THE ELECTRIC CABLE SPAN AT CARQUINEZ.

The longest span in any electric power transmission line operated on the American continent, if not indeed anywhere in the world, is that of the Bay Counties Power Company of San Francisco across the Straits of Carquinez, a comparatively narrow waterway separating Solano and Contra Costa counties of California, and connecting San Pablo and Suisun Bays, which latter form the northerly extremity of San Francisco Bay. The swinging of the electric cables, which cover the horizontal distance of 4,427 feet in a single span that has a clearance of 206 feet above extreme high tide, constitutes one of the most remarkable engineering achievements of the age; and how greatly it exceeds all previous performances of the kind will be appreciated when it is stated that, previous to the construction of the Carquinez span, the most notable example of such construction was found in a sheer stretch of 1,500 feet of cable across the Columbia River in British Columbia.

At the point on the Straits of Carquinez selected for the spanning of the cables the water is about 2,750 feet wide, with a depth ranging up to 120 feet, and through this gap flow the waters of the Sacramento and San Joaquin Rivers. There is also an ocean tide of about five feet. There is thus produced constantly a heavy and dangerous current—a current so strong, in fact, as to render impracticable the laying or operation of high-tension, submarine cables.

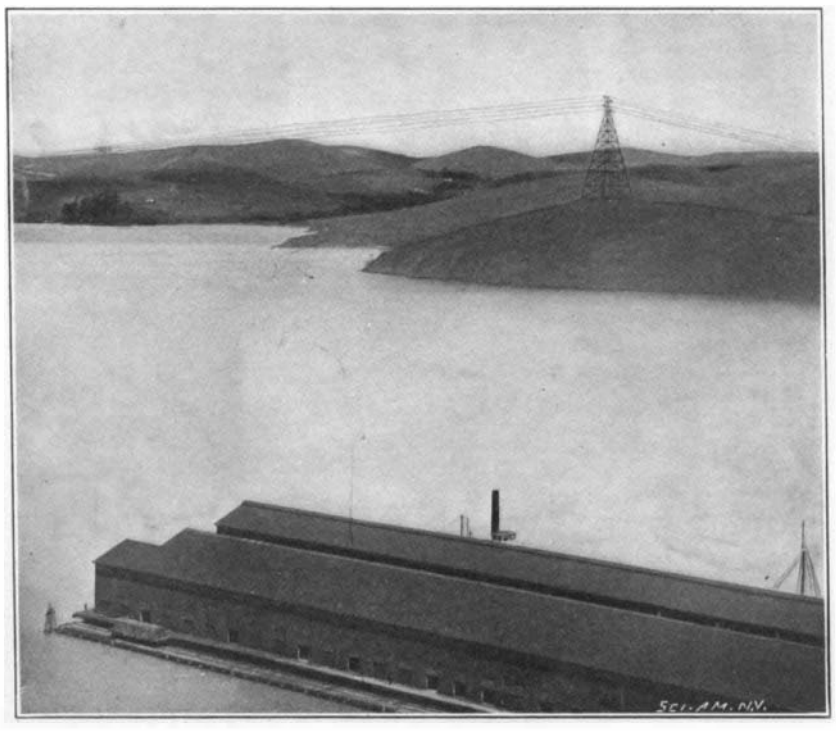
On one side of the Straits where the crossing is made is a bluff, rising to a height of 162 feet above extreme high tide. On the opposite side there is a hill rising about 100 feet from the water's edge, and back of this a gradual incline, culminating at an elevation of 400 feet about half a mile back from the water's edge. The Carquinez span extends from the 400-foot elevation mentioned to the summit of the bluff on the opposite shore, passing directly over the town of Eckley with its stores, warehouses, etc. In planning the span numerous exactions had to be kept in mind, one of which was the provision imposed by the United States government to the effect that a clear headroom of at least 200 feet should be allowed for vessels. This was stipulated in order to insure the free passage of any craft afloat, the peak of the "Shenandoah," the largest vessel in the American merchant marine, being 194 feet above the waterline.

The cables are supported in the great span by two steel towers. The one on the bluff, known as the "main" tower, is 225 feet in height, and the one on the gradually rising ground opposite is 64 feet high, the latter structure being known as the "south" tower. The south tower is located so high on the hillside that its top is fully 80 feet higher than the top of the lofty main tower, and thus the lowest point of sag in the span is thrown off the lineal center between the two towers. In order to bring the cables down to anchorages, only 1,700 feet back of the main tower, there was constructed a third structure known as the "leaning" tower, and which has an inclination of thirteen degrees from the perpendicular.

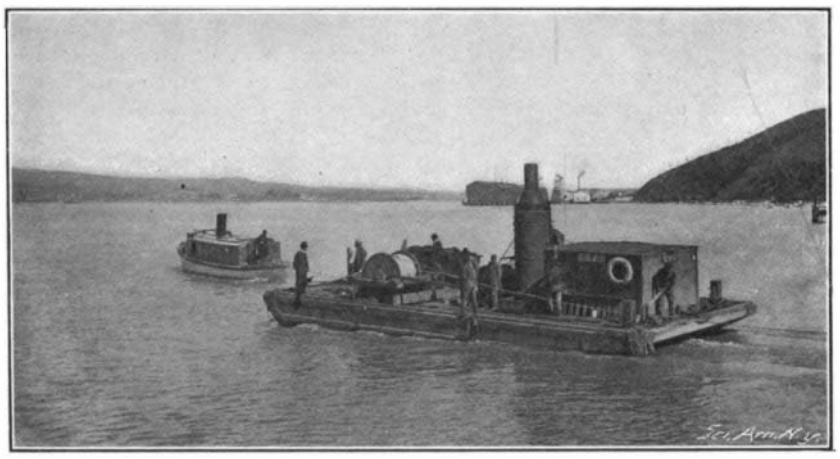
Steel and iron have been used almost exclusively in the construction of all these towers. Estimating the maximum wind pressure at 40 pounds a square foot, each of the four corner posts of the main tower is subject to a maximum compressive strain of 132,510 pounds. The main tower is supported by twelve concrete piers with the corner ones arranged in a quadrangle measuring 69 by 89 feet between the pier centers. Each of the corner piers is a cube of concrete having eight-foot sides. The piers are in reality designed more to give weight as anchorages than to serve as foundations. Each of the smaller towers is supported on four piers of concrete.

The support of the cables from the towers represents an achievement of no inconsiderable magnitude, since each cable exerts a pull of twelve tons on its anchorages. The insulators weigh about fifty pounds each, and every insulator was subjected, previous to installation, to long-continued tests of 120,000 volts. There is an extreme variation in temperature of 60 deg. at Carquinez, so that there may be a difference during the year of five feet in the sag of the cables, a difference which will cause a travel of fully two inches to occur in the cables running over the sheaves of the main tower.

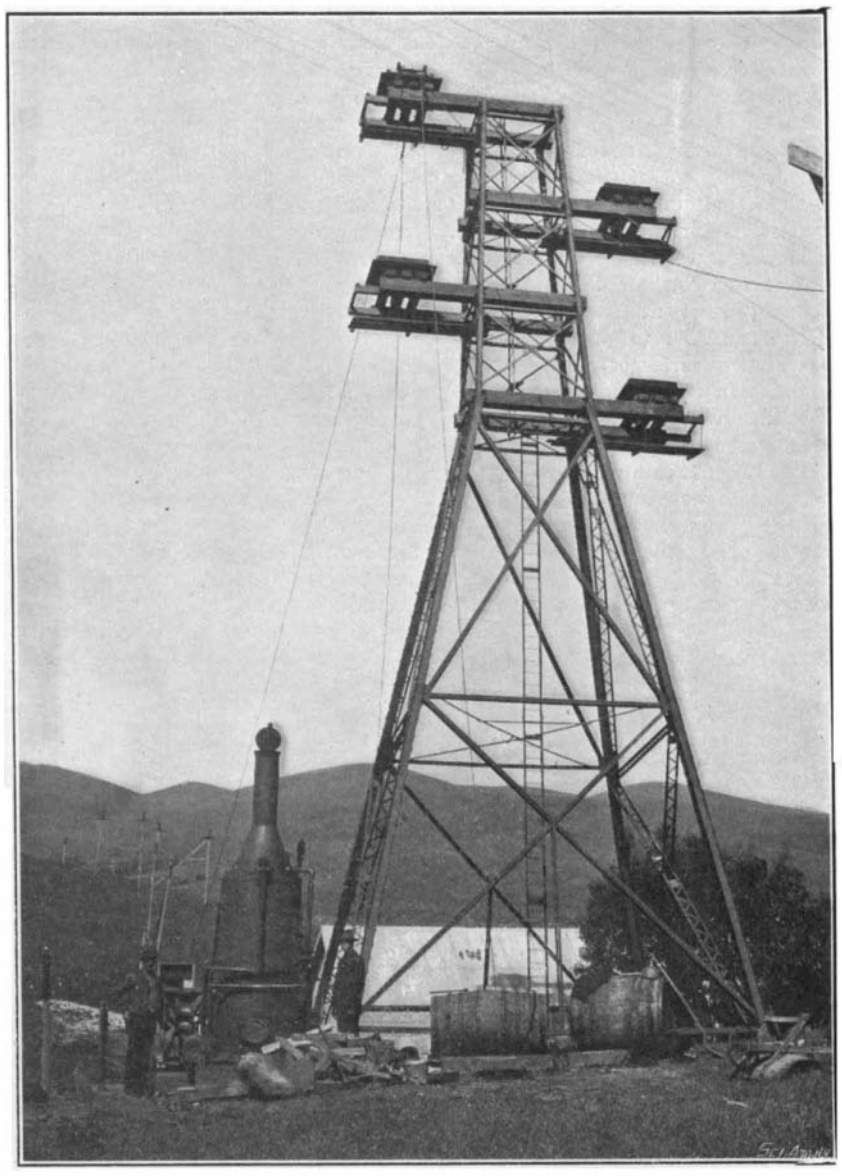
Each cable has an individual anchorage consisting of a mass of concrete nine by ten feet in size and five feet high, set into the bedrock. The cable is turned around a two-foot sheave and secured with clamps and clips. There is an independent housing for each anchorage, and the cable enters by way of a circular hole six inches in diameter cut through the center of the plate glass which forms the front of the inclosure. The cables are "dead-ended" at the anchorages, power being delivered to or taken from them by means of taps. Only three cables are ever in use at one time, the fourth invariably being held in reserve.



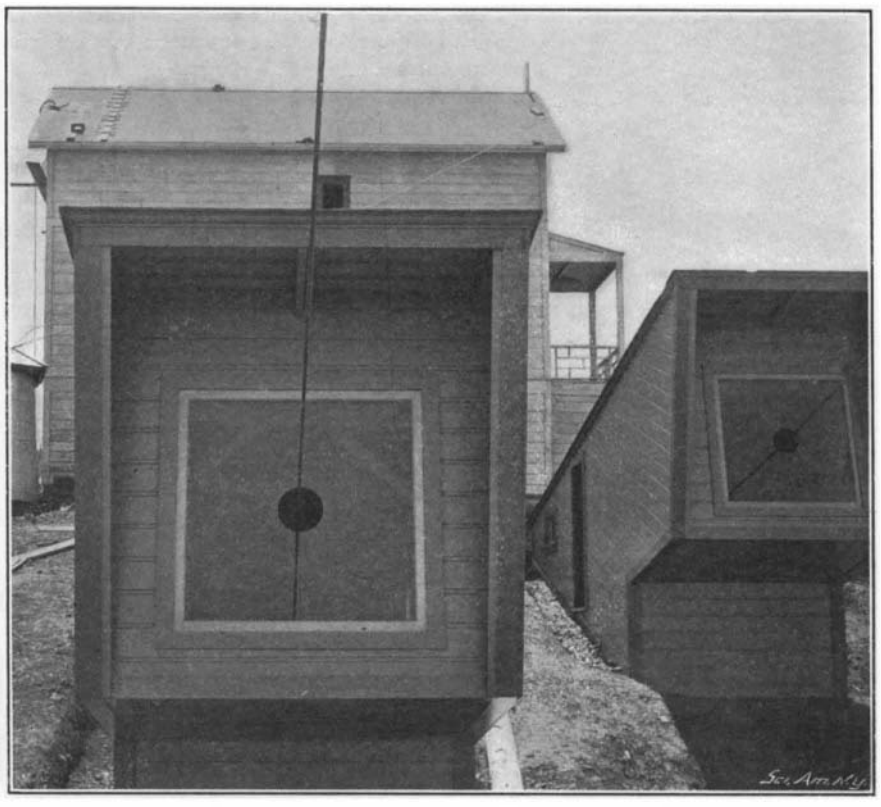
General View of the Straits of Carquinez, Showing the Four Cables and the Main Tower.



Carrying Cable Across the Straits of Carquinez.



The Leaning Tower of Carquinez Span.



Glass-Covered Entrance to Anchorage of Cables.

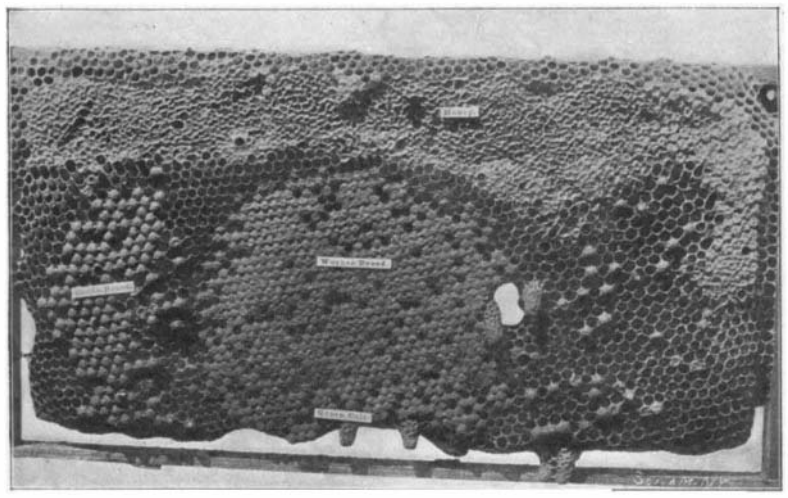
THE GREATEST ELECTRIC CABLE SPAN EVER ERECTED—SPAN, 4,427 FEET.

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

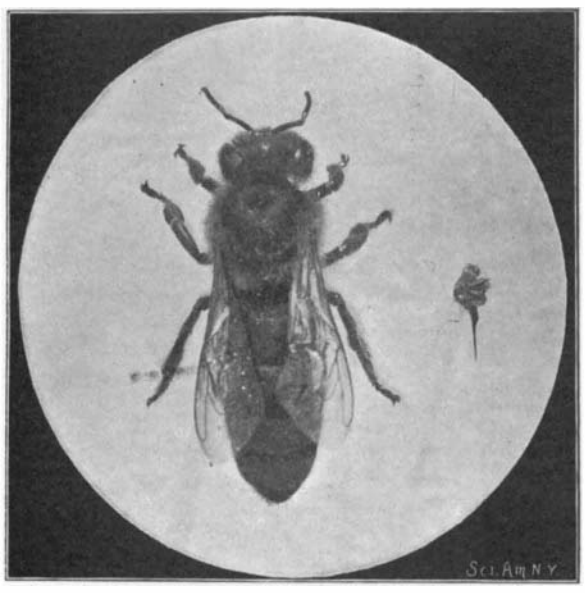
The cables of the Carquinez span are of solid plow steel, with solid steel core. In the twisted strand are nineteen wires, including the core, and the strand has a diameter of seven-eighths of an inch. The erection of the cables comprised a highly interesting feature of the work of construction. When 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.

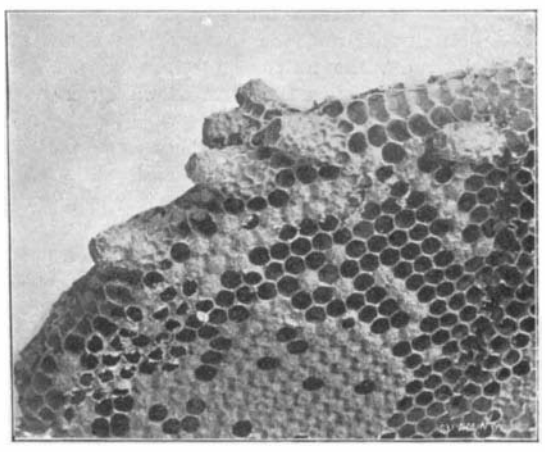
BY WALDON FAWCETT.

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.

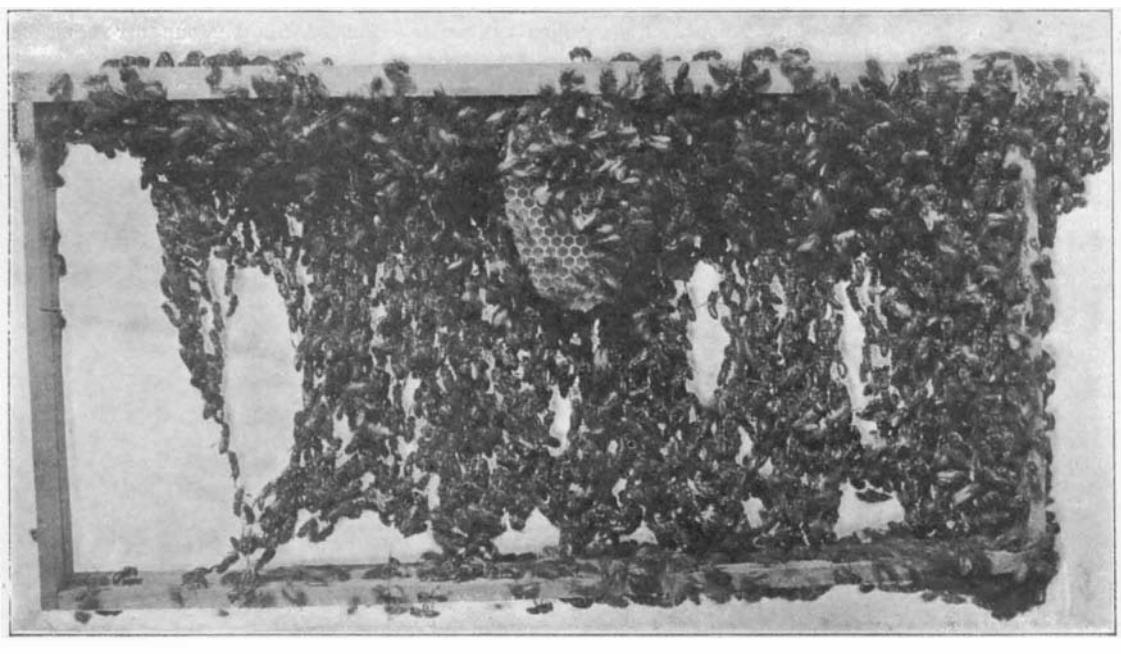
It is estimated that there are fully three hundred thousand persons engaged in the culture of bees in this country at the present time. In the absence of any method of securing official statistics from year to year, many estimates have been made of the quantity of honey produced annually on this side 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.

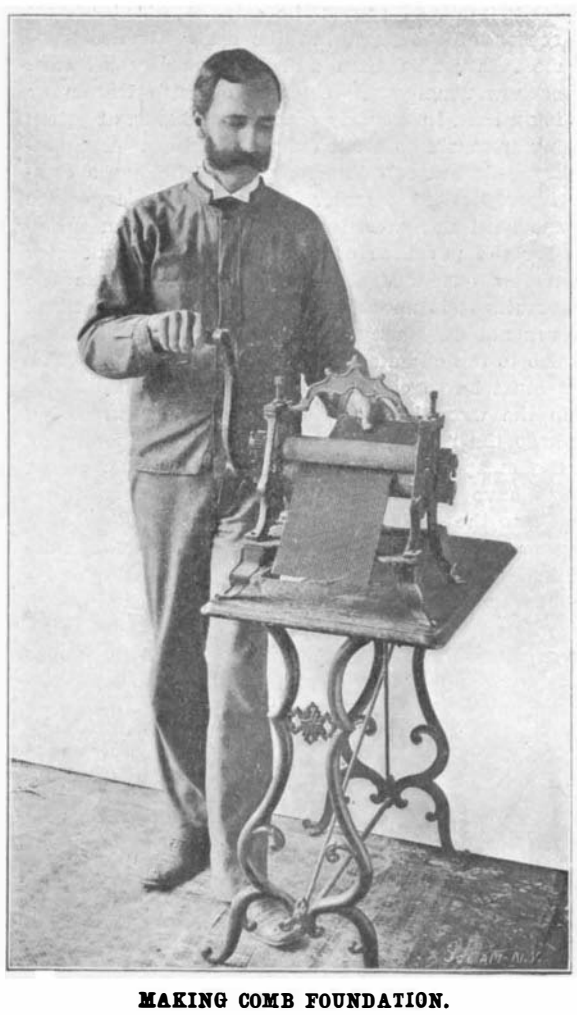
The bee family is made up of several distinct types, including the hive bee, bumble bee, carpenter bee, leaf-cutter and the stingless honey bee of the American tropics. Strictly speaking, the apiarian industry concerns itself only with the hive bee, although the plan of introducing the stingless bees 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.