# Fundamental Research and Theories in Canning Machinery

PAPER J—3

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*The canning industry has grown to a high-speed production operation, necessitating an improvement in machinery design. To help speed fundamental research and development, Food Machinery and Chemical Corp. has made extensive use of high-speed motion pictures. A study of displacement-valve fillers was followed by an investigation of valves used in canning juices, which resulted in improved, faster-flowing valves. Other studies were made of such machines as corn huskers and corn cutters. Results from the studies include basic knowledge of equipment and operation and a number of new theories of operation.*

WITH THE INCREASE in canning operations, improvement in the design of canning machinery has been required. Research and development in these fields is moving fast at Food Machinery and Chemical Corp. with the aid of high-speed motion-picture photography. High-speed films are being used to find the basic operational "whys" and "wherefores" of food-processing equipment. High-speed photography is also serving as a springboard for a host of new developments in the design of the food-processing machines of the future. High-speed motion pictures have been made to evaluate such things as product flow, the action of individual components under actual operating conditions, and economies both in handling the product and in the time required to perform a given operation. Each new idea has resulted in improvement in the handling of the customers' product with less manpower.

Very often, before an engineer will even consider a change in the design, he will view hundreds of feet of high-speed motion-picture film of the basic machine operating on the product for which the machine was designed. Quite often too, a mockup or model will be made of a machine or a section of a machine for the purpose of taking high-speed motion pictures which will be viewed time and time again by the engineer before making his design recommendations.

Although high-speed motion pictures are designed for engineering, they are also fast becoming an effective sales tool, by showing the customer actual machine performance in slow motion under production conditions. This gives the salesman an excellent opportunity to show the advantages of our machine over similar machines.

This new research tool is also valuable in field service work. It has become virtually impossible to detect trouble on high-speed lines with the naked eye. However, the high-speed camera can see it easily. A few rolls of film taken at the trouble area can be sent back to the home office for study by the engineering department. The fault can often be corrected in a matter of hours, whereas before high-speed cameras were used, machine downtime may have been weeks or months.

## History

Early in 1954 the following engineering problem arose at the Food Machinery and Chemical Corp. Just how did a positive displacement filler control the amount of product entering a can, and could it be controlled even more accurately? Could a jar or can be filled to a limit of $\pm$ 4 g? With the aid of a transparent plastic displacement valve, so that product flow could be studied, the engineers tried time and again to watch the actual flow from the filling tank to the can.

High-speed photography was suggested. The plastic displacement valve was again mounted on the test rig. Using high-speed professional color film, with four 750-w spots, placed 18 in. from the test rig, and our largest opening, $f/2.8$, we shot 200 ft of film at 4000 frames/sec.

In viewing our first attempt at high-speed photography, we discovered that the displacement-valve porthole was much too sharp for a smooth flow and would let product flow back into the chamber; this did not give us the accurate fill of close tolerance that we needed.

We redesigned the valve porthole and retimed the test rig so that the valve stroke took $1\frac{1}{4}$ sec (equivalent to 450 cans/min on a 6-oz can). We shot another 200 ft of film with the Fastax camera at 4000 frames/sec. This new footage showed that the drain-back had been corrected, and our tolerance weight was brought down to $\pm 2$ g. Here, for the first time, high-speed motion pictures proved their ability in our research; and by continuing the studies for redesign of the valve, we found a host of new prospects for our displacement-valve filler.

## Juice Valve

Encouraged by our success with the displacement valve, we began a series of experiments with our juice valve. This valve differs from the positive displacement valve as the product must fill by gravity. This proves to be a problem where small 6-oz cans of juice are being filled. In order to hold the filling weight at high speeds, a canner would have to overfill the can. This is expensive because of the high cost of fruit juices.

Again, our engineers made plastic models of the juice valve, both the production model and several new designs. High-speed motion pictures were taken of the production valve and the new design ideas. The production valves proved too slow in filling, and inaccurate. Filmed results showed that the newer design with a corkscrew type of valve stem had a tendency to make the product swirl rapidly into the container in almost half of the filling time with greater accuracy. This new valve gave us filling speeds up to 600 cans/min. With this encouragement, many other types of filling valves are now going through rigid testing and analyzing programs.

Presented on October 21, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by C. C. Collier (who read the paper), Canning Machinery Div., Food Machinery and Chemical Corp., Hooperston, Ill.; and J. J. Larish, Ansco, Div. of General Aniline and Film Corp., Binghamton, N.Y.

## Sweet-Corn Husker

Sweet corn (a seasonal product) had been given top priority listing in the summer of 1960 from stalk to storage. High-speed motion-picture studies were made in every area of sweet-corn handling, from the Mechanical Sweet Corn Harvester to the cutter.

The first in-plant operation in the processing of sweet corn is removal of the husks from the ear. Here again, an age-old theory claimed that there was less damage to the corn if the husk was removed by dropping the ear, butt first (large diameter), into the soft-rubber husking rolls. With the use of the Fastax camera, engineering studies were conducted to test all conceivable ways of dropping ears of sweet corn into the rolls. Each test was recorded on high-speed motion-picture film and analyzed. It was found that the husks were removed, with a quick, gentle peeling action with little or no damage to the ear of sweet corn, by feeding the ears to the husking rolls *small end (tip) first* and at a slight angle.

As the result of a few simple engineering changes and some small additions to the sweet-corn husker, ears of corn are now being directed into the feed rolls tip first and are husked with less damage, an obvious example of the direct value of high-speed motion-pictures of machinery in action.

## Corn Cutter

After husking, the ears are washed and inspected several times, then the kernels are cut from the cob. This is done by a high-speed machine with rotating knives which we call the Corn Cutter. Ears are fed into a rotating cutting head having 6 knives rotating at approximately 1200 rpm. The knives slice the kernels off the cob as they rotate around the ear.

The problem in cutting corn is to remove the corn at the right depth, not so shallow as to leave usable corn on the cob; nor too deep, making an inferior "cobby" product. With the aid of high-speed motion pictures, a device called ASD (automatic size detector) was engineered. Now a gaging mechanism measures the size of the ear before removal of the kernels and automatically sets the knife blades to the right depth.

By setting up a cutter and placing the Fastax camera so that the action of the knives, ear and kernels could be observed, it was possible for the first time actually to see what was happening in the cutter. These first views showed that damage was occurring because the individual kernels of corn scattered back into the feed rolls. The first views also showed that the angle of the cutting knives did not permit the kernels to clear the rotating head, and that the kernels were being forced together. With this new knowledge, changes have been made in the knife and head area.

With the aid of high-speed motion pictures, work is now progressing in the redesign and development of an entirely new way of removing corn kernels from the cobs.

## Summary

The use of high-speed motion pictures in the manufacturing of canning machinery at Food Machinery and Chemical Corp. has only started; even though several thousands of feet of film have been used. Each new film explains the working principle and gives engineers new ideas for better or more economical ways of handling canned products. The equipment can thus perform feats that were unheard of a few years ago.

Because of the rapid change in machine design and theory, we have placed great emphasis on the use of high-speed motion pictures. They are being used to evaluate any reasonable suggestion or idea. The new ideas that arise from actually seeing something in motion and in action have proved the worth of using the high-speed camera.