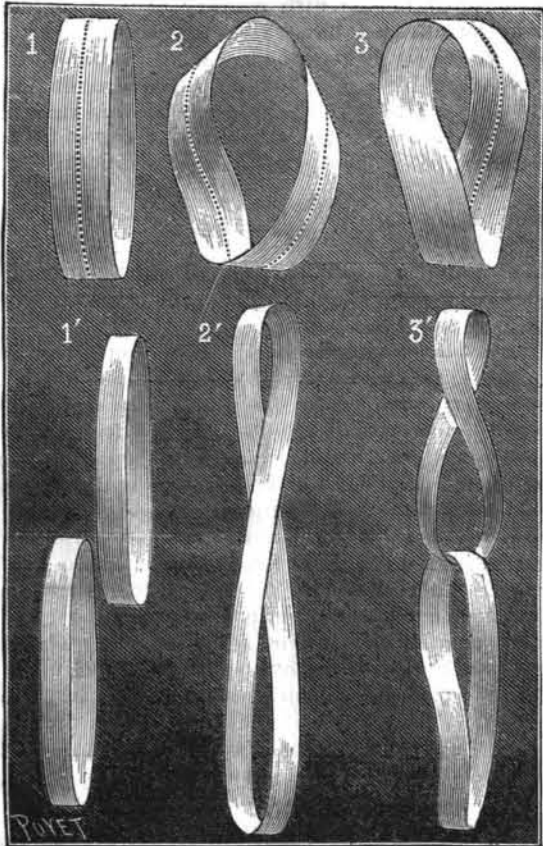


EXPERIMENT WITH PAPER RINGS.

The annexed engraving, from *La Nature*, shows the method of preparing paper rings for the performance of a curious experiment. Take three strips of paper, 2 inches in width by from 2 to 5 feet in length, and with one of them form a ring, as shown in Fig. 1, by pasting the two ends together. Before pasting the ends of the



EXPERIMENT WITH PAPER RINGS.

second ring, give the paper a single twist (Fig. 2), and before completing the third ring give the strip two twists. These twists in the completed rings (1 and 2) will be so much the less perceptible in proportion as their diameter is greater.

If we take a pair of scissors and cut through the circumference of ring No. 1 in the direction shown by the dotted lines, we shall obtain two rings, as shown in No. 1'. Proceeding in the same way with ring No. 2, we shall obtain a single elongated ring, as shown in No. 2', and with No. 3, two rings which are connected like the links of a chain, as shown in No. 3'.

A NEW METHOD OF CONSTRUCTING PROPELLER SCREWS.

For several years past I have been engaged in studying the application of electricity to the propulsion of small boats, and I now desire to communicate to readers the conclusions to which I have been led by my experiments upon the operation of the screw, as well as a new method of constructing the latter.

My motor, which, with a minimum weight and size, develops very great power, gives its maximum of performance with a velocity of several thousand revolutions per minute. We have here, then, very different features from those presented by steam motors, which, on account of the inertia of their oscillating parts and the limited resistance of certain portions, are unable to practically exceed quite a low speed. Instead of re-

ducing the velocity of the motor by the method of transmission, it has seemed to me more advantageous to allow the screw to have a very high rotary speed. It is well known that the resistance of water rapidly increases in measure as the speed of a body moving in it augments; and, in order to obtain a diminution of the screw's recoil, and reduce the loss of live power due to the whirling of the mass of water set in motion, we ought, therefore, to approximate the conditions offered by a screw that takes its bearing point upon a solid nut.

This high speed necessitates a large reduction in the pitch of the helix, which is likewise a favorable condition, since the resultant of the forces due to the inertia of the water, acting upon each element of the surface of the blades, advances toward the direction of the axis—the direction in which the useful effect must exert itself. There likewise results less of a tendency in the water to take on that rotary motion that gives rise to a centrifugal stress, which forces it to escape through the circumference of the helix, and is, as well known, the cause of jarring and loss of live power.

Experiment has confirmed this view of the subject, for, upon increasing the rotary speed up to 2,400 revolutions per minute, the performance of the screw very notably increased, while at the same time the boiling of the water astern was observed to diminish, the jarring to cease, and the motion to become perfectly regular and easy.

As these experiments necessitated the trial of a large number of screws of variable shape and pitch, I was led to devise a method of construction much simpler than those that are in use. The making of the mould for a helix is, in fact, an operation that requires quite a deep knowledge of geometry, since it includes the making of working drawings of the blades, of developing and laying down quite a large number of cylindrical sections concentric with the blades, and of cutting out templates, which, when afterward centered, permit of carving in a wooden mould the curves of the sections that are afterward connected by surfaces in which the sensation of continuity, and, consequently, the skill of the workman, plays a great role. The result is that such pieces can be made only by a small number of special workmen, and that the net cost of them is high.

On the contrary, the new mode of construction presents such simplicity that any workman can thereby make a model of a screw. It is as follows:

In a cylinder of a diameter equal to that of the boss of the screw, I make a helicoidal groove, an operation that the gear lathe performs with perfect regularity. I afterward take a series of metallic rods, of a diameter equal to the width of the groove, and insert one of their extremities in the latter at right angles with the axis of the cylinder, pressing, as I do so, one closely against the other, so as to secure a contact. We thus, with the greatest ease, form a helicoid of determinate pitch. It only remains to connect the outer extremities of the rods by means of a strip of thin metal, to which they are then soldered in order to fix their position, and to likewise solder together the lower extremities, and finally to fill in the spaces between the rods with an easily fusible metal. In this way I obtain two surfaces, with which the rods are flush, and which sensibly coalesce with the geometric helicoid, having exactly the pitch that was chosen.

Moreover, I can form the geometric helicoidal surface perfectly by making one of the angles of the tool coincide with the tracing of such surface on the cylinder. If it be desired, curved blades may be cut out on the surface thus formed, and the face that is not designed to act can be strengthened by means of some plastic material. In this way, there may be easily obtained, at slight expense, a mould, by means of which perfectly regular screws of definite pitch may be cast.

As the mould is of a non-distortable substance, deprived of core, it will re-

main as a standard for verifying either the products of casting or such screws as have got out of true by use.

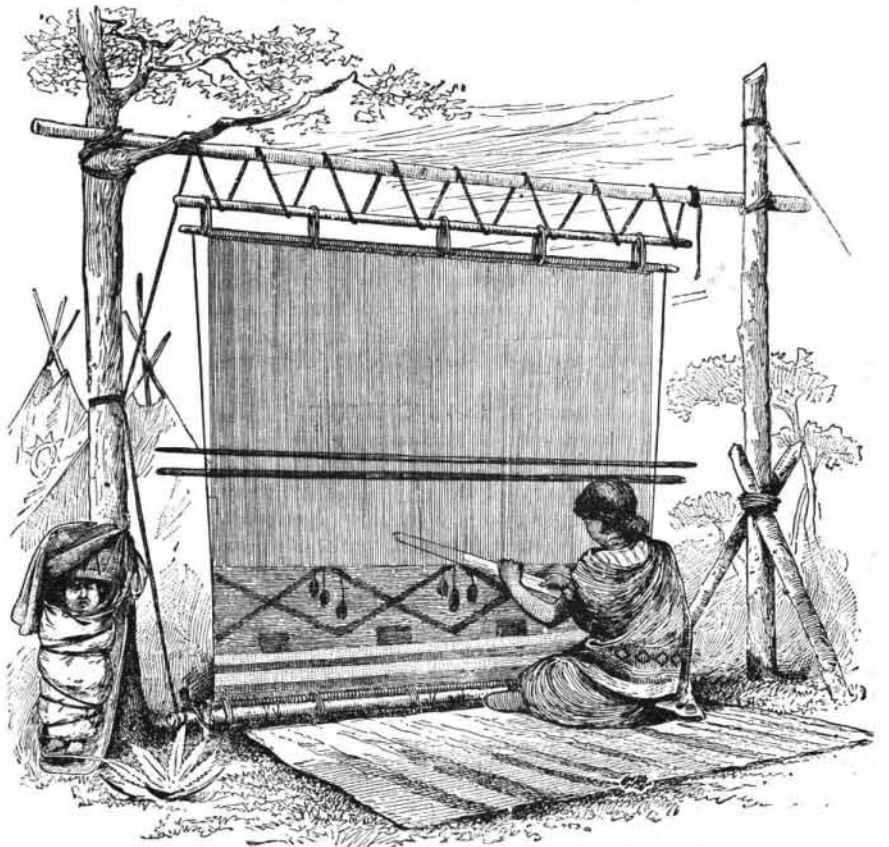
The screw with variable pitch, which is so complicated and so difficult to make, can be formed with the same ease. This method of manufacture may likewise render services in teaching, by permitting of rendering the generation of the helicoid tangible, this being a surface whose form and properties are understood with difficulty through diagrams and drawings.—G. Trouve, in *La Nature*.

HOW THE NAVAJO INDIANS MAKE BLANKETS.

BY W. MATTHEWS.

The art of weaving is undoubtedly of high antiquity among the American aborigines, and was brought to great perfection long before the advent of the white man. My reasons for thus believing cannot be discussed in the limited space here allotted to me. Probably in no tribe on our continent at the present time are higher results in weaving obtained, or ruder means employed, than among the Navajo Indians of New Mexico and Arizona, and among none, perhaps, has the craft of the weaver been less europeanized. Hence a brief description of their processes and appliances cannot fail to interest the student of this art.

In preparing their wool, the Navajos now use the hand card, purchased from the Americans. Previous to the introduction of this tool, a tedious method of picking with the fingers and rolling between the palm was employed. They still spin their wool with the old distaff, consisting of a simple rod of wood thrust through a hole in the center of a round disk, although their Mexican neighbors on the Rio Grande, with



METHOD OF WEAVING A NAVAJO BLANKET—INDIAN WOMAN AT WORK.

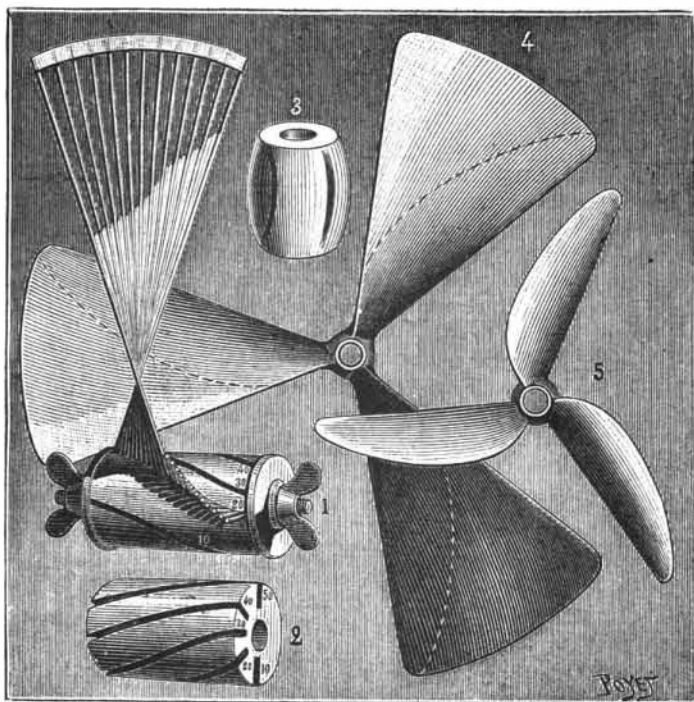
whom they have had constant intercourse in peace and in war for the past three hundred years, use the spinning wheel. And although they probably possess sufficient ingenuity to make wheels, and undoubtedly have ample means to purchase them, they have never adopted them. They cling to the older and simpler implement.

Their most important native dyes are the following: A dull, brownish-red (approximating the tint of burnt sienna), a deep black, and a brilliant yellow. The red dye is a decoction of the bark of alder, mixed with the bark of the root of mountain mahogany (*Cerocarpus*). The yellow is a decoction of the flowers of a species of *Senecio*, with a crude native alum (*almogen*) for the mordant. The black dye is made by throwing into a strong decoction of the twigs of aromatic sumac (*Rhus diversiloba*) a calcined mixture of pinon gum with a mineral substance called by the Navajos *tse kon*.

Besides these colors, they had, in old times as they have to-day, wool of three different natural tints, viz., the white of the ordinary sheep, the rusty brown of the so-called black sheep, and the gray wool of the gray sheep. So, before the introduction of new colors by the whites they had a fair range of tints wherewith to execute their artistic designs.

In time the Mexicans gave them indigo, and, as far as I have observed, this is the only dye which the Spanish Americans introduced. With this, by varying the strength of the solution, they color their wool of different shades of blue, and by adding their native yellow they make different shades of green.

But the Mexicans brought them another material, which has added even more than indigo to the beauty of their fabrics. This is the brightscarlet cloth known



CONSTRUCTION OF A HELIX.

1. Grooved Cylinder. 2. Details of Grooves. 3. Boss. 4 and 5. Three-bladed Screws.

as *bayeta*. The face of this cloth has a long nap; the Indians ravel it and use the weft. Some of the Eastern correspondents of the *Textile Record* will be able to give more trustworthy information concerning the sources of supply of this cloth than I can. Originally brought from the south by the traders from Old Mexico, it is now procured from the wholesale dealers of our Atlantic seaboard by the Anglo-American traders. It is much superior in finish to the scarlet strouding supplied to the Indian trade of the North, and although it comes labeled with an illuminated Spanish coat of arms and the legend in Spanish, "Bayeta de cien hilos grana," it is probable that it is now made in England, if not in the United States.

Of the materials and colors above enumerated, some of their most beautiful blankets are still made. But of late years the Yankee traders have brought much American yarn into the country, and the finer *serapes* are now largely made of Germantown wool. This is most likely to be the case in blankets made to order for Americans, since the party giving the order is usually required to supply the yarn.

Our traders have, strange to say, introduced no new dyes among them; but I believe that a good series of aniline dyes would be extensively purchased by the Navajos if they were once taught the use of them.

To make an ordinary blanket, the weaver usually proceeds in this way: She selects two slender straight trees, about 6 or 8 feet apart, or erects two posts about the same distance from one another. To these she lashes two horizontal parallel poles—one close to the ground, the other at a height of 6 or 8 feet, according to the size of the blanket to be made. This arrangement serves as the frame to which the loom is secured. Thus it is evident that the web must hang vertically before the weaver.

Two stout, round sticks, each about an inch and a half in diameter, form the beams of the loom. I will call the upper stick the yarn beam and the lower one the cloth beam, from their counterparts in the European loom; but they differ from the latter in that they do not revolve. The warp is never wound around the one, nor is the finished web ever wound around the other, hence the Navajo cannot weave a piece of indefinite length. The yarn beam is secured with cords to the upper transverse pole of the frame, so as to hang horizontally, and the cloth beam is tied to the lower pole; the distance between the beams being the length of the proposed blanket.

The application of the warp is the next thing in order. An extra stout woolen cord is laid along each beam parallel to its axis, on the upper side of the lower beam and on the lower side of the upper beam. These cords are secured in position by means of a spiral thread. The warp is then fastened to these stout cords, and when the blanket is finished they are found included in it, forming the borders at the ends.

When this is done, the healds are applied by looping one continuous string in figure 8 loops, twisted once in the middle, one of the circles of each figure 8 including the selected thread of the warp, and the other passing around the rod. In ordinary weaving, only one set of healds is used. The place of the other is supplied by putting a stout rod into the shed. When the weaver wishes to pull the healds forward, she pushes this stout rod up out of the way, and draws the rod which holds the healds toward her. For the next cast of the shuttle she draws the stout rod downward, and so throws the warp in the healds backward.

I say "shuttle" only for convenience of description. Properly speaking, the Navajo woman has no shuttle. If the pattern is a simple one, where a single thread of the weft is passed the whole way through the shed, the yarn is wound on a rough stick or slat; but if the pattern is intricate, where each thread of the weft is reversed every inch or two, the yarn is simply made into a small skein and shoved through the shed with the finger.

Their substitute for the reed is a small wooden fork, having about five or six tines. With this the weft is made to lie smoothly; but in beating it firmly into place another instrument is used, which I will call the batten. The batten is a broad, thin oaken stick; it is inserted lengthwise into the shed, and applied to the weft with firm blows. It is by the vigorous use of this tool that the Navajo blanket is rendered waterproof.

The weaver sits on the ground, and works from below upward. When the web has been completed to the height of about two or three feet, the cords which fasten the yarn beam are somewhat loosed or lengthened, the beam is lowered, the finished portion of the web is folded and sewed with coarse stitches down to the cloth beam, and the unfilled warp is thus brought within convenient reach of the artisan. This arrangement supplies the place of the revolution of the beams in our looms. You will rarely see a new Indian blanket, except one of the smallest size, in which the marks of these stitches are not visible.

Many blankets, particularly those used for saddle blankets and women's dresses, are made in the style of our tweeds and diagonals. In some specimens the

diagonal ridges are seen to run continuously in one direction, while in others the direction is varied, so as to make diamond or zigzag figures. These effects are produced by using three sets of healds, which are applied to the warp and actuated on essentially the same mechanical principle as those employed by our own weavers in making similar fabrics. In goods of this description the Indians do not attempt such elaborate designs in color as they do with goods woven with a single set of healds. Usually, diagonals are seen in one solid color or in plain stripes; but they are more extensively manufactured by the Pueblo Indians than by the Navajos.

The Navajo blankets, notwithstanding their weight and thickness, are all single-ply, and consequently the figures are the same on both sides, no matter how intricate they may be. The Indians do not understand our method of producing figures by completely hiding one set of threads with another set; but neither, it would seem, are our weavers capable of making single-ply patterns like those of the Indians; and this observation leads me to close with a few remarks to those American manufacturers who are endeavoring to imitate the Navajo fabrics.

Of all the imitations I have seen, only those of the plain striped patterns are even tolerably successful; where the more intricate patterns are attempted, it always results in failure. It must be remembered that the Navajo woman has a separate shuttle or skein for every element of her pattern—to see a dozen different little skeins hanging from the front of a growing web is a common sight—and that the shuttle is not thrown the whole width of the web in every case, but only the width of the particular figure to be represented. A similar result, it seems to me, could only be produced cheaply on our looms by using a single warp thread dyed of different colors, the length of each colored section being carefully computed, so that when woven it would make a definite pattern. But even if this arrangement were possible, many blankets of the same pattern would have to be woven in order to "make it pay." How, then, would such blankets compare with those of native make? Of the many hundreds of the finer Navajo blankets which I have examined since I have been in New Mexico, I have never seen two of exactly the same pattern. Every owner of a genuine blanket of this kind may feel reasonably certain that he possesses an article which has not a duplicate in the whole world.

Expensive as these blankets are, the weavers are but poorly paid for their trouble. From three to six weeks are commonly spent in making one of the best *serapes*. They do not weave them for sale; there is too little profit in making them, and the Navajos are too wealthy to seek income from such a source. The women weave them partly for artistic recreation—just as our ladies embroider—and partly for the sake of personal adornment. It is only when they get tired of a blanket and want a new one, or meet with heavy losses at *monte*, that they sell it. Hence new blankets of the best workmanship can rarely be obtained except at exorbitant prices.

Blankets are, however, not the only "fruit" of the Navajo looms. Handsome sashes, garters, bands for the hair, and saddle girths are also woven; the apparatus for making which necessarily differs in size from that used in weaving the blankets. They also knit stockings and slippers with four needles.—*Textile Record*.

Ancient Hygiene.

The Boston *Medical Journal* has recently published a lecture on the hygienic laws and sanitary conditions of ancient Rome, which formed one of a course of lectures delivered before the Lowell Institute by Professor Lanciani, the Government Director of Archaeological Researches at Rome.

As might be expected from such a teacher, says the *Sanitary Engineer*, especially when speaking to such an audience, the address contains much that is interesting to the modern sanitarian. Professor Lanciani suggests that the existence of a thriving and healthy population in the Campagna about Rome, where a few centuries later (at the beginning of the historic period) the locality is described as pestilential, may have depended on the purifying influence exerted by volcanic fires and sulphurous emanations. At all events, malaria invaded these regions as soon as they ceased to be volcanic, and a proof of its prevalence is found in the large number of altars and shrines dedicated by the early inhabitants to the Goddess of Fever. One altar has been found which was consecrated to Verminus, who to-day would be reckoned as the God of Bacteria.

By the construction of drains and sewers, the providing a general water supply, and by regulating burials, etc., Rome was gradually made a healthy city. When these improvements fell into disuse, after the fall of the empire, the vicinity again became pestiferous, and again they resorted to worship to avert the evils, and built a chapel for the Madonna of the Fever.

The great sewer of Rome, the Cloaca Maxima, is well known as one of the oldest triumphs of sanitary engineering. Recently a still larger sewer has been

discovered, of which Professor Lanciani remarks that "the enormous size of its blocks, the beauty and perfection of its masonry, and its wonderful preservation, make it compare most advantageously with the Cloaca Maxima, to which it is altogether superior as regards length and extent of district drained."

The introduction of pure drinking water to Rome was effected in the fifth century of its foundation. "Fancy what must have been in early Roman times the sanitary conditions of a town, the drains of which, not washed by any influx of water, communicated with the streets by large unprotected openings and emptied into a river, the polluted waters of which were drunk by the whole population."

The magnificent water supply brought into Rome by means of fourteen aqueducts was its salvation. The aggregate length of these aqueducts was 359 miles, of which 354 miles were in tunnels. The longest of these tunnels is that of Monte Affiano, 4,950 meters long, 7 feet high, and 3 feet wide.

The public cemeteries for the reception of the dead of the poorer classes were huge pits, into which the bodies were tumbled promiscuously. In one place a mass of human remains 160 feet long, 100 feet wide, and 30 feet deep was found, which is estimated to have contained 24,000 bodies. In and around the great Esquiline Cemetery the refuse and garbage of a population of nearly a million of people were heaped. Finally, in the reign of Augustus, the whole of this was buried under a mound of earth 25 feet high and a third of a square mile in surface, on the top of which magnificent gardens were laid out. This produced an immense improvement in the health of the city. It would seem, from what one sees in and about Rome, that there were skilled engineers in those ancient days. The sewers in many instances have outlasted the temples and palaces.

Lime Cartridges.

The cartridges have been found most valuable for work in many kinds of stone, including granite, Portland stone, sandstone, etc., as well as masonry of stone or brickwork. A block of granite weighing about four tons, and embedded on two sides and at the bottom in strong cement, was recently moved easily by two shots. In experiments for the Admiralty at Portland, three shots of lime cartridges got thirty tons of stone in large merchantable pieces. The cartridges were used with great success for upward of twelve months in the formation of the Copenhagen Tunnel, North London, and they are now in use for removing the sandstone in the excavations of the Mersey Tunnel Railway Company, at Liverpool.

The Longest Tunnel in the World.

An engineering work that has taken over a century to construct can hardly fail to offer some points of interest in its history, and illustrate the march of events during the years of its progress. An instance of this kind is to be found in a tunnel not long since completed, but which was commenced over a hundred years ago. This tunnel, or adit, as it should be more strictly termed, is at Schemnitz, in Hungary. Its construction was agreed upon in 1782, the object being to carry off the water from the Schemnitz mines to the lowest part of the Gran Valley. The work is now complete, and according to the *Bauzeitung für Ungarn* it forms the longest tunnel in the world, being 10.27 miles long, or about 1 mile longer than St. Gothard, and 2½ miles longer than Mont Cenis. The height is 9 ft. 10 in. and the breadth 5 ft. 3 in.

This tunnel, which has taken so long in making, has cost very nearly a million sterling, but the money appears to have been well spent; at least the present generation has no reason to grumble, for the saving from being able to do away with water-raising appliances amounts to £15,000 a year. There is one further point, however, worth notice, for if we have the advantage of our great-grandfathers in the matter of mechanical appliances, they certainly were better off in the price of labor. The original contract for the tunnel, made in 1782, was that it should be completed in thirty years, and should cost £7 per yard run. For eleven years the work was done at this price, but the French revolution enhanced the cost of labor and materials to such an extent that for thirty years little progress was made. For ten years following much progress was made, and then the work dropped for twenty years more, until the water threatened to drown the mines out altogether. Finally, the tunnel was completed in 1878, the remaining part costing £22 a yard, or more than three times as much as the original contract rate.

Phosphorescent Photography.

We publish in this week's SUPPLEMENT, No. 580, an interesting paper by Dr. Jno. Vansant, on phosphorescent photography. It is of special interest in connection with the article on the same subject published by us in the SCIENTIFIC AMERICAN of October 16, 1886. Dr. Vansant, it will be seen, has followed the same path as that followed by M. Ch. Zengler. His practical dark room notes are of interest to all photographers.