

**Manufacture of Wax Cloth, Leather Cloth, etc.**

The name wax cloth carries us back to those ancient days, several decades removed, when it was really attempted to waterproof materials by means of bees' wax or waxlike substances. At present everybody uses oils or varnishes, also rubber; the latter goods would be distinguished by name. The texture, says *The Gumm-Zeitung*, may be coarse or fine, but it should be homogeneous. Linseed oil, admixed or not with resins and other oils, is the chief ingredient which is generally applied to the stretched texture. When this is done by hand and brush, an almost obsolete process, of course, the first cloth is stretched near the floor and the others are fixed in succession above it, as the work proceeds. For large pieces the hand brush does not answer. Machines do their work more uniformly. The first coat requires the greatest care; the second coat may be applied as soon as the first varnish is no longer sticky or after thoroughly drying and rubbing the first skin, in order to remove all knots and blisters, etc. No color is admixed to the oil furnishing the first skin. A good wax cloth generally gets three layers and a further facing with a transparent varnish, mostly copal, diluted with oil of turpentine or petroleum. The layers of coloring matters should always be very thin. Wax cloth works are not desirable neighbors; the drying processes are apt to be malodorous. The first coat applied to canvas for packing should also be linseed oil, without any dye, lest the stuff should crack. The black color is produced by means of soot; the texture must be loose. The leather cloth, which came over from America about 1860, has a base of very firm and smooth cotton texture. This is stretched over rolls; the first coat consists of a solution of rubber in petroleum. Before this has completely dried, very finely powdered materials, French chalk, magnesia, ocher, zinc oxide, English red, ultramarine, soot, etc., are spread on the cloth; the sieves are pieces of silk gauze kept in reciprocating motion. The excess of powder is removed by means of soft brushes, and one or more coats of varnish are then applied; the outer skin should always be a transparent varnish. The tar which is to render sail cloth waterproof must be boiled for some time in closed retorts in order to get rid of the more liquid constituents; the distillation products of this operation are, of course, collected. Heavy cloth is tarred on both sides, and is not, as a rule, elastic. The admixtures to tar, certain soaps, rubber, tar oils, etc., do not supply any cheaper articles.

**PUEBLO ARTS AND INDUSTRIES.**

BY COSMOS MINDELEFF.

In a recent annual report of the Bureau of American Ethnology there appears a full and complete translation of an old Spanish document which is of the greatest importance, not only to the better understanding of the events which led up to and followed the Spanish discovery and conquest of the region we now term New Mexico and Arizona, but also to the student of Pueblo art and culture. The document referred to is Castañeda's narrative of the Coronado expedition, made in 1540, and has a curious history. Its importance is indicated by the fact that, of the hundreds of books and special articles which have been written about the Southwest, probably not one was finished without more or less extended reference to Castañeda. Yet, up to this time no complete translation into English had been printed, and, what is more strange, the fragments we have had were all, with one exception, taken from a French translation, while the Spanish text has been for many years in the custody of the Lenox Library, in New York City.

The narrative was written about 1560, some twenty years after the expedition, but, although search has been made for the original in Simancas, Madrid and Seville, where there are extensive collections of Spanish documents, it has not yet been found. The copy now in the Lenox Library was made at Seville in 1596, and is the one used by Ternaux-Compans in preparing a translation into French, published in 1838, in his "Collection of Voyages." This French translation has now been shown to be very defective, for the Spanish was sometimes rendered with great freedom, and in several cases the translator failed to understand what the original writer endeavored to relate. Notwithstanding these radical defects, the French translation has been the source of practically all the knowledge of Castañeda's account that we have, and the publication of a complete English translation from the Spanish text will be of great value, especially as the publication is accompanied by the Spanish text itself, and by numerous related documents, in the original Spanish, with English translations, consisting of other descriptions of the same expedition. The translation was made by George Parker Winship, of Harvard University, than whom no one could be more competent, and he is also the author of the article referred to which is printed under the title "The Coronado Expedition, 1540-1542," in the annual report of the bureau referred to.

The value of Castañeda's narrative is largely in the graphic and, on the whole, consistent account he gives of the Pueblo Indians of 1540, their houses, manners

and customs, arts and industries. The general truthfulness of the account is apparent, aside from all other proofs, from the fact that, although more than three and one-half centuries have elapsed since the Coronado expedition boldly plunged into the unknown country north of the Gila River, and eventually reached the Pueblo country, Castañeda's descriptions of the manners and customs of the Indians might almost have been written by a careful observer who traveled through the country fifteen or twenty years ago, before the advent of the railroads.

For over thirty years following the Pacific Railroad surveys in 1853-54, which practically first brought the Pueblos under our notice, there were tremendous controversies as to the location of the "seven cities of Cibola," the search for which was the prime cause of the Coronado expedition. It is now universally admitted that the Province of Cibola of 1540 and the Zuñi country of to-day are the same, and this complete identification adds much to the value of Castañeda's narrative. At the time he wrote the Zuñis lived in seven villages located in the valley of the Zuñi River, within a short distance of each other. One of these, called Haloua, has been partly covered by the modern village of Zuñi, built over its remains, while the others are located by well marked ruins in the vicinity.

The houses are described by Castañeda as being ordinarily three or four stories high, but consisting sometimes of seven stories, all with flat roofs. They did not have doors below, but the people used ladders, which could be lifted up like a drawbridge, and so the men could go up to the corridors (or terraces) which were on the inside of the village. The doors opened on these terraces, which served as streets. A reference to the illustration, showing some terraced houses in modern Zuñi, will demonstrate the essential accuracy of this description. The overhanging roofs shown here are mentioned also in the old narrative, and almost the only modern innovations to be seen are the dome shaped structure in the foreground, which is a baking oven patterned after those of the Mexicans, and the chimneys. The latter, although not of aboriginal origin, are one of the most picturesque features of the Pueblo villages.

Externally the chimneys consist of one or more old water jars of pottery, with the bottoms knocked out. The pots are placed one above another, sometimes in a series of seven or eight, and usually rest on a plinth or base of masonry or of adobe. In the interior there is often an elaborate smoke hood, formed of small sticks covered with clay, like that shown on the right of the picture illustrating Hopi grinding and bread making. Sometimes the hood is formed of slabs of stone, cleverly fitted and keyed together. Under the hood there is a fireplace of stone, and the whole structure is commonly placed in a corner of a room, the walls of which furnish two sides of it.

The illustration of terraced houses in Zuñi shows also some of the roof trap doors which are described in the ancient narrative as being "like the hatchway of a ship," for that peculiar construction has come down to the present day unchanged by the lapse of centuries. In the olden days, and to a large extent now, access to the first story rooms could be had only through these trap doors, as no large openings were made in the first story wall. Ladders are used from the ground to the first roof or terrace, and from this other ladders descended into the rooms.

When the Spanish soldiers led by Coronado stormed the first of the "seven cities of Cibola" they were feeble and worn out by long journeying and lack of food, but after an hour of stubborn fighting they conquered and took possession of the houses, where they found an abundance of food; for the Zuñis of old, like their modern descendants, were a provident people and laid by great stores of food. It is no uncommon thing to-day to find supplies sufficient for three or four years carefully put away in the inner rooms of the terraced houses. This trait, which is entirely at variance with the improvidence which characterizes nearly all the other Indian tribes, is one of the peculiarities of the Pueblos; and until law and order were established by the American conquest of the country in 1846, it made these people the target of numerous attacks by the surrounding wild tribes—the Utes, Navahos, Comanches and Apaches—who found in the Pueblo homes convenient and never failing storehouses, from which they could draw supplies of food.

The Pueblo Indians have always been successful farmers, and even under the unfavorable conditions which prevail in the sub-arid region where their homes are located, they seldom fail to secure good crops. In the dry, clear atmosphere for which New Mexico and Arizona are noted, food is easily preserved, and almost everything is dried for future use. Meat of all kinds is merely cut into long strips and hung in the open air for a few days, after which it will keep indefinitely. In the late summer and autumn months the somewhat somber yellowish gray tone of the houses is enlivened by strings of red peppers hung on the walls or festooned from the tops of the ladders; split squashes line the tops of the raised copings, while hundreds of square feet of the roofs are covered with peaches, split and

whole, or with bushels and bushels of corn, dark blue, white, and parti-colored.

In fact, corn has always been the staple, the main reliance of these people. Among the Moki towns in northern Arizona, where the conditions are very unfavorable, large crops are raised without irrigation, although the average white farmer would be hard pushed to harvest the amount of seed he put into the ground. The methods followed are peculiar and distinctively Indian. The seed is always planted in what appears to be pure sand, generally in the bed of some intermittent stream or drainage channel, where deep down in the ground there is always a little moisture. The seed is planted at a great depth, often two feet or more; holes are made with a planting stick and a small handful of grain is dropped into each. The plants come up in thick clumps, instead of in rows, and are not thinned out; for when the summer rains come the water flows in its natural channels, and only heavy clumps could withstand its force.

The native corn or maize has practically disappeared within the past ten years. This is much to be regretted, for in sweetness and delicacy of flavor it was much superior to many of our so-called sugar corns. Perhaps in some remote districts away from the traveled routes it may still be found, but elsewhere the partial settlement of the country by whites and the constant passage of wagons has destroyed it. Where wagons go, there American corn is carried to feed the horses, and the Indians, tempted by the larger grain of our corn, have picked up the waste and planted it in their fields. The well known facility with which corn cross-fertilizes has done the rest, and the native species are now almost extinct.

However, corn is to-day, as it has always been, the distinctive Indian grain, and they have many ways of preparing it for food, but the bulk of the crop is dried, and, as occasion demands, is made up into bread. The illustration, which is from a photograph of a model in the National Museum in Washington, shows a group of Moki (or as they call themselves, Hopi) women and girls preparing piki or paper bread. In one room in each house there is a binlike trough along one side, placed directly on the floor and framed in with low slabs of stone set on edge. This bin is divided by transverse pieces of stone into three or four compartments, and in each of these there is mounted on a slight incline a flat piece of rough stone, usually black lava, which is abundant in that country. This is the metal of the Aztecs, the mitata of the Mokis, and in connection with a small piece of flat stone which is rubbed back and forth over the lava slab, is the grinding mill of these people.

The corn, having been previously soaked in water to loosen the hard outer skin, is thrown into the first compartment, where it is rubbed between the stones into a coarse meal. This is passed over into the next compartment, where it is ground finer, and then into the next, where it emerges in a fine meal, as fine as our wheat flour. Castañeda, in his account of Cibola, says that a special room is set apart for the grinding of the corn, and that this room contains a furnace and three stones made fast in masonry. Three women sit down before these stones; the first crushes the grain, the second brays it, and the third reduces it entirely to powder. The accuracy of this description is apparent.

The fine powder which comes from the third grinding is mixed with water to a thin batter, which another woman spreads with her hand on a heated stone, and immediately after peels off a thin layer about the thickness of heavy manila paper. A number of sheets of this peculiar bread are shown piled up in the center of the picture in front of the mealing bin. Ordinarily it is of a dark blue color, as it is made from blue corn, but for ceremonial feasting it is made of pink, or yellow, or white, or variegated corn, and in each case partakes of the color of the grain. When fresh, this bread is quite palatable, but when a day old it becomes very brittle; and, as it is usually made without salt, it tastes much like sawdust.

The flat stones on which the paper bread is baked, one of which is shown on the extreme right of the picture, are considered very valuable and often descend from mother to daughter through many generations. Their manufacture is a secret process, carried on only by certain old women of the tribe at a distance from the villages and accompanied by numerous rites and ceremonies. A certain kind of stone must be selected in the first place, and it must be of even grain and free from cracks or flaws. Then, after being rubbed smooth, it is treated with pitch and perhaps other ingredients, with frequent exposures to fire and smoke, and at intervals certain incantations and formulas must be repeated. At one stage in the preparation the strictest silence must be observed, as, it is said, a single word spoken then will crack the tablet. If all goes well, the final product is a stone of jet black color, instead of the light yellowish gray of the original sandstone slab, with a highly polished surface, from which the flakes of paper bread peel off readily. If, however, there was any flaw in the stone, or if some of the formulas or incantations were omitted or wrongly pronounced or spoken in the wrong order, the stone

will crack when exposed to the fire and will be worthless. It will be noticed that the stone is mounted some six inches above the floor on low pillars, built up of bits of stone and adobe mud. Commonly it rests on two slabs of stone on edge, forming a boxlike flue or stove, in which a hot fire is maintained by constantly feeding in small sticks.

When there are young girls in the family the grinding of the corn is their especial duty, and is always done by them alone. The work is partly ceremonial in nature and is done in a certain way, being generally accompanied by a weird song, sometimes called a love song, to which the grinders keep time. When three maidens take their places behind the bin to grind, it is not unusual for some young man who is interested in one of them to act as musician. Squatting near by, he evolves a peculiar purring sound by rubbing a stick over another one in which small notches have been cut, while the maidens

themselves sing to this accompaniment. The rubbing is always done by a motion of the body from the hips, the arms being held rigid. At intervals the grinding stone is moved with one hand alone, while with the other the corn or coarse meal is gathered up from the bottom and sides of the bin and placed above it. As the small stone is worked with a slight rocking motion the grain slowly passes under it, and this is repeated until the required degree of fineness is at-

only by the maidens of the tribe, and by them only from puberty until marriage. The custom appears to be of great antiquity, for it was noticed by Castañeda in 1540. The hair is arranged in disklike projections on either side of the head, as shown in the illustration.



HOPI GRINDING AND PAPER BREAD MAKING.

These disks have a symbolical meaning and are thought to represent the squash flower, itself the symbol of fertility among these people. After marriage the women always wear their hair in two short queues wound and tied with a ribbonlike strip of their own weaving.

**A Telephone for the Submarine Boat.**

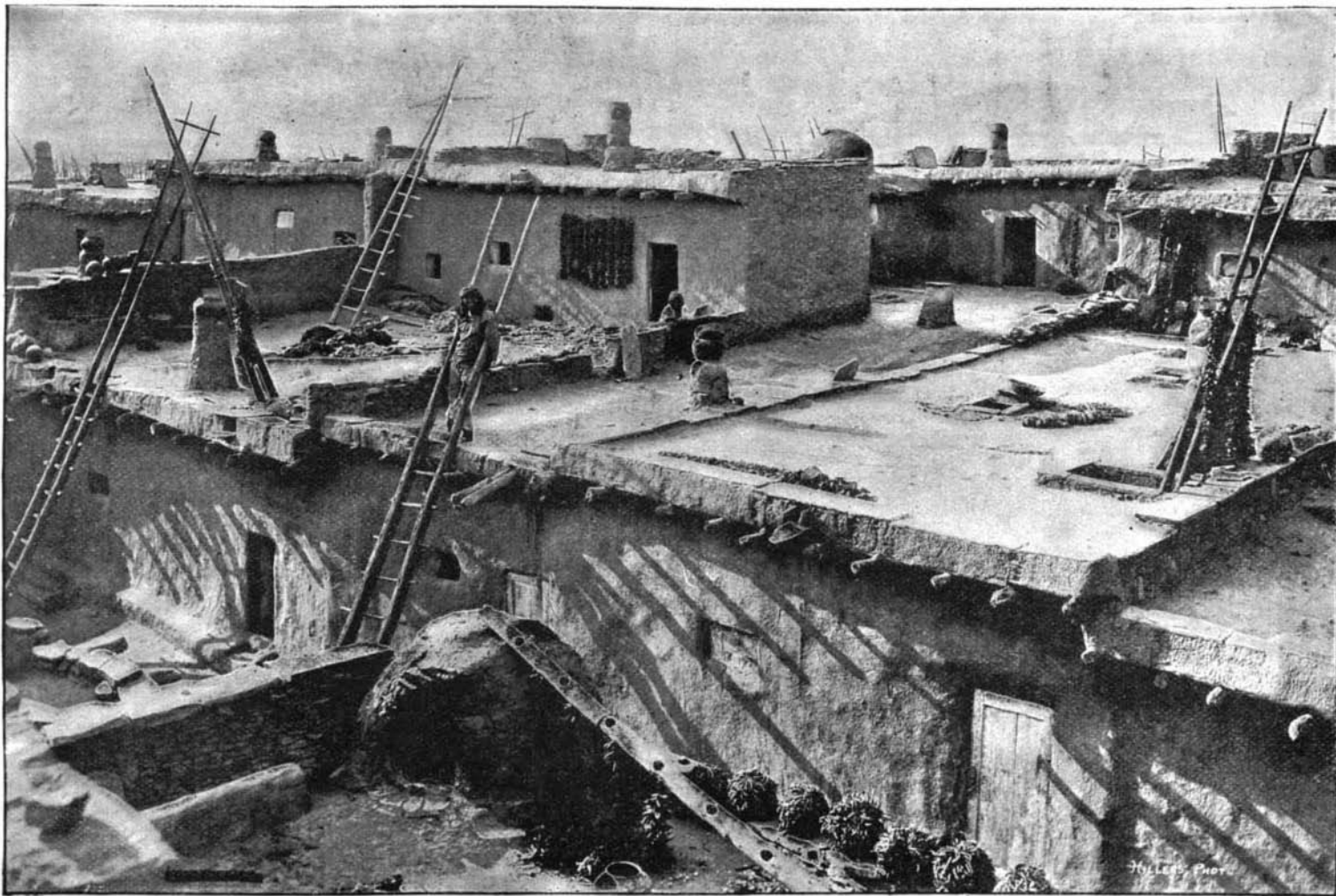
A telephone has been added to the equipment of the "Argonaut," the submarine boat shown in our last

**The Current Number of the Supplement.**  
The SCIENTIFIC AMERICAN SUPPLEMENT for the current week, No. 1150, contains four or five articles of more than usual interest. "The American Bicycle: Its Theory and Practice of Construction," by Mr.

Leonard Waldo, deals with the scientific aspect of the bicycle, not as an assemblage of parts, but as a concrete machine of remarkable efficiency.

The article is accompanied by tables giving valuable data based on experiments with modern testing apparatus, touching especially the comparison of the chainless and ordinary wheel. "Acetylene as an Illuminant" shows some of the latest forms of apparatus for the safe and economical generation of acetylene gas. Lieut. B. W. Dunn, U. S. A., has a valuable continued paper describing "A Photographic Impact Testing Machine for Measuring the Varying Intensity of an Impulsive Force." It shows an ingenious apparatus for which

the Franklin Institute recommends the award of the John Scott Legacy Medal and Premium. The second installment of Prof. Octave Chanute's "Gliding Experiments" is of rare interest to all who care for modern aviation. It is splendidly illustrated by 14 engravings made from instantaneous photographs. "The Mineral Statistics for 1897" gives important statistics of mining industry. "A Unique Case of Complete Removal of the Stomach" describes a brilliant surgical opera-



ON THE TERRACES AT ZUNI.

tained. The description of this simple but effective mill by Castañeda in 1540 shows that it was the same then as it is now and that it is of distinctly aboriginal origin.

The peculiar style of hair dressing is shown by the two figures at the left of the picture. The hair is so worn

week's issue. This vessel can be connected telephonically by calling up "3041 Baltimore." The tests have been very successful and there was no difficulty in communicating with Washington. The wire is stored on a reel and is inclosed in a watertight tube.

tion and is referred to elsewhere. Many of our new subscribers are possibly not familiar with the features of our SUPPLEMENT. All our readers who can afford to do so would find it to their advantage to become subscribers to both our papers.