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THE ELECTROSTATIC SMOKING OF SARDINES

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ABSTRACT

In experiments on a semi-commercial scale, sardines were electrostatically smoked in unsealed cans. As the cans were conveyed through the smoking chamber, they formed the negative side of an electric field of 14,000 to 23,000 volts. In about 12 seconds passage time, the sardines were sufficiently smoked, and the conveyor carried the cans onward to be filled with oil and sealed.

Best results were obtained when the smoke passed from the smoke furnaces through a washing chamber--where soot and some of the moisture and acrid components were deposited--and then through a heater before entering the smoke precipitation chamber.

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Preliminary experiments conducted at the University of Maine[1/] indicated that sardines might be smoked in the canneries by means of electrostatic precipitation. The Fish and Wildlife Service was then requested to test the practicality of employing this method in commercial operations.

In the course of these tests, a pilot-plant apparatus was developed which is capable of smoking the sardines in the cans at a rate of 400 cans per minute. (Present methods of smoking require from ½ to 2 hours, the rate of smoking depending on the amount of equipment and space available.) Several hundred cases of sardines have been electrically smoked in this apparatus and distributed commercially.

The pilot smoking plant is illustrated in Figure 1.[2/] It has five main parts:

1. A smoke precipitation chamber D through which the fish pass on the conveyor M
2. A source of high-voltage electric current A
3. A smoke producer E
4. A smoke washer and dehumidifier G
5. A smoke heater F

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1/ Under the supervision of Professor A. S. Hill of the University of Maine and Dr. R. P. Whitney of the Department of Industrial Cooperation. Earlier research along these lines was conducted by the Fisheries Research Board of Canada, but the experiments were discontinued and the results were not published.

2/ Illustrated by Boris O. Knake, Technologist, Branch of Commercial Fisheries.

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The Precipitation Chamber: The precipitation chamber D is merely a box whose floor is the conveyor M that carries the sardines. The two walls parallel to the conveyor extend a short distance below the conveyor, and glass panes between these walls and the conveyor prevent smoke leakage. The ionizer C is formed of parallel, B and S number 32, chromel wires, spaced 3 inches apart and supported by a steel

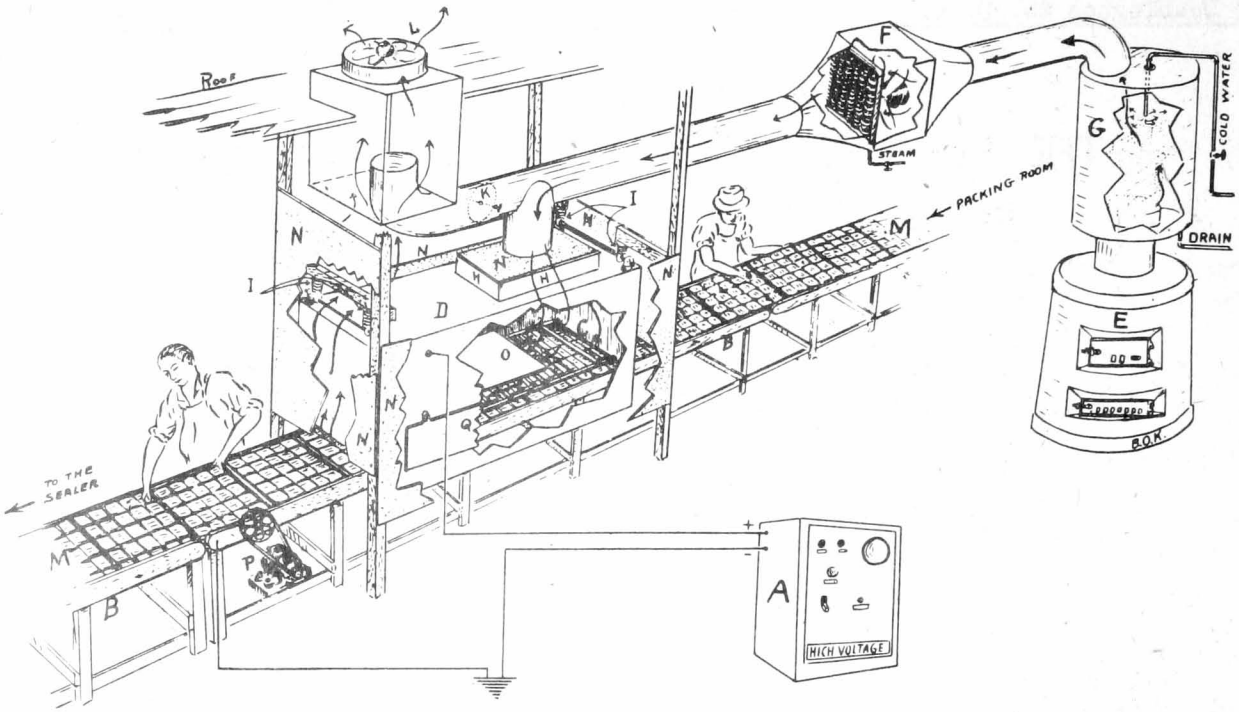

FIGURE 1 - PILOT SMOKING PLANT

A - HIGH-VOLTAGE CURRENT SOURCE
B - CONVEYOR
C - POSITIVELY CHARGED GRID
D - METAL SMOKE PRECIPITATION CHAMBER
E - SMOKE PRODUCER
F - SMOKE HEATER
G - SMOKE WASHER AND DEHUMIDIFIER
H - GLASS-PANE INSULATORS
I - SUPPORT INSULATORS
K - BY-PASS DAMPER
L - EXHAUST
M - PANS
N - ASBESTOS GUARDS
O - BAFFLE
P - MOTOR CONVEYOR DRIVE
Q - DOOR IN SMOKE PRECIPITATION CHAMBER

frame. It is suspended about $1\frac{1}{2}$ inches above the top level of the sardines which pass beneath. This ionizer section is connected to the positive side of the source A of the high voltage current, and the conveyor is connected to the negative side through the ground. As the smoke particles enter the electrical field created by the ionizer, they acquire a positive charge, are attracted toward the sardines, which have received a negative charge from the conveyor, and quickly precipitate upon the sardines. The baffle O is used to cause the smoke to enter the electrical field at one end of the chamber and travel through the box in a strong electrical field. This prevents any bypassing at the exit end and improves the efficiency of the smoke precipitation.

The first chamber used was 60 inches long by 24 inches wide by 36 inches high and was constructed of asbestos board. Although all the experiments on large-scale smoking were carried out in this chamber, it had an important defect. The chamber walls and the supporting frame for the ionizer were electrically insulated from the ionizer itself, and, having the same charge as the conveyor, they soon accumulated large deposits of smoke.

To remedy this defect, the asbestos-board chamber has been replaced by one constructed of 26-gauge galvanized iron. The metal chamber is connected direct-

ly to the ionizer, and since the chamber walls now carry the same charge as the ionizer, they repel, rather than attract, the smoke particles.

The smoke duct and the conveyor are electrically insulated from the chamber by the panes of glass H. These are removable so that, if they become fouled and allow electrical leakage, they can be easily cleaned. Enclosing the chamber, and somewhat separated from it, are panels of asbestos board N to protect the workers from accidental contact with the positively charged metal surface.

The conveyor is similar to those in common use in the Maine sardine canneries. It moves the fish at a speed of 25 feet per minute, carrying them through the precipitation chamber in 12 seconds.

In the earlier experiments, the sardines were conveyed through the precipitation chamber on flakes immediately after having been steamed and air-dried in accordance with the customary preparation procedure. In later experiments, it was found that more satisfactory smoking was obtained when the steamed and air-dried sardines were first packed in the cans and then conveyed through the precipitation chamber just before the oil was added to the cans and they were passed on to the sealing machine.

The Source of High Voltage Current: The electric field which causes the smoke to precipitate on the sardines is derived from a combined transformer and rectifier which operates on 110-volt alternating current and is capable of producing open-circuit, direct-current potentials of from 14,000 to 23,000 volts. Units requiring about 200 watts are satisfactory for this work. These units are furnished by several companies and come equipped with fuses for proper operation. After being started, the unit operates automatically, and the current is cut if any short circuit occurs. In the event of short circuits to the conveyor, it is impossible to receive a shock, as the conveyor is thoroughly grounded. Shocks which might be received by workers opening the access doors to the smoke chamber when the current is on can be avoided through arrangement of the wiring so that the circuit from the primary current to the high-voltage source will be interrupted when the doors are opened. Further installation specifications can be obtained from the firms supplying the high-voltage equipment.

The Smoke Producer: Two 42-inch, ordinary, wood-burning furnaces E are used for the production of smoke, although only one is shown in the diagrammatic sketch. A hot wood fire is started, and when it burns down to coals, these are smothered with hardwood sawdust to produce a thick smoke. If there is any open flame in the furnace during the smoking process, a black, sooty deposit will form on the fish.

The Smoke Washer and Dehumidifier: From the furnace, the smoke passes through a smoke duct 9 inches in diameter into a 50-gallon drum G which is packed with bricks continuously wetted by a stream of cold water. The smoke is cooled to below its dew point, and it deposits a considerable portion of its moisture content. Any traces of soot and some of the bitter and acrid ingredients of the smoke are removed in this treatment, thus giving a better color and flavor to the final product.

The Smoke Heater: The smoke is then warmed somewhat by being passed through a duct containing the finned steam coil F. Raising the temperature lowers the relative humidity of the smoke sufficiently so that water, which would cause current leakage, does not tend to condense on the insulators in the precipitation chamber. The amount of heating required in this operation depends on whether

the dehumidifier is used, and also on the temperature of the smoke chamber. A temperature of about 200° F. was found sufficient in the experiments carried out without the use of the dehumidifier, and this method of operation is satisfactory if no soot is present in the smoke.

Observations and Discussion: When the precipitation chamber is being operated, an occasional sardine may pass too close to the ionizer wires. An arc will then form across the gap, sometimes breaking the wire and causing a short circuit. The apparatus must then be shut down until the broken wire can be replaced. Some of the later experiments indicate that this trouble might be satisfactorily eliminated by the use of a set of sharpened wires so fixed that they point toward the conveyor.

The greatest difficulty encountered is in the uniform production of smoke of the desired quality. In the furnaces used, the smoke of greatest density, which is the most suitable, is formed just before the sawdust breaks into flame. As soon as an open flame breaks out, however, soot deposits on the fish. Thus, although the furnaces produce good quality, heavy smoke for short periods, they are not suitable for continuous operation of the precipitation chamber. Other systems of smoke production should be tried in future experiments. For example, an electrically heated metal plate over which the sawdust is moved mechanically has been found satisfactory in other smoking experiments carried on by the Service. A similar device was successfully employed in the preliminary experiments on electrical smoking that were carried out at the University of Maine and has also been employed for the commercial smoking of fish.