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Color Sorters

F. J. Mayer

COLOR SORTERS

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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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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

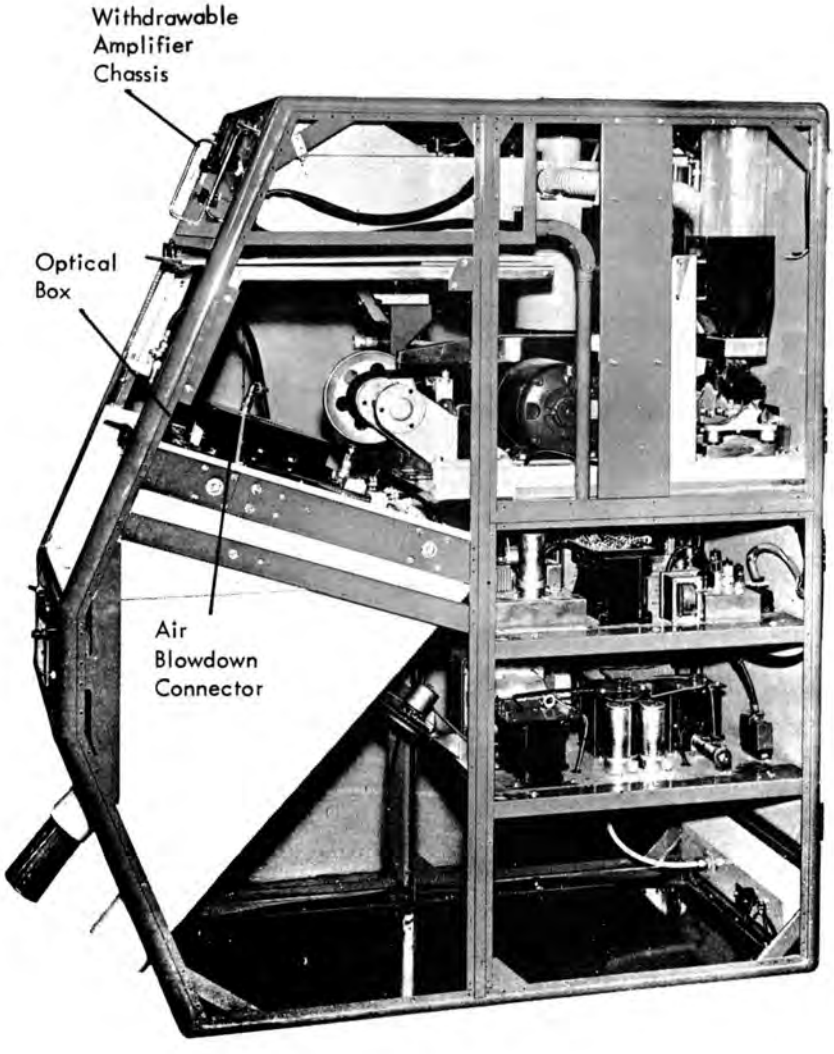


Figure 1. Side View of a Sortex G. 414 Machine

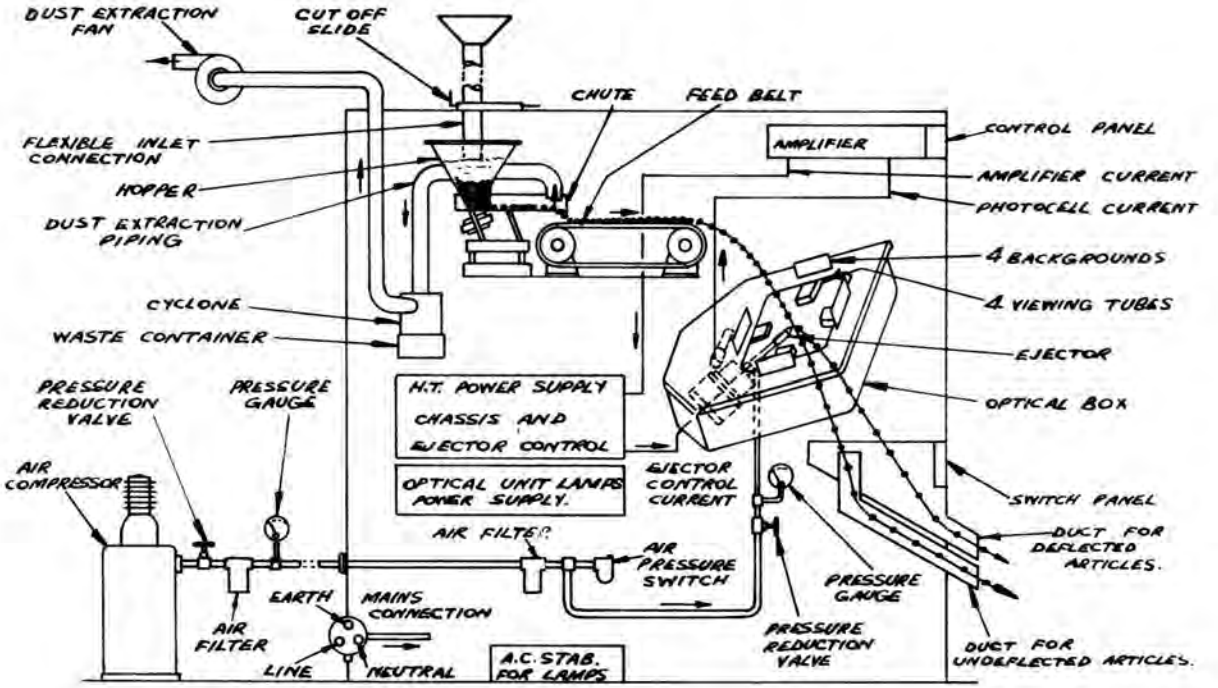


Figure 2. Schematic diagram of the mechanical system for the Sortex G. 414 and G. 415 machines

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,

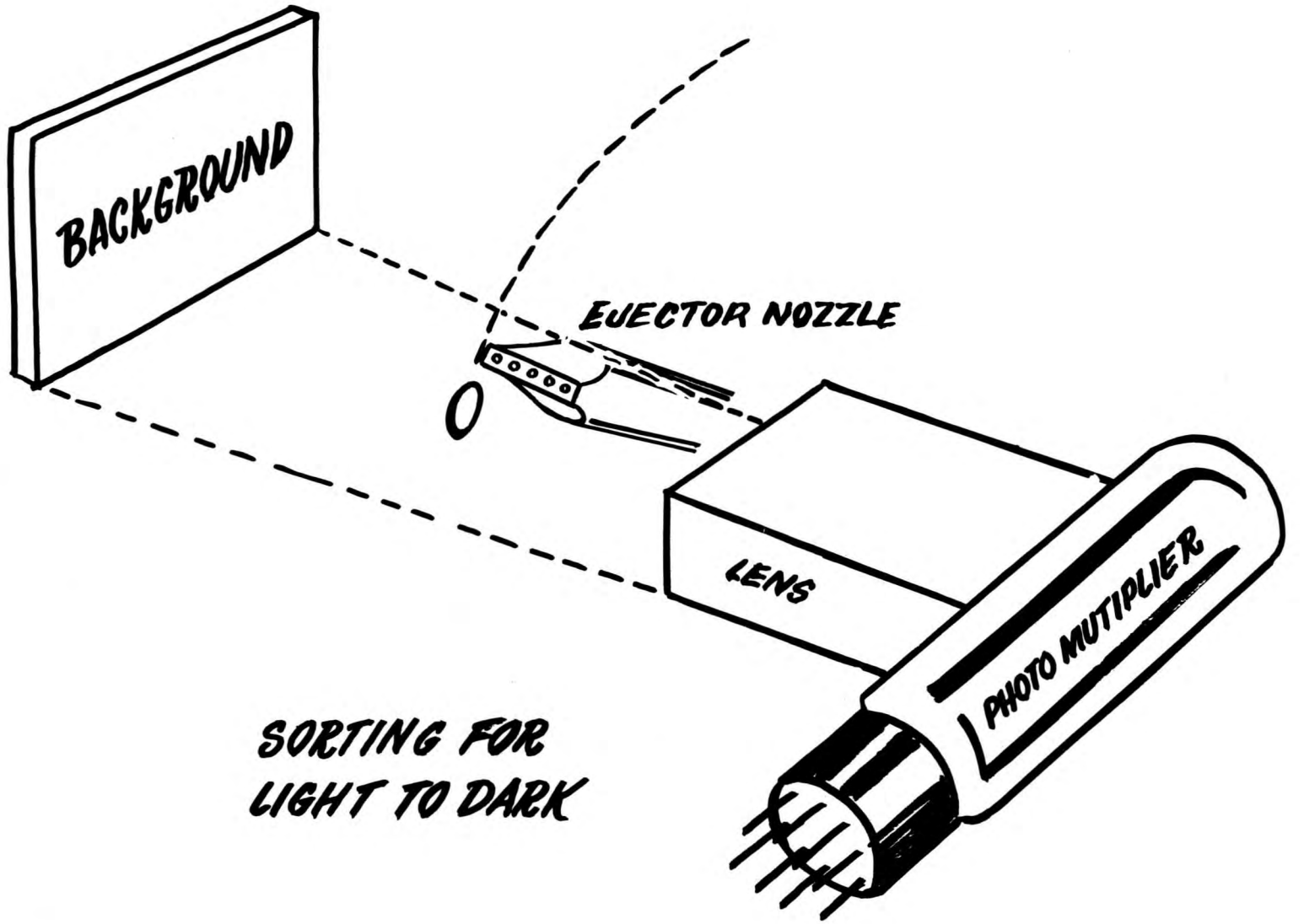
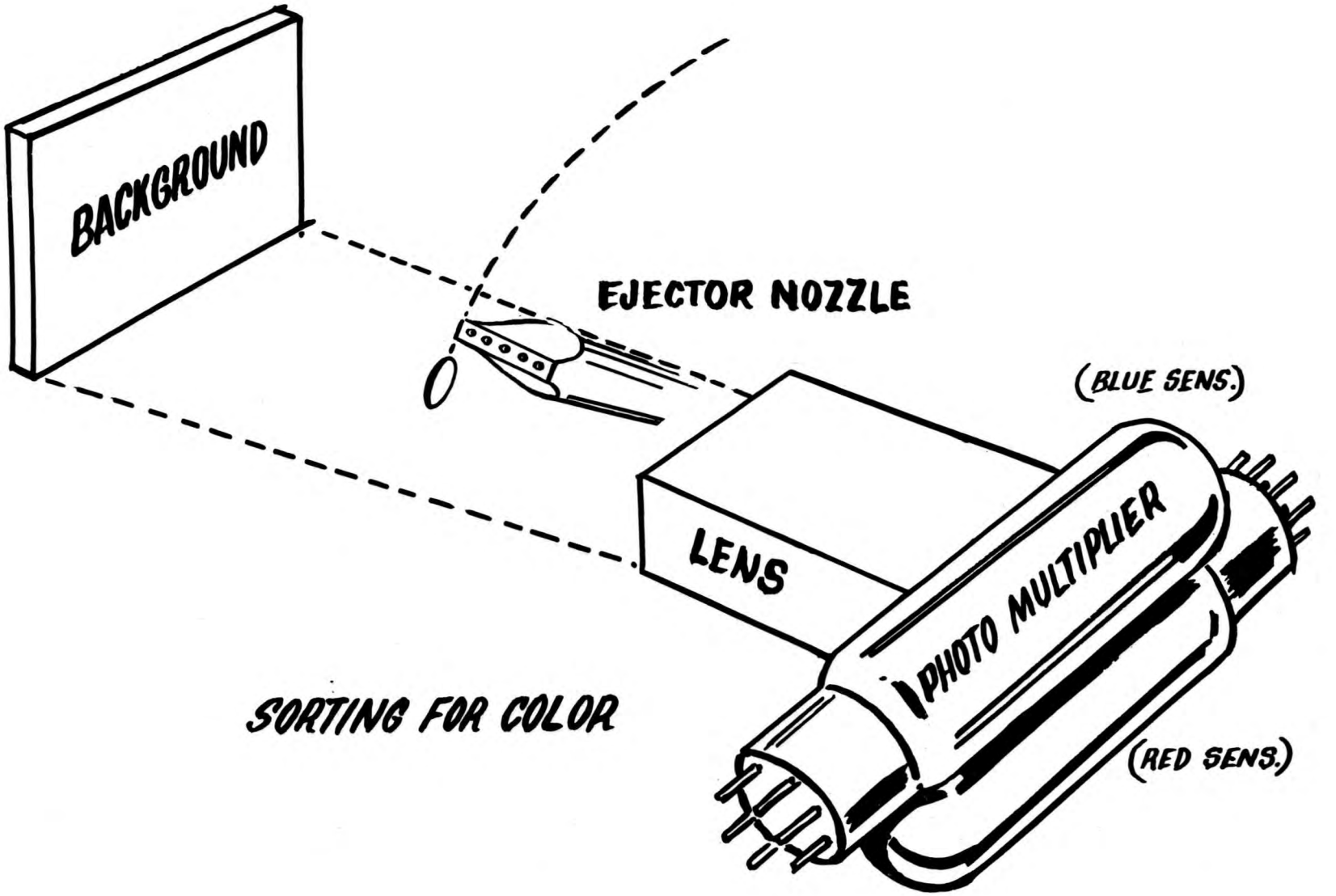

BACKGROUND
EJECTOR NOZZLE
LENS
PHOTO MUTIPLIER
SORTING FOR
LIGHT TO DARK

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