation. Shown below are two of the several makes and many models of this type cleaner.



Clipper, Model Super X-29D



Crippen, Model H-454

SELECTING SCREENS [1]
George M. Dougherty

Seed processing, to many seedsmen conveys the idea of buying - storage - cleaning and selling; to others it primarily means cleaning, that is passing the seed through and/or over a series of machines, each of which is designed to perform a particular type of separation. Yet to some, it merely means passing the field-run seed through an air-screen cleaner. Be it the only machine, or just a single piece of equipment in a long line of machines, the air-screen cleaner plays a vital role in determining the quality of the seed sold by the processor. It is a basic piece of equipment in all seed plants.

To obtain the most from an air-screen cleaner it is important that we understand the various screens available. To help achieve more efficient precision cleaning, manufacturers now produce over 200 different screen types; fifty to sixty of which have been added within recent years. Two examples of recent new screen sizes are the 3 x 16 Special and the 3 x 17 Special. Although both these screens were planned for a particular purpose, the cleaning of flaxseed, they have found a wider range of usefulness. The 3 x 16 is now a popular screen in the separation of small ragweed from small Korean lespedeza seed, and the 3 x 17 screen is being used in the processing of red clover and sweet clover seed. Since these are both woven steel-wire screens, they are being substituted for previously recommended perforated metal screens whenever a comparable separation can be obtained. By way of example, it has been said that the 3 x 17 Special separates dock and ragweed from red clover seed as efficiently as the 3/64 x 5/16 perforated screen, previously recommended for this separation.

The screens in an air-screen cleaner perform the scalping and grading operations, separating the seed to be cleaned from foreign material, other crop seed and weed seed on a bases of differences in shape and size. They may be constructed of either perforated metal or wire mesh. The openings in the perforated metal screens being most commonly round, oblong or triangular, whereas openings in the wire mesh screens are usually square or rectangular. A brief description of screen types, size ranges and methods of measuring follows:

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[1] Mr. Dougherty is Assistant Agronomist, Seed Technology Laboratory, Mississippi Agricultural Experiment Station, State College, Mississippi.

ROUND PERFORATIONS

Round openings in a perforated screen are measured by the diameter of the openings. Perforations of 6/64th and larger are measured in 64ths of an inch and are commonly stocked by manufacturers in sizes ranging from 6/64ths to 80/64ths. These screen sizes are commonly designated by using the numerator of the fraction, i.e., 6, 7, ... 64, 72, or 80.

Round openings of 5 1/2/64ths and smaller in diameter are measured in fractions of an inch and are so designated, i. e., 1/12, 1/13, 1/14 .... 1/25. Sizes ranging from 1/12th to 1/25th of an inch are readily available from most manufacturers.

OBLONG PERFORATIONS

Perforated metal screens with oblong, or slotted, openings are measured in two diminsions, the width and length of the opening. As was the case with round hole screens, openings of 6/64ths of an inch and larger in width are measured in 64ths of an inch. Openings less than 6/64ths of an inch in width are expressed in fractions of an inch.

Oblong openings are usually 1/4 inch, 5/16 inch, 1/2 inch, or 3/4 inch in length.

When designating these screens, it is common practice to give the width dimension first and the length dimension last, i. e., 5 1/2 x 3/4, 6 x 3/4, or 1/22 x 1/2, etc. in cases where fractions of an inch denote the width.

Generally, the direction of the slot will be in the direction of the flow of seeds on the screen. In large screen sizes, however, the screens can be had as cross-slots with the direction of the slot across the direction of the flow of seed. Cross-slot screens are particularly useful in separating split beans from varieties having a relatively flat shape. Also, among the small size slotted screens, there is a 1/22 x 1/2 diagonal which has its slots turned at a 45 degree angle from the usual direction of seed flow. This screen is useful in instances where it will allow relatively short seeds to be separated from slightly longer seed. Manufacturers commonly stock over 60 different oblong hole screens, of assorted sizes, ranging from 1/24th x 1/2 to 32/64ths x 1 inch.

TRIANGULAR PERFORATIONS

Care should be exercised when ordering a new, or replacing an old, triangular screen. There are two methods commonly used by perforators for measuring triangular perforated screens. Using one method, the screen size represents the length of each side of the triangle as measured in 64ths of an inch. Other companies, however, use a method in which the screen size represents the largest diameter circle that can be inscribed within the triangular opening, also in 64ths of an inch.

It follows, two triangular screens with the same numerical size designation may not necessarily have the same size openings. Some examples of similar size screens are shown in Table 1, in which method (A) refers to the first method of measuring mentioned above.

Table 1. Triangular screens most commonly stocked by manufacturers.

Screen Sizes [2/]	
Method (A)	Method (B)
7 Tri.	4 1/2 V
8 Tri.	5 V
9 Tri.	5 1/2 V
10 Tri.	6 V
11 Tri.	6 1/2 V
12 Tri.	7 V

SQUARE WIRE MESH

Tempered steel square wire mesh screens are measured by the number of openings per inch in a horizontal and vertical direction. Therefore, a 9 x 9 screen will have 9 openings per inch both horizontally and vertically. Sizes readily available range from 3 x 3 to 60 x 60. Since numbers on these screens do not increase consecutively, the indicated range includes about 27 different screens.

RECTANGULAR WIRE MESH

Rectangular wire mesh screens are measured the same as the square wire mesh screens. A 3 x 6 rectangular wire mesh screen will have 3 openings per inch vertically and 6 openings per inch horizontally. The lesser number of openings is in the vertical direction (direction of seed flow) and will always be the first number. There are approximately 50 different rectangular wire mesh screens commonly stocked by manufacturers, their sizes ranging as follows:

2 x 8 to 2 x 12, 3 x 14 to 3 x 21, 4 x 15 to 4 x 36 and 6 x 14 to 6 x 60. An 18 x 20 and a 20 x 22 are also available.

[2/] Screens on same horizontal line have same size openings.

GENERAL RECOMMENDATIONS

Crop seeds can be classified as being round, oblong, or lens-shaped. To clean seeds satisfactorily, screens which will accomodate the shape of the seed to be cleaned must be selected. For processors using cleaners having more than two screens, it is generally recommended that the top screen in the cleaner be a round-hole perforated screen because of its ability to screen over straw and long weed seeds. However, when cleaning seed on a 2 screen cleaner the following "Rules of Thumb" will usually give the best cleaning results.

1. When cleaning round seed, use:
   a. Round-hole top screen
   b. Slotted bottom screen
2. When cleaning oblong-shaped seed, use:
   a. Oblong top screen
   b. Oblong bottom screen
3. When cleaning lens-shaped seed, use:
   a. Oblong or rectangular top screen
   b. Round-hole bottom screen

DIMENSIONAL SIZING

T. E. Hartman [1]

The processes of seed separating, cleaning and sizing have been improved to a point where special machines have been developed to solve specific processing problems. Each of these processes is accomplished by utilizing differences in physical characteristics of the seeds to be separated. One principal method employed is separation by size, that is, differences in width, thickness, or length.

WIDTH & THICKNESS SIZING

The Simon-Carter Precision Grader is a unique, rugged, extremely precise, yet simple width and thickness separator. It is available in seven different styles or models, all of which employ either slotted or round perforated cylindrical screens and hold 1, 2, 4 or 6 screens per machine. Figure 1 illustrates a 6-cylinder machine.

Construction:

The primary component of the Precision Grader is the cylindrical shell which is approximately 12 inches in diameter and 60 inches long. These shells or screens are produced from cold rolled aluminum kilned steel and are cyanide hardened by immersion in a molten cyanide bath of 1300 to 1350 degrees Fahrenheit for approximately 12 minutes before being cold water quenched.

There are three types of perforations used in the production of these screens. The slotted perforations are available in widths of 3/64" to 24/64" and are located at the base of the "corrugated" groove having steeply slanted sides (Figure 2). Each slot in one entire screen is punched by the same die and maintains a tolerance of plus or minus 13/10,000 of an inch. The shape of the screen is that of a many-sided polygon with each row of slots contained in its own flat surface plane.

Round hole perforations are available in two styles. The hole sizes from 13/64" to 26/64" are perforated at the bottom of a deep recess or indentation (Figure 3). For those in the size range of 4/64" to 12/64" a different screen construction is used. In the smaller perforation sizes, periodic deep ribs running the length of the cylinder and spaced about 3/4" apart give rigidity to the shell.

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For some separations, an inclined baffle plate or agitator blades are fastened inside the cylinder shells for added conveying and positioning of the product.

The various perforations are kept free of wedged grain by a soft, rotating, five-bladed rubber cleaner mechanism positioned at the top and running the full length of the cylinder shell.

<u>Operation:</u>

The cylindrical screen revolves at approximately 60 RPM while the material to be separated is fed into one end and rolls or tumbles gently, covering more than a third of the screen surface at all times. A combination of gravity, centrifugal force, and product pressure gently forces each particle into a perforation to accomplish a mild "press-fit" for accurate uniform sizing.

In the slotted shell used for thickness sizing, wafer-shaped seeds or particles wider than their thickness are tipped on edge by the humps or ridges between the slots, allowing them to be sized by their narrowest dimensions. These ridges also tend to position long particles parallel to the slot for easy entry. The polygon shape of the cylinder increases product agitation and opportunity to contact the slot in the proper position. A continuous spiral channel and slight incline keep the "overs" moving through the shell.

The deep indented, round hole shell is used for width sizing and having the hole at the bottom of the indent forces seeds or particles to upend. If the width of the upended particle is less than the hole diameter, it will then be in the proper position for passing through the hole.

The full length ribs in the round ribbed screen perform the function of agitating and upending the product, not only positioning the particles for entry, but also preventing stratification.

Changing of the cylinder shells from one size or type to another can be accomplished in only three to four minutes due to removable stub shaft construction.

In some machine styles an internal baffle plate inside the cylinder is used with slots less than 8/64" in width to assist in conveying slick elongated seeds like oats and barley. Agitator blades are also used on occasion in the larger round recessed perforated shells to aid in tumbling large slick three-dimensional grains like corn. Both of these accesories prevent "sliding" of the material on the rising side of the cylinder wall.

The soft rubber-bladed cleaner mechanism mentioned earlier gently taps the cylinder, setting up a sharp but gentle vibration. Those wedged particles not automatically freed by this vibration are pushed back into the cylinder when contacted by a rubber blade.

The product passing through each shell depending on the style of machine will either discharge beneath and the full length of the machine or

Figure 1 - Six-cylinder Simon-Carter Precision Grader

be collected in a vibrating conveyor for discharge at the intake end of the machine. The "overs" of each shell are discharged at the opposite or drive end of the machine.

Various flow arrangements are available which provide flexibility and the possibility of making from one to three separations in a single machine.

Capacities:

Capacity per cylinder will vary greatly depending on the product being separated and the percent of total stream passing through the perforation. Generally, the higher percentage of "throughs", the greater the capacity. The range of seed separation capacities is from 25 to 80 bushels per cylinder.

LENGTH SIZING

There are two methods by which material may be separated by length. The first method to be reviewed today is the so called disc method.

Disc Separator

Construction:

A disc pocket consisting of an undercut recess in the side face of a special hardened cast iron disc is utilized in this method for separating short from long particles. This slide illustrates how the separation is accomplished. As you can see some seeds are small enough to fit in the pocket while others are too long and will not. We will return to this illustration later for a more complete explanation of how the separation is accomplished.

Our third slide is a side view of a complete disc. These discs are produced in four diameters, 15", 18", 21" and 25". There are three different basic pocket designs and over 75 different sizes. The next two slides illustrate two of the types of pockets. The first being a standard square pocket, the second being what is called a "V" type pocket. The square pockets were the first type produced and are used generally for rapid removal of a small fraction of long undesirable material or as an initial rough split. Furthermore, precise separations in the small size range are most often accomplished with the "V" or "R" type pockets.

The "V" pocket derives its name from Vetch, and is so designed as to pick up, and hold for discharge round shaped materials. This pocket has a round "lifting edge" and a squared horizontal "leading edge". Tubular, cylindrical or elongated particles have no flat surface at the bottom of the pocket to "sit" on, and tip out of the pocket as the disc revolves around the shaft.

The "R" pocket derives its name from Rice, and was designed to remove cross broken grains from whole grains. This pocket looks like a "V" pocket, except that it is up-side-down. The lifting edge is flat and horizontal, while

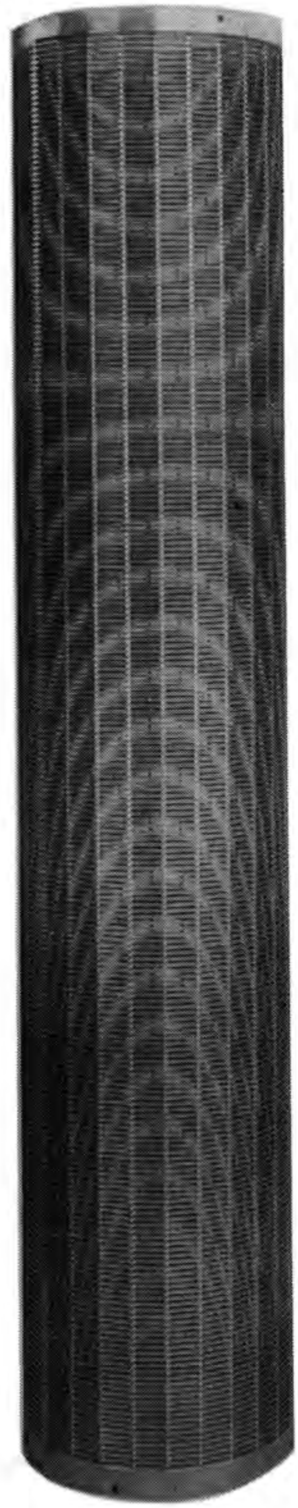

Figure 2 - Cylindrical Screen with slotted perforations.

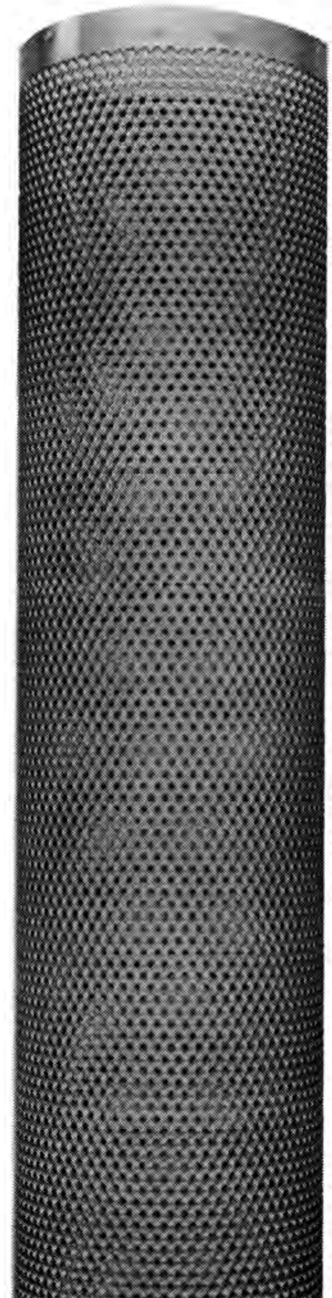

Figure 3 - Cylindrical Screen with round perforations.

the leading edge is round. This pocket will lift out cross broken, short tubular, or elongated particles since they have a flat surface to "sit" on.

Generally speaking, the pockets are consistent in their proportionate dimensions. The pocket size is referred to by its width, measured radially from the center of the disc and range from 2 1/2 mm to approximately 3/4". The length or height of the pocket is essentially the same dimensions as the width while the depth is approximately one-half dimensions of the width.

In the complete machine a series of discs called the rotor are used. The disc pocket sizes used in any one rotor layout may be all identical or may vary in type and size. In most cases when different sizes are used, the pockets become progressively larger from the intake to the discharge end of the machine.

Conveyor blades fastened to the spokes in each disc are used to move the body of material through the disc machine.

A series of paddle like blades are placed between the discs and are used for retarding and adjusting the grain level in the body of the machine.

The tailings gate placed in the rectangular discharge opening of the machine is adjustable and is used for adjusting the level of the mass of material near the discharge end.

A small conveyor running across the front of the machine is used when necessary to return some of the liftings of the discs to the feed end and body of material in the unit.

Splitter valves in some cases are supplied in the liftings discharge hopper.

Operation:

The disc rotor placed in the body of the machine is set in rotation and material to be separated is fed into the machine at one end and on the upward stroke side of the rotor.

Returning to our undercut pocket illustration, short seeds which fit into these pockets are lifted, held in the pocket by centrifugal force and discharged on the opposite side of the rotor much as material is discharged from a bucket elevator. Those particles too long to fit in the pocket will fall out and be conveyed through the eye of the disc by the series of conveyor blades.

The speed of rotation is important as should it be too fast centrifugal force could prevent the material from falling out of the pocket and too slow a speed would allow the material to fall out of the pocket before it reaches its proper discharge point.

A series of small troughs between the discs on the liftings discharge side catch material as it is discharged from the pocket and allows it to fall into the liftings discharge hopper.

As mentioned in the construction section of this presentation, the liftings discharge hopper may be equipped with one or two splitting valves which allow separate discharge of various sections of discs in the rotor. The smallest particles lift out of the mass on the first few discs and it may be desirable to draw off these smaller liftings separately from the longer liftings discharged at the center or tail end of the disc shaft, or it may be desirable to draw off the longer tail end liftings separately from the shorter material discharging from the center and intake end of the machine. As you can see by use of two valves, it is possible to divide the liftings into three different streams.

The speed of the flow through the machine may be adjusted by adding or removing conveyor blades on the spokes of the discs. The speed of this flow through the machine is determined by the type and efficiency of separation required.

The portion of the mass which is not picked up and discharged as liftings, will pass through the eyes of the discs to the discharged end of the machine. At this point, it passes over the adjustable tailings gate which may be used to vary the depth of the mass in the machine.

The grain level control blades are also used for adjusting the depth of material in the body of the machine as well as to retard the flow of certain points along the rotor. By increasing the depth of material in the machine, a greater percentage of the mass will be lifted due to the fact that it has a shorter distance to travel, conversely less material in the machine will produce a smaller percentage of liftings.

The return conveyor mentioned earlier is an important facet of the machine, as it allows some flexibility in the split. This conveyor is placed so that when open it will catch the disc liftings and return them to the body of material at the intake end of the machine. Trap doors close over this conveyor to prevent entry of the liftings during normal operation. In most cases this conveyor is used to return only the liftings of a few tail end discs which may be little longer than the material you wished removed. Therefore by returning it to the main mass of material, it will eventually be discharged with the tailings or longer particles.

Combination Disc Separator

All the subject material so far has dealt with the single rotor disc machine. One combination unit consisting of two disc rotors and designed to produce a four way split of the intake feed is available.

This machine is called a #1547 as it employs 47 discs of 15" diameter. There are two rotors, the top rotor consists of discs with large pockets which will lift the main mass of material and tail longer undesirable seeds of foreign material. The lifting of the top rotor drop into a conveyor which discharges to the lower rotor. This lower rotor normally will employ two or three different size pockets. The liftings of the lower rotor are split by means of a valve into two streams. The very small foreign material is discharged by the first half of this rotor and medium length product by the second half of this rotor. Clean seed is tailed from this lower rotor.

Various arrangements of single rotor units are employed in both series and parallel fashion.

The other method of length separation is by utilizing an indent cylinder machine.

Indent Cylinder Separator

Construction:

The primary component part of the indent cylinder machine is a cylindrical indented cylinder shell which has been heat treated and cyanide hardened to resist wear. Like the disc machine, pockets or indentations vary in size and particles which are short enough to fit into the indent will be separated from those particles too long to fit in the indent.

The cylinder shells are generally 17" in diameter and are available in two different lengths depending on capacity requirements. There are about 15 indent sizes available. Sizes are indicated in 64ths of an inch measured diametrically.

A trough to catch liftings is placed inside and runs the length of the cylinder shell. Inside this trough is a conveyor used to carry lifted material to one end of the machine for discharge.

A retarder or dam is placed at the end of the cylinder and may be adjusted to control the level of material in the cylinder.

A variable speed drive is supplied with single cylinder units to vary speed of cylinder rotation.

A mechanism for adjusting the intake height of the single cylinder machine allows a variance of cylinder incline.

A large hinged door on the top of the discharge end allows visual inspection of the separating area, as shown in this slide.

Operation:

Seed is fed into one end of the indent cylinder which is set into rotation. Material is loaded into the indentations by a combination of centrifugal force and gravity. Those particles or seeds which have their center of gravity within the lip of the indentation will remain in this indentation until the force of gravity pulls them out which at the proper speed of rotation will be within 30° of top center. Those particles which are long enough to have a center of gravity outside the lip of the indent will fall out and pass to the discharge end of the cylinder.

The speed of rotation of the cylinder is variable and can be increased from approximately 45 rpm to 60 rpm. The most efficient operating speed depends on the resistance caused by friction. This resistance varies with the texture, weight per bushel and moisture of the product. Such factors do not affect the operation of a disc length separator. Visual inspection of the separation during performance will indicate the proper operating rpm. Too fast a speed will carry liftings over the trough and too slow a speed will allow liftings to discharge before they reach the level of the trough. The trough which catches liftings of the cylinders may be set at various positions. In this next slide you can see liftings being discharged properly into the trough. If the lip of the trough closest to the grain carrying side of the cylinder is lowered more of the product within the cylinder will fall into it. If this lip is raised less product within the cylinder will fall into the trough. Thus the trough allows a certain range of flexibility of separation within one indent size. In other words when the trough is lowered the average length of particles dropped into it will be longer than when the trough is raised.

Between lots of seeds to be cleaned this trough may be rotated for cleanout purposes. This operation can be performed without disrupting the original trough setting.

As mentioned, the retarder on the discharge end of the cylinder operates as a dam to prevent the bank of material, in the cylinder, from tapering down to a low point at the discharge end. Should this happen the cylinder at that point would be "starved" and would tend to lift material longer than it was designed to lift. This retarder is adjustable so that the depth of material in the cylinder can be varied.

Flow through the cylinder is either by gravity or in older style machines by an open conveyor running in the mass of material in the cylinder. The adjustable intake height is available in order to vary the speed of travel through the cylinder.

Combination Cylinder Separators

The single cylinder length separators may be stacked up to four high and may be fed in parallel or in series. A typical series flow would be to spout the liftings of the top machine in a three high arrangement to the bottom machine and the tailings to the center machine. This type of an arrangement utilizes the top machine as a "splitter", the center machine for removing longer than desired length and the bottom machine for removing shorter than desired length. Many times in an arrangement such as this the liftings of the center cylinder and the tailings of the bottom cylinder are combined as cleaned desirable product.

Other large multiple cylinder machines are available which incorporate in one unit a number of cylinders which may be arranged either in parallel or series. Many of these larger machines also incorporate scalping and aspirating.

In addition to all disc machines and all cylinder machines there are also those which combine both methods of length separating in one unit.

Combination Disc and Indent Cylinder Separators

The combination machines may or may not incorporate scalping and aspirating, if they do this portion of the operation precedes the length separating components.

In these combination units, the disc separation precedes the indent cylinder separation.

Material is fed to a section of discs which perform an initial split of the product. The liftings of this first disc section are conveyed to a second or "grader" section of discs. The tailings of the splitter section are spouted to an indent cylinder with a large size indent.

At this point, long undesirable material is tailed from the cylinder and large desirable product is lifted.

The tailings of the second disc section is clean desirable, medium length product. In some models, the liftings of this second section are discharged as short undesirable material. In other models, these liftings are conveyed to another indent cylinder with a small indentation where a reclaiming operation on the shorter material is performed.

Basically, the disc method of separation has the advantage where certain specific shapes such as smooth, round seeds are prevalent and where it is desirable to have a relatively unattended operation. The indent cylinder method allows a little greater flexibility and has less attritional effect on fragile products. Both methods when properly controlled can produce accurate efficient results.

SPECIFIC GRAVITY SEPARATOR

Charles E. Vaughan and G. Burns Welch [1/]

The names "Gravity Separator" or "Gravity Table" are contractions of "Specific Gravity Separator"; the shortened forms are more commonly used.

Crop seeds often contain immature seeds, weed seeds, or foreign material such as particles of soil that are the same size as the crop seed. Because of this, the undesirable material cannot be separated from the crop seeds with air-screen machines, length graders, etc. However, if each individual unit of the undesirable material has a specific gravity different from that of the crop seed the mixture can be separated with a specific gravity separator. Specific gravity of a solid or liquid is the ratio of the weight of the body to the weight of an equal volume of water at some standard temperature. If some material has a specific gravity of 1.5, this means that the material is 1.5 times as heavy as an equal volume of water.

Operation

Learning to operate a gravity table is like learning to drive a car or ride a bicycle. A person can read all the instructions that have ever been written about how to drive a car, but until he gets a little practice behind the steering wheel he will not be a very good driver. So it is with the operation of a gravity table. After a person understands the principles of operation, if he will spend a few minutes or hours practicing with the various adjustments, it will pay dividends by enabling him to do a better separating job with his machine.

The separation of a mixture of seeds on a gravity table is accomplished in two steps. First, the seed mixture is stratified vertically by air into layers of different specific gravities, the heaviest layer being on the bottom and the lightest on top. After the mixture is stratified the different layers are separated by deck motion and gravity. Both actions occur simultaneously as the seed moves across the deck.

In operation, the deck is vibrating back and forth while currents of air from a fan under the deck are being blown through the deck. The seed mixture that is to be separated is fed onto the deck at the corner farthest from the discharge edge. The strength of the air currents is adjusted to cause the

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[1/] Charles Vaughan and Burns Welch are Assistant Agronomist and Associate Agricultural Engineer, respectively, Mississippi Agricultural Experiment Station, State College, Mississippi.

mixture to stratify into layers. These layers are then separated by the movement of the deck and by gravity. The heavy seeds that are in contact with the deck surface are pitched up and forward on the forward stroke. The deck then moves backward and downward on the backward stroke and catches the heavy seeds at a point farther up the deck. This fast action keeps the heavy seeds moving up the deck. The light seeds which are being floated on top of the heavy layer of seed by the air currents will flow by gravity to the lowest part of the deck.

Deck Shape

Based on shape of deck, the separators may be classified as (1) triangular deck gravities and (2) rectangular deck gravities. The deck is covered with a porous material through which currents of air will pass. It is mounted on inclined toggles which gives it an upward-forward and a downward-backward movement when it is in motion. The deck is slanted in two directions. It is slanted up in the direction of the upward-forward motion (this is known as end raise) and down from the back side to the discharge edge (this is known as back raise). On a rectangular deck, the back raise would be from the feed zone to the side where the light material is discharged.

Deck Coverings

Gravity table decks that are used in the seed industry are covered with a material like oxford cloth or closely woven wire. The cloth-covered deck is used in the separation of small seeds such as the clovers. The wire deck is used when separating large seeds such as beans and corn. It is important that the right deck is used for a given seed species.

Some wire decks have coarse mesh wire about 1/2 inch by 1/2 inch on top of the closely woven wire. The purpose of the coarse mesh wire is to give more traction for smooth seeds. The wire deck also has metal strips about 1/4" high and three or four inches apart on top of the wire. These strips are known as riffles. They serve as dams to prevent the smooth heavy seed from moving toward the discharge edge before they are carried to the highest part of the deck.

Adjustments

There are five main adjustments provided on a gravity table:

1. Amount of Air: This is controlled by an adjustable damper in the inlet side of the fan housing. If excessive air is used, the strong air currents will keep the seeds mixed, prevent them from becoming stratified, and the heavy seeds will flow toward the low end of the deck with the light material. If insufficient air is used, the seeds will not be stratified and the lighter seeds will travel up the deck with the heavy seeds.

2. End Raise: (Elevation of the deck in the direction of the upward - forward motion.) The purpose of the end slope adjustment is to elevate the end of the deck so that the heavy seeds and the light seeds can be separated after they become stratified.

3. Back Raise: (Elevation of back side.) The purpose of the side slope adjustment is to regulate the rate at which the seeds travel toward the discharge edge of the deck. An increase in the amount of side slope will increase the rate of travel while a decrease in the slope will increase the travel. Seed mixtures with only a slight specific gravity difference require a relatively flat slope in order to give the seed more time to become stratified. A steep side slope can be used for mixtures that have a wide difference in specific gravities and stratify more quickly.

4. Speed of the Eccentric: The speed of the eccentric shaft can be varied by adjusting the variable speed drive. An increase in the eccentric speed will cause the seed to travel faster up the back, while a decrease in speed will result in a slower rate of travel.

5. Rate of feed: It is important that a gravity table be fed uniformly and to its capacity. Feeding the machine too fast will cause an excess of good seed to be discharged with the light material. At no time should any portion of the deck be bare as this causes an uneven distribution of air through the deck.

All of the adjustments on a gravity table must be in balance. Only one adjustment should be made at atime after which the machine should be allowed to run several minutes for the adjustment to show its effect on the flow of seed across the deck. Other adjustments are then made as needed.

Recommended Procedure For Setting-Up A Gravity Table

1. Select the right type of deck. A cloth deck is used for small seeds such as the clovers, while a wire mesh deck is used for larger seeds.

2. Close off the air and adjust the side and end tilt for a moderate amount of slope.

3. Start the feed and adjust the speed so that the seed will back up against the back rail until the deck is about one-half covered.

4. Open the air until the seed become stratified and the light material begins to flow downhill.

5. Adjust the feed again and then adjust the air to make the light material flow downhill. This operation is repeated until the deck is completely covered with a layer of seed.

6. The vibration and slope can now be adjusted to increase capacity.

When a gravity table is out of adjustment all material on the deck will tend to move toward the highest or lowest part of the deck.

If all the material tends to move toward the highest part of the deck, it could be caused by one or more of the following:

a. Insufficient air currents.

b. Not enough end raise.

c. Not enough back raise.

d. Speed of vibration too fast.

If all the material tends to move toward the lowest part of the deck, it could be caused by one or more of the following:

a. Excessive air currents.

b. End raise too high.

c. Back raise too high.

d. Speed of vibration too slow.

Installation Tips

The gravity table must be installed properly in order to give the best performance. Some of the mistakes most commonly made when installing a gravity table are:

1. Installing a gravity separator on a weak foundation. The gravity separator is a vibrating machine and should be installed on a firm foundation. A slight vibration at the base of the separator will be multiplied many times before reaching the deck. This is known as false vibration, as opposed to the the eccentric vibration which is built into the machine. If the false vibration becomes synchronized with the eccentric vibrations it will cause the seed to have a tendency to surge across the deck. Should the two vibrations get out-of-step, one vibrating force will counteract the other vibrating force resulting in no forward movement of the seed.

2. Uncleanair. A gravity table uses a large amount of air which is blown up through the deck. If dirty air is blown through the separator, some openings in the deck covering tend to become clogged. This condition can be detected by blind areas on the deck where the seeds do not seem to be floating. Some operators have doubled the capacity of their gravities by piping clean air in from the outside.

3. Fan running backward. If the fan is running backward, it will not develop sufficient pressure in the air chest. Most machines have an arrow on the fan housing or motor showing the correct direction of rotation. If no directional arrow can be located, the deck should be removed and the motor started. The fan blade should be rotating toward the discharge opening, if not, it is turning backward. To change the direction of rotation of the three phase motor, the switch should be disconnected and any two of the wires leading to the motor reversed.

4. Loose deck clamps. All clamps should be tight. Loose clamps will cause vibrations.

5. Loose belts. If the drive belts become loose, the machine will not operate at a uniform speed. Irregular speed will cause the seed to surge across the deck.

6. Wrong type of deck. Be sure to use the right type of deck. The general rule for deck covers is: For small seeds use a deck cover with small openings. Conversely, for large seeds use a deck cover with large openings.

There are many more mistakes that can be made in the installation of a gravity table but these are probably the ones most commonly made.

MAGNETIC SEPARATORS

Dumont A. Souleyrette [1]

In recent years the use of magnetic separators has come into wide use particularly in the clover and alfalfa seed producing areas. Although the principal of magnetic separations were first developed some forty-five years ago it did not gain acceptance due to the fact that the iron oxide that was applied to the seed didnot give a complete separation and discolored the seed. The most common use of magnetic separators has been in industrial applications in separating ferrous from non-ferrous materials.

To place the magnetic separator in its proper prospectus it should be realized that the mill is to be used in addition to and not in place of cleaning mills presently used in the processing of clovers and alfalfas. In many instances the good job on seed cleaning in the past is not good enough to meet the more exacting standards of seed quality today brought about by Seed Certification Standards and the demand by farmers for top quality planting seed. The magnetic separator should be considered as a finishing machine and not a cleaner. Since we would not make any attempt to clean small seeded legumes on a Dodder Mill without first cleaning the seed on an air and screen machine and possibly the gravity table, we should not eliminate any of these procedures before finishing the seed on the magnetic separator.

While the magnetic separator has certain limitations and will not solve all of the seedsmen's problems it does offer certain advantages in making some separations that are difficult or even impossible with other types of cleaners. Often good lots of seed can be upgraded to excellent lots simply by removal of a small quantity of inert material and weed seed which could not be removed by other processing equipment. One advantage is that in the removal of inert matter and weed seed there is a very minor loss in crop seed unless the crop seed was damaged in harvesting. In this event, damaged seed should be removed to maintain quality and prevent lower germination after the seed is on the market. In addition there isn't any large amount of middling product to worry about how to dispose of later.

The principle of cleaning with a magnetic separator is simple. The principle makes use of the differences in seed coat texture between the smooth seed coat of the crop seed, the rough, granular, or gelatinous seed coat of the weed seed. Rough surfaced inert matter can be included with the weed seed.

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To this admixture a small amount of water and iron powder is added. The iron powder sticks to the rough material and not to the smooth seed. Then the seed is passed over a magnet to which the weed seed and inert matter stick and the crop seed pass on over. The degree of successful cleaning depends largely upon the magnitude of the seed coat differences and the thoroughness of the mixing operation.

While there are at least six different makes of magnetic separators representing United States, English, and German companies, all are composed of essentially two units, a mixing mechanism and a magnetic separating device.

Two general systems are used in the mixing of water and iron powder with the seed to be cleaned. The "batch" system mixes a measured amount of water and iron powder with a measured amount of seed and mixed for a specific length of time. In the continuous flow system an unbroken stream of seed is passed thru a series of auger-type mixing chambers or an auger and rotating cylinder with louvers. The water and iron powder are added at different points and are mixed together as the seeds travel toward the separating device. The key to success in magnetic cleaning is in the mixing operation. If the dosage materials are not applied to the seed in the correct amount and mixed thoroughly and uniformly, some of the undesirable seed or inert material will not be coated with the iron powder and will pass over the cleaning unit with the clean seed.

The separating unit consists of a flat revolving belt with the driving roller being a magnet or a rotating cylinder or drum. Magnets may be electro-magnets, permanent magnets, or stationary electric poles. At least one magnetic separator is equipped with an electric drying device to remove any excess moisture after the mixing process has taken place.

Regardless of the type separator used, the same general principals hold true whether the magnets are electro or permanent type. The iron powder is introduced on the seed that have been slightly moistened, after which the dosage materials and seed are mixed together. The rough, gelatinous coated seed and foreign material retain the iron powder where as the smooth seed do not. After mixing the seed are passed over the magnets. The seeds and inert material which have iron powder sticking to them are held to the surface of the drum by the magnetic force and those to which no powder adheres simply pass over the drum. Seed clinging to the drum either fall off by gravity or are brushed off by stationary or rotating brushes into the spouts provided for the rejected material from the seed lot.

Magnetic separators with electro-magnets permit the intensity of the magnetic field to be varied by use of a rheostat on a rectifier or transformer. You can expect to pay more for machines equipped with an electro-magnet due to the additional cost of the drum and direct current power source.

The capacity of magnetic separators varies from approximately 200 to 1300 pounds of clean seed per hour. The price of the magnetic separators vary from $2500.00 to over $8000.00, however, there isn't any relation between capacity and price. There are at least two American made magnetic seed cleaners that are in the $2500.00 to $3500.00 price range with capacities from 450 to 600 pounds of clean seed per hour. Once the magnetic separator is installed the cost of maintenance is very low. The cost of the iron powder in cleaning small seed runs between 25 to 30 cents a hundred weight. Usually a considerable savings can be made in purchasing the iron powder in quantity.

Some of the factors that affect the magnetic cleaning of seed are as follows:

The Kind of Crop Seed

Not all crop seeds which can be cleaned with the magnetic separator respond equally to similar dosage applications. Seeds with extremely hard and slick seed coats, such as Sericea lespedeza, take up less iron powder than seeds with slightly roughened or irregular seed coats such as alfalfa and red clover. Sweet clover will take up even more iron powder than alfalfa and red clover as a result of having a still rougher seed coat. Generally speaking, the crop seed which have the slicker coats will require small dosages, have a lower cleaning loss, and will result in a more effective separation.

The Condition of the Crop Seed

High crop seed losses sometimes accompany magnetic cleaning. These high losses can usually be attributed to the treatment the seed received during harvesting and processing operations prior to cleaning on the magnetic separator. Crop seed which have received careful treatment during harvesting and subsequent handling operations are likely to have less broken and damaged seeds than those which are roughly handled. Cleaning losses are higher with scarified and badly broken seed because the roughened seed coats collect more iron powder than the unscarified seed. This, however, is a blessing in the long run in that the splits and cracked seed are removed thus improving purity and the germination percentage will not be reduced by the cracked seed which will lose their viability in storage.

Seed to be cleaned on the magnetic separator should be thoroughly cleaned with other machines, especially seed high in inert material. When the percent inert matter and weed seeds in a lot reaches 5 percent the efficiency of the magnetic separator is greatly reduced. In lots containing 5 percent inert matter and weed seed the amount of water needed to moisten all of the weed seed and inert matter is an amount that will cause the crop seed to become so moist that the iron powder will stick to the crop seed causing it to be pulled out with the weed seed. A reduction in the amount of water to keep the crop seed from being rejected will result in an incomplete coverage of the weed seed and inert material which will not be removed from the clean seed.

A good screening, aspirating, gravity separation, and roll mill job will result in a better job and less worry. As stated earlier, the magnetic separator is a finishing machine and not a cleaner. Weed seed and inert material in a lot of seed should be held to a maximum of 1.5 percent and preferrably to 1.0 percent.

The Kind and Concentration of Weeds

An ideal mixture is one in which the two species to be separated differ in physical characteristics to such an extent that a separation can be made on basic cleaning machinery. Unfortunately, the weed seeds of many species cannot be satisfactorily removed by the magnetic method because of similarities in physical properties of the seed coat of the weed and the crop in which it is mixed. In mixtures that can be separated some considerations relative to the amount of water and iron powder should receive attention. A seed lot containing a high weed seed concentration requires a higher dosage for effective cleaning than a lot with a lower concentration. Since the gelatinous seed coat of buckhorn absorbs water quite readily, the water requirements of a mixture containing this weed seed is higher than lots of the same crop seed contaminated with a similar amount of dodder.

Insert Materials

The presence of dirt, sticks, straw, leaves, and other contaminating debris in a seed mixture results in a higher dosage requirement for effective cleaning. The inert material competes with the weed seed for the available dosage materials and enough dosage must be applied to coat both the weed seed and inert matter.

Kind of Magnetic Powder

Research at the Seed Technology Laboratory has shown that the effectiveness of iron powders vary considerably. Even though the powders are similar in that each contains a high percentage of iron, they differ in such respects as particle size, shape, apparent density, and to some extent color. The better performing powders are effective on most seed lots that may be magnetically cleaned but in some instances certain powders appear to be somewhat specific, i.e., one material seems to adhere to a particular species of weed seed better than to another.

Adjustments

One adjustment is the rate of feed. For accurate and economical cleaning the rate of feed must be controlled and properly adjusted. An incorrect feed adjustment will result in either a loss of capacity of ineffective cleaning depending upon whether the rate is too slow or too fast. The rate of feed should be adjusted to where the amount fed into the mixing mechanism is at the same rate in which the seed are going over the magnetic separating device. For efficient cleaning the seed should not be more than one layer thick when fed onto the magnetic separating device. This enables every seed to come into contact with the magnet.

A second adjustment is the mixing time. This particular adjustment is important in that an incorrect mixing time will result in an ineffective separation. Too long a mixing will allow the water to evaporate and the iron powder to be rubbed from the seed. Too short a mixing time will not permit thorough coverage of the weed seed with iron powder.

Some units with "batch" type mixers are equipped with an automatic control cabinet for the addition of the pre-set quantities of water and iron powder, as well as automatic control for the timing of the mixing cycle. The mixing time is controlled electrically. The mixing time for magnetic separators using a "continuous flow" mechanism is determined by the rate of feed. The higher the rate of feed the shorter the mixing time. Here the rate of feed and mixing time go hand in hand and are determined by the results of the seed at the clean seed discharge spout. If weed seed are present in the clean seed then the rate of feed should be decreased in order to increase the mixing time.

A third adjustment is the dosage material. Getting the right proportion of iron powder and water is somewhat of a problem and the requirements differ with each lot. Too little liquid results in inadequate coverage by the iron powder and consequently poor cleaning results. Excessive amounts of liquid and powder results in discoloration of the seed, excessive cleaning losses, and increased cleaning costs due to the loss of iron powder. Soft water and warm or water at room temperature gives better results than hard water and/or cold. Hard water may be softened by the use of any of the commercial water softeners on the market today.

A fourth adjustment is the intensity of magnetism. The strength of magnetism can be adjusted on separators equipped with electro-magnets and a rheostat on the variable transformer.

A fifth and the most important adjustment is the operator. In cleaning seed on the magnetic separator no adjustment or factor that enters into the operation and adjustment of the magnetic separator is as important as the operator. A small expenditure in time and money on the operator at the beginning of the operation will return the expense incurred for as long as the magnetic separator is used. The operator should know and understand the principles upon which magnetic separations are made. He should be trained and able to identify the noxious or problem weeds which he will be concerned with in separating with the magnetic separator. The inert matter and other weeds will take care of themselves. For equipment the operator should have a well lighted window or lamp and table where he can analyze a small clean seed sample. In addition, he will need a pair of forceps, a hand lens (1 1/2" diameter) from the dime store that will fold up in a leather case, a white sheet of paper to analyze the samples on, and a small cup that will hold approximately one ounce of seed.

After the mill is in operation, the operator should catch a sample of clean seed from the clean seed discharge spout and check for the number of noxious weed seeds per ounce. If he finds more than the permitted number before he finished the sample he immediately knows that the quality of the seed is not up to specifications and some adjustments need to be made. If the number of noxious weeds in the first sample was on the borderline the operator may decide to draw a second sample for analysis before making any adjustments. This sampling method is quick and does not call for any complicated calculations. In its simplest form the question is how many noxious weeds are in about one ounce of seed. If two noxious weeds are permitted per ounce and the operator finds five per ounce an adjustment is called for immediately. If two or three noxious weeds are found per ounce, another sample should be drawn before deciding on what adjustment to make.

How can the operator determine how much water and iron powder to use plus the correct mixing time required to get a good separation when each lot is different? Since capacity is also important, the feed gate should be opened to where the seed going to the mixing mechanisms is equal to the amount going over the magnet one layer of seed thick. The feed gate should be such that if the gate is closed for any reason it can be re-opened to the same place. To determine how much iron powder to use, watch where the seed comes out of the mixing mechanism and there should be a very small amount of free iron powder, just enough to be visible. Another method is to slide some seed from the mixing mechanism across a white sheet of paper and see if there is any iron powder left on the paper. If the weed seed are being taken out and there is some free iron powder everything is properly adjusted.

If there is free iron powder and weed seed left in the clean seed then the water should be increased. To check for the proper amount of water, examine the reject container and if there is a considerable amount of clover seed, first check to see if the seed is being rejected because of cracks and broken seed due to harvesting or previous processing. If the seed is not damaged, the rejection is due to too much water and the iron powder sticking to the seed.

When it has been determined that the water and iron powder dosage is correct check the purity on the clean seed. If excess weed seed are present, reduce the rate of feed, this will increase the mixing time. Once the correct dosage of water and iron powder has been determined plus the mixing time, the adjustments from one lot to another for a particular kind of crop seed are minor.

One advantage of the magnetic separator is that it will either make the separation or it won't. You do not end up with lots that are better than what you had and still not good enough to sell. Occasionally you will find a lot with an extremely high number of weed seed which the magnetic separator will remove but won't be able to get them all out with any combination of dosage material and mixing time. Make the best separation possible and set the seed aside for a few days to dry and then re-run the lot to remove the escapes.

ROLL MILL

Charles E. Vaughan [1]

The roll mill uses a difference in surface texture and shape of the seed to make a separation. The roll mill is always used after the basic cleaning machines in the processing line. It is often used to finish lots that contain dodder, dock, flat or immature seed and inert matter that passed the previous machines.

The rough seed are separated from the smooth seed by the action of the rolls. A pair of rolls covered with a velvet like material are placed side by side close enough to touch lightly. The rolls are mounted in an inclined position and turn in opposite directions, outwardly when viewed from the top. By the action of the rolls the rough seed are lifted out of the smooth seed and discharged separately.

No matter what roll mill is chosen, the parts and operation of the machine are practically the same.

Component Parts

Feed Hopper. The feed hopper is that part of the machine that receives the seed yet to be cleaned from the elevator or from some other means. From the feed hopper the seed are fed into the machine for the cleaning operation. At the bottom of the feed hopper there is a vertical shaft through which the seeds flow. From this shaft, individual feed spouts lead directly to each pair of rolls. This vertical shaft is equipped with a fast, complete clean-out pull slide.

Rolls. The rolls are the separating parts of the machines. They are covered with a velvet-like material and are placed side by side close enough to touch lightly. The rolls are always used in pairs and each pair of rolls is a separate cleaning unit.

The length of the rolls may vary with different machines, as a certain length is not absolutely necessary for maximum cleaning. The number of rolls may also vary from machine to machine. An increase in the number of rolls does not increase efficiency but merely increases capacity. The number of pairs of rolls may vary from one to ten depending upon the capacity desired.

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Tilt Mechanism. The tilt mechanism is located at the bottom of the feed end of the machine. On some machines it is a large hand wheel screw; whereas, on other machines it is a combination lever-screw device. This variable tilt mechanism permits quick, easy adjustment of the machine's pitch for various types of seeds. A continuous incline range from 7° to 13° may be obtained.

Baffles. The baffles are shields that conform fairly close to the shape of the rolls as viewed from the top. A baffle is placed directly over each pair of rolls for the purpose of deflecting the seed being thrown over, back against the rolls. This causes the rough seed to move very rapidly to the outside. The baffles are independently adjustable at either end of the machine. The range of separations possible may be increased by changing the distance between the rolls and the baffles.

Variable Speed Drive or Speed Control Mechanism. The speed control mechanism is an important part of the machine, because the speed of the rolls is one of the most important adjustments. This part of the machine is located at the discharge end of the machine. By changing a variable speed drive, or changing the size of one pulley in relation to the size of another, the speed of the rolls can be accurately controlled. Either belts or chains are used to turn the rolls.

Operation

The seed mixture is fed onto the rolls at the high end of the machine. As the seed travel downhill between the revolving, inclined rolls, the rough seed are caught by the velvet-like rolls and thrown against the baffles, deflected back against the rolls, etc., until they have been thrown out. The smooth seed continue bouncing downhill between the rolls and discharge off the end. The seeds thrown over the sides are caught in graduated grade hoppers underneath the machine. The grades of seed from these hoppers vary from a high percentage of rough seed from the one nearest the feed end of the machine, to a very low percentage of rough seed from the one nearest the discharge end. The intermediate grades can be re-run to recover the smooth seed that were thrown out with the rough seed.

Adjustments

1. Rate of feed. The rate of feed is adjusted and controlled for two reasons. First, the effectiveness of the separation may be controlled somewhat by the rate of the feed. If the space between the rolls and the baffles becomes crowded the agitation that is necessary to make an effective separation is reduced or prevented. Second, the capacity may be increased by opening the feed slide.

This adjustment is made by opening or closing the feed slide in the vertical shaft underneath the feed hopper. This increases or decreases the size of the opening in the shaft, through which the seeds flow into the individual feed spouts.

2. Speed of the rolls. The most important adjustment is the speed of the rolls which is controlled by the hand wheel at the end of the motor base. In general, the faster the rolls revolve, the cleaner the seed. However, too fast a speed is not recommended, because it results in unnecessary throw-over of good seed. The recommended way of making the adjustment is to start with a minimum speed and the desired rate of feed, then increase the speed of the rolls until the product is clean.

3. Variable tilt mechanism. This adjustment is used less by most operators once a desirable tilt has been established. To increase the tilt has the effect of shortening the rolls. This also reduces the amount of throw-over.

4. Height of baffles. The baffle adjustment is used primarily to widen the range of separations possible. For most cleaning problems, a 1/4 inch spacing seems to be best. The baffles are independently adjustable at either end of the machine. However, all the baffles are adjusted at one end at the same time and have the same spacing.

Common Separations

Below are listed a few rough-coated seeds and objects which are thrown out by a roll mill.

Dodder	Catchfly	Wild Winter Peas
Mustard	Cockle	Wild Carrot
Foxtail	Timothy	Clay or Stones

These rough-coated seeds or objects may be removed from clovers, alfalfa, hulled lespedeza, hairy vetch and other smooth-coated seeds. Because of its triangular shape and sharp corners, dock is commonly and easily removed from the clovers.

The removal of buckhorn can be accomplished with this machine if prior treatment has been given the seed lot containing buckhorn. This prior treatment involves adding a foreign material, such as wood dust, to the moistened buckhorn seed. Separation is then an easy matter.

The roll mill is a very economical machine because the cost of operation and maintenance is extremely low. The minimum attention needed to operate the roll mill, once it is adjusted, is also a point to remember when considering this machine.

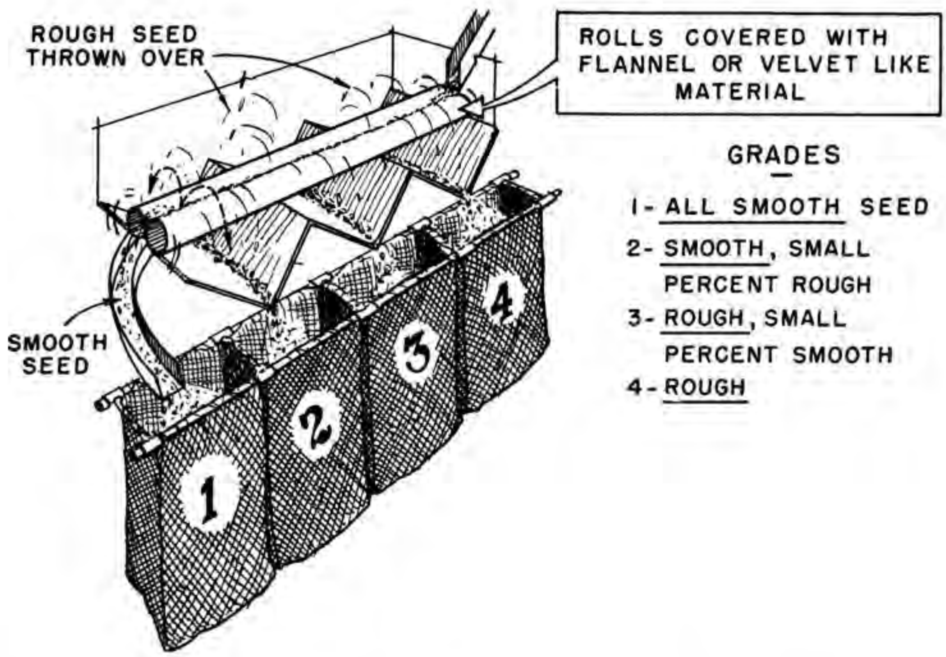

Figure 1. Diagrammatic section of roll mill showing method of operation.

COMPLEMENTING YOUR BASIC PROCESSING MACHINES

Bill Gregg [1]

The basic cleaning operations performed by basic processing machines generally do the bulk of the processor's work in changing field-run seed into a high-quality product ready for planting. However, they will not always remove all undesirable seed, and capacity may not be as high as desired. The progressive processor is always looking for ways to improve his efficiency.

Consideration should always be given to whether a particular crop or weed seed should be removed in the field or in the cleaning plant. It is poor management to grow seed in weed patches, make no effort to clean them up, and then expect the processor to separate everything from the crop seed. Every processor should have a field man who knows processing, weed and insect control, and fertilizers. The field man can work with growers---help them select clean fields and keep them clean.

Special-purpose machines can sometimes increase processing efficiency, or remove a contaminant, and make their use not only practical but necessary. These machines can be divided into two categories: machines which improve the condition of your seed before actual processing; and, machines which will make a specific separation, based on specific seed differences. These machines, properly used, will complement the operation of basic cleaners to produce a higher quality product in a more efficient operation.

The first such machine, the scalper, is actually a precleaner. It is intended to "scalp off the top", to make a rough removal of sticks, straw, and other inert from a seed lot before it is cleaned or stored. In my opinion, every dryer or processor of seed should have and use a scalper. Reduced drying costs, less elevator plugging, and faster processing of scalped seed will pay for a scalper in a short time.

A wide range of types and sizes of scalpers are available. Screen scalpers range from a single "airless" screen to multiple-screen scalpers with 1 or more air separations. There are reel screen scalpers ranging from huge receiving scalpers to the reel on disk-cylinder separators. Some scalpers include an aspiration, while others use only an air separation.

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For maximum effectiveness, the scalper should be used as soon as the seed come in. For example, a high-capacity scalper can scalp wheat, oats, peas, peanuts, etc., before they go into storage. This will often reduce the storage space needed. Scalping to remove high-moisture trash will enhance drying and storage of freshly-harvested seed. Scalping before the seed are cleaned will usually put the seed in better condition for processing, increasing the capacity of cleaners and the precision of separations. A processing line scalper should be mounted at the first point in the line. It will reduce the bulk of material going into your cleaners. This prevents elevator and feed-hopper plugging, reduces the bulk of material that must be removed, and allows you to make closer separations.

The Huller-Scarifier was designed for a specific job - to remove hulls from seeds and to scarify hard seed coats. This is usually accomplished on a production scale by some means of rubbing the seed against an abrasive surface, although heat, irradiation, and acid can also be used to scarify seed. When seed are scarified mechanically, the scarifier should follow the air-screen machine, or be further down the cleaning process. After all foreign material has been removed, more uniform scarification can be done. This allows all seeds to be scarified properly, with a minimum of seed damage.

The amount of hulling necessary depends, of course, on the seed being cleaned. Seed may be hulled to increase seed weight, and to make processing and planting easier. Hulling may change the physical characteristics of your seed enough to make possible the separation of a weed seed that could not be removed from unhulled seed.

In some installations, the huller is located between a scalper and the air-screen machine when all seed must be hulled. If only a portion of the seed require hulling, the huller is located so that it can be fed from the cleaner that separates hulled from unhulled seed. Hulled seed are fed from the huller back into the cleaning line.

The scarifier-huller is a useful machine in processing clovers, lespedeza, alfalfa, and some grasses. As a huller, it improves the efficiency and uniformity of processing and planting. As a scarifier, it gives more uniform field stands of crops that contain hard seed.

The scalper and the scarifier-huller put the seed in condition for easier handling. Some machines that actually separate seeds are the spiral, the draper, and the vibrator. These separate seeds by differences in their ability to roll or slide under different conditions.

The spiral separator is a very simple machine with no motor and no moving parts. It consists of a vertical arrangement of sheet metal spirals set at a certain pitch. It resembles an open screw conveyor standing on end.

The seed mixture is fed onto the inner spiral from a hopper at the top of the machine. As seed travel down this inclined inner flight, the round seed gain momentum and roll at a much faster speed. They soon roll over the edge of the inner flights and fall into the outer flight. They are discharged from a separate spout.

Less round seed tend to slide or move more slowly. They remain on the inner flights and discharge through a different spout. Some spirals have several separate flights which all have separate discharge spouts.

The spiral is simple, inexpensive, light and requires little floor space. Its only adjustment is the rate of feed. However, its capacity is limited, and it has a narrow range of separations. As a "separating and upgrading" machine, it is used after the seed have been cleaned down to a single contaminant. Such separations as vetch and dogfennel from wheat, and splits from soybeans can be made on the spiral.

Many spirals were used in the past, particularly in small grain areas. New chemical herbicides have greatly reduced the need for spirals. Also, other machines such as the disk-cylinder and the precision grader will make many of the same separations, and offer more flexibility and higher capacity.

The draper makes a similar separation, but offers more flexibility. It consists of an inclined draper belt which moves toward the high end. When the seed mixture is fed onto the center of the draper, the rounder seed roll or slide and fall off the lower end. Flat seed come to rest on the draper belt, and are carried off the upper end. Slope and speed of the belt can be changed to gain wider separating power. Different draper belts can be used to separate seed that vary in ability to slide. A smooth belt surface will allow smoother seed to slide downhill. Drapers may have from 1 to 4 separate draper belts.

The vibrator separator uses an entirely different motion to make a roughly similar separation. It consists of a tilted deck mounted on an electromagnetic vibrator. This gives the deck a high-frequency, "live-action" vibration, similar to the vibration of a tuning fork. A rheostat control varies the vibration. When a seed mixture is fed onto the tilted vibrating deck, no seed is able to sit completely still. Rougher or flatter seed will be able to gain some footing, and "creep" across the deck toward the high side. More rounded or smoother seed are not stable enough to move up the deck; the vibration causes them to move down toward the lower end of the deck.

Deck tilt and rheostat vibration control can be combined to produce very close separations. For example, pigweed and hulled Johnsongrass can be removed from alfalfa with the vibrator. This machine has, however, disadvantages which severely limit its use. The deck surface must be kept small. Larger decks introduce false vibrations which destroy the separation. As a result, capacity is very low. The cost of the machine is high, and it is hardly economical to use them in batteries. The vibrator has been used largely in experimental work.

Decks stacked several high over a single vibrator perform well, but capacity is still low. Seedsmen will be able to solve many difficult separation problems if a high capacity machine is ever developed to separate seeds by imparting this type of motion to them.

Aspirators and pneumatic separators separate seed according to differences in their terminal velocities. Terminal velocity is the air velocity that will suspend a seed if it is placed in a rising air column. When an air column is adjusted to a given terminal velocity and mixed seed are dropped into it, all seed with terminal velocities less than the air velocities will be lifted. Seed with terminal velocities greater than the air velocity will fall down through the air column. Seed characteristics such as shape, surface texture, and specific gravity all affect a seed's air resistance and its terminal velocity.

Both aspirators and pneumatic separators employ this principle, but in slightly different ways. The aspirator has a fan at the exhaust end of the separating air column. This creates a vacuum or negative pressure in the separating column. The pneumatic separator has a fan at the air intake, which creates a positive pressure, greater than atmospheric pressure, in the separating column.

The positive-pressure pneumatic separator operates much like a laboratory seed blower. A seed mixture is dropped into a vertical air column. The air is adjusted, by a lever at the fan intake, to blow the lighter seed fraction up into a discharge pan and out a spout. The heavier crop seed fall down through the air column until they reach a sloping screen placed across the air column. They then slide off this screen to the heavy seed discharge spout.

In the aspirator, the exhaust fan draws air through a falling curtain of seed. Heavy seed fall through the air column, while lighter seed are lifted to separate discharges. The air chamber in some aspirators has a moveable side. This allows the air velocity to be decreased as it moves up the column. As the air velocity decreases, it will drop below the terminal velocity of some of the lifted seed. They will drop out of the air column into intermediate discharge spouts. With this feature, a seed mixture can be fractionated into heavy, light, and one or more intermediate fractions. This is the "fractionating" aspirator.

Several different aspirators and pneumatic separators are available, and will produce excellent results when properly used. Aspiration improves scalping; combined with reel or flat screens, an air separation will remove dust and other fine material along with larger trash.

These separators will remove lightweight and immature or broken crop seed, and weed seed whose terminal velocities are different from that of the crop seed. They have proven very useful to upgrade seed by removing specific contaminants. For these separations, aspirators or pneumatic separators are located in the final phases of the cleaning process.

The successful processor realizes that seed processing is more a science than an art. He examines his seed, and notes differences in the seeds' physical properties. Two kinds of seed that differ in degree of roundness or smoothness may be a job for a spiral or draper. If the seed appear to differ in the characteristics that cause air resistance, an aspirator or pneumatic separator may be able to separate them.

Low capacity, elevator or feed hopper plugging, heavy rates of trash removal by a separator, may show a need for a good scalper. If hulls or hard seed are a problem, don't risk trying to remove them with a combine - use a huller-scarifier which can be closely controlled.

COLOR SORTERS

F. J. Mayer [1]

Color sorters, their use in associated industries and their adaptation to seed separation is the subject to be covered here this morning.

Perhaps the first question to come to your minds is "What do they mean by color sorting?" Some of you might think we are contemplating the delightful idea of separating the blondes from the brunettes. Granted, this is color sorting. But it is hard to believe that any machine could match the human male for this type of color selection. What is more, fortunately, in this particular field Government standards have not been established as yet.

We in the Seed Industry are accustomed to working with machines which have been in use for many years but, let's be frank, not much new has been invented in the last 30 to 35 years, although certain perfections in the mechanical design of existing machines have been made. Being myself a Seedsman in the third generation, I also have the privilege to be associated with the oldest seed firm in the world, established a little while ago somewhere around 1560, therefore, I ought to know what I am talking about.

When we speak of electronic color sorting, we have something which is actually, by now, also over 35 years old. Imagine that when the first color sorters were created the speed was so slow that, for example, the sorting of beans by hand was much faster than the sorting by machine. It is only during the last years that really sensational progress has been made. Today many thousands of machines for the electronic sorting by color are in use all over the world for the separation of all types of agricultural products such as mustard seed, rice, coffee, beans, peas, peanuts, walnuts and many others.

The SORTEX ELECTRONIC COLOR SEPARATOR, (Figure 1) which we take as an example for our today's subject, is in use in 53 different countries.

Now, what is color sorting, actually? Our definition of color sorting would be that separation within a product based on the difference of shade or color to a desired standard. In our present day industries, machine sorting for visual differences in products has become a necessity. The main reason is certainly profits, which, after all, is the ultimate aim of any enterprise. Second, the constantly improving quality standards have created a demand for equally improved ways to create such quality. It is a known fact that labor costs in production are on the increase. This means that we can expect that the already high cost of hand sorting can only become more expensive.

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[1] Mr. Mayer is Executive Vice President, Sortex Company of North America.

Another factor not to be overlooked is that the use of automated sorting assures an even quality during any given time period. The fact is important that an electronic sorting machine does not need a coffee break, lunch period or sick leave. What is more important, it does not take three machines to work three shifts, but only one machine. When people are involved in the performance of a job, such factors as efficiency and reliability cannot be ignored. Hand sorting is probably one of the most dreary and boring types of labor that a person could be asked to do. It is little wonder that the quality of sorting will fluctuate literally with the temperament of the individual. Most hand sorting is done from a wide moving belt, which means that for the most part only one side of the product can be seen. The ability of seeing the product from more than one side when sorting by electronic machine is, in itself, an obvious gain. In some cases, hand sorting may be completely impractical. The amount of damage may be excessive or the size too small to handle, as in the case of rice, mustard, onion or tomato seed.

Just for curiosity's sake, I want to mention the many applications which color sorting has gained and is still gaining in other industries. For instance, in the food industry, color sorting is widely used for peanuts, pecans, walnuts, almonds, filberts, and edible beans, where the appearance of the product is one of the major indications of quality. Since human vision is such a perfect and complex system, it may never be duplicated by man in all of its many abilities. There are, however, certain properties of sight which have been improved upon by the use of mechanics, optics and electronics. Duplicating the ability of the eye to detect differences in color and shade has been successfully performed by electronic color separation to a degree that is phenomenal. To better understand how this has been done, we take as an example cutaways of the Sortex Electronic Color Separator, which will permit us to see the process.

A comparison to the functions of the human eye can be made. The optical box is the eye, the amplifier is the brain, and the air ejector is the hand. The variations of what is seen by the eye is transmitted to the brain, which has the capability of translating what it has seen and has the intelligence to command the hand to do the separating.

The flow of material is almost completely accomplished by gravity with the exception of the horizontal path from the hopper at the rear of the machine to a point above the optical box. The entire movement of the product through the machine is done with no more than two moving parts. One is the vibrator that controls the flow of material. The other is the feed belt that carries the product from the vibrator to the optical box. The speed at which the belt moves has been predetermined. When the product is lined up end to end on the belt, there will be a spacing of the product as it passes through the viewing area of one-and-one-half times its own length. This assures us that when the ejector

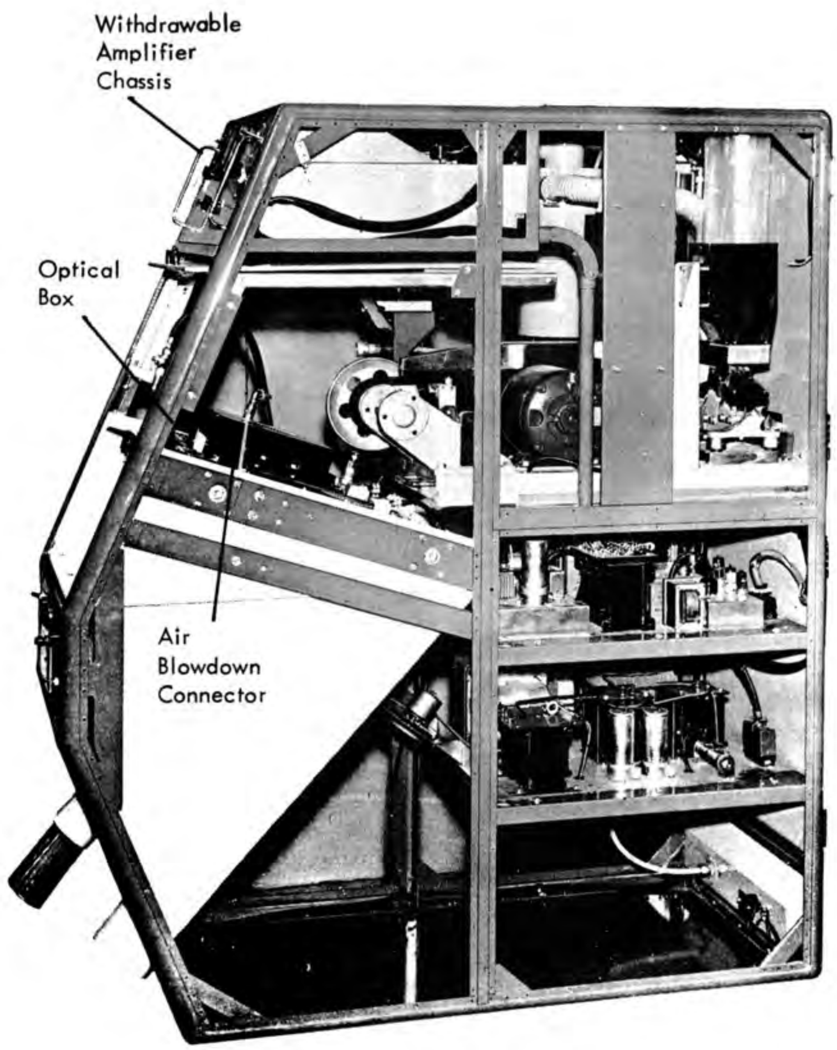


Figure 1. Side View of a Sortex G. 414 Machine

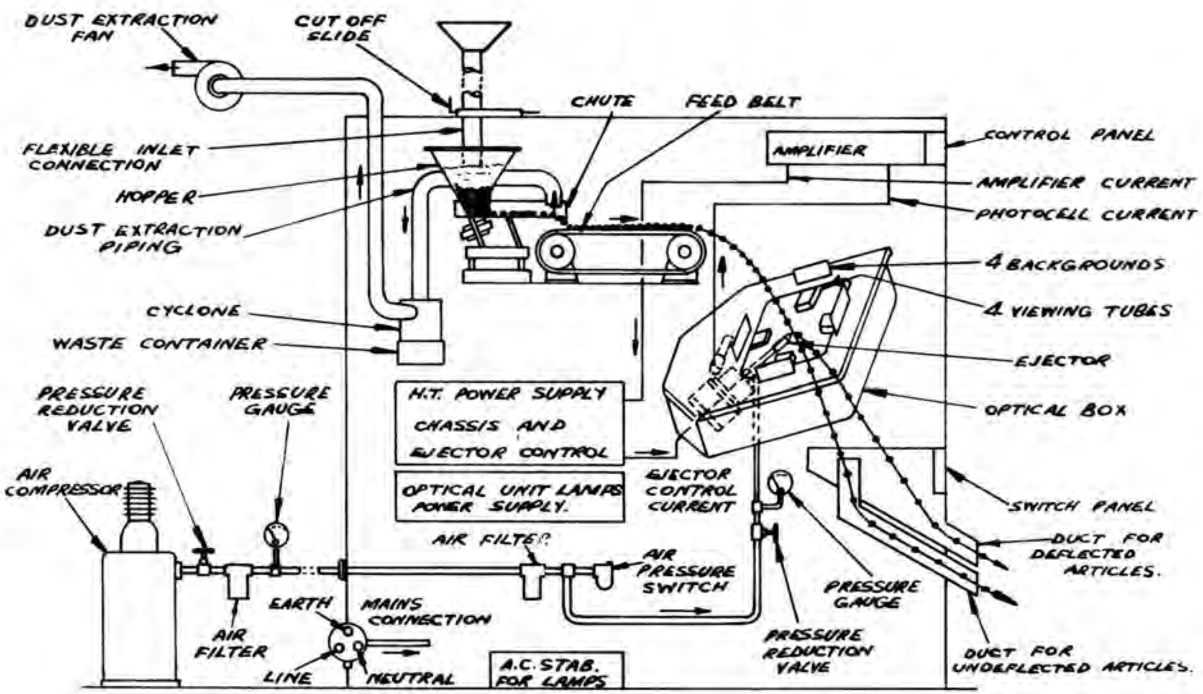


Figure 2. Schematic diagram of the mechanical system for the Sortex G. 414 and G. 415 machines

has been given a command, it will not eject the good particle that has followed a bad one in a stream.

The commodity leaves the belt at a point above the optical box in such a manner that the natural trajectory of the stream is through a viewing area formed by four lenses. These lenses are positioned slightly above the air ejector. If not interrupted, this stream drops into the so-called accept spout while any unwanted particles will be ejected by a blast of air emitted from the ejector nozzle and will drop into the reject spout.

Here we see a schematic of the optical box (Figure 2). Here are the eyes of our system and here is a device for rejecting the unwanted product. One of the advantages over human vision is that the eyes of the electronic sorter look at the stream from four sides. These eyes are focused on a viewing area through a lens system that permits as many as two photomultipliers to be used on one side. This particular electronic sorter which is explained today enables the sensing of differences in the product to a predetermined standard, both in terms of light to dark and to actual color content as well in using as many as six photomultipliers. This gives us two concepts of visual sorting: First, the separation by light to dark. Second, the separation that relies on color content only. As the light to dark sorting is the least involved of the two, we will look at it first. This sketch (Figure 3) illustrates the basics of light to dark sorting. Since a photomultiplier reacts to reflection the same as the eye, then it is possible to select a background that will serve as a standard. The eye will be literally blind to any product in the stream that has the same reflectivity as the background. A particle that is lighter will cause the photomultiplier to generate a pulse that will be negative in polarity and the particle that is darker will give a positive pulse.

This intelligence is transmitted to the amplifier for interpretation. The amplifier can be present to convert the information furnished by the eye to a command to the air ejector. The air ejector performs the function of the hand and pushes the undesired object into the reject spout. The presetting of the amplifier permits the choice of rejecting either the lighter or the darker objects.

When it is desired to make a separation of products that do not differ in reflectivity with respect to light and dark, then it becomes necessary to rely on color sorting. An example of this would be the separation of garden peas where there is a mixture of colors in variation, which, according to optical science, is considered to go from blue to red. While the quality of the reds may be as good as that of the blues, marketing research has shown that a woman's logic tells her that peas of a single color rather than a mixture is a must for her table. Where Government regulations apply,

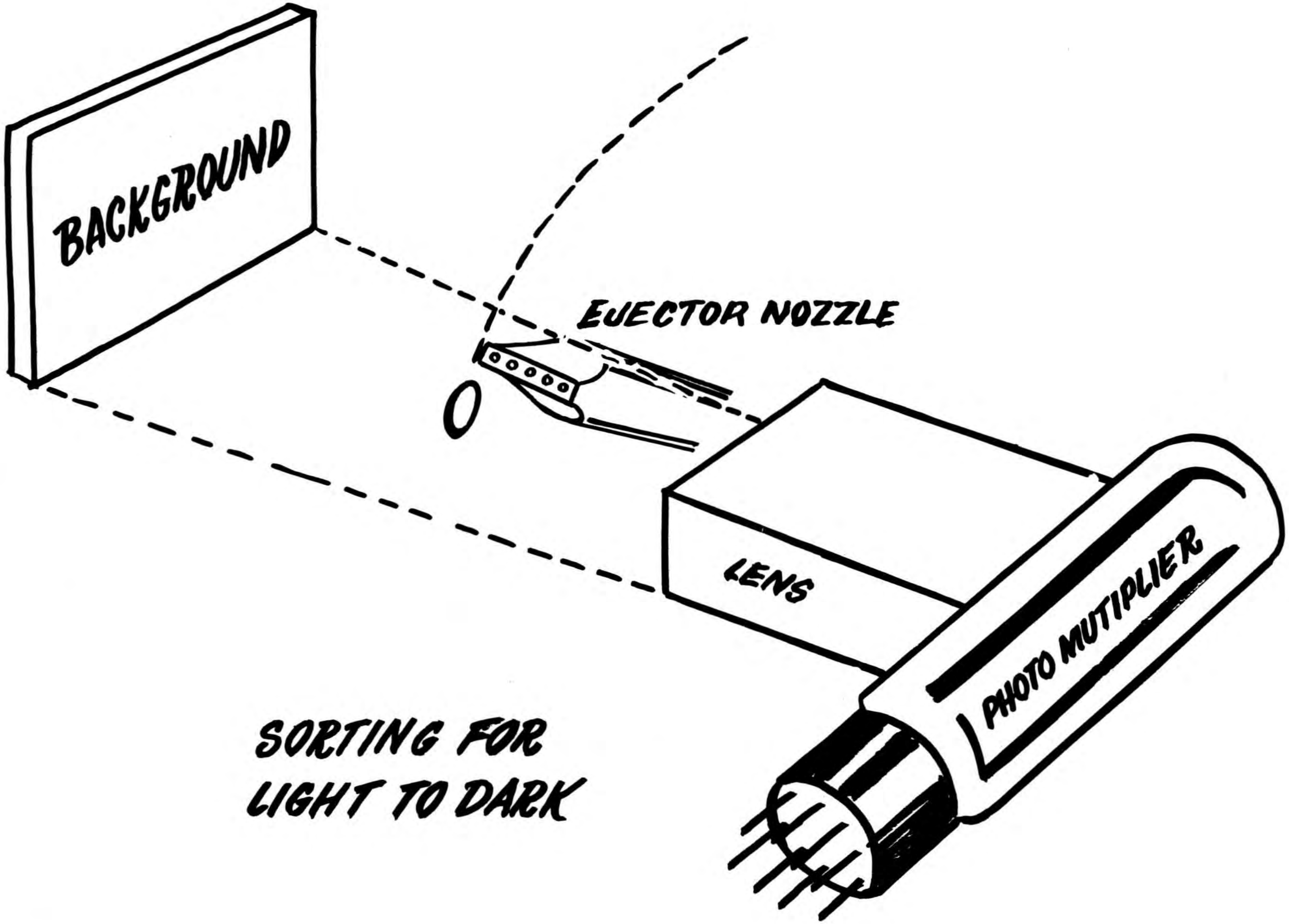
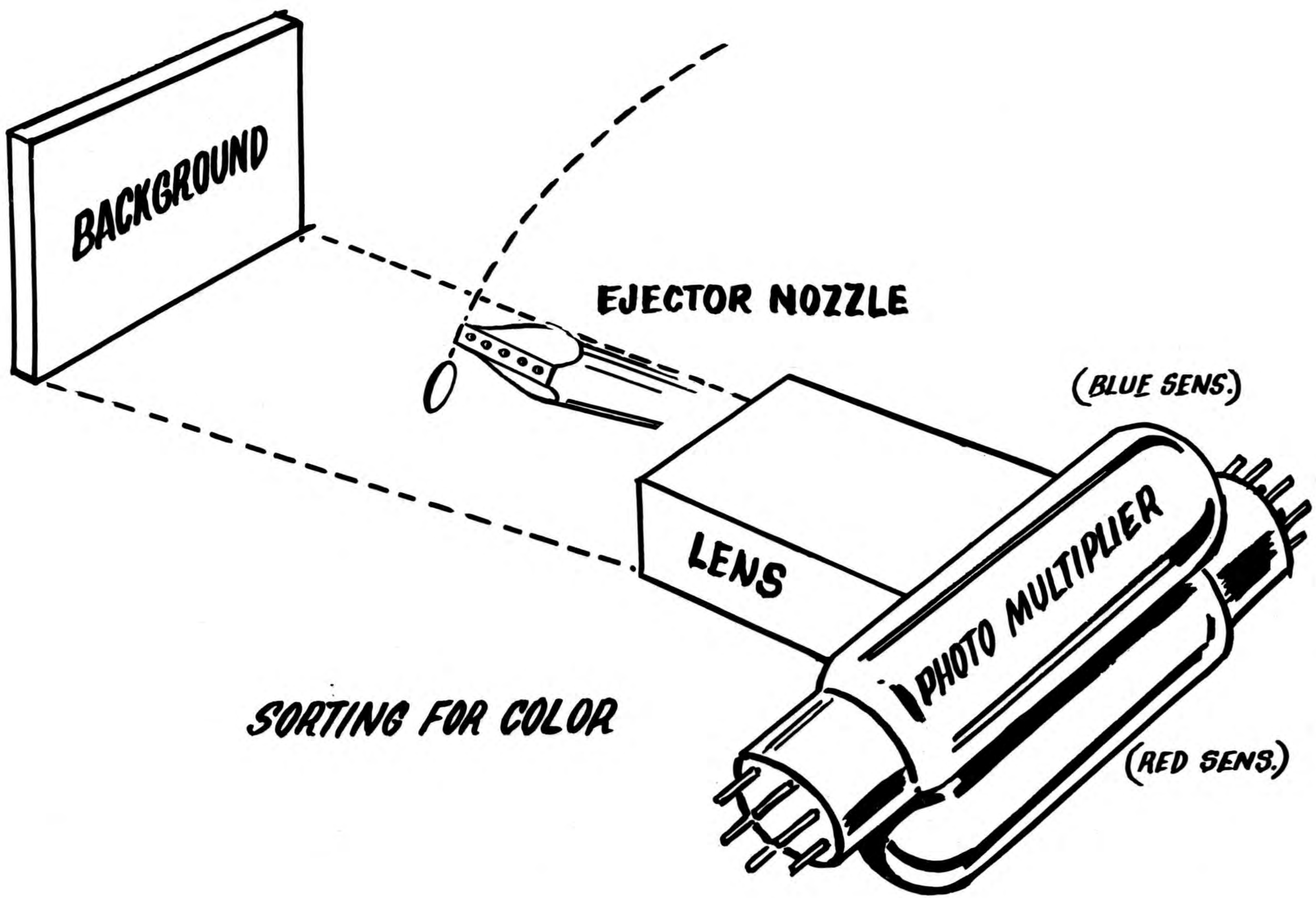

BACKGROUND
EJECTOR NOZZLE
LENS
PHOTO MUTIPLIER
SORTING FOR
LIGHT TO DARK

Figure 3

Figure 4


BACKGROUND
EJECTOR NOZZLE
(BLUE SENS.)
LENS
PHOTO MULTIPLIER
SORTING FOR COLOR
(RED SENS.)

evaluation of color quite likely will often play an important role. In the seed industry, the removal of certain weeds, such as cocklebur in mechanically delinted cottonseed, has been difficult to perform by mechanical means, but as you might already have seen or will see during the demonstration of the sorting machine it can be perfectly well removed by color sorting, under the condition that fuzz is removed either by flaming or other methods. The same applies to the sorting out of immature acid delinted cottonseed by color. I do not need to tell you, as seedsmen, the present consequences of these new possibilities in eliminating these most unwanted weeds and immature seeds.

Color analysis is the key to color sorting. To better understand color sorting, the sketch of the components involved is shown (Figure 4). You will recall that for the light to dark sorting, the product was viewed by an individual photomultiplier. For color sorting, we use the combined intelligence created by having the product viewed by two eyes at the same time. One is sensitive to the blue side of the color spectrum and the other to the red side.

A color analysis of the good product will establish the choice of background. These are graded in variations of color content and also to degrees of light to dark.

Since the blue sensitive eye measures the blue content of the product and the red sensitive eye of the red, it is possible for the amplifier to be adjusted to weigh the amount of each and have an excess of one or the other cause the air ejector to act.

There are occasions where both light to dark and color separation will be necessary at the same time, and this is possible. In fact, due to the extreme flexibility of the control system, it is possible to sort both light and dark, as well as two different color separations all at the same time. Experience has shown that this is the exception rather than the rule, but has solved some very difficult problems, such as, for instance, in the sorting of certain varieties of garden beans or pinto beans, where frost damage, water damage, mold and other discolorations occur at the same time, all being of different colors.

While today's machines do not yet permit the sorting of legumes, such as crimson clover or alfalfa, to an extent which would be practical for industrial applications, because the quantity obtained would make such an application uneconomical, laboratory tests for such sorting have been made very successfully.

With the unlimited possibilities in the field of electronics, we can expect that in a few year's time, even such small seeds will be processed. As already mentioned, such small vegetable seeds as tomato seed and onion seed are successfully sorted. The Sortex Color Separator shown here has the flexibility of being used for such small size vegetable seeds as well as for peas and other products up to the size of lima beans. Even larger products, such as, for instance, walnut halves can be sorted. The changeover from one variety to another does not require more than the turning of a few knobs and in some cases the changing of a belt, altogether a few minutes.

These explanations will give you an idea of what can be done. I am sure all of you, with great interest, will see the various equipment which is shown in the afternoon, amongst which are also electronic color separators and the Sortex machine explained here, should you not already have spent some time in this particularly interesting part of the Seed Technology Laboratory.

I want to thank Dr. Dean Bunch and his staff for the opportunity given to me to explain to you the electronic sorting of seeds, which we consider an immense step forward in the development of seed equipment.

Editors Note: There are several makes and many models of color separators. Shown below are two machines presently located in the Seed Technology Laboratory.

Mandrel, Model B350

Sortex, Model G414

THE APPLICATION OF ELECTROSTATICS TO SEED SEPARATIONS

T. Wayne Still [1]

The machines discussed up to now utilize the differences in physical properties of the seed, such as weight, shape, size, length, width, surface texture, and color to make a separation.

Unfortunately, the components of certain seed mixtures do not differ sufficiently in physical properties of characteristics to permit separation by conventional methods or equipment. Application of the electrostatic principle of separation offers solutions to such problems.

Electrostatic separators are not a new principle of separation but its application to the separation of seeds has not received much attention until recent years. The electrostatic separator, like the gravity, the magnetic and other separators, was designed for use in the mining industry and has found its way into the seed industry, with certain modifications of course.

Since electrical properties and not physical characteristics are the basis for separation in an electrostatic separator, the adaptation of this equipment for seed cleaning may be somewhat more complicated than it appears by casual observation. Those of you that have experience with this machine will readily agree with this, I'm sure.

Electrostatic separation is the process of separating one material from another with charged electrodes. The materials or seed to be separated must be oppositely charged, or must exhibit different intensities of the same charge. The chief value of electrostatic separation lies in the area of separating seeds of the same size, and weight, which cannot be separated by common or conventional means.

An electrostatic separator consists of a feeding mechanism, a separating area energized by a positively or negatively charged electrode, and divided compartments for receiving the separated seed.

Separation is accomplished on the basis of the law that like charges repel and unlike charges attract. Separations may also be possible where unlike particles acquire different strengths of charge. When a mixture of seed differing in polarity or strength of charge are passed through the separating area, oppositely charged seed are attracted toward or repelled from the electrode in proportion to the strength of the charge.

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[1] Mr. Still is an Assistant Agronomist, in the Mississippi Agricultural Experiment Station, and Assistant Director of the State Seed Testing Laboratory, State College, Mississippi.

The principle of electrostatic separation is employed by use of two methods or a combination of the two methods, which utilize different adjustments and electrodes. One is the non-discharging field or low intensity method and the other is the discharging field or high intensity method.

In the low intensity method separation of the seeds is dependent chiefly upon the polarity of the charge on the individual seeds. When seeds are passed through the electrostatic field, particles charged oppositely from the electrode are attracted toward the electrode, lifted away from the normal pattern of fall and separated from the remainder of the seed with the adjustable splitters.

In the high intensity method separation of the seeds is dependent upon the conductivity of the individual seeds. Seeds passing through the discharging field are pinned to the grounded rotor. The length of time seeds remain pinned to the rotor depends upon the duration of the charge on the surface of the seed. The charge is rapidly dissipated from good conductors to the grounded roll, allowing the seed to fall freely while non-conductors retain the charge much longer, and are brushed away from the rotor and into a different compartment. Poor conductors react intermediately to the other two classes. Polarity is of little importance as the charge assumed is opposite that of the rotor.

Successful application of the electrostatic separator to the separation of seeds is dependent upon several factors.

1. Moisture content of the seed - usually lower than that required for safe storage of the seed.
2. Relative humidity of the air - usually lower than prevailing humidities in this part of the country.
3. Temperature of the air - not too important as long as it is constant. Temperatures that fluctuate quickly affect the effectiveness of the separation.
4. Temperature of the seed - slightly heating the seed immediately prior to entering the separating area may render a separation not possible without heating.
5. Mechanical factors - adjustments of the machine itself, such as voltage, polarity of the charge, position of the electrode, speed of the grounded rotor, and others, all affect the separation.

As pointed out earlier, the most practical application of the electrostatic separator is in separating seeds of the same physical characteristics and which cannot be separated by conventional means. Several workers have reported that the separations listed below have been successfully accomplished by use of the electrostatic separator. The list is not all inclusive.

Hulled Johnsongrass from hulled sesame

Rat excreta from grain

Wild onions from wheat and rye
Pigweed from white clover
Curly dock from red clover

Preliminary work at the Seed Technology Laboratory indicates that it may be possible to separate cocklebur from machine and flame delinted cottonseed. More work on this is forthcoming.

MODERN PRE-ENGINEERED STEEL BUILDINGS

James M. Beck [1]

In hundreds of communities, pre-engineered, mass-produced steel buildings are being used for a wide variety of applications. Because they are versatile - permitting dramatic architectural styling - they are being used not only for industrial plants and warehouses but are now being used to create attractive commercial and community facilities. Shopping centers, banks, bowling alleys, service stations and even schools and churches are now being built - without sacrificing quality of construction or beauty - with pre-engineered, mass-produced steel components. When planning a new processing or marketing facility seedsmen should consider the many advantages of modern pre-engineered steel buildings.

Manufacturers of prefab steel buildings provide a basic building system. Structural framing, panel walls, roofs, windows, doors, partitions, factory applied insulation, ceilings, exterior color - even erection service and financing when they are wanted - are engineered, mass-produced and provided by a number of manufacturers.

From the large selection of pre-engineered building components virtually any size building can be constructed by merely selecting the proper standardized components which are then bolted together on the building site. Some of the standard sizes offered by manufacturers are listed and described in the accompanying drawings and tables. (Figures 1 and 2) [2]

The modern rigid frame building begins with the erection of a sturdy structural framework of steel. This superior way to build offers many advantages. With ordinary construction methods much valuable floor space is taken up by rows of columns. These columns will impose strict limitations on the way this space can be used. In a clear-span building production, traffic and storage areas can be laid out with complete freedom. Every foot of space is useable.

There is no need to over-build in anticipation of future needs. The ease with which a rigid-frame building can be expanded gives management better control over long-range space requirements. With standardized components it's a simple matter to increase the width or length of the pre-engineered steel building. The new addition can have higher or lower sidewalls, be engineered

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[1] Mr. Beck is Engineer Technician, Seed Technology Laboratory, Mississippi Agricultural Experiment Station, State College, Mississippi.

[2] Illustrations taken from Sweet's Architectural File.

Butler pre-engineered building components

Rigid Frame (RF)

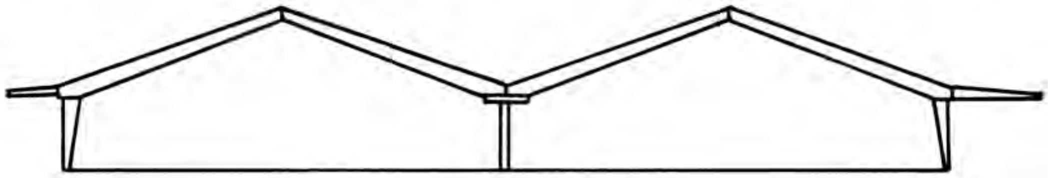
EAVE HEIGHTS	20	24	28	32	36	40	50	60	70	80
	CLEAR SPAN STANDARD WIDTHS									
	10	10	10	10	10	10	10			
	12	12	12	12	12	12	12	12		
	14	14	14	14	14	14	14	14	14	
						16	16	16	16	16
						20	20	20	20	20
						24	24	24	24	24

	BUILDING	CANOPY	WIDTH EXTENSION
Bay lengths	18′, 20′, 21′, 24′	18′, 20′, 21′, 24′	18′, 20′, 21′, 24′
Total length	Unlimited	Unlimited	Unlimited
Roof slope	4 in 12	1 in 12	1 in 12
Design loadings	1, 2, 4, 6	2, 4, 6	2, 4, 6
Widths		6′, 10′	24′, 48′

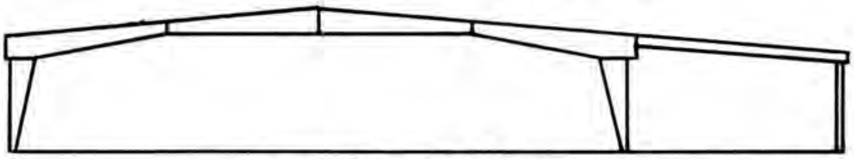
Low Rigid Frame (LRF)

EAVE HEIGHTS	24	32	36	40	50	60	70	80	100	120
	CLEAR SPAN STANDARD WIDTHS									
	10	10	10							
	12	12	12	12	12	12	12			
				16	16	16	16	16	16	16
				20	20	20	20	20	20	20
				24	24	24	24	24	24	24

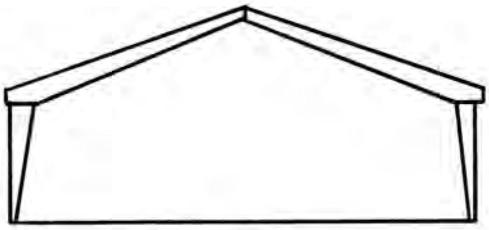
	BUILDING	CANOPY	WIDTH EXTENSION
Bay lengths	18′, 20′, 21′, 24′	18′, 20′, 21′, 24′	18′, 20′, 21′, 24′
Total length	Unlimited	Unlimited	Unlimited
Roof slope	1 in 12	1 in 12	1 in 12
Design loadings	2, 4, 6, 8	2, 4, 6, 8	2, 4, 6, 8
Widths		6′, 10′	24′, 48′



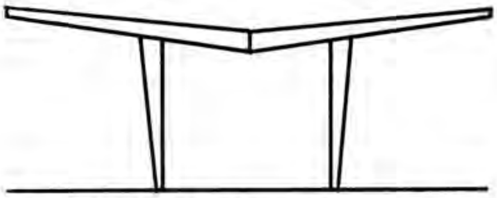
Multiple RF With Canopies



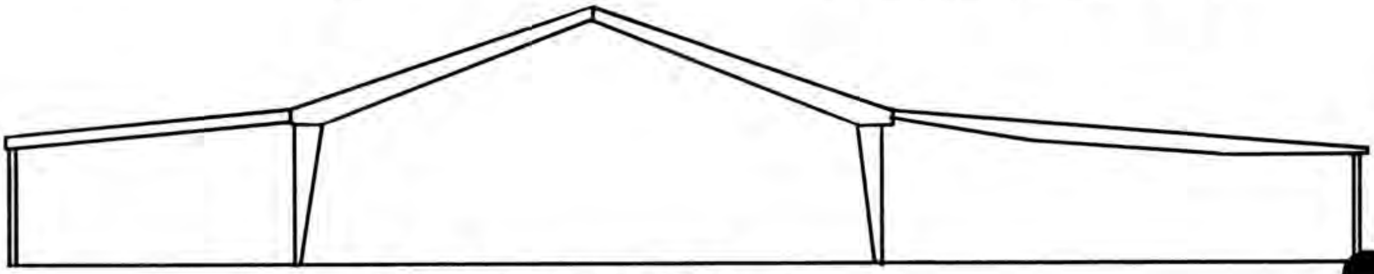
LRF With Width Extension



RF



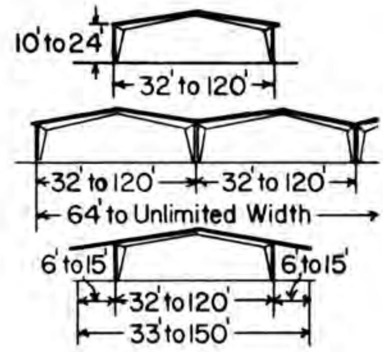
Butterfly Roof and Columns



RF With Width Extensions

Figure 1

THE RIGID FRAME ARMCO BUILDING S-3



Clear Span Width	Wall Height	Length
32', 40', 50', 60', 70', 80', 90', 100', 120'	10', 12', 14', 16', 20', 24' (10' height not available in 80', 90', 100', 120' widths)	Unlimited in increments of 16', 20', 24'. Minimum 32'.

Condensed Specifications

Roof Pitch—2:12 or 4:12

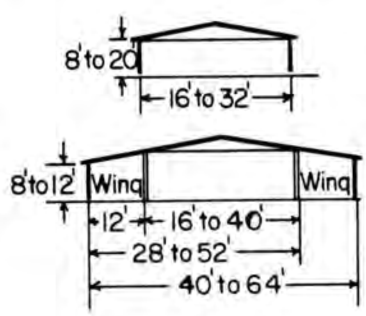
Structural System—Rigid Frame

Column Spacing—16', 20', 24'

Wall Covering—Sculptured STEELOX Panels

Roof Covering—Armco STEELOX Panels or Armco Deep Corrugation Sheets

THE SELF-FRAMING ARMCO BUILDING S-2



Clear Span Width	Height	Length
8', 12', 16', 20', 24', 28', 32'	8'	Unlimited in increments of 4 feet. Minimum must be no less than width.
12', 16', 20', 24', 28', 32'	10', 12'	
16', 20', 24', 28', 32'	14'	
20', 24', 28'	20'	

Condensed Specifications

Roof Pitch—2:12 or 4:12

Structural System—STEELOX Panel covering is self-framing

Wall Covering—Armco STEELOX Panels

Roof Covering—Armco STEELOX Panels

Figure 2

to support heavier or lighter live or dead loads, and becomes an integral part of the building. There is no waste of existing materials; an end wall can be moved out to the new location as a single unit. Sidepanels are then bolted to the added structure framework. (See Figure 3)

Pre-engineered and man-production economics can save costly planning time and custom fabrication. A small but efficient facility can be completed in a matter of days. As business grows and more space is needed, the building can be quickly and economically enlarged. Components can be altered - even relocated - with ease, to meet changing requirements.

A building with sidewalls and roof of steel becomes a continuous interlocked unit or rigid ribbed steel ... it is steel throughout. Such a structure assures the utmost in fire safety. It is also designed for all weather conditions including snow loads and wind loads.

Steps for Maximum Economy

1. After determining space requirements and equipment layout, call your steel building representative. He will be glad to recommend a standard size building to fill your requirements, thus avoiding special size and shape. There is practically no limit to combinations of standard sizes of prefab buildings - specials usually increase not only the initial cost but also cost of future expansion.

2. Check insurance rates and compare them using prefab all steel construction against other type construction.

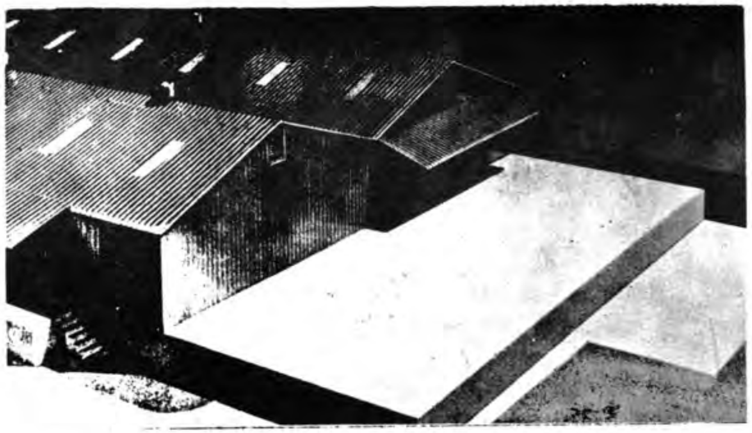
3. Figure the period of your investment and compare the maintenance cost of a steel building against other type construction.

4. Consider the completion date - remember your investment begins paying only after the operation begins.

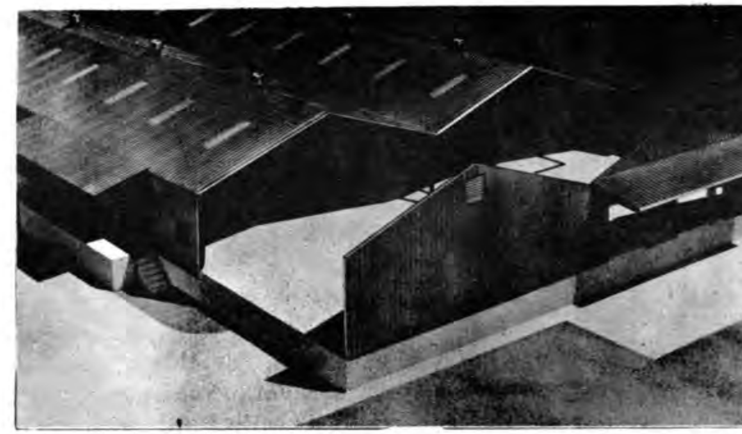
Summary

A pre-engineered steel building may not be the cheapest type construction, but it is economical when the following advantages are considered:

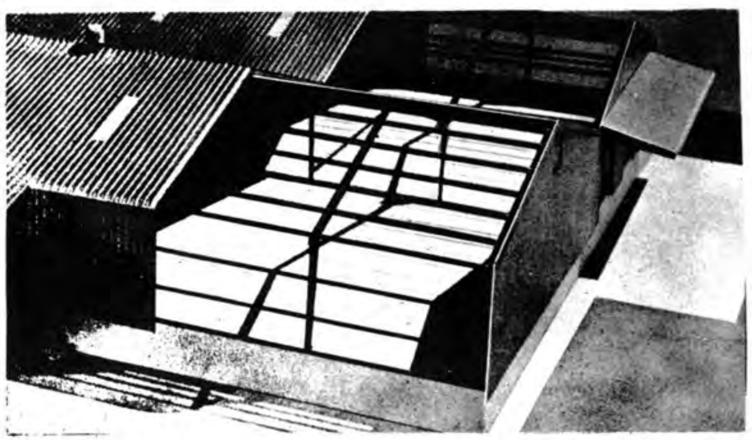
1. Fast occupancy
2. Durability
3. Utilization of space
4. Ease of expansion
5. Safety
6. Low insurance rates
7. Low maintenance cost
8. Attractiveness



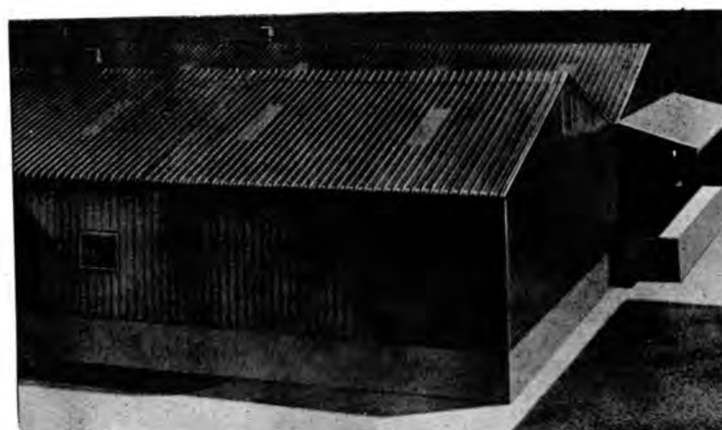
First, establish your expansion area and install the foundation.



Next, loosen the endwall and move it out to the new location as a single unit.



Now, add the necessary rigid frames and other structurals.



Then, add cover panels. That's all there is, your new addition is ready for occupancy.

Figure 3. A pre-engineered building quickly and easily expanded.

SAFETY IN PROCESSING PLANTS

Tom A. Adler[1]

It is a compliment to my company and a decided pleasure for me that we should be asked to participate in your program. Years of active work in property and life protection and especially as it relates to our nation's grain plants, has given me a great respect and admiration for the men behind this industry and for their accomplishments.

The time was that most insurance underwriters either turned thumbs down on a grain milling risk or carefully scrutinized every phase of its operation before accepting any line of property protection on it. Through the concern and efforts of men of integrity heading these plants, much progress has been made in reducing hazards formerly closely associated with it. It has been a privilege and certainly one we are very proud of to be a part of the hazard reducing effort. It has been my personal observation that grain men everywhere are just nice people to be with. The broad reaches of this nation's grain industries continues to branch forth new progress and specialization. Exposures to fire loss and to accidental injuries too have kept pace with processes development. We are convinced more than ever that dealing in the commodities of this industry requires constant vigilance, and more than ordinary care must be exercised to maintain it through its growing pains and thereafter. First the seed, and then grains and their products are the fundamental requirements of peoples of all nations. Protection of grade, quality and purity are essential. Protection against damage and loss by fire and assurance of safe plant operations are kindred to quality and purity control.

The assigned topic for this period is "Safety in Processing Plants". I shall endeavor to confine my remarks to seed processing and handling although I may also use the term grains occasionally. When considering fire hazards normally associated with storing, processing, drying, cleaning or milling processes, it makes little difference whether the term seed house or grain house is used. Germination factors of seeds are highly important items to seedsmen, but in so far as fire safety measures and accident prevention are concerned, either term is suitable. Perhaps the one difference deals mainly with damage-ability of seeds versus grains. We will consider this a little later in this discussion.

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[1] Mr. Adler is a Fire Protection Engineer for the Millers Mutual Fire Insurance Company of Texas.

Ignition temperature for most grains and/or seed is 329° F. Charring will occur to the fibrous dust at temperatures as low as 250° F. We can readily see that these are relatively low temperatures when we consider that it requires about 600° F. to ignite common news print paper. This ease of ignition certainly gives reason for caution and care wherever seeds and grains are handled or processed. I know that you would not intentionally permit a condition which could create temperatures in your stored commodities even approaching 250° F. I know that you would not intentionally, but unintentionally I wonder if chances are not being taken where even much higher temperatures could exist or be caused to happen. Let us examine a few possibilities where because of a careless act or a lack of understanding, these temperatures and possible fire may be caused to occur.

"What are some of the common conditions which might lead to ignition temperature requirements of the commodities handled in our plants?" If you have pencil and note paper handy, jot these down, then check them in your plants at your first opportunity. Light bulbs.......Frayed insulation of any electric wiring.......Dust settled out in fuse cabinets and on contacts of motor starters ....A portable or extension cord light without a good dust tight outer globe ....A heat lamp used for spot heating perhaps at the scale or bagging machine ....A space heater with open flame or electric resistance element.......A motor with ventilation ports and coils clogged with dust.......Bagged or binned uncleaned seeds containing stems and leaves.......High moisture stock in bins ....Loose or bent cups in a bucket elevator.......Bearings that haven't been inspected or perhaps lubricated for weeks.......Poorly designed V-belt drives.......Smoking in the cleaner room or in the process area....... Insecticides applicators.......and many more. The list can be much longer but you now have the idea I wish to convey. These and any other condition of fire hazard can suddenly be the cause of ignition and just as suddenly you are temporarily or permanently out of business.

Forklift trucks can offer great advantages in moving stock and in man-hours of arduous labor saving. But forklift trucks, with internal combustion engines requires that they be recognized as a potential fire source. The manifold and exhaust may exceed ignition temperature requirements for the dust it is subject to. Hot carbon leaking from the exhaust can become imbedded in piled stock or sacks. A hazard more common than these two is related to the engine fuel. Gasoline has a flash point of -45° F. Highly combustible vapor will be released at this temperature or higher. Any tiny spark or the heat of friction can immediately set off a flash in gasoline vapor. Fuel lines must be checked frequently for leaks. Engine must <u>NEVER</u> be refueled while the engine is running or when the truck is inside a building of your plants. Minor spilling of the fuel can cause a sudden blaze to not alone destroy the truck but to injure your employee and perhaps destroy your plant. A word of warning too, regarding operation. Carelessness in the operation of these trucks can cause serious injury to the driver and to others. Like other mechanical machines, care and intelligent operation will prolong their useful life. The opposite might cost in dollars and lives. Any one of these items can cause a heat source to exist or be responsible for a fire. No one wants a fire to destroy his business. No one intentionally will permit a condition of accident or fire hazard to jeopardize life or property. A first approach to reducing the chance of either is a more conscientious effort to recognize the likely causes and then see that they do not exist.

Bear in mind that every plant represented by you, gentlemen, is powered by electricity. You may have heard it said that "Electricity does not cost, it pays". On the basis of efficient power, perhaps this statement is true. Nevertheless, electricity is also one of the most powerful destructive forces known. It is destructive to life and to property when its path for productive use is not insulated every inch of its travel. High energy sparks and heat of uncontrolled electricity can burn and destroy anything combustible. Earlier, we spoke of the low ignition temperature requirement of grain and its fibrous dust. This fact requires a consideration for safe use of electricity much more pronounced than than ordinary. The mere attachment of electric conductors to a motor or its starter will probably permit its operation. Without a knowledge and application of this knowledge in circuit installation, however, safe use of electricity is not possible. For the avoidance of shock injury and the avoidance of fire hazards, we urge you to employ only qualified electricians and not rely on any other for safe circuit and device operation.

Little things like a light bulb may not be thought of as a fire source. Where we are dealing in grains and seeds and in the dust created by their handling, a light bulb can create surface temperatures sufficient to burn any dust settling on it. Dust tight fixtures with their outer glass globes are engineered to protect against this circumstance. Their choice for use throughout a dusty area of your plant is a very wise one. I not only suggest, but I urge you to consider the dangers of an open light bulb on an extension cord. In any grain or seed house, extension lights for portable use should be equipped with a substantial dust tight fixture approved for the purpose. Another thing, have a designated place for storing extension lights and check them frequently to make certain that there is no fault in the cord or fixture.

Grain and seed drying can involve several likely sources for fire to develop. A clean dryer, carefully maintained will materially reduce this hazard. Sensitive heat detecting elements located in vulnerable spots within a dryer can be used to detect the presence of high temperature and sound an alarm or shut down the operation until the trouble is corrected. These conditions we have mentioned are likely sources of fire. Not mentioned as a likely source was housekeeping. Nevertheless, housekeeping in very exacting measures is perhaps as demanding of attention as any other single item of fire protection. Where housekeeping is neglected and where webs, dust, paper bags and scrap, burlap or other combustible refuse are permitted to accumulate, should ignition occur from any source, rapid fire spread and entire plant destruction can be expected.

Damageability of seeds was mentioned earlier. Let us see what this could mean to us. Where grain seeds are involved in a fire, damageability becomes a most important factor both to you and to your insurance carrier. Seeds damaged by smoke, water or odor contamination are usually degraded from seed value to sample grade grain. If treated, they can drop in value to zero. The results of even a small fire could find you without stock for your customers. A lost customer is hard to win back.

Let us get down to some brass tacks in this fire prevention business. First of all may I suggest that we all accept as a fact that "Fire Prevention is Everyone's Business". From that start we can work singularly and together to practice what will benefit our lives, our pocket book and our businesses. All large fires are small at their beginning. Fires account for too staggering a loss in this nation of ours. These fires need not happen. The majority of them can be prevented from occurring. These figures I am about to quote are not estimates or educated guesses, they are the result of compiled figures of the NFPA, and are facts. In 1963 this nation suffered fire loss of almost two billion dollars. There were 2,275,790 fires in the United States. 12,800 lives were lost in fires in these 12 months. 4,000 of these were children. In the U.S. the average daily fire toll of lives lost by fire is 32. The fire toll to structures has reached a daily average of 1,500 homes, 12 schools, 9 churches, 5 hospitals and nursing homes, 114 stores and 112 industrial plants. Unless fire prevention is accepted and practiced by more people in all walks of life, these figures will most suredly increase. No accurate report is available on the number of injuries sustained but a fair estimate would place it in the hundreds of thousands yearly. Why should people have to be reminded of fire hazards in their homes and places of business when the evidence of fires' trickiness and destructiveness is so frequently demonstrated. Frankly, we do not know the answer. But it is sad to think that an awakening will only result after an experience to ourselves or to a loved one in our family.

If you listed the items mentioned earlier, you have a partial check list to work from in correcting possible fire sources in your places of business. Basically, prevention means "to ward off loss or harm by means of previous measures". Prevention is practiced in several ways by all of you I am sure, to reduce the chance of errors and loss in bookkeeping, in driving on the highways, and while stalking game in a wooded area. Prevention is an absolute necessity for the avoidance of injury whether financial or personal. Not to practice it is being bold and without judgment. The same zeal can be applied to preventing causes of fire and for the occurrence of accidents in the plants which earns us a livelihood.

I have not meant to be harsh in my remarks but it was intentional in placing before you some things to think about and a base on which corrective action can be taken. A hazard can be explained as "an exposure to the chance of loss or harm". This exposure I believe, can be materially reduced and made harmless only with a will and intent to bring it about through planning and practice. The benefits are to those who will measure and fit prevention in its place.

Permit me to go back for a moment to the electrical hazards and correction of some common conditions which generally lead to device breakdowns and motor failures. These equipments and devices in your plants are essential to the plant's operation. Every breakdown in electric equipments or circuit components is placing an exposure to more serious loss on your plant and on the personnel who operate them. When a motor starter fails to function or should a motor burn out, the minimum result is a costly repair and time delay. The maximum could be the complete destruction of a building and its contents. Care and proper maintenance to all electrical equipments including motors can usually void the chance of any unnecessary business interruption. Let me suggest a few important items of maintenance and care which should be attended to as preventive maintenance. (a) Keep all electric apparatus and devices clean inside and outside any enclosing cabinet or frame. Where other than totally enclosed motors are in use, inspect them for worn or damaged insulation. This may require disassembly of the motor, but remember that dust is abrasive and can do great harm to minor insulation on motor coils. (b) Avoid using high pressure air to clean dust from motors. This sometimes can do greater damage to the insulation. Do not overload a motor beyond its name plate rating. (c) Make sure that overload heaters are properly sized for maximum protection. (d) See that terminal connections are made up tight and are provided with sufficient tape insulation inside the motor terminal box. Vibration can cause wear and tear to taped terminals resulting in a grounded circuit conductor, single phasing of the motor and probable motor burnout. (e) Ground the conduit and all other non-current carrying components of all circuits. This will greatly reduce the chance of shock injury and will give assurance of quick operation of fuses or breakers in event of a live circuit conductor becoming grounded. (f) Even before there is doubt, make sure that voltage is maintained at the rated pressure prescribed for the service. Your power company will usually be glad to install a recording volt meter on your service lines. Such a meter will give immediate indication of any serious fluctuations in voltage, and corrections can be made before damage is done to your inside equipments. (g) Do not trust electrical repairs to any other than a qualified electrician. Even then, make certain that he knows and follows recognized code procedures.

Gentlemen, the interest that you display in safe practices in your plants, whether they be regarding accident prevention or measures for reducing the chance of fire occurrence will be contagious and spread to others around you. Talk prevention and set the example which will be noticed and respected. I wonder how many of you have ever given thought to the advantage you might gain by closer contact with your fire department. Perhaps some of you or some of your personnel are volunteer firemen. Those who are, will be quick to recognize the great benefit and advantage to fire combat when you know something about the interior of the building in advance of actual combat of flames. Your fire department will usually welcome an opportunity to dry run your plant and become familiar with all the interior. The chances are that such a tour will be the topic of discussion at more than one subsequent fire hall meeting. You can be doing yourself and your department a great favor in arranging for such a tour and personally pointing out the location of entry ways and exits, electric services, stairs or elevators, and other features of your building plan.

Today, in any discussion of fire prevention and safety measure, a most important omission is made unless the severe fire hazards associated with welding and metal cutting is given mention. In fact, this item could take up a full period at any meeting where fire protection is being discussed. Fires set from these uses of a torch are occurring at a rate far beyond reason. Fires and resulting property loss are frequent and costly, but all too frequently, lives are lost and severe injuries are sustained in explosions resulting from a careless act with a welding torch. Bins, hoppers, tanks, elevator stands and buildings themselves in our grain facilities all contain appreciable amounts of highly combustible dust. The torch can set off immediate ignition. The hot slag will spit from the point where the torch makes contact to distances of 40/50 feet away. Any particle of this slag falling in grain or in the dust of grains can set off a fire or set up a smoldering mass which will be whipped into flame with a slight breeze or wind. I honestly believe that the dangers of these torches are not understood by a great many people who attempt to use them. The danger just cannot be understood or the chances that are now being taken would never be attempted. I mentioned that an entire period could be devoted to this subject. Time won't permit this now. Nevertheless, if a few simple rules will be understood and practiced, fires and deadly explosions from these causes could be completely and forever cured. Remember, if you will, three time elements of safety. BEFORE - DURING - and AFTER.

Dismantle and do the job out of doors wherever possible even if this method does require a little extra effort. But when it is absolutely necessary to do the job inside, do it during the early daytime hours. Never, but never close your plant and leave it unattended and without a watchman after a welding job has been done. BEFORE.......Before attempting a job, clean the area thoroughly. Stop all machines, all conveyors, elevator legs, etc., and plug all spouting or holes where hot slag might fall. DURING.......While doing the job, use flame proof tarpaulin or other suitable covering over bagged or loose stock around and under the spot job. Wet down the floor and keep a watchman with fire extinguisher ready while the job is in process. AFTER.......Keep a watchful lookout for smoldering fires not alone in the immediate area of the job but wherever hot slag or sparks could have been thrown. The front office and responsible supervisory personnel should be given notice of any proposed welding or cutting and the job should be done only after those persons have inspected the area and have given their consent and approval. These brief statements concerning safe practices for use of a welding torch only sum up to good judgment for preventing a possible loss or injury. It is a means for warding off harm by means of previous measures. Thank you and good fortune to you.......

FEED BACK AUTOMATION
James Henderson [1]

Automation is the science of operating or controlling a mechanical process by automatic means. The intent of automation is to relieve the human operator of tedious, time-consuming tasks and free him for the work of controlling which requires human judgement. In addition, automated control equipment coupled to machines can maintain an even feed of material to these machines, accurately adjusted to insure their continual operation at maximum efficient capacity.

The elements of physical success of man are:

1. Mind - which decides and controls.
2. Nerves - which record and report.
3. Muscle - which responds and acts.

The simple act of a man opening a valve controlling grain flow through a spout consists of the following actions:

1. He uses his hand to open the valve.
2. He uses his eyes to see the amount of grain flowing through the spout.
3. His eyes FEED BACK this information to his brain which in turn tells his hand when to stop opening the valve.

A true automation system differs from a remote control system in that it will feed back information. It will perform the actions a man performs except that it will not reason. Therefore, it cannot predict the future, but must make corrections for events that have already happened and tell what it has done.

Some of the tools used in automating grain, seed or feed handling plants are:

1. Bin level controls.
2. Electrically operated gates, valves and distributors.
3. Interlocked wiring.
4. Load limiting devices.
5. Flow indicating devices.
6. Indicating flow diagram at a central control center.

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Let us apply these tools to a simple installation consisting of a driveway dump gravity feeding into an elevator leg which is equipped with a three-way valve and spouts to three different bins. We equip the elevator's intake with an electrically operated slide gate. This will be interlocked so it cannot be opened unless the elevator is running. We equip the elevator motor with a load limiter to control the opening of the slide gate and this will cause the electrically operated slide gate to always maintain a position that will give maximum feed to the elevator without overloading or unloading. The electrically operated three-way valve on the elevator head will direct the flow of the grain to one of the three bins. In each spout we will have a flow indicating device and near the top of each bin will be mounted a bin level control.

When this system is put in operation the operator at the central control panel will start the elevator. He will set the three-way valve to one of the positions to spout the grain into the bin of his choice. He will then open the slide gate which controls the feed into the elevator. The system is put on automatic, the load limiter causes the gate to seek a position that permits flow into the elevator at the maximum rate the elevator can handle the grain. The three-way valve directs the grain to the desired bin. The flow indicating device signals back to the central control center that grain is flowing down the correct spout. When the bin becomes full, the bin level control is activated. Its signal immediately causes the slide gate feeding the elevator to close. When the grain in the elevator itself has stopped flowing down the spout, the signal from the flow-indicating device indicates that grain is no longer flowing down this spout. At that time the system can sound an alarm or if it has been correctly programmed will cause the three-way valve to automatically index to another position and seek another bin that is not full. When it finds an empty bin the electrically operated slide gate will once again open to full position and grain will again flow through the system into the empty bin. This can be continued until all bins are full at which time it will be necessary for the operator to take action to empty one of the bins before more grain can be received through the driveway dump.

Figure 1, shows a central control center which incorporates all of the electrical controls needed at a large size grain handling plant. Included are the following:

1. Service entrance - terminals are provided for the incoming power line.
2. Main disconnect switch.
3. Power distribution center.
4. Lighting circuit breakers.
5. Circuit breakers for all motors used including double safety lock-outs.

6. Meters to measure the power consumption.
7. Timed fumigation systems.
8. Starters for all motors.
9. Push button for each motor.
10. On-off lights for each motor.
11. Alarm system coupled to bin level controls.
12. Flow indicating diagram with selective interlocking. This permits the operator to plan a flow of grain through the system and so interlock the motors operating the conveyors and elevators that they cannot be started out of sequence and will stop the flow instantly when activated by an over-load or a bin level control.
13. Separate amp meters for each motor. Each will have a maximum load position field marked so that the operator can spot an over-load or underload condition instantly.

For complete automation this control center would have controls coupled to the selector switches which automatically cause all slide gates, two-way valves, three-way valves and other such distributing units to be activated from the central control center and position indicating lights showing the position of each of these.

Such a control center is intended for installation in a new plant. It incorporates all of the electrical controls needed to operate the plant and when this is taken into consideration the extra cost of adding the automation equipment when the plant is being built is moderate.

Some of the machines that you are using in your plant can be individually automated at very moderate costs with a resultant increase in their performance. A hammermill that is being gravity fed can be equipped with a modulating electrically operated slide gate controlled by a load limiter. The load limiter is adjusted so that the hammermill always operates at maximum load which will cause the slide gate to open to a corresponding point and hunt a position which will keep the hammermill running at full capacity all the time. The same system is useable on bucket elevators, steamers, debearders, roller mills and other machines whose power consumption increases according to the increase of rate of feed.

These "building block" tools of automation can be assembled to automate almost any installation.

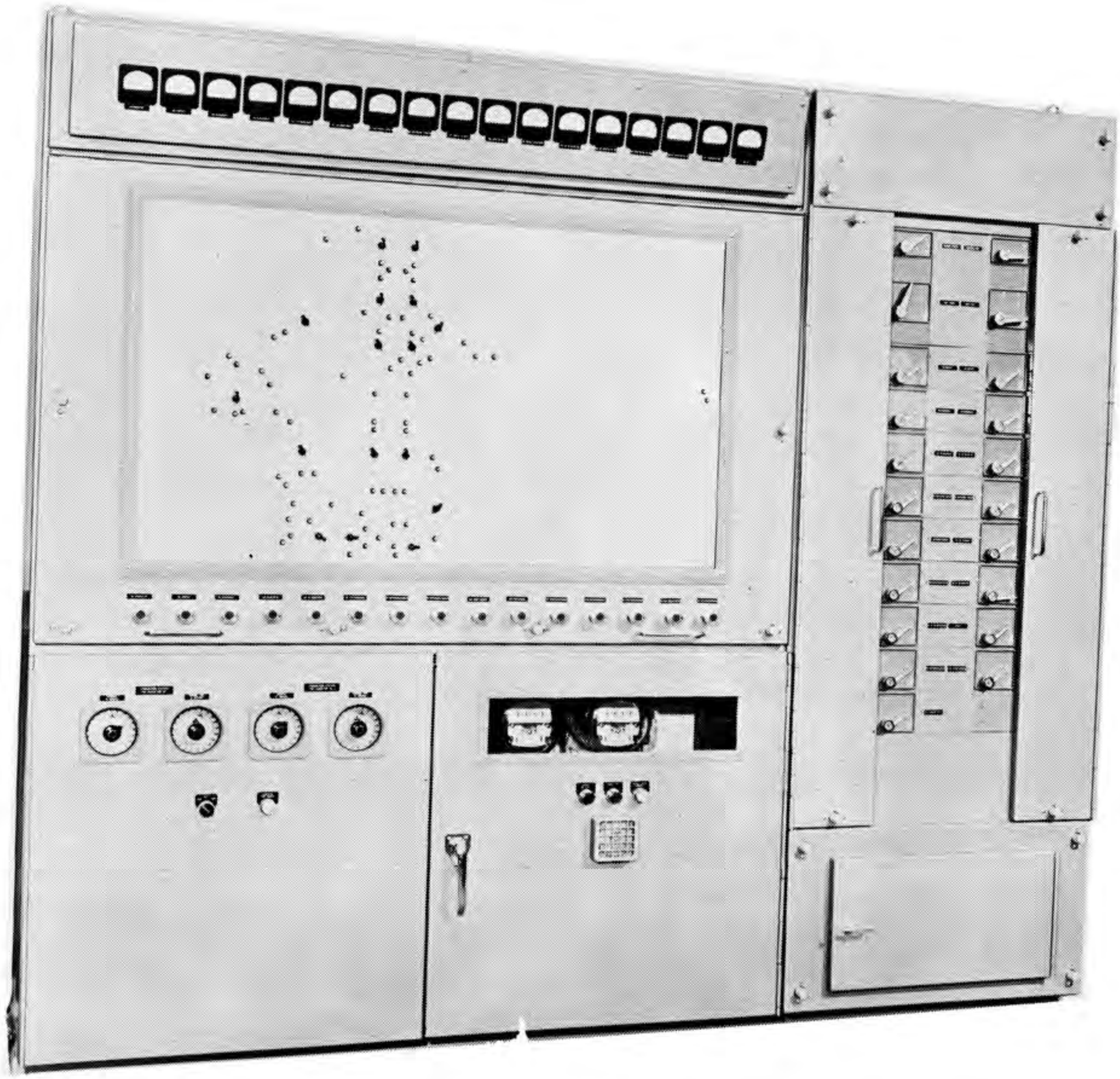

Figure 1. Control Center

SEED TREATMENTS TO CONTROL PLANT DISEASES

Earl D. Hansing [1]

Seed treatments are used to prevent or reduce losses from diseases caused by organisms associated with seeds or present in the soil.

Such organisms are associated with seeds in several ways. They may be mixed with seed as sclerotia, smut balls, nematode galls, and/or infested plant parts. Pathogens may be present in or on seeds.

Treating infested seeds with chemicals or heat greatly reduces the incidence of many seed-borne pathogens. Seed treatment is used also to protect healthy seed against soil-borne organisms, such as _Pythium_, _Fusarium_, and _Rhizoctonia_, which cause seed rots, preemergent damping-off, and seedling blights of many crops.

Some treatments kill organisms mixed with the seed or on its surface. Some destroy pathogens within the seeds. Others kill or retard the activity of soil organisms near the planted seeds.

Mechanical, physical, and chemical methods are used.

The _mechanical method_ is designed to remove infections materials mixed with seeds. Seeds should be thoroughly cleaned before being seeded. Mechanical treatment does not kill pathogens within a seed, remove all organisms from the surfaces of seeds, nor protect seeds from soil-borne organisms. Mechanically treated seed, therefore, often requires further treatment.

Physical methods are used primarily to kill pathogens deep in the seeds. Some pathogens, such as those that cause loose smuts of wheat and barley, can be inactivated in no other way.

Physical methods include hot-water and water-soak treatments and ultraviolet, infrared, X-ray, and other kinds of irradiation. Dry heat has been tested, but only the hot-water and water-soak treatments have been shown to be practical. Physical methods do not protect seeds against soil-borne organisms; they are effective against pathogens on or in seeds.

The hot-water treatment was the most commonly recommended physical method before 1950, but it never has been used extensively because of difficulties in exactly controlling temperature and duration of treatment. Its margin of safety is small and adequate supplies of steam or hot water, accurate thermometers, water tanks or vats, and drying facilities also are required.

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The method has been used mostly to disinfect small lots of seed and batches of small-seed crops that require low seedling rates per acre. Procedures differ with the crop and to some extent with the pathogen.

Various modifications of a water-soak method have been developed since 1950. They are safer and have less critical requirements than the hot-water treatments. They have been used mostly to control loose smuts of barley and wheat but are effective against some other pathogens.

In all water-soak treatments, the seeds must be soaked at least 2 hours and subsequently kept under anaerobic or near anaerobic conditions are one day or longer. In some instances the seeds are soaked 64 hours in water at approximately 72° F. and then dried. Sometimes the seeds are soaked only 2 hours, and then placed in air-tight containers at 80° for 48 hours before being dried.

Other effective modifications differ in temperature used and duration of treatment. The higher the temperature, the shorter is the time required. Varieties of crops differ considerably in sensitivity to injury from soaking for long periods. The possibility of injury is reduced by adding 1 percent of common salt or 0.2 percent of Vancide 51 to the water the seeds are soaked in.

Chemical treatments are the most commonly used to treat seed. Many excellent chemicals are available. They may be organic or inorganic, mercurial or nonmercurial, and metallic or nonmetallic.

Organic fungicides are used more than inorganic ones, but the latter are sometimes preferred. Fungicides may be applied as liquids, suspensions or powders. Equipment is available for all three forms. Recommended dosages vary with the fungicide, the crop, the length of the storage period after treatment, and sometimes with the method of application. Using excessive amounts of fungicides may injure the seeds, waste the chemical, and make handling and sowing treated seeds disagreeable and even dangerous. Using less than the recommended amount of fungicide hampers disease control and may reduce yields and quality.

Volatile fungicides usually are used at lower dosages than nonvolatile materials and are more effective when the treated seeds are stored at least a few days before being planted.

All dry fungicides present hazards. Special precautions are necessary. All powders harm people who inhale them over long periods or in excessive amounts. Seed fungicides are even more dangerous because all of them are poisonous. The extent of the hazard depends on the amount of powder inhaled, the toxicity of the chemical, the length of exposure, and the person's sensitivity.

When treating large quantities of seeds, particularly over a period of many days, artificial ventilation should be provided to collect and exhaust the powder from the treating room. Workmen should wear clean filter masks over their noses and mouths. A special mask must be used against volatile chemicals. If the fungicides are applied wet, this special equipment may not be necessary, but one must not inhale the chemicals or their fumes. The chemicals should not come in contact with the skin. If a worker get the chemicals on him, he should wash promptly and thoroughly with soap and water.

Originally wet treatments involved soaking the seeds in a water solution of a fungicide for a prescribed time, then removing and drying them before using or storing them. Farmers never liked the method; it took time, much work, and extra drying space in the granary. Seeds not properly dried were damaged.

Today wet treatments are applied mostly by the slurry method or by quick-wet procedures, and no drying is necessary because the treatments add less than 1 percent of moisture to the seeds.

In the slurry method, seeds are completely coated with a thick suspension of the chemical in water. The suspension is applied by a special machine, a slurry treater. Because this method eliminates flying powder during treating, it is safer and less disagreeable for workmen. It permits more nearly accurate and uniform dosages of chemical than do other methods for most kinds of seeds.

In the quick-wet method, a concentrated solution of a volatile fungicide is added to the seeds and thoroughly mixed with them. Panogen 75 and Ceresan L are examples. Use of volatile liquid fungicides has increased greatly since 1950, especially for treating small grains, cotton, flax, and rice.

Pelleting is another way to apply chemicals. Pelleting is used mostly as a protectant against soil organisms and as a repellent against birds and rodents. It has been particularly valuable for treating seeds of pine and other conifers. It is used to some extent to treat seeds of other crops, notably onion, to control smut.

Insecticides are applied to the seeds of many crops. Insecticides increase the need for fungicides since insecticides tend to predispose seeds and young seedlings to attack by soil fungi. Compatible fungicides and insecticides, like captan-dieldrin and thiram-dieldrin, are available.

Some manufacturers package fungicide-insecticide mixtures, and the combination is applied as a single treatment. Others market insecticides and fungicides separately, and the materials are applied separately.

All seeds containing chemical powders should be placed in closely woven bags (10-ounce or heavier) to reduce chemical sifting during handling and shipping. This is particularly desirable when chemicals are applied at high rates to smooth-surface seeds. If the seed is to be sold, it must be labeled to indicate that it has been treated and is unfit for food or feed.

An ideal fungicide would be highly effective in disease control, harmless to seed even at higher than recommended dosages, economical to use, easy to apply, relatively nontoxic to people, noncorrosive to machinery, adapted to use in planting equipment without interferring materially with uniform seed flow, stable for relatively long periods, and relatively harmless to animals that might consume the treated seeds. No chemical in use in 1963 met all those requirements.

The choice of treatment depends on the crop, the nature of the disease problem, the condition of the seeds, the relative cost and availability of acceptable fungicides, the availability of treating equipment, and weather conditions expected after seeding.

Crops differ in responses to seed treatment. Some benefit more than others. Some are more sensitive to injury than others. It is essential to know which diseases are to be controlled and whether the pathogen is located in or on the seeds or in the soil.

Only high quality seeds should be planted. They should be thoroughly cleaned, cured, and dried before being treated. Cracked, damaged, and old seeds sometimes benefit more from treatment than good seeds, but treatment should not be expected to substitute for good seeds. Even good seeds may benefit from a protectant.

When soil and weather conditions after seeding are unfavorable for rapid germination and development of seedlings, treatment of seeds often will mean the difference between a good and a poor stand. When growing conditions favor the host, there may be no apparent benefit from treatment. Because weather cannot be foreseen several weeks in advance and treating costs are low, many crops are treated every year as insurance against losses. Corn and sorghum are examples.

The treatments have been standardized to a remarkable degree, and recommendations applicable over wide areas for controlling diseases in specific crops can be made. Nevertheless, a grower will do well to consult his agricultural experiment station for the best fungicides for his situation.

Corn is extensively treated. Almost all of the seed of hybrid corn is treated chemically to prevent seed rots and seedling diseases.

The monmercurial organic fungicides, principally captan and thiram, are used most. They are applied as powders or slurries. Captan is superior at low dosages and on old seed, especially when conditions after planting are unfavorable. Both chemicals, when applied at recommended rates, give adequate protection to good seed. Dieldrin can be combined with either captan or thiram if protection against soil insects is needed. Such combination treatments are commonly used in some states. Heavy insect infestations, however, can be controlled best by treating the soil.

Sorghum also is extensively treated to control kernel smuts, seed rots, and seedling blights. The nonmercurial fungicides captan and thiram are principally used. Mercurial fungicides are used to some extent.

Dieldrin often is added to the nonmercurials. Insecticides are less often combined with mercury compounds, although aldrin has been used with Panogen.

Wheat is treated to control bunt, loose smut, seed rots, and seedling blight.

Organic mercury compounds, like Ceresan (M and L), Panogen (15 and 42), Chipcote (25 and 75), and various Ortho LM Seed Protectants, are recommended generally for bunt control when the pathogen is not present in the soil. Depending on the formulation, seeds may be treated with a direct-type or a powder machine slurry.

Formulations such as Orthocide HCB and Ceresan M-DB may be used to treat seed directly in a drill-box.

If the pathogen is present in the soil, seeds should be treated with HCB, which is sold under trade names of No Bunt, Smut Go, Sanocide, and Anticari. It is a wettable powder suitable to use as a powder or slurry.

Soil surface treatments with HCB (10 pounds an acre of a 40-percent formulation) have effectively reduced dwarf bunt in the Pacific Northwest. Seed treatment does not control dwarf bunt.

Loose smut can be controlled only by a hot-water or water-soak treatment. The hot-water treatment is: Soak cleaned grain in water at 60° to 70° F. about 4 hours; preheat it in water at 120° for 1 minute; treat it in water at 129° exactly 10 minutes; plunge it into cold water immediately to cool; remove and dry it rapidly at not more than 100°.

The water-soak method has already been discussed. It is less dependable for wheat.

Seed treated with either the hot-water or the water-soak method should also be treated with a fungicide, like captan or thiram, to protect it against soil organisms.

Seed-borne pathogens that cause seed rots and seedling blights are killed by mercurials ordinarily used to control bunt, the hot-water treatment, or the water-soak method. They are not controlled by HCB.

Barley diseases that respond to seed treatment are covered smut, loose smut, intermediate loose smut, stripe, seed rot, and seedling blights. Loose smut is controlled by hot-water or water-soak treatments like those described for wheat.

The standard hot-water method for barley is: Soak the seed in water at 60° to 70° F. 5 or 6 hours; preheat it in water at 120° for 1 minute; treat it in water at 126° for 13 minutes; cool it; and dry it.

The water-soak method is effective against loose smut and is replacing the hot-water method because it is safer and easier to use. All organic mercury compounds used on wheat will control covered smut, intermediate loose smut, stripe, and seed-borne pathogens that cause seed rots and seedling blights of barley.

Oats are treated with the same organic mercury compounds recommended for wheat and barley. Those fungicides are effective against loose smut, covered smut, Helminthosporium blight, seed rots, and seedling blights.

Treating rice seeds with captan and thiram powders or slurries will improve rice stands. Those fungicides protect germinating seeds against soil-borne pathogens. Organic mercury compounds are recommended if the seed is known to be infected with Helminthosporium, Piricularia, or other seed-borne fungi.

Cotton seed is treated to protect against angular leaf spot, anthracnose, sore shin, seed rots, and seedling blights. The seed usually is delinted before it is treated. Delinting is done mechanically by reginning, or chemically by acid. The method of delinting may influence the choice of fungicide.

Organic mercurials, like Ceresan (M or L) and Panogen 15, generally have been most effective against seed-borne pathogens.

The nonmercurial captan is superior against soil organisms.

In some Cotton Belt localities, incorporating a fungicide or a mixture of fungicides as a spray or dust into the covering soil at planting time has helped to reduce preemergent and postemergent damping-off by reinforcing the effect of seed treatment and by providing a treated zone for seedlings to emerge through.

Flax seed commonly is cracked and damaged by threshing. Cracks also develop in the seedcoat of some yellow-seeded varieties while they mature. The cracks let many fungi enter that rot seeds or cause seedling blights.

Organic mercury compounds, like those used for wheat, are recommended for flax. They also kill seed-borne pathogens. They may be applied as liquids, slurries or powders. Heavier dosages are required for flax than for most field crops because fungicides do not readily adhere to smooth seedcoats and because flax seeds have more surface area per bushel. Wet treatments cause some gumming of flax seeds because their coats are mucilaginous.

Nonmercurial organics, like captan, have not been widely used for flax, but they are effective against soil organisms.

Sugar beets should be treated with a good protective fungicide like captan, thiram, Dexon, or dichlone to control seed rots and damping-off.

Organic mercury compounds are effective against seed-borne pathogens but are less satisfactory against soil organisms.

Sugar beets usually are treated with powders rather than slurries or liquids.

Yields of soybeans are rarely increased by seed treatment unless poor seeds are used or weather conditions after planting are especially unfavorable. Captan, thiram, and chloranil are the best fungicides when treatment is required. Organic mercurials are sometimes injurious.

Treating peanut seed is profitable, especially when machine-shelled seed is used. It reduces seed rotting and improves stands. Recommended chemicals include thiram, chloranil, and 2-percent Ceresan applied as powders.

Small-seeded forage legumes like alfalfa, clover, sweetclover, vetch, lespedeza, and trefoil, usually do not respond to seed treatment under field conditions. Occasionally small increases in stand are obtained, but not increased forage yields.

Treatment may be helpful on Pythium-infested muck soils and under certain other special conditions where it is hard to establish a stand. Captan and thiram are among the most effective and safest seed fungicides for those crops. Copper and mercurial fungicides may cause severe injury.

The many species of forage grasses differ in disease problems and responses to treatment. Losses from seed decay and damping-off can be reduced by using a protectant like captan or thiram. Damaged seeds usually benefit more from treatment than sound seeds.

Seed treatment also is valuable in controlling seed rots, seedling blights, and other diseases of many vegetables, fruits, ornamentals, and forest trees.

SEED TREATMENT IS GOOD, INEXPENSIVE INSURANCE.

OBSERVATIONS ON SEED DETERIORATION

James C. Delouche [1]

I welcome this opportunity to discuss the general subject of seed deterioration with you. To be sure there are other topics about which we know more - much more - but I feel that too often we expend our efforts and opportunities reconsidering the things we know most about - to the great neglect of those areas, such as seed deterioration, about which we know little. Yet these neglected areas frequently offer not only the greatest challenge but the most potential for the advancement of knowledge and the solution of major problems.

Only a few years ago, the title of this talk would have been "Storage of seeds" or some such similar phrase. For we were prone to think that all the "ills" of seed had their origin somewhere in the storage cycle - and that "good" storage conditions were the key that would solve all problems. Concepts are changing, however, and our span of observation and concern has broadened to include not only the storage environment but also the pre-storage history of seed lots all the way back to the time seeds are maturing in the field and even before. These concepts have been surprisingly late in developing, for they are based upon a simple fact either overlooked or ignored: that the best of storage conditions have never <u>improved</u> seed quality. Or to put it another way - the seeds we take out of storage are never higher in quality than the seeds we put into storage. Actually the quality is always lower, for the processes of seed deterioration are inexorable.

Characteristics of Seed Deterioration

No attempt will be made here to define "seed deterioration" for too little information is presently available to permit any rigorous definition. Rather let us consider "seed deterioration" as a vaguely descriptive phrase applied to a complex of changes that occur in seed as they die.

While seed deterioration presently defies definition, it can be characterized in terms of several premises:

1. <u>Seed deterioration is an inexorable process.</u>

This means that seed deterioration must be considered as an unalterable fact, at least in the light of our present knowledge, for seeds die as well as cabbages and kings. We cannot <u>prevent</u> deterioration; we can, however, influence or control its <u>rate</u>.

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[1] Dr. Delouche is Associate Agronomist, In Charge, Seed Technology Laboratory, Mississippi State University, State College, Mississippi.

2. Deterioration in seeds is an irreversible process.

In its very basic form this premise simply states that dead seeds cannot be brought back to life - or more realistically perhaps, dead portions or areas in seeds cannot be rejuvenated or made whole again. There is a practical implication here: if seed are allowed to deteriorate in the field, or are mechanically abused in harvesting, the damage cannot be undone by subsequent good storage, gentle handling or even seed treatment.

3. Deterioration is at its lowest level at the time of seed maturation.

By seed maturation we mean the point in the developmental history of a seed when it is physiologically and morphologically capable of developing into a highly vigorous seedling. Although it is generally not realized, seeds usually reach maturity long before normal harvest and at relatively high moisture contents - 30 to 45%. Once the peak of maturation is attained, the seeds having reached maximum dry weight, vigor and viability, there is only one direction to go, downhill. There can be considerable deterioration before harvest.

4. Rate of deterioration varies among the different kinds of seed.

One cannot generalize too broadly about seeds: cottonseed and soybeans have somewhat similar chemical composition - they are both high in oil and proteins with relatively little starch. Yet, cottonseed will store or keep for 2 or even 3 years while soybeans often deteriorate before the first planting season after harvest. Several years ago one of our inspectors sampled a carry-over ryegrass-fescue seed mixture. The seeds were over 4 years old. Upon analysis the ryegrass germinated above 80%, the fescue seed germinated less than 10%. While it is not known why some kinds of seed live longer than others, it is a fact that must be considered.

5. Rate of deterioration varies among seed lots of the same kind and variety stored under the same conditions.

Several years ago, we started a modest project on seed deterioration financed in part through a grant from the ASRF. We proposed to work on certain aspects of deterioration in crimson clover and sorghum seed and decided to replicate the work by using two similar lots of each kind. The lots were carefully selected, sized, aspirated, etc. Yet, as we followed the study over a three year period, the most significant thing to emerge was that the two lots of crimson clover and the two lots of sorghum responded very differently. In each case there was a "good" lot that maintained high viability and vigor for a relatively long period of time, and a "bad" lot that deteriorated rapidly. How can such responses be explained? Undoubtedly certain events occurred in the life history of the "bad" lots of each kind prior to the time they came into our hands which predisposed them to early deterioration. Since the effects of these events were irreversible, and generally unrecognizable, the careful sizing, processing, etc., were to no avail. The lesson that can be drawn from this is that seed lots of the same kind and variety, of the same chronological age and viability, and which even look alike, are not necessarily of the same quality. This situation is responsible in a large part for many of the seedsmen's troubles.

Factors Predisposing Seeds to Rapid Deterioration

As previously indicated, certain factors or events in the life history of seeds predispose them to rapid rates of deterioration. Let us consider some of these:

1. Preharvest environmental conditions

Conditions in the field during seed development and maturation have an important influence on the subsequent characteristics of the seeds: prevalence and persistence of hard seededness and dormancy, extent of mechanical damage, viability, vigor, test weight, appearance, and storability. Adverse field conditions are diverse: early frost damages corn, peanuts, sorghum; dry-hot weather leads to a rapid loss in seed moisture, small seed size, low test weight and more mechanical damage during harvest; warm-humid weather is conducive to weathering and deterioration in soybeans, cottonseed, sorghum. Cotton provides one of the best illustrations of the interaction of preharvest environmental conditions and seed quality.

Cotton is an indeterminate species. Blooming starts at the bottom of the plant in July and progresses upward until early fall. Correspondingly, the seeds mature and bolls open in the bottom portion of the plant in August and then progressively up the plant. Thus, if one examined a cotton plant in early September, he will usually find some buds, blooms, small bolls or fruit, and large fruit bolls that had been opened for several weeks. Prior to the middle 1950's much of the cotton was harvested by hand and several harvests were made so that opened bolls did not remain on the plants for more than 2 or 3 weeks. Seed quality was generally good. Since 1956, however, seed quality has been poor except for two years. This period corresponds to the increasingly widespread use of mechanical harvesters. Only one harvest is made - after a majority of the bolls are opened. Thus, bottom and middle bolls might be open as long as 6-8 weeks before harvest. The seed are in effect stored in the field for a long period of time and subjected to all the adversities of high humidity, frequent showers, and high temperatures prevailing in late summer and early fall. High rates of nitrogen application, and irrigation tend to produce dense foliage forming a sort of "sweat" box within the canopy of foliage. Studies have shown that at harvest the seeds of bottom bolls might germinate below 30%, seed from middle bolls around 60%, and seed from top bolls above 90%.

When these are mixed together - the result is low quality seed. While this situation does not always occur - cool, dry weather during the maturation period minimizes deterioration - it happens frequently enough to constitute a serious problem.

While cotton provides a good illustration it is not the only one. Sorghum and wheat seed sometime sprout in the field when maturing under warm, humid conditions and oats are often severely weathered.

2. Harvesting and processing procedures

Improper harvesting and processing can contribute greatly to deterioration. In 1963, one of our soybean seed growers harvested a beautiful field of soybeans. The weather had been hot and dry during late summer and early fall and the beans were 8 to 10% in moisture at the time of harvest. After harvest, the beans were scalped, elevated to a holding bin, fed into the hopper of an air-screen cleaner, cleaned, re-elevated to a bin and finally treated in an auger type mixer-treater and bagged. The result: 70% germination - below the minimum for certification. When this problem was analyzed, it was determined that some hand harvested beans left over from moisture tests taken before harvest germinated almost 100%. Germination of seeds after combining was 82%, after processing about 78% and after treatment in the auger mixer 70%. It is obvious that, here, one is dealing with mechanical damage. The soybean seed were dry, brittle, and very susceptible to damage. Each step in the harvesting and processing operation took its toll - adding to a very significant loss in seed quality.

Mechanical damage apparently has several effects: (a) direct effects - resulting from impacts or abrasions that immediately render seeds incapable of germination; (b) latent effects - it seems likely that deterioration is initiated at sites of mechanical fractures or bruises and show up in poor keeping quality; (c) indirect effects - ruptures in the seed coat or fruit coat play an important role in the incidence and severity of certain seed rotting organisms, and susceptibility to treatment and fumigation damage.

3. Environment during storage and transit

We are all most aware of the influence of storage environment on retention of viability and vigor. Several years ago we received a rather irate letter from a seedsman. This seedsman had read one of our articles on seed storage in which it was stated that seed retained their viability for a long time in "cold storage". He had a 2000 bu. carry-over of some certified seed, and had placed them in "cold storage" after the planting season. The seeds remained in cold storage for 8 months and were removed from storage in August. Samples tested 6 weeks after the seeds were removed from storage showed only 32% germination. (The seeds at the time they were placed in storage germinated above 90%.) The seedsman wanted to know why we had recommended "cold storage" when it was so obviously detrimental to the seeds. Upon investigation, it was determined that the seed were stored in the type of cold storage facility used for vegetables and other succulent materials. The temperature was about 40° F. and the humidity near 100%!! Under such conditions the moisture content of the wheat had increased to about 18%. When the seeds were taken out of storage in August the temperature was near 100° F. At this combination of high moisture content and temperature, it didn't take long for the seeds to deteriorate to 32% germination. The seedsman finally admitted that the article referring to the beneficial effects of low temperature also stated that low humidity was essential.

Moisture content is the single most important factor controlling rate of deterioration. It also influences the nature and severity of mechanical damage, and the extent and severity of injury from fungicides and fumigants.

A good rule of thumb for judging how good storage conditions are is to add the temperature in ° F. to the percent (%) relative humidity - the nearer the sum approaches 100, the better the storage conditions, e. g., 50% r.h. - 50° F.; 80° F. - 20% r.h., etc. This is an excellent rule of thumb, unfortunately it is difficult to achieve economically. Also implicit in this rule of thumb is the suggestion that temperature and humidity are exactly compensating. Such is not the case - if storage conditions of 50° F. and 80% r.h., and 80° F. and 50% r.h. are available - both adding to 130 - then the combination with the low humidity is preferred. Low humidity means low seed moisture - and within certain ranges - decreasing moisture content by 1% almost doubles the life of the seed.

There is currently much interest in packaging, particularly in the use of plastic bags. The idea is to place a moisture vapor proof barrier between the seed and the environment so that the moisture content is maintained at the same level as at the time of packaging. This is a good development. However, several precautions must be observed. Generally, seed moisture contents for sealed storage should be 2 to 3% lower than that considered "safe" for unsealed storage. And the vapor barrier should be maintained. I am reminded here of a contact with the packaging division of a large manufacturer. They were working with a corn producer on use of plastic bags. Corn was dried to 10% - sealed in 6 mil-poly bags and placed in a "tropical" room for observation. After 6 months under warm humid conditions in the tropical room -

the corn were always dead. We puzzled over this awhile and finally gleaned the very significant information that thousands of tiny holes were punched in the plastic bag before packaging because everyone was afraid that otherwise the seed might smother: after all, they were alive. The seed of course might just as well have been in a cloth bag as in a perforated plastic bag. Seeds don't smother, they do respire but very little. Vegetable seeds have been packed in air-tight, vapor-tight cans for years.

So far, we have discussed several premises relative to the deterioration process in an attempt to characterize it. We have considered several factors which either contribute directly to deterioration, or predispose seeds to early and rapid deterioration. What about the effects of deterioration on the seed itself? Actually, this is the subject about which least is known.

In most cases the most obvious evidence - and often the only evidence - of deterioration is loss in germination or viability. However, closer examination reveals that loss in viability or germinability are only manifestations of deterioration - the final evidence. Other changes precede loss in viability. In oily seeds, the oil begins to deteriorate and free fat acidity increases. A general increase in seed permeability occurs and the seeds seem to lose their capacity to hold materials on a cellular level. Certain areas of the seed begin to die beginning at sites of old injuries, or if seeds are uninjured, at sites of morphological weakness, or along margins of the seed. More and more of the tissue dies until a point is reached wherein the seed can no longer germinate - or if they do - only abnormally. For example, the root or radicle often dies at an early stage. The seedlings produced become weaker and weaker - growth rate becomes slower and slower. Germination percentage might be little affected at this stage - but if the seeds are planted under the relatively unfavorable conditions operating in the field or soil environment, a stand is seldom obtained.

Thus, the seeds become low in vigor. Finally, the bottom drops out and germination suddenly and rapidly decreases. This is about as much as we know of the deteriorative process itself. Can anything be done about it? Deterioration cannot be prevented - but its rate surely can be controlled. One can control and minimize such things as mechanical damage which predispose seeds to rapid deterioration. Harvesting carefully at the right time, reducing moisture content rapidly, storing seeds under dry, cool conditions enables the seedsman to maintain seed quality for a long time. You are aware of some of the recent advances: drying of seed, packaging in moisture-proof containers, redesigning processing, elevation and storage facilities to minimize impacts and abrasions to seeds. We should continually bear in mind - that seeds are living organisms. Handle them carefully - the life you save means greater profits to you.

BASIC CAUSES OF POOR STORAGE AND REFRIGERATED DEHUMIDIFICATION

James D. Helmer [1]

For many decades, the retention of seed viability has been of major concern to seedsmen, plant breeders, nurserymen, farmers - in fact anyone who is concerned with plant life has been faced with the problem of the preservation of seed life. The major factor involved in the retention of seed viability is seed storage. Without a proper storage environment, the task of preserving seed life is impossible.

Before we delve any deeper into the area of seed storage, let us examine one of the prime prerequisites for good seed storage and that is, first of all, you must start with top quality seed. Conflicting seed storage data commonly occurs because of a difference in the vigor level of the seed to begin with. Although germination percentages of various lots of the same seed type may be comparable, a large variation may exist within these same lots as to the degree of seed vigor which each possesses. Consequently, different storage research data will be obtained when these lots of seed are placed under identical storage conditions. Therefore, to realize the maximum benefit from your storage facilities, you should start with high quality seed.

Table 1 shows different seed equilibrium moisture contents at 75° F. and various relative humidity percentages.

Table 1. The effect of various levels of relative humidity upon seed moisture equilibrium at 75° F.

	Relative Humidity (%)		
Seed	55	70	85
Reed Canarygrass	11.4	12.1	15.4
Orchardgrass	10.0	11.1	14.9
Sudangrass	10.8	11.8	15.6
Kentucky Bluegrass	9.7	11.3	16.4
Crown Vetch	-	9.9	18.1
Sweet Clover	-	9.3	18.3
Red Clover	-	9.1	18.7

[1] Mr. Helmer is Assistant Agronomist, Seed Technology Laboratory, Mississippi Agricultural Experiment Station, State College, Mississippi.

The two main "demons" in seed storage are relative humidity and temperature. The moisture content which seed will attain during storage is dependent on these two factors. A storage environment which is characterized by a high temperature plus a high level of relative humidity will result in a high seed moisture equilibrium. Consequently, seed deterioration will be very rapid under these conditions.

As noted from the results in Table 2, relative humidity has a more pronounced effect on seed storage than temperature. However, it should also be kept in mind that an interaction does exist between temperature and relative humidity insofar as seed longevity is concerned.

Table 2. Germination percentages of sorghum seed after various intervals of storage at different temperatures and relative humidities.

Relative Humidity	Temperature	Months of Storage						
%	°F.	0	2	4	6	8	10	12
20	50	95.2	93.5	94.2	95.7	95.7	94.7	96.5
	68	95.2	94.0	94.2	94.7	95.0	96.5	95.7
	86	95.2	93.2	92.5	95.2	93.0	94.0	94.5
40	50	95.2	94.2	93.7	95.0	95.0	96.2	95.0
	68	95.2	93.0	93.7	92.7	93.7	93.0	94.7
	86	95.2	93.0	93.7	95.5	93.2	95.2	92.0
60	50	95.2	93.2	93.2	95.2	93.5	94.5	97.2
	68	95.2	92.2	94.5	94.7	95.0	93.7	92.2
	86	95.2	92.5	94.2	89.2	89.5	86.2	75.2
80	50	95.2	92.7	92.3	56.7	47.5	44.5	38.0
	68	95.2	56.5	47.2	39.2	10.5	0.0	0.0
	86	95.2	45.0	0.0	0.0	0.0	0.0	0.0
100	50	95.2	85.5	44.0	22.7	0.0	0.0	0.0
	68	95.2	41.0	0.0	0.0	0.0	0.0	0.0
	86	95.2	1.0	0.0	0.0	0.0	0.0	0.0

Control of the relative humidity in a seed storage area can be accomplished in one of two ways. One of these methods is by dessicant type dehumidification and the other is by mechanical refrigeration.

Refrigeration dehumidification operates on basically the same principle as to why moisture will accumulate on the outside of an ice tea glass. If a given surface is at a sufficiently low temperature, moisture vapor present in the atmosphere, which the surface is in contact with, will deposit as a liquid on this surface. This temperature is referred to as the dewpoint. The dewpoint of an atmosphere is reached by simply cooling the air without changing its water vapor content.

Table 3. The effect of temperature and relative humidity on dewpoint.

Temperature °F.	Relative Humidity	Dewpoint °F. (Approx.)
60	60	46
50	60	37
40	60	28
30	60	19
60	30	29
50	30	21
40	30	13
30	30	5
60	10	6
50	10	0
40	10	-7
30	10	-16

The temperature of the cooling coils on your refrigeration system must be at or below the dewpoint temperature before you will get any drying or dehumidification effect. For example, if you had a storage atmosphere which you desired to maintain at temperature of 50° F. and 60% R.H., the temperature of the cooling coils must be at 37° F.

If the dewpoint of the coils is required to be below 32° F. to attain the desired level of temperature and relative humidity, then it will be necessary to periodically remove the moisture, which will accumulate in a solid state from the coils. This can be accomplished by installing a heating arm near the cooling coils. This heating arm should be activated periodically to melt the ice which has formed on the coils.

Remember, most seed can be safely stored for considerable periods of time if the storage atmosphere which the seed are in contact with is maintained at a proper temperature and relative humidity.

HOW TO DRY YOUR SEED-STORAGE ROOM

Ernest N. May, Jr. [1]

Moisture is one of the most subtle and dangerous enemies that seedsmen, plant breeders and anyone concerned with seed preservation, have to fight. The enemy is subtle because he does his worst damage without being seen. Hiding under a cloak of invisibility he leaves a trail of disease and rot and mildew wherever he goes. Moisture causes seed to germinate in storage and robs it of its most precious ingredient - its viability.

Of course, all moisture is not invisible. In its solid state, ice, it is easy to handle and carry and manage. As a liquid, you can pipe it and make it go anywhere you wish. But, as a gas it becomes more difficult to deal with.

All air contains some moisture in the form of vapor. The warmer the air, the more moisture it can hold. A room full of air at 80° F. might be able to hold a gallon of water in the form of vapor. That same room can hold only half that much moisture vapor at 60° F.

And although the air in the room might be able to hold a gallon of moisture at 80° F., it does not follow that there is always that much moisture in the room. The moisture content of air varies widely. It varies from hour to hour in the same location and it varies from location to location. In the desert lands of the West, the air is relatively dry and seldom contains all of the moisture it can hold. That is why a shirt on the line will dry more quickly in Arizona than in New Jersey.

Probably the least understood characteristic of moisture vapor is its ability to move about under its own pressure. It tries to fill every available space and is constantly pushing itself here and there to be sure no spot has been left unoccupied. You can witness this characteristic when a woman enters a room wearing too much perfume. Almost at the instant she walks through the doorway, people across the room catch the fragrance. It was driven there by vapor pressure.

It is this same vapor pressure that forces moisture from a humid area into a dry area. Moisture can come into a room in a steady stream through a keyhole or through cracks around a loosely fitting window or even through wooden or concrete walls.

For this reason, the most important factor to consider when planning a seed storage room is its construction. It should be made as nearly vaporproof or airtight as possible.

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[1] Mr. May is President, Universal Dynamics Corporation, Alexandria, Virginia.

Since most seed storage rooms are either air conditioned or refrigerated, it should be pointed out that insulating and vaporproofing are not necessarily the same thing. A well insulated space can have a high degree of moisture leakage.

So, special attention should be given to vaporproofing the room, over and above whatever thermal insulation may be required.

The ideal vaporproof room is one that is lined with metal, with all seams welded or soldered, and which is equipped with a refrigerator type door. Lining a refrigerated room with seam welded light gauge steel would cost little more than other vaporproofing methods.

If you have lined the room with steel you will have what amounts to a well sealed tin can. If you had a room of that kind, keeping it dry would be relatively simple. The main problem then would be the amount of traffic in and out during the day because every time the door is opened, moisture rushes in. But, even with constant daytime movement in and out, the humidity could be brought down quickly and easily after working hours.

Of course, every new seed storage room cannot be lined with steel. And there are many storage rooms now in use that can be made relatively vaporproof by other means. For example, a lining of polyethylene sheeting is an effective vapor barrier. It might be made a part of the walls when the room is built, or added later, either on the inside or outside of the room. Or, the room might be panelled with one of the newly developed plastic coated panels, again making sure that the seams are vaporproofed.

If your room already is tight, all that may be necessary is a covering of vaporproof paint on all sides. In the case of the floor, wood flooring should be installed over the painted surface to protect it where trucks roll or where there is much movement.

No attempt is made here to list the many vaporproofing materials on the market. New materials are constantly appearing and the best procedure is to check with your local contractors and building supply houses. Also, any paint manufacturer can give you a list of the vaporproof paints that he has available.

After the size and the detailed construction of your room has been decided on, the next step is to determine the temperature and humidity you will maintain and the size of the air conditioner and dehumidifier you will need.

In either case, competent engineers should be consulted, but in this article we will discuss only drying equipment.

We would point out that the ideal situation for storage of seeds, as agreed on by most of our leading agronomists, is a temperature and relative humidity, which when added together, come to a total of ninety or less.

For example, if you were maintaining a temperature in your seed storage room of 70° F., you would want to hold a relative humidity of 20%. Or, if your temperature is set at 50° F., the relative humidity should not go over 40%.

The correct size of the dehumidifier can be determined by figuring the amount of moisture you must remove from your room to bring the humidity down to the desired percentage. This can be done by a bit of simple arithmetic and the use of a psychometric chart. (Figure 1.)

If you wish to figure the amount of moisture you must remove to maintain the proper humidity in your room, refer to the chart and follow the directions given on the next page.

There are two important factors that must be considered when figuring the size of the dehumidifier. The first is the amount of moisture that comes into a room. An open door in a medium sized storage room can give you a complete change of air as quickly as one minute. A crack under the door can let moisture flow into the room at an amazing rate.

In figuring the total 24 hour moisture load of a dry storage room, it is well to figure on a minimum of ten to fifteen air changes a day. Therefore, if you figure that four pounds of moisture must be removed from the air to give you the desired humidity, you should install a dehumidifier that will remove ten to fifteen times that amount of moisture in a twenty-four hour period.

The second factor to consider is the limit to the moisture removing capabilities of your air conditioning or refrigerator unit. Any unit that removes moisture from the air by condensation becomes ineffective at temperatures below 35° to 40° F.

This is quickly discernable when you refer to the chart again. (Figure 1.) Note that the figures on the extreme left of the chart indicate the dew point under various conditions. The refrigerator unit can only operate as low as 35° to 40° F., because the condensed moisture will begin to freeze on the coil. This means that no relative humidity which falls below that dew point, can be reached by condensation.

To illustrate this, a heavy line has been drawn on the chart showing the point below which refrigerant-type dryers will not work. Note for example, that if you want to maintain your seed room at 50° F. and 40% relative humidity, this point comes below the dewpoint that can be reached by refrigeration.

The only drying unit that will bring the humidity lower is a desiccant dehumidifier. In this type of dehumidifier, moisture is adsorbed from the air by a dry desiccant, of which silica gel is a typical example.

Silica gel is non-toxic and non-corrosive and has no adverse effect on the seeds in storage. It does not get sticky or messy, and if the air flowing through it is properly filtered to remove dust and foreign particles in the air, it will function for years.

By quickly plotting on the chart the conditions that you want to reach in your seed storage room, you can determine whether your air conditioner or refrigerator unit can do the job.

Desiccant dehumidifiers are being used more and more in the seed industry. When they are properly sized and installed, they operate efficiently and relatively trouble-free and give you the protection against humidity that you need.

As an example, take a room with a volume of 4,000 cubic feet. The temperature of the summertime air that comes into your room from outside is 90° F. and the relative humidity is 80%. The temperature of your storage room is 50° F. and you want to maintain a relative humidity of 40%. Problem: How much moisture must you remove from ONE ROOM FULL OF AIR in order to bring the humidity in the room down to 40%?

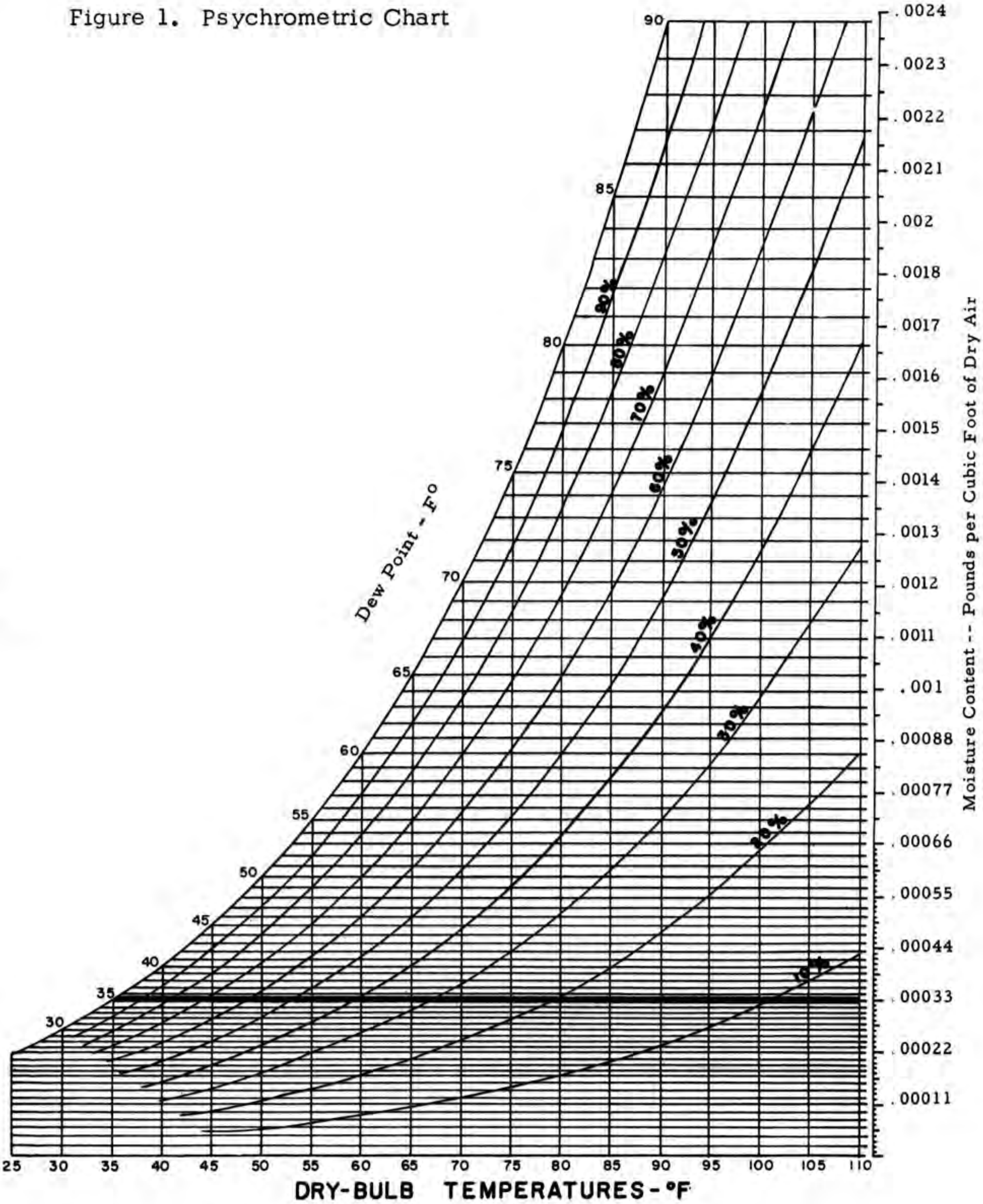
First, plot the point where 90° dry bulb temperature and 80% relative humidity curve meet. Follow the straight line from there to the extreme right of the chart. This will show you the amount of moisture in each cubic foot of air under these conditions. It is .0018 pounds.

Second, plot the temperature and humidity as you want them to be, 50° F. and 40%. By drawing your line to the extreme right you find that at these conditions the air will contain .00022 pounds of moisture per cubic foot.

The amount of moisture that you must remove per cubic foot is the difference between these two figures, or .00158. Therefore, the amount of water you would have to remove from your room under these conditions would be 4,000 times .00158 or 6.3 pounds. If you have as high as 15 air changes a day, you must remove up to 94.5 pounds or approximately 12 gallons of water a day.

It is easy to see that the biggest problem is to keep moisture from coming into the room, both by building it as near vapor-proof as possible and by limiting the amount of time that moisture is allowed to rush in through an open door.

Figure 1. Psychrometric Chart



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REGISTRATION LIST

1964 SEEDSMEN'S SHORT COURSE

ALABAMA

1. Hugh E. Adams
The Mill Mutuals
5602 17th Street, East
Tuscaloosa, Alabama

2. Billy Ray Gregg
Alabama Crop Improvement Assoc.
Auburn, Alabama

3. Ray Simpson
Mike Simpson Fertilizer Company
Box 457
Atmore, Alabama

4. James H. Sims
Sims Seed Company
Route 2
Union Springs, Alabama

5. James M. Sims
Sims Seed Company
Route 2
Union Springs, Alabama

6. Larry Spooner
Dothan Seed & Supply
Box 650
Dothan, Alabama

7. Mrs. Larry Spooner
Dothan Seed & Supply
Box 650
Dothan, Alabama

8. C. S. Stirling
Lee's Seed Store
Aliceville, Alabama

ARKANSAS

9. John Baldwin
Arkansas State Plant Board
P. O. Box 1069
Little Rock, Arkansas

10. Richard Cross
Wonder State Mfg. Co.
Paragould, Arkansas

11. Alton Fryer
Warren & Coody Grain Co.
Eudora, Arkansas

12. Richard A. Graves
Alice-Sidney Dryer & Seed Co.
Jerome, Arkansas

13. Mrs. Richard A. Graves
Alice-Sidney Dryer & Seed Co.
Jerome, Arkansas

14. H. P. Hazzard
Pioneer Grain & Seed
P. O. Box 351
Dewitt, Arkansas

15. Wayne Hogue
Arkansas State Plant Board
P. O. Box 1069
Little Rock, Arkansas

16. L. F. Jones
Pioneer Grain & Seed
Eudora, Arkansas

CALIFORNIA

17. John F. Grisez
John F. Grisez Company
P. O. Box 25
Crows Landing, California

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COLORADO

18. William D. Munroe
    Oliver Manufacturing Co.
    Rocky Ford, Colorado

DISTRICT OF COLUMBIA

19. J. Dennett Guthrie
    I.A.D.S.
    Department of Agriculture
    Washington, D. C.

DELAWARE

20. Charles N. Jackson
    H. P. Cannon & Son, Inc.
    Bridgeville, Delaware

21. Edwin J. Kelly
    H. P. Cannon & Sons, Inc.
    Bridgeville, Delaware

22. Dr. T. C. Ryker
    E. I. DuPont de Nemours Co., Inc.
    Industrial & Biochemical Dept.
    1007 Market Street
    Wilmington 98, Delaware

FLORIDA

23. Tom Branan
    Florida Seed & Feed Co.
    1901 Duval Road
    Ocala, Florida

24. Joe Morgan
    Uveyor
    Box 3153
    Jacksonville, Florida

25. Mrs. Joe Morgan
    Uveyor
    Box 3153
    Jacksonville, Florida

FLORIDA (CONT'D)

26. Norman E. Twisdale
    Uveyor
    Box 3153
    Jacksonville, Florida

27. James D. Warner
    Florida Foundation Seed Producers, Incorporated
    P. O. Box 962
    Havana, Florida

GEORGIA

28. Ralph Graham
    DeKalb Agric. Association
    Box 281
    Bogart, Georgia

29. Ed Green
    Green & Jackson Seed Co.
    P. O. Box 47
    Byron, Georgia

30. Mrs. Ed Green
    Green & Jackson Seed Co.
    P. O. Box 47
    Byron, Georgia

31. C. J. Hulsey
    Hulsey Seed Laboratory
    P. O. Box 132
    Decatur, Georgia

32. Mrs. C. J. Hulsey
    Hulsey Seed Laboratory
    P. O. Box 132
    Decatur, Georgia

33. J. S. Hulsey
    Hulsey Seed Laboratory
    P. O. Box 132
    Decatur, Georgia


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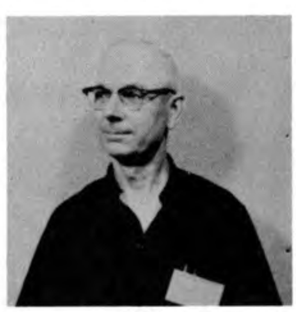
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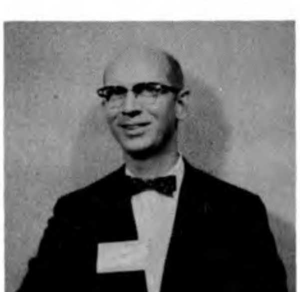
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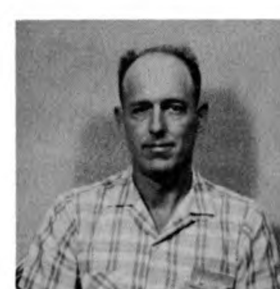
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GEORGIA (CONT'D)

34. Mrs. J. S. Hulsey
Hulsey Seed Laboratory
P. O. Box 132
Decatur, Georgia

35. James W. Walden
Barron & Prescott, Incorporated
Matthews, Georgia

36. Elmo Winstead
Georgia Department of Agriculture
Atlanta, Georgia

ILLINOIS

37. Roger Anderson
Heritage House Products, Inc.
Bristol, Illinois

38. Merle D. Brokate
Noble Brothers
Gibson City, Illinois

39. Mrs. Merle D. Brokate
Noble Brothers
Gibson City, Illinois

40. Charles R. Finley
Funk Brothers Seed Company
1300 West Washington Street
Bloomington, Illinois

41. Bernard Dahlquist
Funk Brothers Seed Company
1300 West Washington Street
Bloomington, Illinois

42. Mrs. Bernard Dahlquist
Funk Brothers Seed Company
1300 West Washington Street
Bloomington, Illinois

43. Gene Greenwood
Moews Seed Company
Granville, Illinois

ILLINOIS (CONT'D)

44. Warren Kuester
Heritage House Products, Inc.
Bristol, Illinois

45. Phillip Lyness
Moews Seed Company
Granville, Illinois

46. A. E. Morr
Crows Hybrid Corn Company
Milford, Illinois

47. Howard E. Reeder
Funk Brothers Seed Company
1300 West Washington Street
Bloomington, Illinois

48. Wilson Seely
Edgar County Seed Company
220 West Washington
Paris, Illinois

49. Dr. Raymond P. Seven
Morton Chemical Company
110 North Wacker Drive
Chicago, Illinois

50. Jack T. Snader
Seedburo Equipment Company
618 West Jackson
Chicago, Illinois

51. Louis Taylor
Bergmann-Taylor Seeds
R. R. #2
Trenton, Illinois

52. Harold Thurnau
Bergmann-Taylor Seeds
St. Jacob, Illinois


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INDIANA

53. H. A. Brummel
H. A. Brummel Company
P. O. Box 201
Cedar Lake, Indiana

54. Edwin C. Gutwein
Fred Gutwein & Sons, Inc.
Francesville, Indiana

55. Mrs. Edwin C. Gutwein
Fred Gutwein & Sons, Inc.
Francesville, Indiana

56. Marmon Heaston
Acme-Goodrich, Inc.
Winchester, Indiana

57. Mrs. Marmon Heaston
Acme-Goodrich, Inc.
Winchester, Indiana

58. L. C. Meade
Agric. Alumni Seed Imp. Assoc. Inc.
2336 Northwestern Avenue
West Lafayette, Indiana

59. James Puckett
Agric. Alumni Seed Imp. Assoc. Inc.
2336 Northwestern Avenue
West Lafayette, Indiana

IOWA

60. Gary Blaylock
F. Plank Seed Company
West Street
North English, Iowa

61. Mrs. Gary Blaylock
F. Plank Seed Company
West Street
North English, Iowa

62. Dan McAllister
McAllister Seed Company
Mt. Pleasant, Iowa

IOWA (CONT'D)

63. Mrs. Dan McAllister
McAllister Seed Company
Mt. Pleasant, Iowa

64. Mrs. Dorothy Montross
F. Plank Seed Company
West Street
North English, Iowa

KANSAS

65. Marvin Bretz
Sharp Brothers Seed Company
Healy, Kansas

66. Fred Ferguson
Ottawa Coop.
Ottawa, Kansas

67. Dr. Earl D. Hansing
Botany & Plant Pathology
Dickens Hall
Kansas State University
Manhattan, Kansas

68. Norman Hollis
Sharp Brothers Seed Company
Healy, Kansas

69. Orville Kohls
Rudy-Patrick Seed Company
Hutchinson, Kansas

70. Dwaine L. McCarty
Sharp Brothers Seed Company
Healy, Kansas

71. Donald Moore
The Coop. Exchange
Arlington, Kansas

72. Joe Reams
Ottawa Cooperative
Ottawa, Kansas


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KANSAS (CONT'D)

73. Gerald Sharp
Sharp Brothers
Healy, Kansas

KENTUCKY

74. James S. Ansert
Kentucky Seed Company
P. O. Box 1261
Louisville, Kentucky

75. B. W. Fortenberry
Kentucky Seed Improvement Assoc.
929 South Limestone
Lexington, Kentucky

76. E. L. Goodman
Goodman Brothers
Hardinsburg, Kentucky

77. Clyde Jackson
Country Seed Cleaners
R. R. #2
Box 362
Danville, Kentucky

78. Mrs. Clyde Jackson
Country Seed Cleaners
R. R. #2
Box 362
Danville, Kentucky

79. Miller Levi
Seed Farms, Incorporated
Georgetown, Kentucky

LOUISIANA

80. Olen D. Curtis
Louisiana State University
Agricultural Extension Service
Knapp Hall, University Station
Baton Rouge, Louisiana

LOUISIANA (CONT'D)

81. Johnny Meredith
Southern Seedsmen's Assoc.
2036 Line Avenue
Shreveport, Louisiana

82. Sam Savage
Alexandria Seed Company
Belcher, Louisiana

83. E. H. White
Terral-Norris Seed Company
P. O. Box 826
Lake Providence, Louisiana

84. Lane Wilson
Southern Seedsmen's Assoc.
2036 Line Avenue
Shreveport, Louisiana

85. Mrs. Lane Wilson
Southern Seedsmen's Assoc.
2036 Line Avenue
Shreveport, Louisiana

MICHIGAN

86. Vergil Frevert
Crippen Mfg. Company, Inc.
Box 350
Alma, Michigan

87. Mrs. Vergil Frevert
Crippen Mfg. Company, Inc.
Box 350
Alma, Michigan

88. Jim Henderson
A. T. Ferrell & Company
1621 Wheeler Street
Saginaw, Michigan

89. Francis J. Mayer
Sortex Company of North
America, Incorporated
Lowell, Michigan


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MICHIGAN (CONT'D)

90. Don Vanderveen
Sortex Company of North
America, Incorporated
Lowell, Michigan

MINNESOTA

91. W. S. Acheson
Gustafson Mfg. Company, Inc.
6501 Cambridge Street
Minneapolis, Minnesota

92. Earl M. Bitzer
Northwest Coop. Mills
635 North Fairview Avenue
St. Paul, Minnesota

93. George Durkot
Simon-Carter Company
655 19th Avenue, N. E.
Minneapolis, Minnesota

94. Thomas W. Oben
Land O'Lakes Creameries, Inc.
2215 Kennedy St., N. E.
Minneapolis, Minnesota

95. William J. Quello
Northwest Coop. Mills
635 N. Fairview Avenue
St. Paul, Minnesota

96. Dale W. West
Cargill, Incorporated
Box 328
St. Peter, Minnesota

MISSISSIPPI

97. Joe Clark
Shaw Grain & Elevator
Box 509
Shaw, Mississippi

MISSISSIPPI (CONT'D)

98. Walter Clark
Stoneville Pedigreed Seed Co.
Stoneville, Mississippi

99. Miller T. Flowers
Miss. Seed Improv. Assoc.
State College, Mississippi

100. Jim Ford
Miss. Seedsmen's Assoc.
Sawan, Incorporated
Columbus, Mississippi

101. Ernest L. George, Jr.
Imperial Oil & Fertilizer Co.
Macon, Mississippi

102. W. T. Gilbert
Sawan, Incorporated
Columbus, Mississippi

103. W. W. Guerry
Miss. Seed Improv. Assoc.
State College, Mississippi

104. Louis King
Delta & Pine Land Company
Scott, Mississippi

105. Loren M. Leleux
Delta & Pine Land Company
Scott, Mississippi

106. Kenneth S. McClain
Delta & Pine Land Company
Scott, Mississippi

107. R. E. McCollum
Mississippi Federated Coop.
Canton, Mississippi

108. R. Chester Milner
Miss. Seed Improv. Assoc.
State Collge, Mississippi


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MISSISSIPPI (CONT'D)

109. Baxter Nichols
Shaw Grain & Elevator
Box 509
Shaw, Mississippi

110. Don Ouzts
Wallace Equipment Company
Cleveland, Mississippi

111. Harry Pittman
Hollandale Seed & Delinting Co.
Box 397
Hollandale, Mississippi

112. John A. Reichle
Sawan, Incorporated
Columbus, Mississippi

113. Harry Rodgers
Farm Seed Company
West Point, Mississippi

114. Earl W. Terrell
Industrial Education
P. O. Box 1105
State College, Mississippi

115. James D. Walcott
Walcott and Steele
Greenville, Mississippi

116. Bill Wallace
Wallace Equipment Company
Cleveland, Mississippi

117. Walter H. Williams
Kyle & Williams
Clarksdale, Mississippi

118. Jack Wilson
Hollandale Seed & Delinting Co.
Box 397
Hollandale, Mississippi

MISSOURI

119. John K. Bradley
Bradley Seed Service
Leonard, Missouri

120. Mrs. John K. Bradley
Bradley Seed Service
Leonard, Missouri

121. Neil Bradley
Bradley Seed Service
Leonard, Missouri

122. Hubert H. Dooley
Rudy-Patrick Seed Company
1212 West 8th Street,
Station A
Kansas City, Missouri

123. Bill Dunn
Tindle Seed Company
Box 701
701 East Chestnut
Springfield, Missouri

124. E. L. Reed
Reed Seeds, Incorporated
Box 387
Chillicothe, Missouri

125. Viola M. Stanway
102 Waters Hall
Missouri University
Missouri Seed Testing Lab.
Columbia, Missouri

126. Ernest M. Wagner, Jr.
Missouri Hybrid Corn Co., Inc.
Fulton, Missouri

127. Mrs. Ernest M. Wagner, Jr.
Missouri Hybrid Corn Co., Inc.
Fulton, Missouri


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MISSOURI (CONT'D)

128. Murriel Young
Rudy-Patrick Seed Company
1212 West 8th Street
Station A
Kansas City, Missouri

NEW MEXICO

129. Nelson Clayshulte
Ag. Prod. Co.
Mesquite, New Mexico

NORTH CAROLINA

130. Stacey Bass
McNair Seed Company
Box 706
Laurinburg, North Carolina

131. Mrs. Stacey Bass
McNair Seed Company
Box 706
Laurinburg, North Carolina

132. Raymond Gurley, Jr.
Gurley Milling Company
P. O. Box 388
Selma, North Carolina

133. W. G. Quarles
Wyatt-Quarles Seed Company
Box 2131
Raleigh, North Carolina

134. Bruce Shands
North Carolina Department of Agriculture
Raleigh, North Carolina

OHIO

135. Roy Becker
Ohio Seed Improv. Association
1001 West Lane Avenue
Columbus, Ohio

OHIO

136. William Epperson
Ohio Seed Improv. Assoc.
1001 West Lane Avenue
Columbus, Ohio

137. Don Garlinghouse
Ohio Seed Improv. Assoc.
1001 West Lane Avenue
Columbus, Ohio

138. Merwyn Garlinghouse
Scott Farm Seed Company
Mechanicsburg, Ohio

139. W. M. Stallings
Ohio Foundation Seeds, Inc.
Croton, Ohio

PENNSYLVANIA

140. Albert C. Brushaber
Eastern States Farmer's Exchange
P. O. Box 166
East Butler, Pennsylvania

141. Vincent J. Palau
Mercator Corporation
Box 142
Reading, Pennsylvania

SOUTH CAROLINA

142. J. W. Little
Little Cleaning Company
Cheraw, South Carolina

TENNESSEE

143. R. H. Marsh
Yale & Towne, Incorporated
3340 Poplar
Memphis, Tennessee

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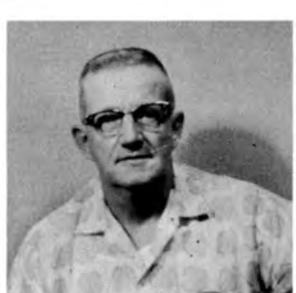

158

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TENNESSEE (CONT'D)

144. Thomas R. Rider
Monroe Farmers Coop.
Route 1
Madisonville, Tennessee

145. Mrs. Thomas R. Rider
Monroe Farmers Coop.
Route 1
Madisonville, Tennessee

146. D. B. Swaty
Armco Company
Memphis, Tennessee

147. W. L. Warren
Morton Chemical Company
1087 Kraft Road
Memphis, Tennessee

148. Mrs. W. L. Warren
Morton Chemical Company
1087 Kraft Road
Memphis, Tennessee

149. Van White
The Lilly Company
Memphis, Tennessee

TEXAS

150. Tom A. Adler
The Millers Mutual Fire Insurance
Company of Texas
Fort Worth, Texas

151. Ira R. Annoot
Mandrel Industries
Electric Sorting Machine Division
Box 36306
Houston 36, Texas

TEXAS (CONT'D)

152. Robert Chapman
Mandrel Industries
Electric Sorting Machine Div.
Box 36306
Houston 36, Texas

153. Ray Cooper
Cap-Tex Distributing Co.
Box 395
Lubbock, Texas

154. W. A. Dorman
Box 303
Lubbock, Texas

155. Mrs. W. A. Dorman
Box 303
Lubbock, Texas

156. Warren K. Dulin
Dulin & Company
5520 Brownfield Hwy.
Lubbock, Texas

157. Carl P. Harrison
Box 88
Cooper, Texas

158. R. E. Kessler
Carl P. Harrison Co.
Cooper, Texas

159. Charles Kniejski
Asgrow Seed Company
P. O. Drawer A
San Antonio, Texas

160. James H. Moore
Sutton, Steele & Steele
1031 South Haskell
Dallas, Texas


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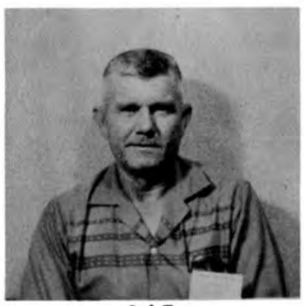
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TEXAS (CONT'D)

161. John C. Powell
Cap-Tex Distributing Company
Box 395
Lubbock, Texas

162. Mrs. John C. Powell
Cap-Tex Distributing Company
Box 395
Lubbock, Texas

163. C. A. Robinson
1107 Yonkers
Plainview, Texas

164. Mrs. C. A. Robinson
1107 Yonkers
Plainview, Texas

165. Ray Sheer
Carl P. Harrison Company
Cooper, Texas

166. Ken Skarien
Seedsmen's Digest
1910 W. Olmos Drive
San Antonio, Texas

167. J. E. Swindell
L. R. Barron Company
Athens, Texas

168. Jerry S. Workman
Texas Research Foundation
P. O. Box 43
Renner, Texas

169. Richard N. Wright
Asgrow Seed Company
P. O. Drawer A
San Antonio, Texas

VIRGINIA

170. Ernest N. May, Jr.
Universal Dynamics Corp.
4200 Wheeler Avenue
Box 9080
Alexandria, Virginia

171. Winston K. Pendleton
Universal Dynamics Corp.
4200 Wheeler Avenue
Box 9080
Alexandria, Virginia

WISCONSIN

172. John Tracy
Tracy and Son Farms
R-1
Janesville, Wisconsin

173. Leonard Holub
Tracy & Son Farms
R-1
Janesville, Wisconsin

174. Mrs. Leonard Holub
Tracy & Son Farms
R-1
Janesville, Wisconsin

MEXICO

175. Antonio Berentsen, Jr.
Dr. Velasco 18
MEXICO 7, D. F.

176. Bill Berentsen
Dr. Velasco 18
MEXICO 7, D. F.

177. Jose Luis Garduno
Banco Nacional de
Credito Ejidal
Uruguay 56
MEXICO 7, D. F.


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MEXICO (CONT'D)

178. Daniel Guerrero
National Institute of Agricultural
Research
Lab de Semillas Chapingo
MEXICO

179. Jesus Jasso Mata
Instituto Nacional de Investigacione
Progreso No. 5
Coyoacan 21, D. F.

180. Jeronimo Zolezzi
Anderson Clayton & Company
SA. DE C.V.
Paseo de La Reforma No. 51
MEXICO 1, D. F.

LIST OF PROCESSING EQUIPMENT

IN THE SEED TECHNOLOGY LABORATORY

EQUIPMENT	MANUFACTURER
Air and Screen Cleaners	
Clipper, Model Super X-29D	A. T. Ferrell and Company 1621 Wheeler Street Saginaw, Michigan
Clipper, Model M-2B	" "
Crippen, Model H-534-A	Crippen Manufacturing Company Alma, Michigan
Crippen, Model 334-A	" "
Vac-A-Way, Farm Model	J. W. Hance Manufacturing Co. Westerville, Ohio
Aspirator	
Pneumatic Separator	Electric Sorting Machine Co. 5234 Glenmont Drive Houston, Texas
Buckhorn Separator	
Sutton, Steele and Steele	Sutton, Steele and Steele, Inc. 1031 South Haskell Dallas 23, Texas
Color Separators	
Mandrel, Model B350	Electric Sorting Machine Company 5234 Glenmont Drive Houston, Texas
Sortex, Model G414	Sortex Company of N. America, Inc. Lowell, Michigan
Corn Graders	
Morecorn Grader, Model 2SA	Universal, Incorporated 245 South Washington Hudson, Iowa

EQUIPMENT	MANUFACTURER
Corn Graders (Cont'd.)	
Rock-It Corn Grader, Model S-4	Superior Division, Daffin Corp. 121 Washington Avenue South Hopkins, Minnesota
Conveyors	
Burrows Belt Conveyor, Model R-13-3/4HE	Burrows Equipment Company* 1316 Sherman Avenue Evanston, Illinois
Clipper Vibrating Conveyor	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Universal Belt Conveyor, Model H-2	Universal, Incorporated 245 South Washington Hudson, Iowa
Uveyor U-belt Conveyor Model, 1/2 inch unit Model, 1 1/2 inch unit	Uveyor Box 3272 Jacksonville, Florida
Debearder	
Clipper	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Dehumidifiers	
Dryomatic, Model 105	Dryomatic Corporation Box 591 Alexandria, Virginia
Una-dyn, Model A30LT	Universal Dynamics Corporation 4200 Wheeler Avenue Alexandria, Virginia
Electrostatic Separator	
Carpco, Model HL118	Carpco Research & Eng. Co. P. O. Box 3272 Jacksonville 6, Florida

EQUIPMENT	MANUFACTURER
Elevators	
Burrows Bucket Type, Model 50	Burrows Equipment Company* 1316 Sherman Avenue Evanston, Illinois
Clipper "Series 100"	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Gordonbilt Airlift, 1-H.P.	Gordon Machinery Corporation P. O. Box 1452 Marysville, California
John F. Grisez	John F. Grisez Company Crows Landing, California
Lift-Master Airlift, 2-H.P.	Holzinger Brothers 10140 South Shoemaker Avenue Sante Fe Springs, California
Seedburo Bucket Type, Model 200	Seedburo Equipment Company* 618 West Jackson Boulevard Chicago 6, Illinois
Universal Bucket Type, Model B2	Universal, Incorporated 245 South Washington Hudson, Iowa
Universal Bucket Type, Model C2	" "
Gravity Tables	
Forsberg, Model 40-V	Forsberg, Incorporated Thief River Falls, Minnesota
Oliver, Model 50-A	Oliver Manufacturing Company Rocky Ford, Colorado
Sutton, Steele & Steele Model AX-250	Sutton, Steele & Steele, Inc. 1031 South Haskell Dallas 23, Texas

EQUIPMENT	MANUFACTURER
Hullers and Scarifiers	
Clipper, Eddy-Giant	A. T. Ferrell and Company 1621 Wheeler Street Saginaw, Michigan
Clipper, Model HSC-2	" "
Crippen, Model S	Crippen Manufacturing Company Alma, Michigan
Length Graders	
Carter Disc Separator, Model 1522	Simon-Carter Company 655-19th Avenue, N. E. Minneapolis, Minnesota
Carter Disc Separator, Model 1827	" "
Carter Disc Separator, Model 1547	" "
Hart Uni-Flow Cylinder Separator Model 3	" "
Superior Length Grader (Cylinder) Model C-56	Superior Division, Daffin Corporation 121 Washington Avenue South Hopkins, Minnesota
Magnetic Separators	
John F. Grisez	John F. Grisez Company Crows Landing, California
Mixers	
Mac Lellan Batch Mixer Model 1	Burrows Equipment Company* 1316 Sherman Avenue Evanston, Illinois
Roll Mills (Dodder)	
Clipper, 10 rolls	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Warsco, 8 rolls	W. A. Rice Company Jerseyville, Illinois

EQUIPMENT	MANUFACTURER
Scales	
Apex Bagging Machine, Model D-100	Burrows Equipment Company* 1316 Sherman Avenue Evanston, Illinois
Fairbanks-Morse 1000# Platform Scales	" "
Fairbanks-Morse 2500# Warehouse Scales	" "
Waymatic	Waymatic Welding and Fabricating Company Fulton, Kentucky
Scalper	
Clipper, Model 1297-1	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Seed Treaters	
Gustafson Mist-O-Matic Model M100	Gustafson Manufacturing Co., Inc. 6501 Cambridge Street Minneapolis 26, Minnesota
Gustafson Mist-O-Matic Model M400	" "
Panogen Automatic, Model US 60-C	Morton Chemical Company 110 North Wacker Drive Chicago 6, Illinois
Panogen Automatic, Model MC	" "
Spiral Separator	
Krussow Double Spiral	Cleland Manufacturing Company 2800 Washington Avenue North Minneapolis 10, Minnesota
Width and Thickness Grader	
Carter Precision Grader	Simon-Carter Company 655-19th Avenue, N. E. Minneapolis 10, Minnesota

*Supplier

LIST OF LABORATORY MODEL SEED PROCESSING AND TESTING EQUIPMENT

EQUIPMENT	MANUFACTURER
Air and Screen Cleaner	
Clipper, Office Model	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Aspirator	
Superior, Fractionating	Superior Division, Daffin Corp. 121 Washington Avenue, South Hopkins, Minnesota
Dielectric Heater	
Thermex High frequence Unit Model CP10 A254	Votator Division, Chemetron Corp. Box 43 Louisville, Kentucky
Dockage Tester	
Carter, Model XT 1	Simon-Carter Company 655-19th Avenue, N. E. Minneapolis, Minnesota
Electrostatic Separators	
Carpco, Model HP-16	Carpco Research & Eng. Co. P. O. Box 3272 Jacksonville 6, Florida
Coronatron	Ding's Magnetic Separator Co. 4740 West Electric Avenue Milwaukee 46, Wisconsin
Gravity Tables	
Forsberg	Forsberg, Incorporated Thief River Falls, Minnesota
Oliver Stoner	Oliver Manufacturing Company Rocky Ford, Colorado

EQUIPMENT	MANUFACTURER
Gravity Tables (Cont'd.)	
Sutton, Steele & Steele Model V-135A	Sutton, Steele & Steele, Inc. 1031 South Haskell Dallas 23, Texas
Kvarnmaskiner Laboratory Cleaning Plant Type KM	Aktiebolaget Kvarnmaskiner Box 7015 Malmo, Sweden

This plant consists of the following equipment:

- Scourer (Huller)
- Air Separator (Aspirator)
- Shaking Sieve Sifter (2 Screen Cleaner)
- Table Separator (Gravity Separator)
- Trieur (Cylinder Separator)

EQUIPMENT	MANUFACTURER
Length Graders	
Carter, Test Cylinder	Simon-Carter Company 655-19th Avenue, N. E. Minneapolis, Minnesota
Carter, Test Disc	" "
Kvarnmaskiner, "Pedigree" Cylinder	Aktiebolaget Kvarnmaskiner P. O. Box 7015 Malmo, Sweden
Superior, Test Cylinder	Superior Division, Daffin Corp. 121 Washington Avenue South Hopkins, Minnesota
Magnetic Separator	
Gompper-Maschinen Gesellshaft "Lilliput"	Buderich bei Dusseldorf Grunstr 32, Postfach, Germany U. S. Distributor: Ulbeco, Incorporated 484 State Highway 17 Paramus, New Jersey

EQUIPMENT	MANUFACTURER
Moisture Testers	
Burrows Moisture Recorder	Burrows Equipment Company 1316 Sherman Avenue Evanston, Illinois
Motomco Moisture Meter, Model 919	Motomco, Incorporated 89 Terminal Avenue Clark, New Jersey
Steinlite Moisture Tester Models, RCT, S, G	Seedburo Equipment Company* 618 West Jackson Boulevard Chicago 6, Illinois
Tag-Heppenstall	Weston Electric Instrument Corp. 614 Frelinghuysen Avenue Newark 5, New York
Universal, Model EH	Burrows Equipment Company* 1316 Sherman Avenue Evanston, Illinois
Roll Mill (Dodder)	
W. A. Rice	W. A. Rice Seed Company Jerseyville, Illinois
Scarifier	
Forsberg, Sample-Seed Model	Forsberg, Incorporated Thief River Falls, Minnesota
Screens	
Complete set of Clipper 9" x 9" Hand Screens	A. T. Ferrell & Company 1621 Wheeler Street Saginaw, Michigan
Seed Treater	
Calkins	Calkins Manufacturing Company Spokane, Washington
Spiral Separator	
Krussow Spiral	Cleland Manufacturing Company 2800 Washington Avenue North Minneapolis 10, Minnesota

EQUIPMENT	MANUFACTURER
Thresher	
Vogel Head Thresher	Bill's Machine Shop Pullman, Washington
Width and Thickness Grader	
Carter Test Precision Grader	Simon-Carter Company 655-19th Avenue, N. E. Minneapolis, Minnesota

* Supplier

Additional equipment includes: bag holders, sewing machines, seed probes, germinators, ovens, purity boards, seed dividers, seed counters, balances, microscopes, seed sample cabinets, the Vitascope, and other laboratory equipment.

Some of this equipment was contributed by:

Burrows Equipment Company
E. L. Erickson Products
Gustafson Manufacturing Company
Paul Hattaway Company
Redhead Bagholder Corporation
Seedburo Equipment Company