Soap Finishing

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THE soap and detergent industry, over the years, has developed language of its own to describe unique process operations. The words, "soap finishing," taken as a subject, might, in soap maker's language, limit discussion to the "finishing" or "settling" step. This is considered a special art and part of a saponification procedure for producing boiled soaps, in other words, for the production of "neat" soap. Our assignment however is broader and covers manufacturing processes from saponification through to stamping, packing, or filling of the final product. Obviously, in the time allotted we cannot cover all types of soap finishing. We must be selective.

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Process details in the soap industry vary according to the type of product desired. They are designed to take care of inherent characteristics of the soap. These in turn depend upon formula, method of saponification, and specifications for the finished article.

The five generally used methods for producing "neat" soaps are cold made, half boiled, full boiled or kettle settled, continuous manufacture by the centrifugal process, and continuous manufacture direct from fatty acids. Cold made soaps frequently are only framed, slabbed, cut, and stamped.

Half boiled soaps may be handled in the same manner as cold made products, or they may be finished in flakes or granulated form.

Similar operations may be made on soaps saponified by the last three methods, but there are changes in intermediate steps brought about by variations of the moisture content in the original "neat" soap as well as in the finished product or, as indicated previously, by the physical characteristics or formulations required for the end-product.

Of the variety of finishing steps used in practice, we shall confine comments in this paper to a) a typical toilet soap procedure and b) a process for producing spray-dried granulated soaps. To assist our presentation we will use a motion picture of spray-drying operations for the production of granulated soaps.

On both types of products we assume processing operations to begin with "neat" or 30% moisture soap. If the moisture content of the soap is materially less than that normal to settled soap, then subsequent steps, particularly drying, may be modified or even completely eliminated.

Figure 1 illustrates a simplified diagrammatic flow sheet for toilet or milled soap manufacture. The hot neat soap at a temperature, say, of 190° to 220°F. is pumped to an intermediate storage tank. From the storage tank the soap is passed to a dryer, where the moisture is reduced to a prescribed level, such as, for instance, 8% or 10%. The dried soap, if a conventional apron dryer has been used, is generally delivered in ribbon or flaked form. This is then conveyed by gravity, mechanically or by air, to storage bins. From these bins the soap flakes are drawn as required into an amalgamator or mixer, where the necessary perfume, pigments, and preservatives are added and thoroughly mixed. From the amalgamator the soap is fed either to milling rolls or refiners for thorough homogenizing.

The next step consists of pelletizing the soap prior to being fed to a continuous plodder. This operation is usually accomplished by forcing the soap through a perforated plate, where, as it issues, it is cut into pellet form. Following this, the plodder compacts the soap continuously into long bars, and these in turn are cut into proper lengths for stamping.

It is common practice to skin-dry the soap blanks before final pressing. This may be accomplished by passing the tablets through a continuous air-drying unit, or the tablets may be placed on racks and allowed to dry for a short period. The soap is then fed to a stamping and wrapping machine and delivered to a case packer. This, in brief, covers common process steps for manufacturing toilet soap.

The neat soap storage tank is often provided with a means for agitation in order to maintain uniformity of the soap as fed to the dryers. Without such agitation there could be variation in its composition, particularly with respect to its alkalinity, and this is undesirable. Means of agitation may be mechanical, or the soap may be circulated by a pump withdrawing from the bottom of the storage tank and redelivering near the top.

WITH regard to dryers there are several types. Two of the most common are the apron type, heated air-dryers, and the more recently introduced tubular flash dryers.

Hot molten soap is often filtered as pumped to the dryer. This may be accomplished by using twin filters placed in the soap line, which serve to remove fine particles of foreign matter. Such filters may be provided with standard mesh baskets and lined with non-corrodible fine wire screens. The screens are readily cleaned without stopping the flow of soap by means of

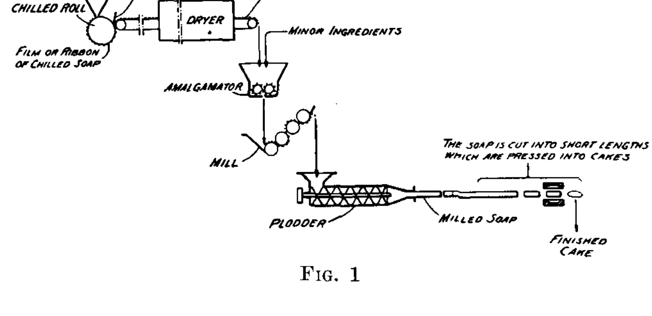

FIG. 1

valves set to change the flow of soap from one strainer to the other.

The proper time for changing or cleaning screens may be determined by noting pressure rise in the line on the pump side or by observing an ammeter reading, showing the load on the motor if the soap pump is electrically driven.

Small specks of iron rust picked up during process operations may, if retained, adversely affect the quality of toilet soap. One means of removing these is to use a special filter consisting of a stack of grids strongly magnetized by a direct current coil surrounding but electrically insulated from them. The soap flows through the grids and, in so doing, is exposed to a large number of magnetized grid edges. These efficiently remove magnetic particles, and they are retained in the filter until it is demagnetized and flushed.

Upon delivery of the hot neat soap to the apron dryer, it is spread out over a chilling roll in a thin sheet and thus solidified during its passage over the roll. In some cases the rolls may be in multiple units. Again the soap is cooled by a single large roll equipped with a smaller spreader roll. The solidified soap is scraped off the roll, usually in ribbon form, and delivered directly to a moving apron which continuously feeds the hot air dryer.

The drying air circulated in the dryer is generally filtered. At the feed end of the dryer the air may be at a temperature of 160° to 170°F. while at the delivery end this is usually dropped to about 120° or 130°F.

Flash dryers have found considerable favor in recent years. Briefly, their operation involves pumping a continuous flow of liquid soap through a heating tube and discharging the heated soap through an orifice into a suitable receptacle or flash chamber. During its passage through the heating tube the temperature of the soap may be raised to approximately 390° F. with a corresponding pressure of approximately 120 pounds per square inch generated within the tube. As long as a temperature-pressure equilibrium is maintained in the tube by means of the feed pump and the orifice size at the discharge end of the tube, the soap will remain in a liquid phase and steam will be generated only when the moisture is flashed off as the soap passes through the orifice into the flash chamber.

The flash drying of soap, properly controlled, offers some obvious advantages, such as lower initial cost of the equipment, smaller floor space for equipment, and lower steam consumption. There are also additional advantages, such as greater uniformity of moisture distribution through the dried soap and reduction of time consumed between the neat soap stage and its preparation for the milling step.

Chipped toilet soap storage bins are usually installed in such a manner that the dried soap may be dropped by gravity. These bins should be designed so as not to permit pocketing of the soap otherwise deterioration of the soap due to oxidation may cause trouble in the finished product. Should there be any tendency for stored chips to stick or hang onto the sides of the bins, they should be frequently cleaned.

It is important to follow a carefully standardized mixing procedure in the soap amalgamators. At this stage the soap chips are usually weighed into the mixer or amalgamator. If a soap preservative is used, this may be added first and the mixer run for a prescribed length of time. This may be followed by other materials such as coloring dye, pigment consisting of zinc oxide or titanium oxide. Finally a suitable perfume may be added and the mixing continued until it is uniformly distributed throughout the soap batch.

The moisture content of the finished product should be controlled mainly by the dryer operation and only the minimum amount of water added at the mixer.

NOW, regarding milling or refining methods, it was common practice years ago to mill soap on granite rolls, such as shown in Figure 2. Later these rolls were improved by developing water-cooled steel units. In recent years rolls have been entirely replaced in many installations by refiners in which the dried soap is pressed by powerful screws through a series of fine screens backed up with perforated pressure plates. This equipment is illustrated in Figures 3, 4, and 5.

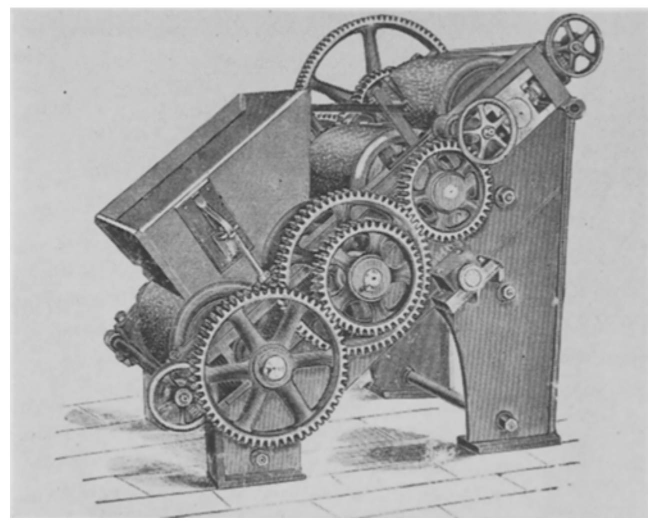

FIG. 2. Old style granite rolls for milling soap

Figure 6 illustrates the appearance of the soap immediately after passing through the refiner screens and again after being pelletized. The refiner method for milling reduces the floor space required for soap milling, reduces power consumption and labor, and frequently effects a marked improvement in the qual-

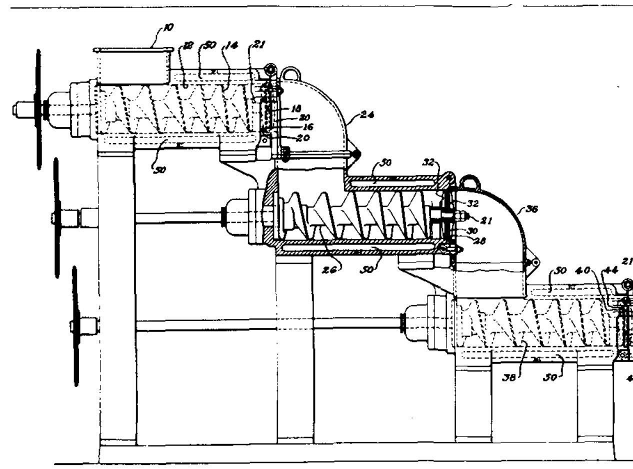

FIG. 3. Cross section view of soap refiner

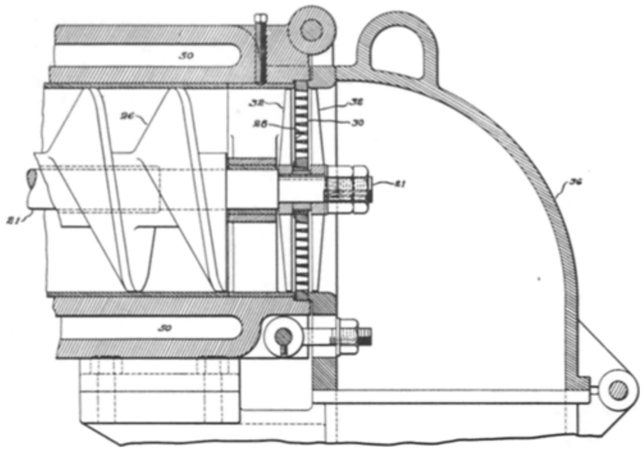

FIG. 4. Cross section view of soap refiner screening arrangement

FIG. 6. (Left) Screened soap. (Right) Soap after being pelletized

ity of the finished soap. Another feature of this method of processing is that it removes foreign material accidentally introduced into the soap between the drying and milling stage.

The plodding operation is important as a means of putting the soap in a compact uniform bar, free from cracks, with a smooth attractive surface. Cracks may be caused by an unusual amount of occluded air passing with the soap to the plodder. These may be especially evident in the interior of the bar. Illustrations of this condition are shown in Figure 7. One means of avoiding excessive cracks is to remove most of the air from the soap by putting a partial vacuum on the plodder feed hopper.

It is good practice to control the temperature of the soap pellets as they are plodded, and, as a further refinement, the temperature of the plodder nose is usually controlled by an electric heater or a steam jacket.

The surface drying of the soap bars before stamping requires careful attention in order that only perfectly finished bars are pressed and wrapped. This step aids in obtaining a superior finish to the bar and helps prevent soap sticking to the stamping dies.

In the manufacture of granulated soaps by spray-drying process steps are controlled to a large extent by the specification for the finished product. For our purpose, let us assume, as an objective, the production of a heavy duty laundry soap of the following composition:

Soap—Dry Basis	63.00%
Sodium Silicate	13.75
Sodium Carbonate	2.50
Tetrasodium Pyrophosphate	5.80
Glycerine	0.20
Salt	0.75
Water	14.00
Total	100.00%

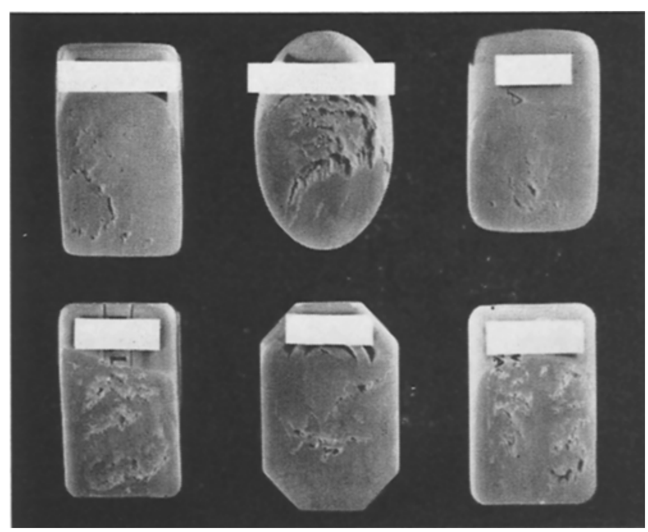

FIG. 7. Illustrations of toilet soap cracking

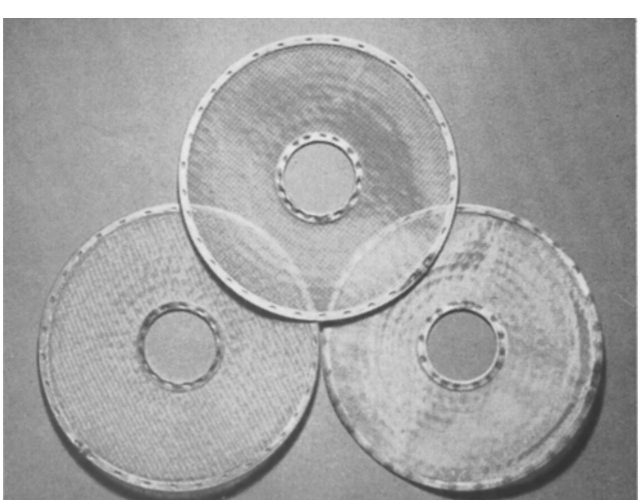

FIG. 5. View of screens used in soap refiner units

The first step in the operation is to bring the neat kettle soap and the various builders, consisting of sodium silicate, sodium carbonate, and tetrasodium pyrophosphate, together in a crutcher. This may take a charge of 5,000 pounds or more. The crutcher is designed thoroughly to mix and blend the builders with the soap. Following this operation the blended charge is delivered to an intermediate storage tank, sometimes called a booster tank. This serves as a reservoir for feeding spray nozzles in a drying tower by means of a pressure pump. Spray nozzles may have two orifices or a single orifice. The former atomizes the molten soap by impinging steam or compressed air on the soap as it issues from an orifice while in the latter atomization is accomplished entirely by means of forcing the soap, under high pressure, through a small opening of proper design. Construction of pressure nozzles may be such as to give the issuing soap a whirling motion.

The location of the spraying apparatus, consisting of one or more nozzles, is usually near the top of the spray tower. The exact position is determined by tower characteristics and experience.

After atomization the soap granules fall by gravity against a rising hot air current, if the system is countercurrent, or travel with the drying air if concurrent. By the time they reach the bottom of the spray tower, the soap particles are dried to the desired moisture content. The stream of spray-dried soap is removed continuously from the bottom of the tower and then delivered to a screening room where oversized and undersized particles are removed, after which the finished, classified granules are delivered to filling machines, packed, and cased.

Silicate and caustic soda are weighed into the crutcher. Following these, water, if used to thin the mix, and also phosphate, soda ash, and returned fines from the screening room are weighed into the crutcher and blended. The time for mixing should be sufficient to assure a smooth, uniform slurry.

IN general, the temperature of the soap, as pumped to the booster tank, should not fall below about 170°F. After delivery of the crutcher mix to the booster tank, the temperature of the soap in the circulating line delivering the slurry to the spray nozzles is maintained at a level suited to the characteristics of the type of spray nozzle used. In some cases the soap is raised to a level of 220°F. or higher to increase its liquidity. In other cases however the soap slurry is sprayed at considerably lower temperature as, for instance, from 190° to 210°F.

At this point we will take a moment to illustrate two types of spray dried particles, namely, round and hollow particles, and multi-cellular particles (Figures 8 and 9).

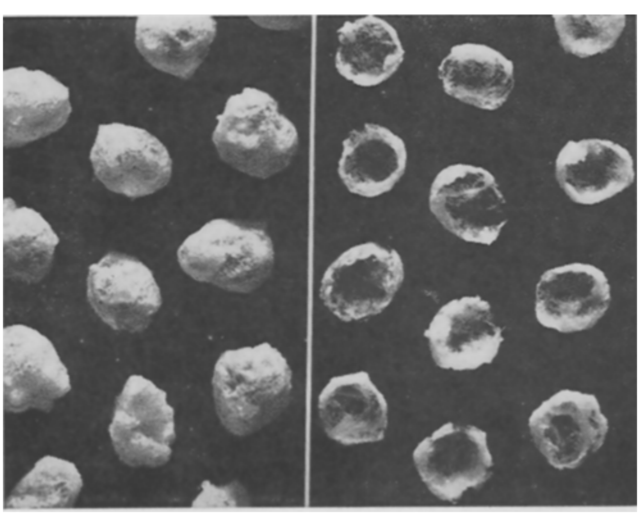

FIG. 8. (Left) Spray dried soap particles—round and hollow. (Right) Cut samples of hollow soap particles.

Inasmuch as there has been a great deal of speculation regarding the mechanism of forming round and hollow particles, you may be interested in pictures showing the manner in which round and hollow soap particles may be formed, using a pressure atomizing nozzle. These pictures were taken with a special high

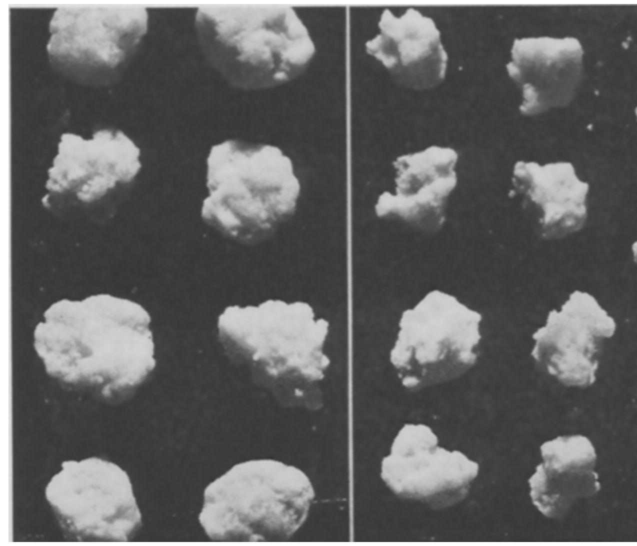

FIG. 9. (Left) Multi-cellular soap particles. (Right) Cut samples of multi-cellular particles.

speed camera operating at 6,000 exposures per second. Figures 10, 11, 12, and 13 illustrate the action in sequence.

It is evident from these pictures that round and hollow particles are formed by the collapse of soap films as they whirl away from the pressure atomizing nozzle. The photographs clearly disclose such particles forming quite close to the nozzle. Obviously, if they are fixed in this condition by drying, they will continue to remain round and hollow particles.

Time does not permit discussion of details covering either the various types of spray towers or the relative merits of countercurrent and concurrent units. Both systems have advantages, depending upon the duties to be performed and characteristics desired in the finished product.

Spray-drying towers are constructed of various materials. Commonly, however, they are built of sheet steel, lined or not, with a protective coating depending upon the nature of the material processed. They vary in size and shape. Size is a function of the productive capacity desired, and commercial units may vary, say, from 12′ inside diameter and 75′ high to 18′ in diameter and 120′ high. Some towers are rectangular, others are pear shaped or cylindrical with straight sides in the drying area.

It is a matter of importance, in introducing drying air into a tower, to see that this is done in such a manner that air currents can be regulated within the tower. Likewise it is desirable to place the spray nozzles in the tower so that a uniform blanket of sprayed soap particles is obtained over a cross-section of the tower, thus assuring the greatest drying efficiency. Drying air may be heated directly or indirectly. If the products of combustion are introduced with the drying gas, care must be taken to assure complete combustion. When gas or oil is used for heating, the furnace air temperatures may range from 725° to 800°F. This highly heated air may be reduced in temperature by dilution with cold air as it enters the distributing inlet ducts leading to the tower to a temperature range between 400° and 500°F. The exhaust air temperature from the tower may vary

FIG. 10 FIG. 11

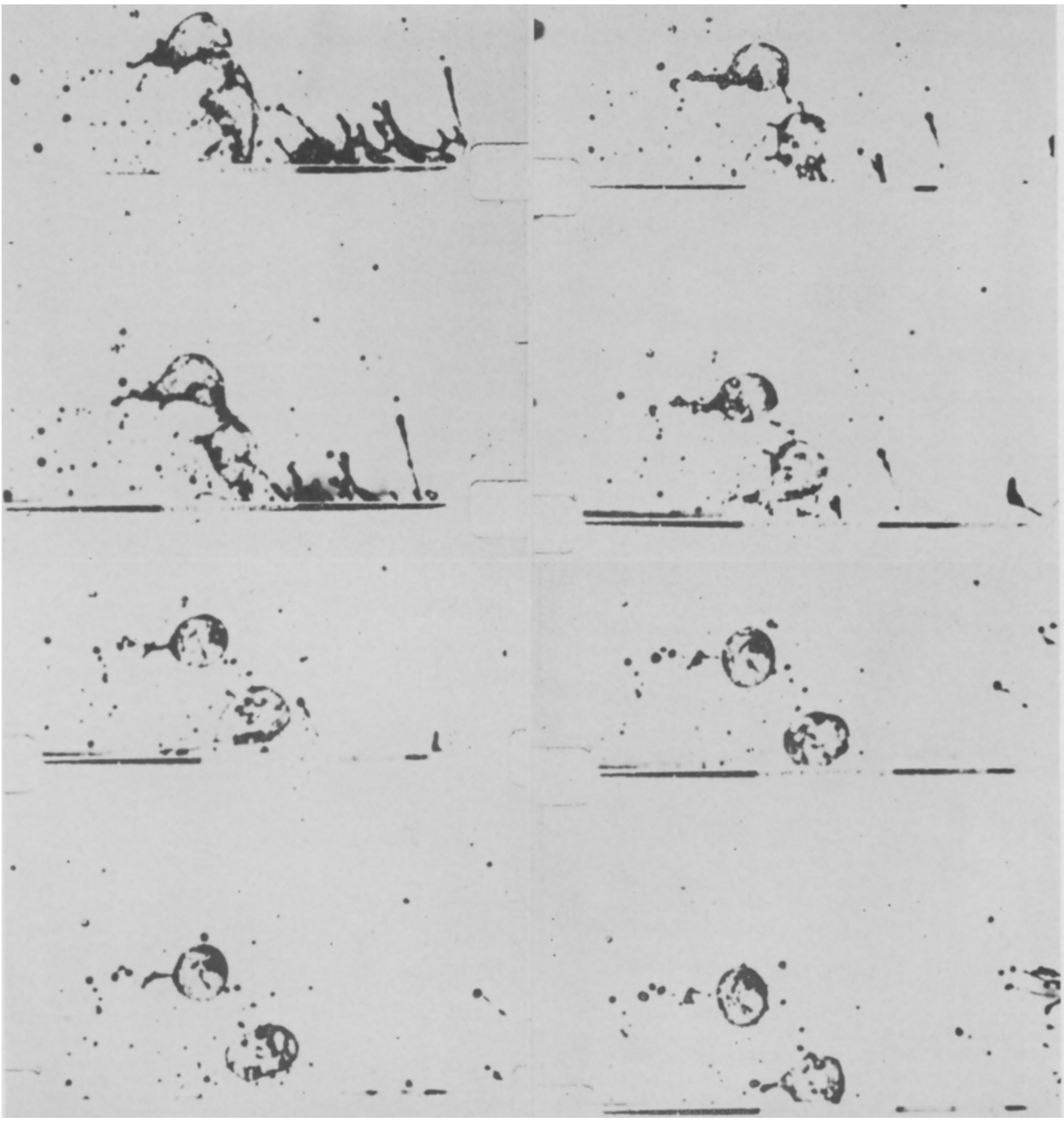

FIG. 12 FIG. 13

Photographs (Figures 10 to 13) illustrating formation steps producing round and hollow particles by a pressure nozzle (taken at 6000 exposures per second).

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from 175° to 225°F. Obviously, if the exhaust air is not recirculated, its temperature should be reduced as much as possible.

Finally, while on the subject of spray drying, it should perhaps be mentioned that spray towers suitable for the production of granulated soaps are often adaptable to the production of granulated synthetic detergents. Auxiliary equipment however will vary from the ordinary soap installation due to differences in nature of the ingredients handled. Nevertheless, in general, the operation of the spray tower itself follows closely the principles used for spray-drying soap.