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DIPPING CANDLES—THE OLD METHOD.

COOLING ROOM.

AMERICAN INDUSTRIES.—No. 79.

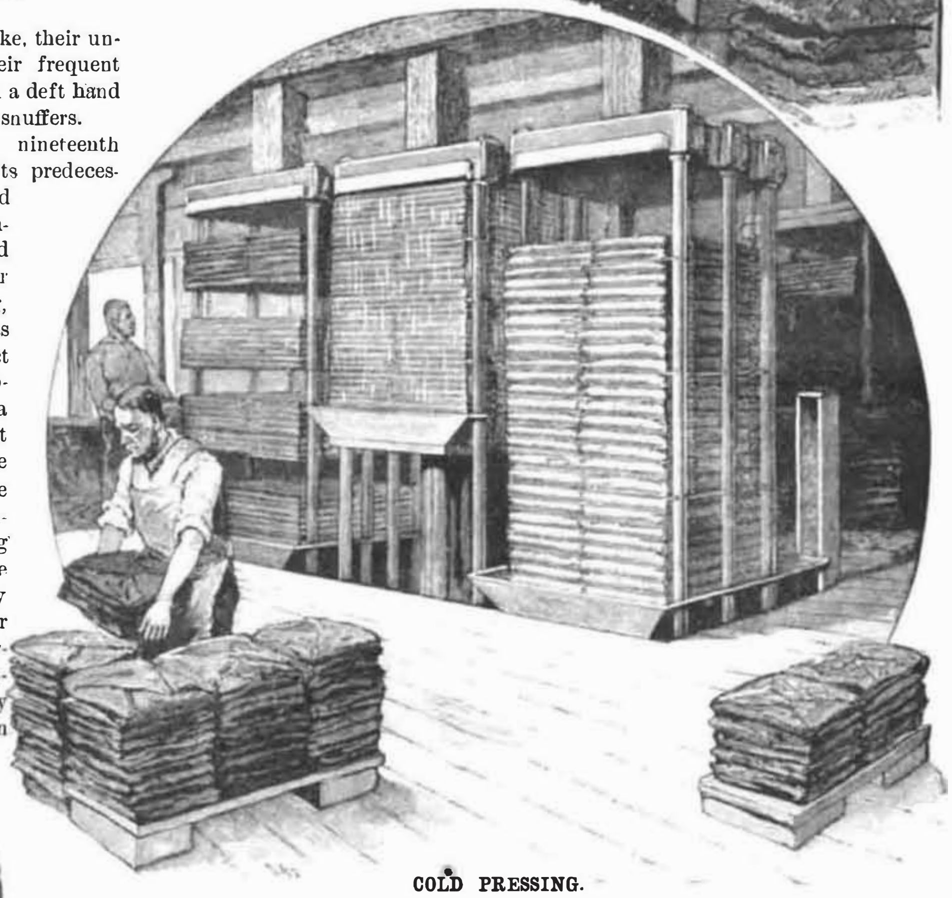
THE MANUFACTURE OF CANDLES.

It is only the history of the modern candle that is written—the graceful, sightly, and tapering cylinder which burns with a clear white and brilliant light; that neither smokes nor "drips;" which retains its hardness in the hottest weather; which can always be handled without greasing the fingers, and does not require snuffing. The primitive character of the candles by which the last generation read its primers and studied its Euclid, is a curious phenomenon when viewed as the product of unnumbered centuries of intellectual growth. The vision is easily conjured up in the memory, of their yellow light, their smoke, their unpleasant odor, and their frequent need of attention from a deft hand and the old-fashioned snuffers.

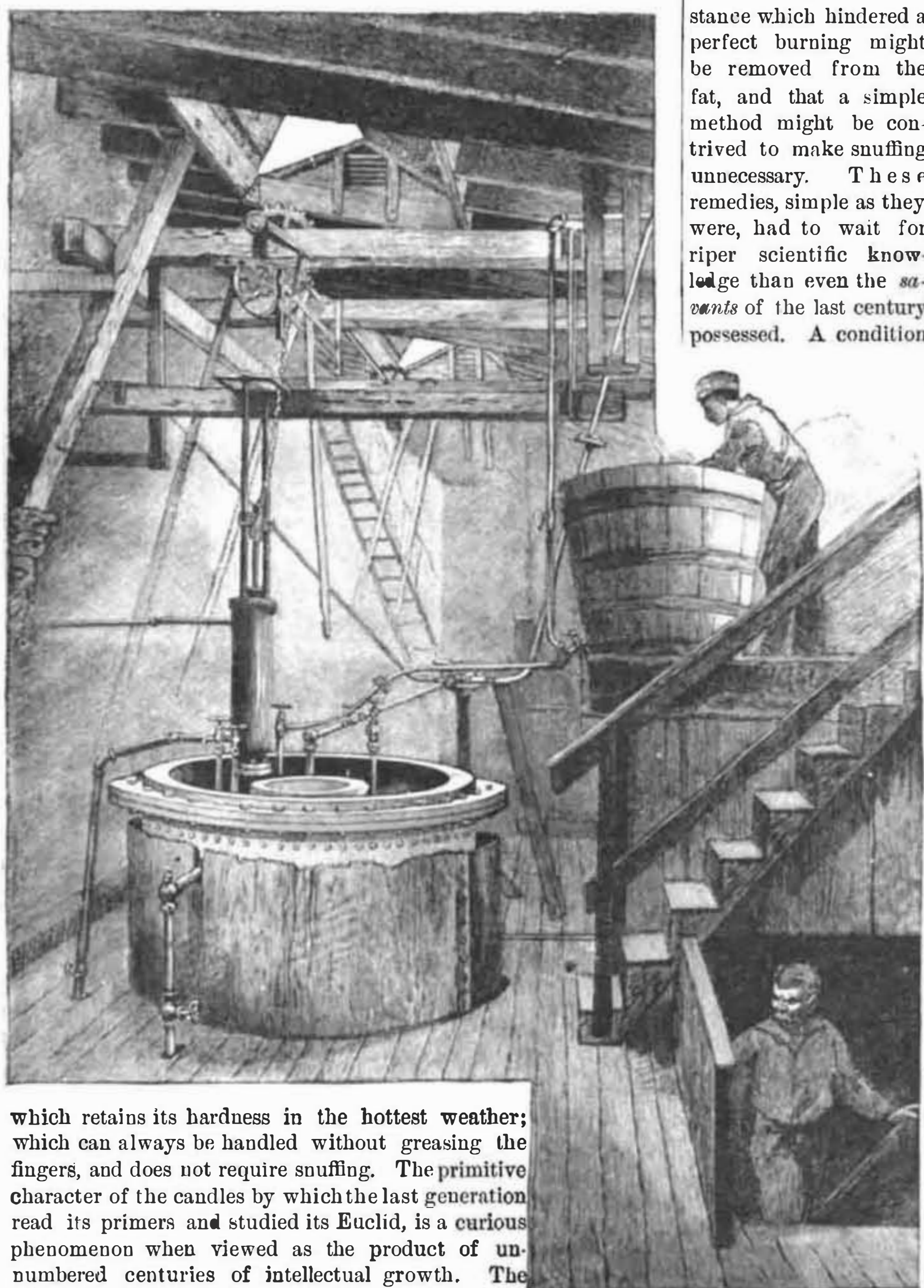
One quarter of the nineteenth century had followed its predecessors before it occurred to man that tallow candles might be made hard enough to keep the year round without melting, that the smoke was caused by imperfect combustion, that the substance which hindered a perfect burning might be removed from the fat, and that a simple method might be contrived to make snuffing unnecessary. These remedies, simple as they were, had to wait for riper scientific knowledge than even the *savants* of the last century possessed. A condition precedent was a knowledge of the nature of fats and of that energetic display of chemical action which we now call combustion.

The progressive steps in candle-making from the age of the primeval savage up to the

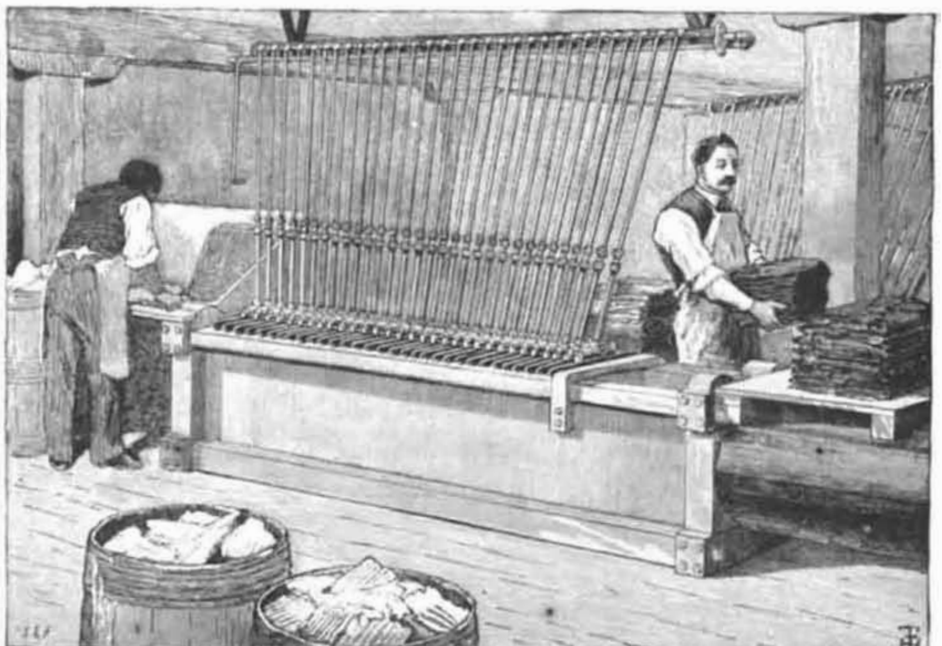
[*Continued on page* 386.]



COLD PRESSING.



THE DIGESTER.



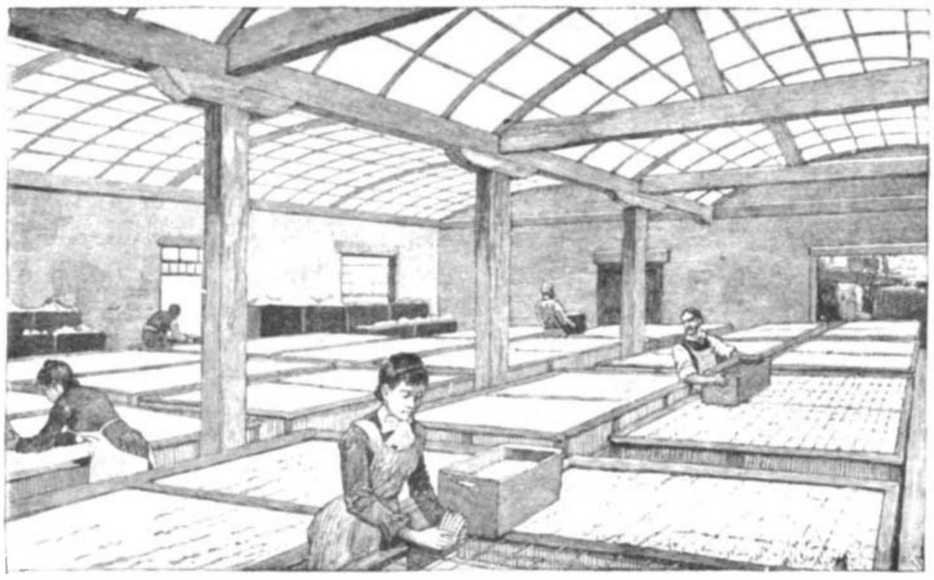
HOT PRESSING.

HOW CANDLES ARE MADE.—MANUFACTORY OF PROCTER & GAMBLE, CINCINNATI, OHIO.

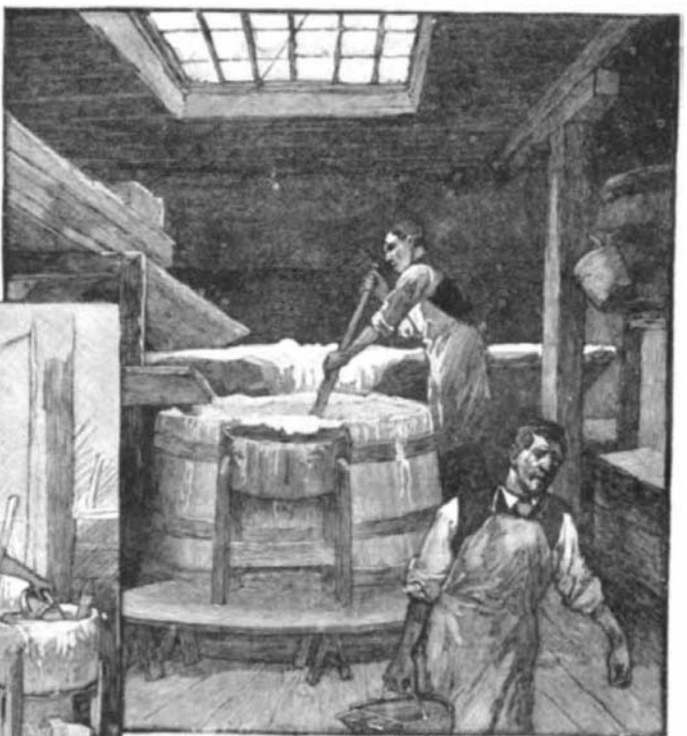
THE MANUFACTURE OF CANDLES.

[*Continued from first page.*]

nineteenth century were not many. First the pine knot, then the oil nuts on a skewer—which is now the means of illuminating used by the Otaheitans and Society Islanders, who are not far behind the rural housewife of not long ago, who gathered rushes, peeled them on one side, and soaked the pith in the skimmings of the bacon pot, or our mothers, who hung a row of wicks of cotton yarn upon a stick, and dipped the wicks into the melted tallow prepared only by the removal of the membranes, etc., in the shape of cracklings. The operation had to be repeated several times, until sufficient tallow had hardened around the wick to make a not very shapely cylinder, the sticks being supported, while the tallow cooled, by parallel bean poles or quilting frames. Dipping day then was not looked forward to with pleasure by the cleanly housewife; it was dirty work at best—the kitchen floor was bound to suffer unless the weather permitted the dipping to be done in the yard or under the cover of the woodshed. Cool days in the spring or fall were chosen, so that the tallow might harden quickly and evenly, and if the attic supply gave out in the midst of warm weather, the grocery had to be patronized for the crude mould candles just coming into use. In those days the construction of kettles specially adapted to melting the tallow and keeping it at an even temperature, and a contrivance for expediting the dipping by putting the rods with the rows of looped wicks upon a revolving rack, marked substantially all the advance of the tallow chandler's art. Aided by all these appliances, a workman could dip probably three or four thousand candles in a long day, and congratulate himself on his luck and his skill, but in the warm weather he had to do the dipping in the cool of the very early morning, and doubtless he often wondered if the time would come when his work could proceed in defiance of the thermometer. This method of dipping candles for the trade came down to our own day. Moulds were invented in Paris in the eighteenth century, but it was not until the whole process of candle-making had undergone a change that they came into general use and stopped the domestic manufacture. The history of tallow-candle making up to the invention of the modern method is a curious one, because of the long time that the crude methods obtained, and it has its complement in the fact that wax candles are still made by kneading the softened wax to the wick with the fingers; the candle is then given a symmetrical shape by rolling it between marble or wooden slabs. Moulds cannot be used here, because of the great shrinkage which melted wax undergoes while cooling. Doubtless the wax candles were made in this way which King Alfred caused to be marked into divisions and shut up in this horn lantern, that by their graduated burning he might apportion his hours to study and devotion and sleep. "Asser's Annals" preserve the great king's directions: "He commanded his chaplain to supply wax in sufficient quantities, and he caused it to be weighed in such a manner that when there was so much of it as would equal the weight of seventy-two pence, he caused the chaplain to make six candles thereof, each of equal length, so that each candle might have twelve divisions marked across it." Each of these divisions burned one-third of an hour, so that the six candles lasted one day.

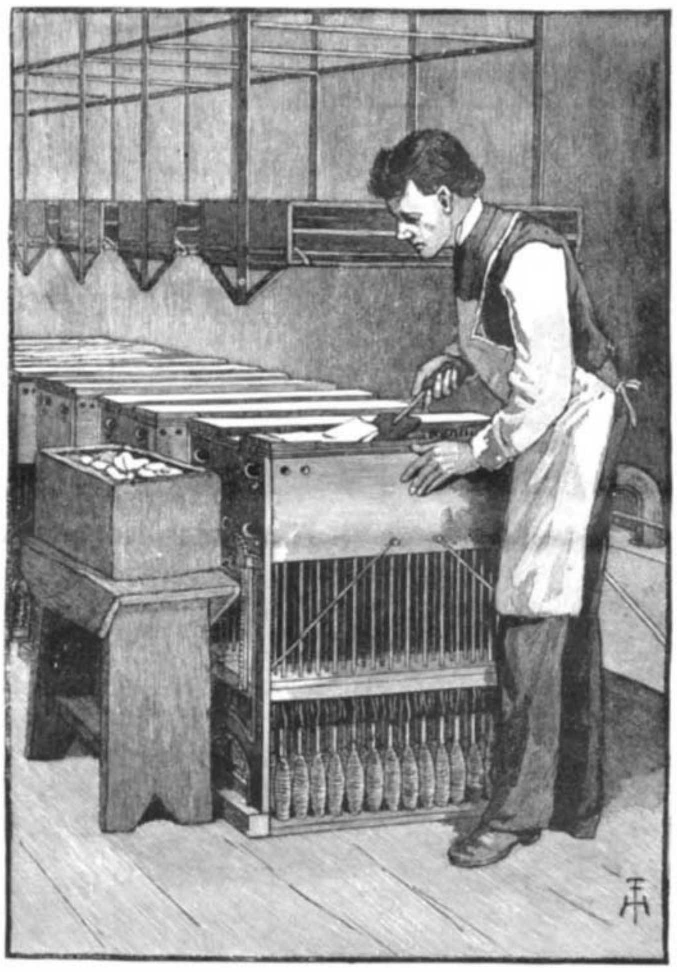


THE BLEACH.



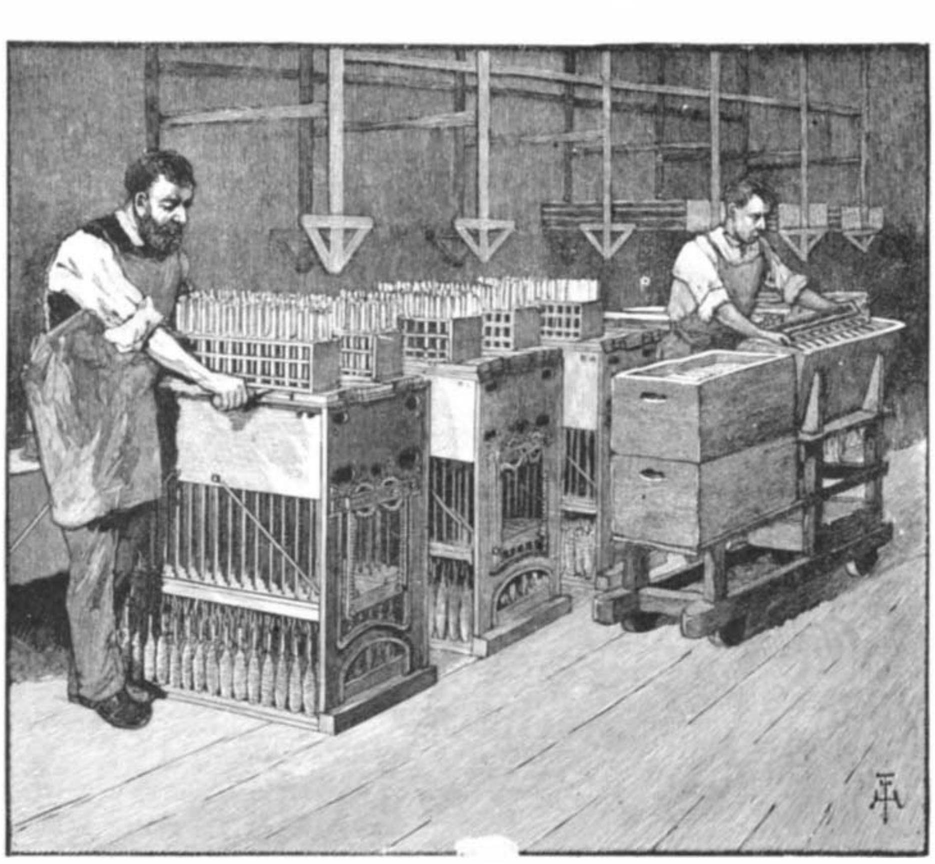
TEMPERING.

The discovery of gas lighting and improvements in lamps have done much to curtail the manufacture of candles, but it is yet a vast industry. An estimate of the consumption in the United States places it at twenty-two millions pounds annually. Candles are still the staple illuminating medium for the poor of large cities, and for all classes in small towns and villages where there are either insufficient or no gas works. Country hotels and taverns are large consumers, and the preference of many people for candles over lamps, as portable lights, keeps up a constant demand in all sections. Candles likewise are the true aristocrats among illuminators, and the renaissance in art taste which holds no illuminating medium to be quite so beautiful and effective as the candle for dinner tables and party and ball rooms, calls for an extensive manufacture of fine grades. Now, it is not the beauty of the polished brass or silver candelabrum alone which makes appeal to the æsthetic judgment, for, except the yet imperfect electric light, no illuminator can give so pure and white a light as a perfect candle. The finest fruit of science applied to the once homely industry is the stearic acid mould candle of to-day, which is not only quite as handsome in appearance as the wax candle, but burns with equal brilliancy and purity, and has to a great extent usurped the place of the more costly light. The mines of the far West share with the boudoirs and *salons* and dining rooms of the East in the consumption of the best of these candles. A very large proportion of the finest grades goes to Nevada, Colorado, and the other mining States and Territories of the Pacific slope, the high temperature of the mines demanding a very hard and pure candle. The old candle would be entirely useless here, for tallow melts at from 90° to 104° Fah., and the temperature of the deep mines of Nevada often reaches 120° and even 130°. A good stearic acid candle will withstand a temperature of from 15° to 10° more than this.



SCRAPING OFF SURPLUS.

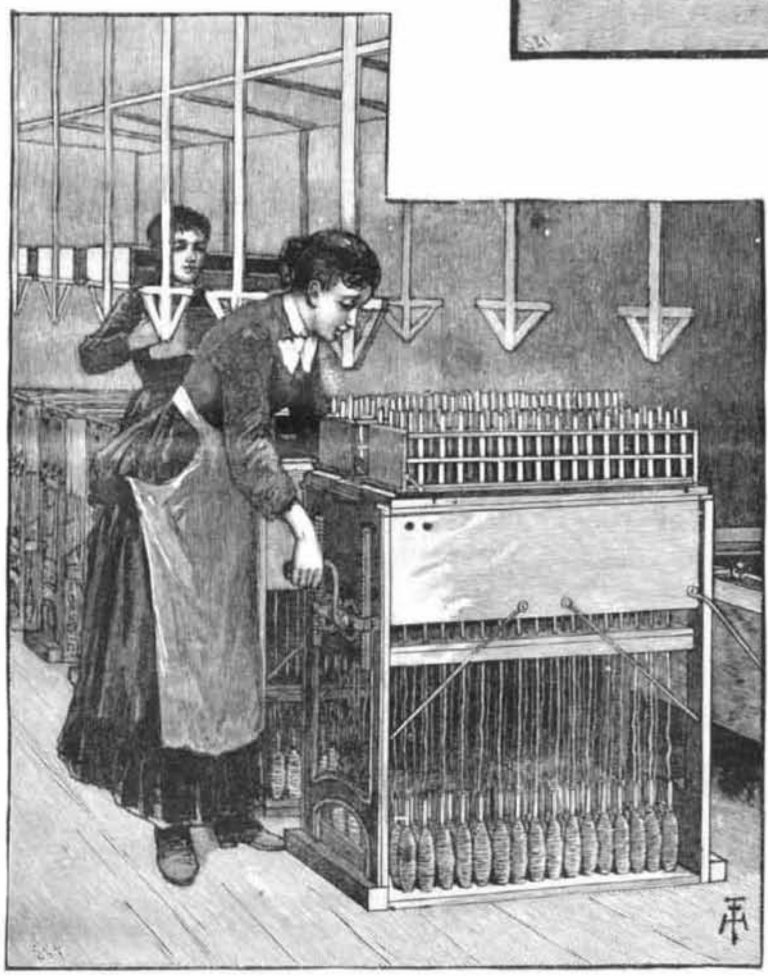
To the vast manufactory of Procter & Gamble, in Cincinnati, the most complete and extensive on this continent, we go for our illustrations and our description of their process, for there the most recent and most perfect of scientific and mechanical appliances are kept at work, and the latest of scientific research is constantly utilized. More than *one hundred thousand* candles are sent out from this factory every day, which, if moulded into one candle, would make it *eleven miles* in length. Every step of the process through which they pass, from the time the fats are deposited into the emptying room until the pretty cylinders, snugly packed in boxes, are sent to all parts of the world, is full either of interest to the student or entertainment to the simply curious. For the edification of the seeker after knowledge as well as those whose curiosity interests them in wishing to know "how to make candles," we will give both the scientific and the mechanical means of candle-making.



CUTTING AND CARRYING OFF.

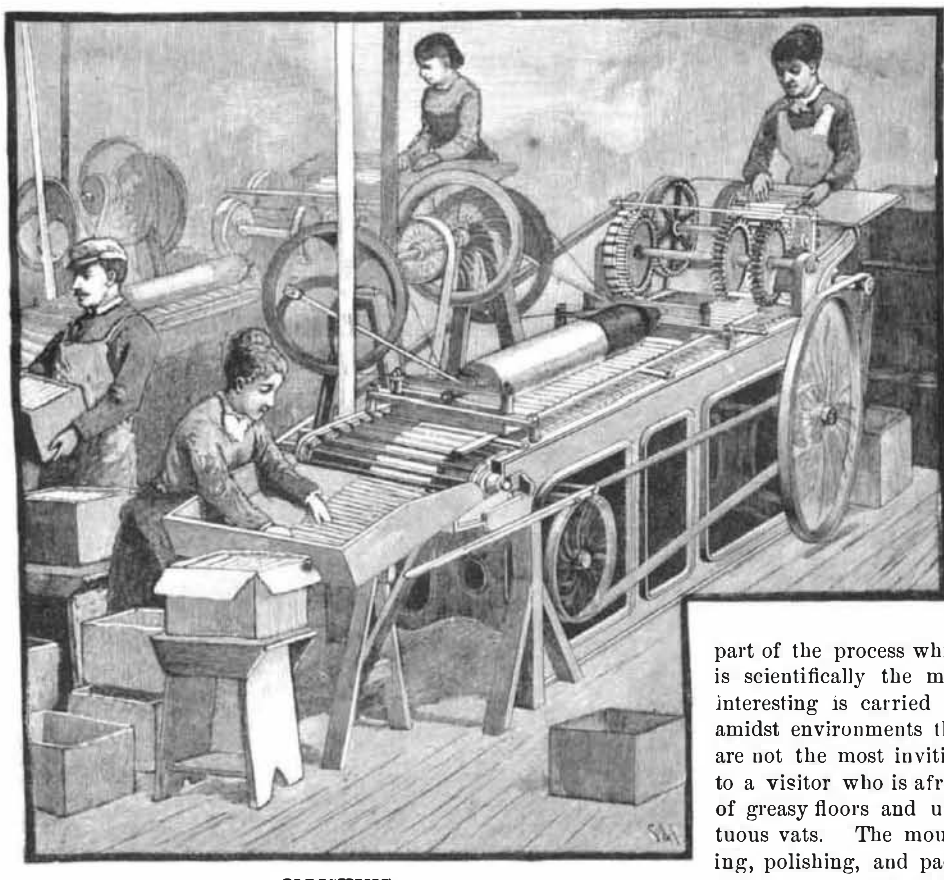
The stearic acid candle, which is now the principal candle of trade, represents the high-water mark of the progress in candle-making which began fifty years ago. Unlike its primitive predecessor, the tallow dip, it is a product of scientific study, and one of the many triumphs of philosophic chemistry. The movement which effected a complete revolution in the industry, and ran a rapid growth after once it was started, was an outcome of the discoveries of M. E. Chevreul, the French chemist, published to the world in 1823, in his book, "Recherches sur les Corps Gras, d'origine animale." In it lies the foundation of all our present knowledge of the chemistry of fatty oils, and this knowledge is the starting point of modern candle-making. Chevreul established the scientific fact that, as a rule, all fatty oils, both liquid and solid, are neutral compounds of glycerine and the so-called fatty acids. In tallow and other candle fats, these acids are stearic and oleic. A third acid, called margaric, also enters in small proportions, but it occupies very little attention. Stearic acid is a crystalline substance, unctuous to the touch, but not greasy. It melts at a temperature a little short of 150°, and when burned through a wick gives out a white and clean light. Oleic acid is liquid at common temperatures, and was the cause of the melting of the old tallow candles at a temperature 50° lower than is withstood by pure stearic acid. The glycerine base caused them to burn yellow, and to smoke with an offensive odor. The discovery of the chemical properties of these constituent elements of candle fat led with a single step to the fundamental idea of the improvement in candle-making: the oleic acid and glycerine are deleterious to the candle, and must be removed; and all the steps since taken—and they followed hard on the heels of the first—have looked to the doing of this in the most expeditious and cheap manner, and the perfection of the moulding machinery. Naturally the first processes were chemical, but they put a great obstacle of costliness in the way of the manufacture which almost proved fatal. The early industry, after surmounting this difficulty by combining mechanical means with chemical in separating and purifying the fats, again came near suffering shipwreck from another cause. It was found by the French chandlers, to whom belongs much credit for developing as well as originating the modern method, that the stearic acid on cooling in the mould crystallized, and the candles became unsightly, brittle, and uneven of combustion. The remedy appeared to lie in breaking the grain of the acid, and this was done by the introduction of a powder. Unfortunately, white arsenic was the powder chosen, and the result was so noticeably injurious to health that Chevreul's discoveries were brought into disrepute, and the early art of stearic acid candle-making was almost annihilated. Better study found a simple and harmless remedy to lie in lowering the temperature of the acid before pouring it into the mould, and in heating the mould to receive it. Improvements were also successively made in the methods of preparing the fat, and when, finally, American ingenuity was brought to bear upon the mechanical side of the problem, a machine was developed out of Sieur de Brez's last-century mould that has marvelously simplified and cheapened the manufacture of candles. The purification of the fat had done much to improve the combustion, and the smoke had been abolished; the flame, too, had become much brighter and clearer, and the snuffing of the wick had become less necessary, for, the combustion being more perfect, the wick, whose only duty is to conduct the oil to the flame, was more nearly consumed. A little attention to the making of wicks soon banished the snuffers and the snuff tray to the curiosity shops of the antiquaries.

MOULDING.



RAISING THE CANDLES

The old-fashioned wicks were simply twisted. Cambaceres conceived the plan of plaiting them, with one strand drawn tighter than the others. In the candle the wick is kept straight by the hardened fat, but, when released by the flame, the tightened strand draws the end of the wick over to one side, so that it is brought in contact with the outer envelope of the flame, where the combustion is most perfect because of the liberal supply of oxygen received from the air, and thus the wick is continuously consumed. The process is helped by steeping the wick in boracic acid, in order that a glassy bead may be formed at the end of the wick, and drop off by its own weight. This plan was suggested by De Milly in 1830.



POLISHING.

Fortunately, a promenade through the factory in fancy is attended with consequences much less disagreeable than the actual walk, for all that part of the process which is scientifically the most interesting is carried on amidst environments that are not the most inviting to a visitor who is afraid of greasy floors and unctuous vats. The moulding, polishing, and packing, however, have picturesque phases which appeal to even a dainty æsthetical sense. Three processes are necessary in the preparation of the fat for the mould. The glycerine must be removed, the acids must be freed from the new base combined in getting rid of the old, and the solid acids must be separated from the liquid. In the first process the principle followed is the law in chemistry, according to which a strong base under favorable conditions will separate a weaker one from its acids by combining with the acids and taking the place of the weaker base. The fat is thereby saponified, a soap being formed, which is next decomposed, the fatty acids liberated and then separated. In this last process begins the employment of mechanical instead of chemical means, for, though repeated dilutions would effect a more perfect separation of the acids, the plan pursued is quicker, cheaper, and sufficiently effective for the purpose desired.

The saponification of the fat is accomplished in an apparatus called, in chandler's parlance, the "digester." It consists of a copper cylinder inclosed within an iron one, and a pump arranged to force the contents of the inner cylinder from the bottom to the top. Into this the fat, which

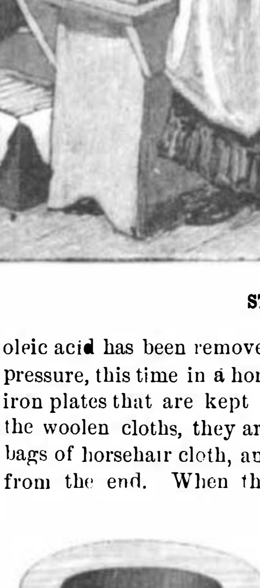
HAND POLISHING

has been melted out of the barrels by steam, is run and is mixed with lime and water. The mixture is kept at a heat of 600° Fah. by steam which is let into the outer cylinder at a pressure of two hundred and fifty pounds to the square inch. The water, being the heavier, sinks to the bottom of the copper cylinder, whence it is pumped and thrown on a perforated plate above the fat, that it may fall through it in many little streams. This agitation is kept up for eight or nine hours, after which it is found that the lime has united with the fat acids and formed a soap, while the water has consorted with the dissociated glycerine. The contents of the cylinder, after being permitted to remain at rest for a time, separate into two strata, the lime soap on top, the crude glycerine and water below. These are blown off to separate vats by the power of steam. It is from the candle factories that the enormous supply of glycerine comes, which is now a very important article of trade. A few years ago it was wasted; now it is sent to the manufacturing chemist, who purifies it by distillation and filtration through bone charcoal, and puts it upon the market. It is put to a great variety of uses, many of which depend upon its peculiar properties of non-volatility and absorption of atmospheric moisture. Harness makers and leather workers use it in making leather pliable; it is put into gas meters because it does not freeze except at a very low temperature; modelers keep their clay studies moist with it; tobacconists sweeten chewing tobacco with it, and ladies apply it to their hands and faces to soften the skin. Much of it goes into the manufacture of the terrible explosive nitro-glycerine, which is made by treating it with a mixture of sulphuric and nitric acid, or concentrated nitric acid. Not less than three million two hundred thousand pounds of glycerine are produced by the candle factories and utilized every year in this country, and yet so late as the year 1854 it was counted as worthless, and was run off into the sewers.

STAMPING.

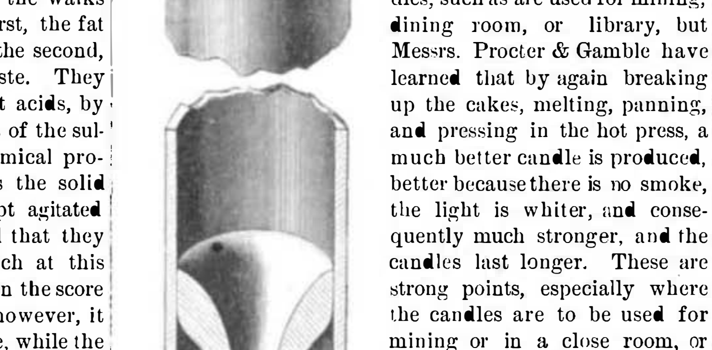
When the French chandlers first began the manufacture of the new-process candles, and for a long while after, they permitted the lime soap to become hard, and then ground it up in order to dissociate the lime from the fat acids. Now this is done without delay, the liquid soap being run into lead-lined vats with a proportion of sulphuric acid added. The chemical principle involved is the same as in the more laborious process of saponification; the glycerine base has been supplanted by the lime base, and this must now be got rid of. The sulphuric acid takes hold of the lime, forming sulphate of lime, and the acids float off free. In these vats, between which the paths are narrow and the walks greasy, the liquid settles in three strata—the first, the fat acids, now free of their base, but still mingled; the second, an acid water; the third, sulphate of lime, a waste. They are easily drawn off without mixing, and the fat acids, by washing in boiling water, are cleaned of all traces of the sulphuric acid, and we are now done with the chemical processes, and our product is a fat which contains the solid and the liquid acids. If cooled rapidly or kept agitated while cooling, the acids become so intermingled that they cannot be separated by mechanical means, which at this stage of manufacture must replace the chemical, on the score of cheapness. If the fat is cooled very slowly, however, it has been found that the solid acids will crystallize, while the liquid acid, the oleic which it is desired to banish, will lie snugly ensconced between the crystals, to be afterward forced out by heavy pressure.

The cooling of the fat is a slow process. It is run into shallow pans, lined with enamel to prevent the acids from eating the metal, and permitted to remain in a warm room two or three days. These pans are arranged in sections, like alcoves in a library, one row of pans underneath the other, and each extending a slight distance alternately to front or rear beyond the one above it. The hot fat is conducted over the top of the alcove in a wooden chute, and the filling of all the pans down to the floor is accomplished by taking a plug from the chute immediately over the top pan. When this is full it overflows at the front end by means of the slight depression made at that end, and the overflow is caught by the pan below, and so on down to the bottom. When the fat is become hard it is a cake of a brown, greasy mass, not unlike unrefined maple sugar. The discoloration comes from the oleic acid, which permeates the whole cake and can be forced from between the crystals of the hard acids by pressure with the thumb. The cakes are wrapped in heavy woolen cloths, piled into hydraulic presses between iron plates, and the pressure applied. A dark oil gushes from the woolen, pours over the edges of the plates, and is caught up beneath the press to be used in soap-making. The cakes have now been squeezed down to less than two-thirds of their original thickness, and the mass presents a yellowish-white appearance. By breaking it, its crystalline texture can still be seen despite the fact that the shape of the crystals has been ruined by the pressure it has undergone. They are still somewhat greasy to the touch, for in this first pressure only fifty per cent of the oleic acid has been removed. They now succeed to a second pressure, this time in a horizontal press, and between hollow iron plates that are kept hot by steam. Still wrapped in the woolen cloths, they are suspended between the plates in bags of horsehair cloth, and a very heavy pressure is applied from the end. When the cakes issue from this process they are as white almost as snow, very hard and dry, and when broken into small particles have a flaky appearance. The mass is now almost pure stearic acid, and is ready to be moulded into star or adamantine candles. Without an exception, this single hot pressing is deemed by other manufacturers to be sufficient for their higher grades of candles, such as are used for mining, dining room, or library, but Messrs. Procter & Gamble have learned that by again breaking up the cakes, melting, panning, and pressing in the hot press, a much better candle is produced, better because there is no smoke, the light is whiter, and consequently much stronger, and the candles last longer. These are strong points, especially where the candles are to be used for mining or in a close room, or where a pure, soft, white light is desirable, such as at a dinner party or reception.



A MOULD.

These are the scientific phases through which the stearic acid candle goes; what follows it is simply the fruit of the inventive faculty of our day. The visitor emerges from dark basement rooms, where he has been moving between tubs and under pipes and chutes all dripping with liquid grease, into a room on the ground floor. Here there is light in plenty, and opening off one side is a vista of a room vast in extent, with a glass roof like a hothouse, with long rows of tables separated by narrow paths, on which, bolt upright, stand thousands of shapely candles undergoing a brief bleaching process by sunlight. One end of the first room is filled with vats in which the prepared candle fat is melted, purified, sometimes colored, and brought to the temperature requisite for moulding. Utility is here, of course, the guiding consideration, but the group of big and little tubs, with the men moving among them, is not without its picturesque element. Upon the edges, and hanging from the spouts at which the moulder fills his double-lipped can, the candle fat has hardened in fantastic shapes, with surfaces of ivory-like smoothness and sheen. The floor of the room is covered with moulds. In these moulds there is little remaining of the group of tin tubes through which the domestic candle maker, who had got beyond dips a few years ago, laboriously drew her wicks, to fasten them below with a knot, and above by looping them over little sticks. The tubes are now fixed in a frame having troughs along the top, into which they all open. They end below with the shoulder of the candle, and the moulds for the tips are the upper ends of piston rods, which, by a rack and pinion, are forced upward through the tubes to expel the candles, and which, when at rest, fall snugly into the shoulders. These rods are hollow, and the wicks pass continuously through them from bobbins placed in the floor of the frame. Care is exercised to have the fat at a temperature just above the melting point, to heat the mould to receive it, and immediately to cool it rapidly by forcing around the tubes a blast of cold air, so that the fat shall not crystallize as it did in the panning. When the candles are hard, the surplus fat in the troughs is removed, and a few turns of a handle forces them upward out of the moulds and into a rack placed on top of the machine to receive them. The lower board of the receiving rack is slightly shifted, so that the edges of the openings through which the candles pass catch the shoulders of the candles, and prevent them from dropping back into the moulds with the piston rods. These rods in expelling the candles draw up with them wicks for the next pouring, and in falling back into position pull the wicks taut and into place through the middle of the tubes. The candles in the rack are left until the next mouldful is cold; then the wicks are cut by passing a knife between the mould frame and the rack, and they are emptied into boxes, which are mounted on trucks, and pushed from mould to mould. Bleaching, polishing, stamping, and packing are all that remain to be done. The first process takes place in the adjoining room already mentioned; a few hours of sunlight bleaches the yellowish tinge out of the fat. Common grades are then rubbed with cloths and packed; better grades are polished by a machine, into one end of which they are fed by one woman, while another packs them into boxes from the other. The process is very simple: a grooved cylinder receives the candles from the feeder, and after carrying them past a revolving saw, which cuts off the butts evenly, deposits them upon a bed plate between the rods of an endless frame with linked sides, kept in motion by cog wheels. Over this bed plate they roll under a revolving buffer, which gives them a vigorous brushing from end to end, and gives them the beautiful porcelain finish as they pass toward the end where they roll off into the packer's box. All grades are stamped with the name of the maker, and in some instances the trade name of the candle, "Composite," etc. This stamp is melted into them by a branding iron as they pass through a small machine, which, like the polisher, is fed by a grooved cylinder.



MISCELLANEOUS INVENTIONS.

Mr. John B. Casley, of Coolville, Ohio, has patented an improvement in metal roofing. This invention relates to that class of metal roofs in which the ends of the sheets are bent upward to form flanges which are held on the roof by anchors. The invention consists in the combination, with flanged roofing plates, of an anchor provided with one or more prongs at the upper end and with an enlargement or bead at the inner end. This anchor is passed into a slit or cut in the edge of the roofing strips or boards, the enlarged part or bead resting against the inner surface thereof, whereas the prongs project above the flanges of the metal sheets, and are then bent down over these flanges. The flanges may be bent one over the other, or the joint may be covered by a cap. By this invention the plates are held firmly by the anchors, and can be attached to the building very rapidly and conveniently. The plates can be attached to the sides of a house in the same manner.

A very efficient carpet stretcher has been patented by Mr. David G. Rulon, of Monmouth, Ill. In this device a clutch bar, which lies flat upon the carpet, and has inclined steel points that catch into the latter, is connected by cords or chains with a rear bar, which is provided with steel points that pass through the carpet and into the floor. The clutch bar is moved forward to stretch the carpet by a lever having a steel point that sticks into the floor, said lever passing through a loop in a draw cord, that rests by its loop in any one of a series of hooks on the lever, while the ends of the cord are connected with the clutch bar by draw rods, which keep