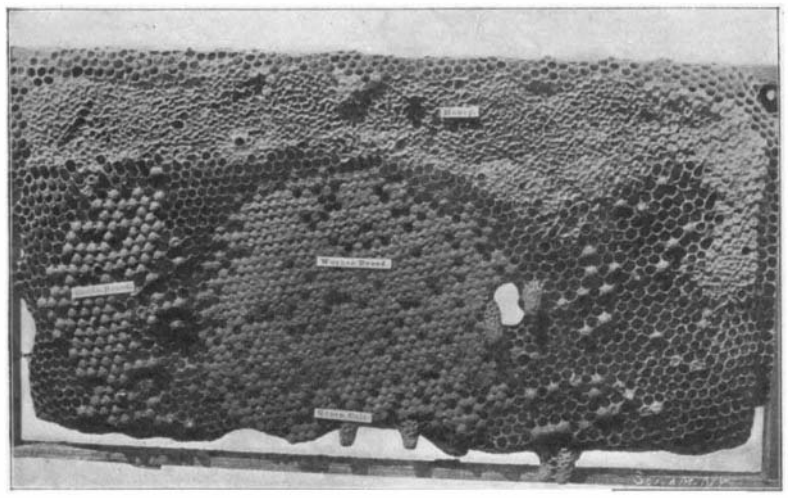
The provision of this extra cable also makes it possible to overhaul or repair any cable at any time.

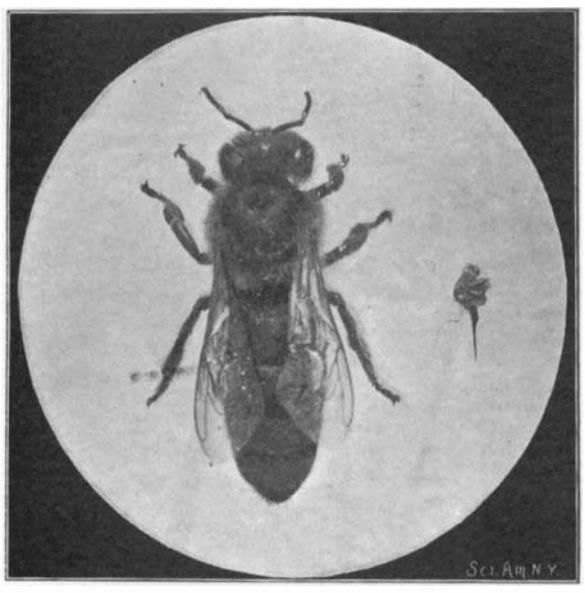
The cables of the Carquinez span are of solid plow steel, with solid steel core. In the twisted strand are nineteen wires, including the core, and the strand has a diameter of seven-eighths of an inch. The erection of the cables comprised a highly interesting feature of the work of construction. When the four cables, each 6,400 feet long, were in readiness, the ends were hauled up to the south anchorage by windlass and secured to the anchorage system. The reels, one at a time, were then carried across the Straits on a self-propelling steam barge, paying out the cable as they went. On the north shore the donkey hoisting engine for pulling up the cables was located near the leaning tower previously mentioned, or some 1,800 feet from the landing. Leading from the engine through a block in the anchorage and over both the leaning and main towers was run a hemp line which was utilized to pull over the slack end of the cable. The four cables were raised in five days. Some idea of the power required to pull up the cables may be gained from the fact that when the sag of a cable was such that it touched the surface of the water, its length was 4,535 feet and the strain was 9,000 pounds; when 120 feet above the surface, the length of span was 4,482 feet and the strain 12,750 pounds; and when in final position the length was 4,448 feet and the strain 22,500 pounds.

The electrical power which is transmitted via the Carquinez span is derived from the Yuba River. The initial electric pressure for distribution is 40,000 volts; but this is to be increased to 50,000, and ultimately to 60,000 or 70,000 volts, in order to minimize the losses incurred in transmitting the power for long distances. The three generating stations have an aggregate capacity of 23,000 horse power, and the company possesses water rights for 20,000 horse power additional.

One supplementary power house contains three 500 horse power dynamos, while the main power house at Colgate has a capacity of 18,000 horse power. In building the great flume more than 8,000,000 feet of lumber were used. This flume has a capacity of 23,000 cubic feet of water a minute. Three of the dynamos in the Colgate power house have a capacity of 3,000 horse power each, making them the largest horizontal shaft dynamos driven by water power in the world. Similarly, the buckets used on the water-wheels are the largest and heaviest ever made for a wheel of tangential jet. It may be mentioned in conclusion that the Carquinez span is nearly three times the length of the Brooklyn Bridge, and is therefore the longest single span between two supports which the world has ever seen.



FRAME OF COMB FROM THE BROOD NEST OF A COLONY THAT HAS RECENTLY CAST A SWARM.



WORKER BEE AND STING.

BEE-KEEPING IN THE UNITED STATES.

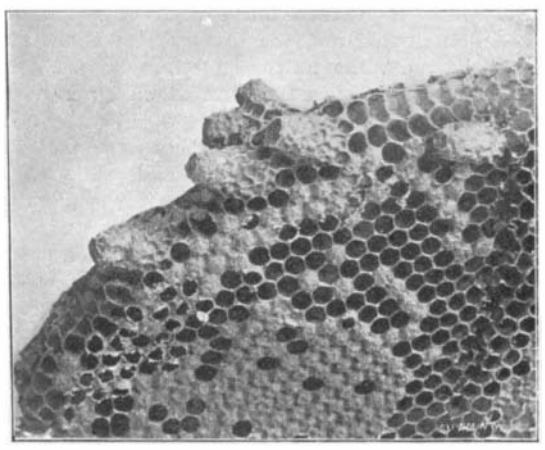
BY WALDON FAWCETT.

The general public is prone to think of bee-keeping merely as an adjunct of agricultural operations, but in reality it has attained during the past few years to the position of a very important American industry. Extensive apiaries have been established, and thousands of persons in various parts of the country are devoting their entire time to the scientific fostering of honey production. Something of the scope of the operations now being carried on may be imagined from the fact that there are now in the United States considerably over one hundred apiarian societies, eight periodicals published solely in the interests of the industry, and fifteen steam factories for the manufacture of beehives and apiarian implements.

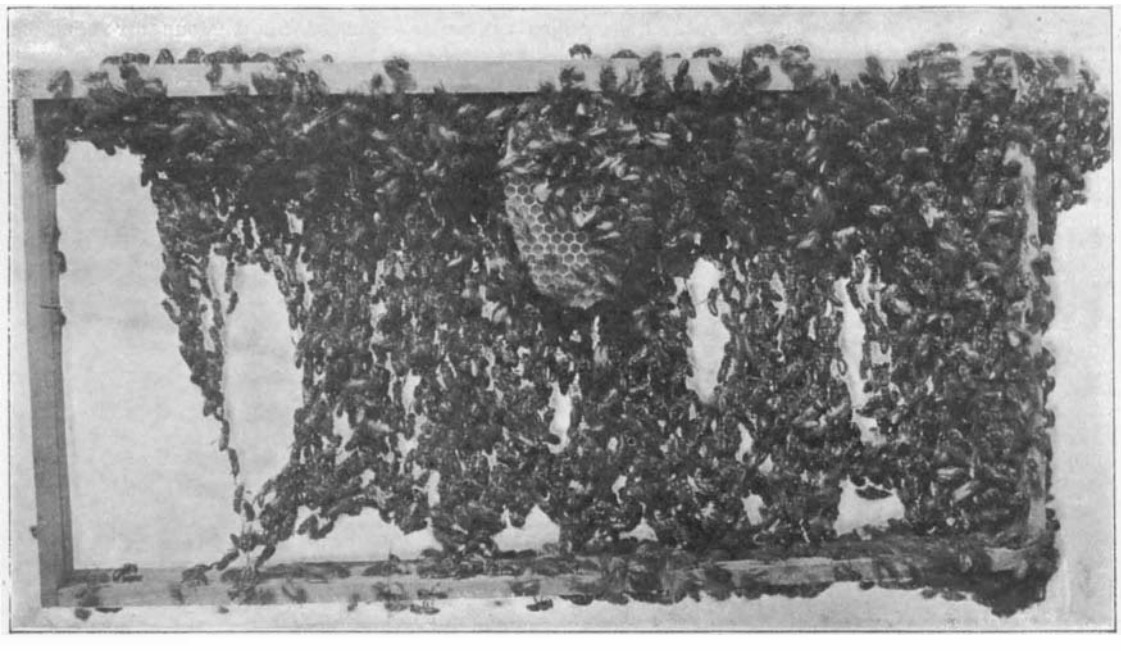
It is estimated that there are fully three hundred thousand persons engaged in the culture of bees in this country at the present time. In the absence of any method of securing official statistics from year to year, many estimates have been made of the quantity of honey produced annually on this side of the Atlantic, and though the figures presented have invariably seemed extravagant to the uninitiated, the statements, there is every reason to believe, have been, without exception, highly conservative. Prominent beekeepers who undertook, a year or two ago, to form some idea of how much honey is produced in the country came to the conclusion that at least fifty thousand pounds is stored in sections every year, while they assumed that one hundred thousand pounds of extracted honey is produced—an aggregate of one hundred and fifty thousand pounds. The beekeepers, however, were probably too modest in their claims, for their calculations showed the annual honey crop of the country to be worth $10,000,000, whereas the officials of the United States Department of Agriculture who have made an especial study of the subject place the valuation at fully double that figure.

This record of the great wealth represented in a comparatively obscure food product is all the more remarkable when it is remembered that the apiarian industry in the United States is practically a development of the last forty years, although isolated individuals were engaged in the work long prior to that time. In the score of years from 1869 to 1889 the American production of honey was quadrupled, increasing from less than fifteen million pounds annually to nearly sixty-four million pounds annually; and the closing decade of the century witnessed a growth proportionately greater, since the estimated output of the closing year of the cycle, as given above, is very much more than double that recorded ten years ago. The bee-keeping industry, however, far from having reached the acme of possible development, would appear to be only just entering upon an era of even more remarkable growth, and it is estimated by the authorities of the apiarian world that the present existing flora of the United States could undoubtedly support, with the same average profit, ten times the number of colonies of bees now to be found in the land.

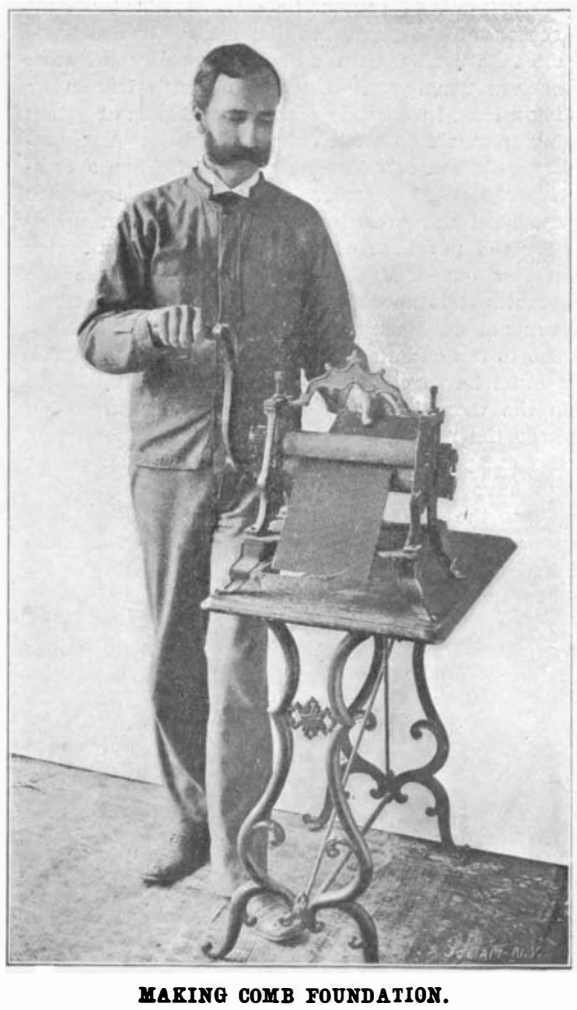
The bee family is made up of several distinct types, including the hive bee, bumble bee, carpenter bee, leaf-cutter and the stingless honey bee of the American tropics. Strictly speaking, the apiarian industry concerns itself only with the hive bee, although the plan of introducing the stingless bees from tropical America has frequently been considered. It is admitted that this latter class of insects might be kept in the warmer parts of the country, but the fact that their honey yield is small and not easily harvested makes it problematical whether the attempt is justifiable. Passing by the varieties of hive bees which are natives of Asia and Africa, we find in America at the present time a variety of distinct bee families. The common brown or German bee was imported from Europe



CLUSTER OF QUEEN CELLS.



COMB BUILDERS HANGING IN CLUSTERS, SECRETING WAX.



MAKING COMB FOUNDATION.

during the seventeenth century and is now to be found in every section of the Union from the Atlantic to the Pacific. Other races—all introduced during the last half century—include the Egyptian, Italian, Cyprian, Syrian, the Palestine, the Carniolan and the Tunisian. Almost all of these races have become to a greater or less extent hybridized with the brown or German race.

Each colony of bees in good condition at the opening of a season contains a laying queen and some thirty thousand to forty thousand worker-bees, or six to eight quarts by measurement. It is quite possible, too, that several hundred drones may be included in such an assemblage. Under normal conditions the queen lays all of the eggs which are deposited in the hive, being capable of depositing as many as four thousand in a day. Upon the workers, or females, devolves all the labor of gathering honey, secreting wax and building combs. The drones, or males, are not a factor save in contributing somewhat to the general warmth of the hive necessary to the development of the brood.

The food of honey bees is found in pollen and honey. Pollen, the fertilizing dust of flowers, is carried home by the bees in small pellets held in basket-like depressions on each of the hind legs. The liquid secreted in the nectaries of flowers is usually quite thin, and much of the water which it contains must be eliminated either during the transportation of the nectar to the hive or after it has been stored temporarily in open cells. To transform this nectar with its raw, rank taste into the greatest of table luxuries is one of the chief functions of the worker-bees. Workers are stationed in lines near the hive entrances, and by incessant buzzing of their wings drive currents of air into and out of the hive and over the comb surface. The loud buzzing of the bees frequently heard in the vicinity of a hive at night is due to the action of the wings of the little workers busily engaged in ripening nectar. When a considerable portion of the water has been eliminated and the disagreeable odors and flavors driven off, the finished product is stored in waxen cells, and seals in the form of waxen caps are speedily put in place.

The successful manipulation of bees is one of the most delicate of tasks and requires skill and experience. A majority of professional bee manipulators in time grow somewhat indifferent to stings, since they become so thoroughly inoculated with the poison of the bee that the pain of the sting is less severe and the swelling slight. Moreover, with a number of the races of bees recently introduced into this country the avoidance of stings is simply a question of care in the manipulation of the insects combined with a free use of smoke. Even in utilizing this latter safeguard, however, care must be exercised, for the idea is to simply alarm and subjugate the bees with the smoke and not to stupefy them. The time usually selected by expert bee-growers for the manipulation of swarms is when most of the bees are busy in the fields. The young bees left at home are most easily controlled, and the old ones upon their return are, as a rule, heavily laden with the fruits of their foraging expedition.

Apiaries may, of course, be established at almost any season of the year, but the spring is decidedly the most favorable time and that usually selected. Bee-masters usually sell colonies of pure Italian or Carniolan bees, in securely constructed hives, at prices ranging from six to eight dollars a colony. The bee-keeper needs but few implements. If he has a comparatively limited number of hives his aggregate expense need not exceed six dollars, the sum necessary for the purchase of a smoker, a wax extractor and a few queen-introducing cages. To secure the best results it is necessary to have constructed hives that are not only adapted to the nature of the bees, but also to the climate of the particular locality. The hives must be so constructed also that while able to retain the warmth of the bees in outdoor wintering and keep the rain from beating in, they still provide for the escape of moisture. Dozens of labor-saving devices have within the past few years been introduced into the apiarian world, and bees are now even given artificial outlines of cells as a basis for comb building.

The process of extracting honey is another operation wherein care is necessary. The filled combs, as fast as removed from the hives, are placed in a light case the size of a hive, or a tin can made especially for the purpose, covered closely to prevent the access of robber bees and taken to the extracting room, which is bee-proof. The uncapping knife, held in hot water when not in use, is passed rapidly under the capping of the sealed combs, the point of it being used to reach depressed surfaces. The loosened cappings drop into a sieve resting over a pan, or into the upper part of a can especially designed to receive cappings. The small amount of honey removed with the cappings drains through the strainer and is drawn off below. The uncapped combs are placed in the extractor at once. In this branch of honey capture three persons usually work together—one removing the surplus cases or combs from the hives, freeing them of their bees and bringing them into the extracting room, where two assistants uncap and extract the honey. The honey extractor itself consists of a large can within which a light metal basket revolves. The full combs of honey from which, as explained, the cappings of the cells have been removed, are placed inside the basket and after several rapid revolutions by means of a simple gearing are found to have been emptied of their contents. The combs, only very slightly damaged, can then be returned to the hives to be refilled by the bees. If extra sets of combs are at hand to supply as rapidly as the bees need the room in which to store honey, great yields can often be obtained.

The progressive, present-day apiarist does not look for the production of wax in so great a proportion compared with his honey yield as did the old-time box-hive bee-keeper. The latter obtained much of his honey for the market by crushing the combs and straining it out, leaving the crushed combs to be melted up for their wax. Frequent losses of bees in wintering and through queenlessness also gave more combs for melting, as without hive frames, honey-extractors, comb-foundation machines and the other new modern devices the vacated combs were seldom used a second time. The wax from the pressed combs was all marketed, since there could be but little home use for it.

The bee-keeper of to-day, however, as has been noted, after having removed the honey from the combs by centrifugal force, returns them, but slightly injured, to be refilled by the bees, and at the end of the season these combs are stored away for successive years or else the surplus is marketed as stored—that is, without cutting. Nowadays the only source of wax production is found in the cappings of the combs, occasional broken combs, etc. However, since the marketable price per pound of extracted honey is usually not less than one-third and that of comb honey one-half the price of wax, while it requires some twelve or fifteen pounds of honey to produce one pound of comb, it may readily be appreciated that it is far more profitable to turn the working force, in so far as possible, to the production of honey instead of wax.

Not only is there only such production of wax as may be secured without lowering the yield of honey, but even what wax is taken is practically turned into honey the following year, for it is made into comb foundation which, judiciously used, increases, in turn, the season's yield of honey. Wax being so much more valuable than honey, it behooves the bee-keeper to preserve even the smallest pieces of comb. The old way of rendering wax was to put the combs into a sack made of some open stuff, weight this down in a kettle of water and boil for some time. The wax rose, and when cold was removed in a cake. The new approved plan of rendering is by means of the solar wax-extractor. The machine is placed in a sunny spot and filled with wax cappings or bits of comb. As the direct rays of the sun strike it, the melted wax trickles through a strainer and collects in a tin placed at the lower edge of the tank or melter. The cake is removed each morning. When the solar apparatus is not available, wax is rendered by steam heat.

An Interview with M. Santos-Dumont.

An authorized article on the Brazilian aeronaut M. Santos-Dumont appears in the November Century from the pen of Sterling Heilig:

This young Brazilian inventor works for the love of the thing, not for lucre. He has never felt moved to apply for a single patent. He is a son of the "Coffee King" of Brazil, the proprietor of the Santos-Dumont plantations of Sao Paulo, the friend of the former Emperor Dom Pedro, and the benefactor and adviser of whole populations. Santos-Dumont, the father, although a Brazilian by birth and nationality, was French by descent, and had his technical education at the Ecole Centrale (Arts and Industries) in Paris. Thanks to this education, he was the first to apply scientific methods to Brazilian coffee-culture, so that his plantations became the most flourishing in the land, having four million coffee-plants, occupying nine thousand laborers, comprising towns, manufactories, docks, and steamships, and served by one hundred and forty-six miles of private railroads. It was on these railroads that the young Santos-Dumont, before he was twelve years of age, drove locomotive-engines for his pleasure, and developed the taste for mechanics and invention which saved him, coming young and rich to Paris, from a life of mere sporting leisure. Until eighteen years of age, when he completed his education at the University of Rio de Janeiro, he remained in Brazil, always returning in vacation-time to the wild back-country of the plantation, where he became a mighty hunter, killing wild pigs and tigers by preference, and great snakes out of a sense of duty.

Arriving in Europe in 1891, he made a tourist trip, and ascended Mont Blanc. A part of 1891 and 1892 he spent between London and Brighton, perfecting his English, which he now speaks as well and as often as French; but he always returned to Paris, where in 1892 he was already driving automobiles. In 1894 he made a short trip to the United States, visiting New York, Chicago and Boston. He did not begin ballooning until 1897, in the summer of which year he made his first ascent in company with the late M. Machuron. In the same year he made twenty other ascensions, a number of them unaccompanied, and became a reliable pilot of spherical balloons. He was, indeed, an ideal figure for the sport, uniting remarkable strength, agility and coolness to his jockey's weight of scarcely one hundred pounds. For this reason he was able to lower the volume of the "Brazil," his first spherical balloon, to the unusual minimum of one hundred and thirteen cubic meters. The little "Brazil" was always filled with hydrogen, and after each ascension he never failed to bring it back with him in his valise.

AN INTREPID AUTOMOBILE CHAUFFEUR.

This Brazilian has neither the structure, the complexion nor the exuberant gestures of the men of his country. He is pale, cold, and phlegmatic, even, if the words may be applied to one so active. In his moments of greatest enthusiasm and of most lively disappointment he is always the same; and he is as free from affectation as a child. He has a weakness for driving dog-cart tandems, and—something which has had a vital influence over his career as a balloonist—he has been an intrepid automobile chauffeur from the first.

He began with a Peugeot roadster of two and a half horse power. He has since owned and driven half a dozen automobiles of continually increasing speed and power, his longest trip without stop being taken in 1898, between Nice and Paris, and accomplished with a six horse power Panhard in fifty-four hours. Latterly he has abandoned petroleum in favor of electricity, in a dainty light-running American buggy manufactured in Chicago. It serves him, he says, better than the more troublesome *teuf-teuf* for his morning spin through the Bois and his afternoon errands from the balloon-maker's at Vaugirard to his apartment in the Avenue des Champs-Elysées, and from the Aéro Club's ground at St. Cloud to the Automobile Club in the Place de la Concorde. "I was once enamored of petroleum automobiles, because of their freedom," he explains. "You can buy the essence everywhere; and so, at a moment's notice, one is at liberty to start off for Rome or St. Petersburg. But when I discovered that I did not want to go to Rome or St. Petersburg, but only to take short trips about Paris, I went in for the electric buggy.

"I got my first idea of putting an automobile motor under a cigar-shaped balloon filled with hydrogen gas while returning from the Paris-Amsterdam automobile race in 1897," he said when he began giving me this interview. "From the beginning everybody was against the idea. I was told that an explosive gas-engine would ignite the hydrogen in the balloon above it, and that the resulting explosion would end the experiment with my life. Lachambre, my balloon-constructor, went to work without enthusiasm. So far from others 'convincing me that their notions were worth taking up,' as has been said, I met with nothing but discouragement."

Such a categorical statement ought to dispose of the legend of a young "Mæcenas of balloon-builders," who "does not set up himself to invent machines, only to judge of those which inventors bring to him, and of the work done by the mechanics he employs." Col. Renard's assertion that M. Santos-Dumont is not a man of science, but *un sportsman de l'aérostation qui a beaucoup de crânerie* (an aerostatic sportsman who has a great deal of swagger) is equally inexact. Sufficiently at home in mathematical mechanics to make the calculations which necessarily preceded not only the construction of his various air-ships, but their very idea, sufficiently practised and ingenious to make his own models, the young inventor owes no more to his constructors and hired mechanics than he does to his theoretical friends.

Improvements in Champagne Manufacture.

Certain improvements have been introduced in champagne manufacture. As is well known, the wine is bottled and placed in racks in an inclined position. The bottles are turned regularly, the idea being to cause all the impurities in the wine to reach the cork. The old cork is finally removed at a certain stage of the process in order that the final liquoring and corking may be done. Formerly it was the universal practice in the momentary removal of the cork to allow the deposit to be sprayed out by the pressure of the gas with just enough of the contents of the bottle to remove the substance, which would be cloudy, and damage the wine. Of late years an ingenious freezing machine has been introduced to freeze solid a thin wedge next the cork of just the needed thickness to remove all that need not remain. This reduces the waste of wine from 8 per cent to 12 per cent.