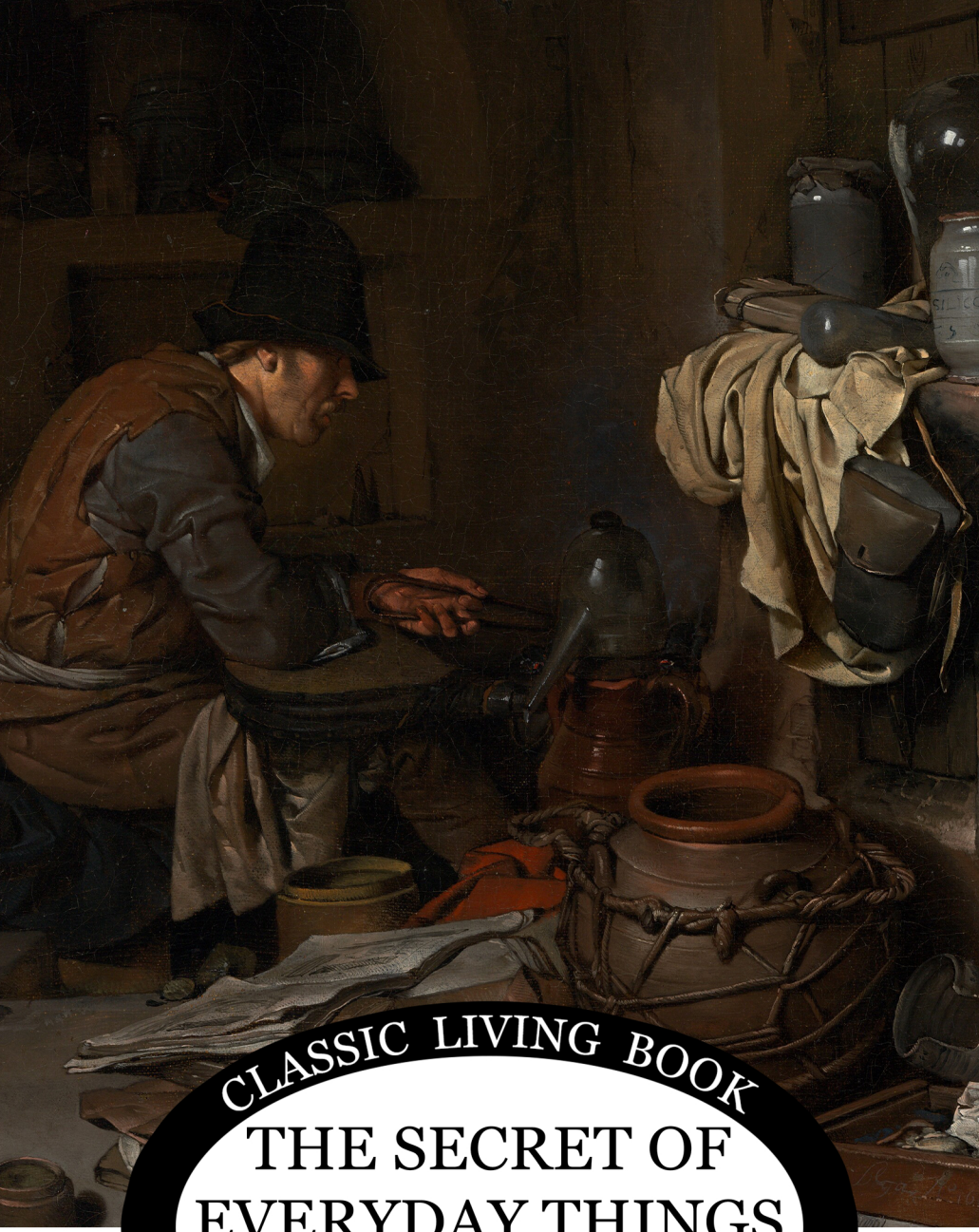

CLASSIC LIVING BOOK

THE SECRET OF EVERYDAY THINGS

Jean Henri Fabre

COMPLETE AND UNABRIDGED

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The Secret of Everyday Things

by

Jean Henri Fabre

INTRODUCTORY NOTE

The clearness, simplicity, and charm of the great French naturalist's style are nowhere better illustrated than in this work, which in its variety of subject-matter and apt use of entertaining anecdote rivals "The Story-Book of Science," already a favorite with his readers. Such instances of antiquated usage or superseded methods as occur in these chapters of popular science easily win our indulgence because of the literary charm and warm human quality investing all that the author has to say.

-Translator.

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CHAPTER I

THREAD

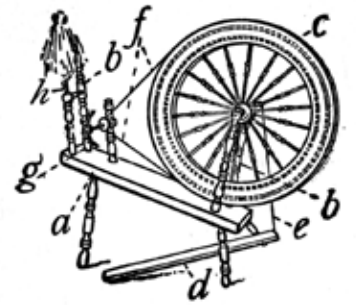
UNCLE PAUL resumed his talks on things that grow and things that are made, while his nephews, Jules and Emile, and his nieces, Claire and Marie, listened to his "true stories," as they liked to call them, and from time to time asked him a question or put in some word of their own.

Continuing the subject of cotton-manufacture, he called his hearers' attention to the number of processes the raw material must go through before it emerges as finished fabric ready for making into wearing apparel, and to the countless workmen that must, from first to last, have been engaged in its production and in all the operations leading up to its final application to household uses.

"Then I should think," said Marie, "that cotton cloth would be very expensive if all those workmen are to get their pay for the time and labor they have put into its manufacture."

"On the contrary," Uncle Paul assured her, "the price is kept down to a very moderate figure; but to accomplish this surprising result two powerful factors are called into play,-wholesale manufacture and the use of machinery. The process employed for spinning cotton into the thread that you see wound on spools will help you to understand my meaning.

"You know how the housewife spins the tow that is used for making linen. First she thrusts inside her belt the distaff, made out of a reed and bearing at its forked end a bunch of tow; then with one hand she draws out the fibers and gathers them together by moistening them a little with her lips, while with the other



SPINNING-WHEEL FOR FLAX *A*, BENCH OR STOOL; *B*, STANDARDS; *C*, DRIVING BAND-WHEEL WITH GROOVED RIM; *D*, TREADLE; *E*, ROD CONNECTING TREADLE WITH CRANK; *F*, CORD-BANE DRIVING THE FLIER-SPINDLE; *G*, FLIER; *H*, DISTAFF CARRYING FLAX TO BE SPUN AND, WHEN IN USE HELD IN OPERATOR'S LEFT HAND.

she twirls her spindle and thus twists the loose fibers into a single strand. After she has twisted it tightly enough she winds it on the spindle, and then proceeds to draw out another length of tow from the distaff."

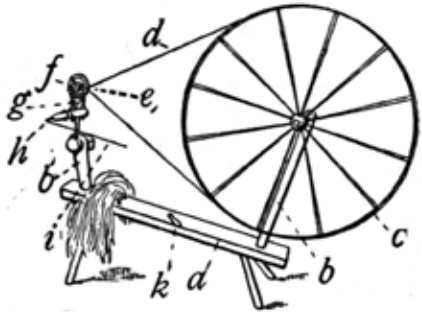
"Mother Annette is very skillful with the distaff," put in Claire. "I like to hear her thumb snap when she twirls the spindle. But when she spins wool she uses a spinning-wheel."

"First of all, Uncle Paul explained, "the carded wool is divided into long wisps or locks. One of these is brought into contact with a rapidly twirling hook, which catches the wool and twists it into a thread that lengthens little by little at the expense of the lock of wool, the latter being all the while held and controlled by the fingers. When the thread has attained a certain length it is wound on the spindle by a suitable movement of the wheel; and then the twisting of the lock of wool is resumed. In case of need cotton could be thus spun by hand; but, skillful as Mother Annette is at such work, cloth made from thread spun in that fashion would be enormously expensive because of the time spent in producing it. What, then, shall we do? We must resort to machinery, and in vast establishments known as cotton factories we set up hundreds of thousands of spindles and bobbins, all moving with perfect precision and so rapidly that the eye cannot follow them."

"It must be wonderful," remarked Jules, "to see all those machines spinning the cotton into thread so fast you can't keep track of them."

"Yes, those machines, surpassing in delicate dexterity the nimble fingers of the most skillful spinner, are indeed among the cleverest inventions ever produced by man; but they are so

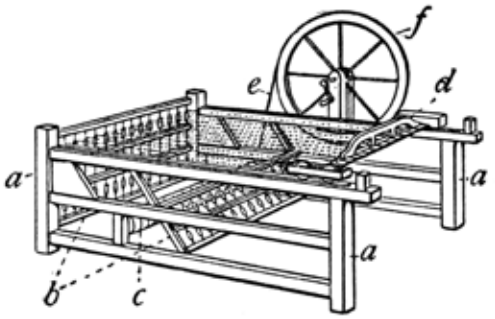
complicated that the eye gets lost among their innumerable parts. I can only point out to you the more important of these parts, without hoping to make you understand how the whole machine operates.



SPINNING-WHEEL FOR WOOL
A, BENCH; *B*, *B'*, STANDARDS; C, DRIVING BAND-WHEEL WITH FLAT RIM, TURNED BY THE PEG *K* HELD IN THE RIGHT HAND OF THE SPINNER; *D*, CORD-BAND, CROSSED AT *E* AND DRIVING THE SPEED PULLEY *F*; *G*, CORD-BAND IMPARTING MOTION TO THE SPINDLE *H*; *I*, THREAD IN PROCESS OF SPINNING.

"First there are the cards which comb the mass of cotton into fine strips or ribbons, just as Mother Annette cards the wool she is about to spin on her wheel. These cards of hers, you understand, are nothing more nor less than big brushes bristling with a multitude of fine iron points. One card remains at rest and receives a thin layer of wool, after which the other is made to pass over it in such a way as to comb the wool and draw out fine locks of it, one after another. In this fashion, too, the cards in cotton factories play their part. On leaving the cards the ribbons of cotton fiber are drawn out, lightly twisted, and then wound on bobbins. Next a machine called a spinning – jenny takes the partly spun cotton and twists it into thread more or a less fine according to a the purpose it is to serve. Finally this thread finds its way automatically to the reel, which forms it into skeins, or to the winder, which winds it into those regular balls that we can't admire too much for their perfect shape. You have doubtless observed with what precision, what elegance, the thread is wound into a ball that the merchant delivers to you at the insignificant price of a few centimes. What human hands would have the steadiness, what fingers the skill to achieve anything comparable with this little masterpiece?"

"I know I can't begin to wind such a ball," said Marie; "it just makes a shapeless lump instead of the pretty ball I buy at the store."



HARGREAVES'S ORIGINAL SPINNING-JENNY

A, FRAME; *B*, FRAMES SUPPORTING SPINDLES; *C*, DRUM DRIVEN BY THE BAND *E* FROM THE BAND-WHEEL *F*, AND CARRYING SEPARATE BANDS (NOT SHOWN) WHICH SEPARATELY DRIVE EACH SPINDLE; *D*, FLUTED WOODEN CLASP WHICH TRAVELS ON WHEELS ON THE TOP OF THE FRAME, AND IN WHICH THE ROVINGS (THE SLIGHTLY TWISTED FIBERS) ARE ARRANGED IN DUE ORDER.

"No one, depending only on his hands, could ever achieve that admirable regularity," Uncle Paul assured her. "To that end we must have machines, unvarying in their movements and working with a precision that nothing can derange.

"Thread is numbered according to its degree of fineness, the higher the number the finer the thread. Every skein and every ball being of the same length, its weight increases as the fineness diminishes. We say, then, of a particular thread that it is number 200 when it takes two hundred skeins or balls to make half a kilogram in weight, and that it is number 150 when it takes one hundred and fifty to make up the same weight."

CHAPTER II

PINS

"AFTER thread, come the needle and its companion the pin. I shall take up the latter first, because its manufacture will help us to understand that of the needle, which is rather more complicated.

"The things most often used by us are not seldom those of whose origin we are ignorant. What is there more convenient, more often used, than the needle and the pin? What could take their place if we were deprived of them We should be reduced to Claire's makeshift that day we went on a picnic and she tore a hole in her apron and fastened the edges together with a thorn from the hedge. We might also, as do those savage tribes that have no manufactured articles, shred an animal sinew or a strip of bark into fine thongs to serve as thread and sew with a sharp-pointed bone for a needle. We might replace the pin by a fish bone."

"That would be a funny sort of gown," exclaimed Marie, "sewed with thongs of bark or the sinews of an ox; nor should I care much to have my hair fastened with codfish bones."

"Yet there are even to-day savage tribes that have nothing else; and often the great ladies of ancient times had nothing better: they used rude pins made of metal or little splinters of bone. Advance in the manufacturing arts has given us the pin, with its pretty round head, at a price so moderate as to be almost negligible, the needle with its fine point and its admirable suitability to our use, and thread of remarkable strength and fineness. Now let us learn how pins are made.

"Pins are made of brass, which is composed of copper and zinc. Copper is the red metal you are familiar with in copper kettles, zinc the grayish-white metal of watering-pots and bath-

tubs. Mixed together they-form brass, which is yellow.

"The first step is to reduce the copper to wire the size of a pin. This is done by means of a draw-plate, a steel plaque pierced with a series of holes, each smaller than the preceding. A little brass rod is thrust into the largest hole and forcibly drawn through it. In passing through this hole, which is a little too small for it, the metal rod becomes correspondingly thinner and longer. It is then thrust into a still smaller hole and again drawn out, becoming once more thinner and longer in the process. This operation is continued, passing from one hole of the draw-plate to the next smaller, until the wire acquires the desired fineness.

"While we are on the subject note this fact-that all metal wires, whether of iron, copper, gold, or silver, are made in the same way: namely, by being passed through the draw-plate.

"The brass wires are now put into the hands of the cutter, who gathers several of them into a bundle and then, with a strong pair of shears, cuts them all into pieces twice the length of a pin.

"These pieces must next be sharpened at both ends by means of a steel grindstone which has its grinding-surface furrowed like a file, and which turns with the prodigious velocity of twenty-seven leagues an hour. The man charged with this work, whom we will call the sharpener, sits on the ground in front of his grindstone, legs crossed in tailor-fashion. He takes in his fingers from twenty to forty pieces, spreads them out regularly in the shape of a fan, and brings all these branching tip-ends simultaneously into contact with the grindstone, at the same time twirling them in his fingers so that the tip is worn off equally all around and the point made even. The reverse tips are sharpened in the same way.

"But this first process merely produces points in the rough, so to speak; the sharpener retouches and finishes them on a finer grindstone. Finally the pieces sharpened at both ends are arranged several together and cut in two in the middle with one clip of a pair of shears. Each half, known as a shank, now lacks only a head in order to become a complete pin.

"This heading process is the most difficult part of the whole operation. On a slender metal shaft, very smooth and slightly larger than the pins, a thread of brass is tightly wound in a spiral,

after which the shaft is removed, leaving a long corkscrew with its turns touching one another. A cutter of consummate skill in this delicate work, which demands at the same time so much precision and so much swiftness, divides this corkscrew into small pieces, each containing just two turns. Each of these pieces is a head.

"The workman who is to put them in place and fasten them takes the shanks one by one and plunges them haphazard, pointed end first, into a wooden bowl full of heads. The shank is drawn out with a head strung on it, which the operator pushes with his fingers to the unpointed end. He immediately places it on a little anvil having a tiny cavity into which the head fits; then by means of a pedal moved by the operator's foot a hammer provided with a similar cavity comes down, strikes five or six little blows, and behold the head firmly fixed.

"As a finishing touch the pins have still to be coated with tin. To this end they are boiled with a certain proportion of this metal in a liquid capable of dissolving it and depositing it in a thin layer on the brass. After being thus coated they are washed, dried on cloths, and finally shaken up with bran in a leather bag in order to heighten their polish.

"It only remains to stick the pins in paper in regular rows. A kind of comb with long steel teeth pierces the paper with two lines of holes. Work-women known` as pin-stickers are charged with the delicate task of inserting the pins one by one in these holes. A skilled pin-sticker can insert from forty to fifty thousand pins a day.

"Including some details that I omit, the manufacture of a pin requires fourteen different operations, and consequently the cooperation of fourteen workmen, all of consummate skill in their part of the operation. Nevertheless the manufacture is so rapid that these fourteen workmen can make twelve thousand pins for the modest sum of four francs."[1]

1 Since the foregoing was written automatic machinery has been invented which greatly facilitates the manufacture of pins. Pointing, heading, and papering are now done with great rapidity by such machinery, and hand-work is almost entirely dispensed with. -*Translator*.

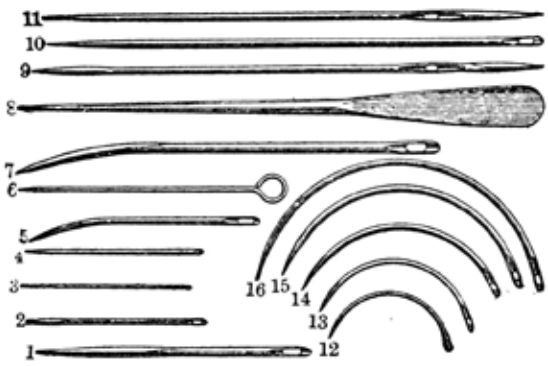
CHAPTER III

NEEDLES

"TAKE from a case one of the finest needles, examine its sharp point, its tiny, almost imperceptible eye, and note finally the polish, the shine. Tell me if this pretty little tool, so perfect in its minuteness, would not seem to require for its manufacture the superhuman fingers of a fairy rather than man's heavy hands. Nevertheless it is robust workmen with knotty fingers blackened by the forge and covered with great calluses that do this most delicate work. And how many workers does it take to make one needle?-one only? For the manufacture of a pin, I have already told you, it takes fourteen different workmen; for the manufacture of a needle it requires the cooperation of one hundred and twenty, each of whom has his special work. And yet the average price of a needle is about one centime.2

"The metal of needles is steel, which is obtained by adding carbon to iron heated to a very high temperature. Under this treatment iron changes its nature a little, incorporating a very small quantity of carbon and thus becoming exceedingly hard, but at the same time brittle. A needle must be very hard in order not to bend under the pressure of the thimble forcing it through the thickness of the material on which the seamstress is at work, and also in order that the point may not become blunted, but always retain the same power of penetration. Steel, the hardest of all the metals, is the only one that fulfils these conditions of resistance; neither copper nor iron nor the precious metals, gold and silver, could replace it. A gold needle, for example, in spite of its intrinsic value, would be useless, becoming blunted and twisted before using up its first needleful of thread. Steel alone

2 Nearly one fifth of a cent in our money.-*Translator*.



NEEDLES
VARIOUS SHAPES AND SIZES USED BY SAILMAKERS AND UPHOLSTERERS.

is suited to the manufacture of needles, though unfortunately this metal is brittle, and the more so the harder it is."

"But I should think," Marie interposed, "that since steel is so hard it ought not to break."

"You will think otherwise if you listen to me a while. Hardness is the degree of resistance that a body opposes to being cut, scratched, worn away by another. Of two bodies rubbing against each other the harder is that which cuts the other, the softer is that which is cut. Steel, which scratches iron, is harder than iron; in its turn glass is harder than steel, because it can cut the steel without being cut by it. But a diamond is still harder than glass, since it scratches glass and glass cannot scratch it. In fact, a diamond is the hardest of all known substances: it scratches all bodies and is scratched by none. Glaziers take advantage of this extreme hardness: they cut their panes of glass with the point of a diamond."

"I have heard," said Claire, "that a diamond placed on an anvil and struck with a hammer stands the blows without breaking and penetrates into the iron of the anvil, it is so hard."

"That is a great mistake," replied Uncle Paul. "A diamond breaks like glass, and he would be very ill-advised who should submit the precious stone to the proof of the hammer. At the first blow there would be nothing left but a little worthless dust. You see by these different examples that hardness and brittleness are often united. Steel is very hard, glass still harder, the diamond the hardest of all substances; nevertheless all three are brittle. That explains to you why needles of excellent steel,

which gives them their rigidity and power of penetration, nevertheless break like glass in clumsy fingers.

"Now I come to the subject of manufacture, from which the properties of steel turned us for a moment. The metal is drawn out into wire by means of a draw-plate; then this wire, several strands at a time, is cut into pieces twice the length of a needle, just as in pin-making. The pieces are pointed at each end, first on a revolving sandstone similar to an ordinary grindstone, then on a wooden wheel covered with a thin layer of oil and a very fine, hard powder called emery. Imagine glass reduced to an impalpable powder and you will have a sufficiently correct idea of what emery is. The first process gives a more or less coarse point; the second sharpens this point with extreme nicety.

"The pieces thus pointed at both ends are cut into two equal parts, each one of which is to be a needle. The workman then takes in his fingers four or five of these unfinished needles, spreads them out like a fan and puts the large end of them on a little anvil; then with a light blow of the hammer he slightly flattens the head of each. It is in this flattened end that later on the eyelet or hole of the needle will be pierced."

"But you just told us, Uncle," Marie interrupted, "that good steel is brittle, the same as glass; yet the workman flattens the head of his needles with a hammer without breaking anything."

"Your remark is very timely, for before going further we have to take note of one of the most curious properties of steel. I must tell you that it is only by tempering that this metal becomes hard and at the same time brittle. Tempering steel is heating it red-hot and then cooling it quickly by plunging it into cold water. Until it undergoes this operation steel is no harder than iron; but, to compensate for this softness, it can then be hammered, forged, and in fact worked in all sorts of ways without risk of breaking. Once tempered, it is very hard and at the same time so brittle that it can never henceforth stand the blow of a hammer. Accordingly needles are not tempered until near the end of the process of manufacture; before that they are neither hard nor brittle and can be worked as easily as iron itself.

"If you look at a needle attentively you will see that the

head is not only flattened but also hollowed out a little on each side in the form of a gutter or groove which serves to hold the thread. To obtain this double groove, the workman places the needles, one by one, between two tiny steel teeth which, moved by machinery, open and shut like two almost invisible jaws. Bitten hard by the shutting of these two teeth, the head of the needle is indented with a groove on each side.

"Now the eye must be pierced, an operation of unequalled delicacy. Two workmen cooperate in this, each equipped with a steel awl whose fineness corresponds with the hole to be made. The first places the head of the needle on a leaden block, puts the point of his instrument in the groove on one side, and, striking a blow with the hammer on the head of the awl, thus obtains not a complete hole but merely a dimple. The needle is then turned over and receives a similar dimple on the other side. The other workman takes the needles and with the aid of his awl removes the tiny bit of steel that separates the two dimples. Behold the eye completely finished.

"Probably no work requires such sureness of hand and precision of sight as the piercing of the eye of a needle. Certainly he has no trembling fingers or dimmed eyesight who can, without faltering, apply his steel point to the fine head of a needle, strike with perfect accuracy the blow of the hammer, and open the imperceptible orifice that my eyes can scarcely find when I want to thread a needle."

"There are needles so small," remarked Marie, "that I really don't see how any one can manage to make an eye in them."

"This incomprehensible achievement is mostly the work of astonishingly skillful children. So skillful, indeed, are some of them that they can make a hole in a hair and pass a second hair through this hole."

"Then the needle's eye," said Emile, "which seems such a difficult piece of work to us, is only child's play to them."

"Child's play indeed, so quick and dexterous are they at it. And they have still another kind of dexterity that would astonish you no less. To make the needles easier to handle in the process of manufacture, they must be placed so that they all

point the same way; but as in passing from one operation to another, from one workman to another, they become more or less disarranged, it is necessary to arrange them in order again, all the points at one end, all the heads at the other. For us there would be no way but to pick them up one by one; with these children this delicate task is but the work of an instant. They take a handful of needles all in disorder, shake them in the hollow of the hand, and that is enough; order is reestablished, the heads are together, the points together.

"The eye completed, the next process is tempering, to give the steel its required hardness. The needles are arranged on a plate of sheet-iron, which is then placed on red-hot coals. When sufficiently heated, the needles are dropped quickly into a bucket of cold water. This produces in them the hardness characteristic of steel, and its accompanying brittleness.

"As a finishing touch the needles must be polished till they shine brightly. In parcels of fifteen or twenty thousand each they are sprinkled with oil and emery and wrapped up in coarse canvas tied at both ends. These round packages, these rolls, are placed side by side on a large table and covered with a weighted tray. Workmen or machinery then make the tray pass back and forth over the table unceasingly for a couple of days. By this process the packages, drawn this way and that by the tray, roll along the table, and the needles, rubbing against one another, are polished by the emery with which they are sprinkled.

"On coming out of the polishing machine the needles, soiled with refuse of oil and detached particles of steel, are cleaned by washing with hot water and soap. It only remains now to dry them well, discard those that the rude operation of polishing has broken, and finally wrap with paper, in packages of a hundred, those that have no defect. The most celebrated needles come from England, but needles are also made in France, at Aigle in the department of Orne."[3]

3 Since Fabre wrote, the manufacture of needles, like that of pins, has undergone important changes and improvements through the ap-plication of machinery. *Translator.*

CHAPTER IV

SILK

THE culture of the silkworm having been explained by Uncle Paul in one of his previous talks[4], 1 he now confined himself chiefly to the structure of the cocoon and the unwinding of the delicate silk thread composing it.

"The cocoon of the silkworm," he began, "is composed of two envelops: an outer one of very coarse gauze, and an inner one of very fine fabric. This latter is the cocoon properly SO called, and from it alone is obtained the silk thread so highly valued in manufacture and commerce, whereas the other, owing to its irregular structure, cannot be unwound and furnishes only an inferior grade of silk suitable for carding.

"The outer envelop is fastened by some of its threads to the little twigs amid which the worm has taken its position, and forms merely a sort of scaffolding or openwork hammock wherein the worm seeks seclusion and establishes itself for the serious and delicate task of spinning its inner envelop. When, accordingly, the hammock is ready the worm fixes its hind feet in the threads and proceeds to raise and bend its body, carrying its head from one side to the other and emitting from its spinneret as it does so a tiny thread which, by its sticky quality, immediately adheres to the points touched. Without change of position the caterpillar thus lays one thickness of its web over that portion of the enclosure which it faces. Then it turns to another part and carpets that in the same manner. After the entire enclosure

4 See "The Story-Book of Science."

has thus been lined, other layers are added, to the number of five or six or even more. In fact, the process goes on until the store of silk-making material is exhausted and the thickness of the wall is sufficient for the security of the future chrysalis.

"From the way the caterpillar works you will see that the thread of silk is not wound in circles, as it is in a ball of cotton, but is arranged in a series of zigzags, back and forth, and to right and left. Yet in spite of these abrupt changes in direction and notwithstanding the length of the thread-from three hundred to five hundred meters-there is never any break in its continuity. The silkworm gives it forth uninterruptedly without suspending for a moment the work of its spinneret until the cocoon is finished. This cocoon has an average weight of a decigram and a half, and it would take only fifteen or twenty kilograms of the silk thread to extend ten thousand leagues, or once around the earth.

"Examined under the microscope, the thread is seen to be an exceedingly fine tube, flattened and with an irregular surface, and composed of three distinct concentric layers, of which the innermost one is pure silk. Over this is laid a varnish that resists the action of warm water, but dissolves in a weak alkaline solution. Finally, on the outside there is a gummy coating which serves to bind the zigzag courses firmly together and thus to make of them a substantial envelop.

"As soon as the caterpillars have completed their task, the cocoons are gathered from the sprigs of heather. A few of these cocoons, selected from those that show the best condition, are set aside and left for the completion of the metamorphosis. The resulting butterflies furnish the eggs or 'seeds' whence, next year, will come the new litter of worms. The rest of the cocoons are immediately subjected to the action of very hot steam, which kills the chrysalis in each just when the tender flesh is beginning slowly to take form. Without this precaution the butterfly would break through the cocoon, which, no longer capable of being unwound because of its broken strands, would lose all its value.

"The cocoons are unwound in workrooms fitted up for the

purpose. First the cocoons are put into a pan of boiling water to dissolve the gum which holds together the several courses of thread. An operator equipped with a small broom of heather twigs stirs the cocoons in the water in order to find and seize the end of the thread, which is then attached to a reel in motion. Under the tension thus exerted by the machine, the thread of silk unwinds while the cocoon jumps up and down in the warm water like a ball of worsted when you pull at the loose end of the yarn. In the heart of the unwound cocoon there remains the chrysalis, inert, killed by the steam.

"Since a single strand would not be strong enough for the purpose of weaving, it is usual to unwind all at once a number of cocoons, from three to fifteen and even more, according to the thickness of the fabric for which the silk is destined; and these united strands are used later as one thread in the weaving machines.

"As it comes from the pan the raw silk of the cocoon is found to have shed its coating of gum, which has become dissolved in the hot water; but it is still coated with its natural varnish, which gives it its firmness, its elasticity, its color, often of a golden yellow. In this state it is called raw silk and has a yellow or a white appearance according to the color of the cocoons from which it came. In order to take on the dye that is to enhance its brilliance and add to its value, the silk must first be cleansed of its varnish by a gentle washing in a solution of lye and soap in warm water. This process causes it to lose about a quarter of its weight and to become of a beautiful white, whatever may have been its original color. After this purifying process it is called washed silk or finished silk. Finally, if perfect whiteness is desired, the silk is exposed to the action of sulphur, as I will explain to you when we come to the subject of wool.

"Cocoons that have been punctured by the butterfly, together with all scraps and remnants that cannot be disentangled and straightened out, are carded and thus reduced to a sort of fluff known as floss-silk, which is spun on the distaff or the spinning-wheel very much as wool is treated; but even with the utmost pains the thread thus obtained never has the beautiful regularity

and the soft fineness of that which is furnished by unwinding the cocoon. It is used for fabrics of inferior quality, for stockings, shoe-laces, and corset-laces.

"The silkworm and the tree that feeds it, the mulberry, are indigenous to China, where silk-weaving has been practised for some four or five thousand years. To-day, when the highly prized caterpillar is dying out in our part of the world, China and its neighbor Japan are called upon to furnish healthy silkworm eggs. Silk-culture was introduced into Europe from Asia in the year 555 by two monks who came to Constantinople with mulberry plants and silkworm eggs concealed in a hollow cane; for it was strictly forbidden to disseminate abroad an industry that yielded such immense riches."

CHAPTER V

WOOL

"WE live," continued Uncle Paul, "on the life of our domestic animals. The ox gives us his strength, his flesh, his hide; the cow gives us her milk besides. The horse, the ass, the mule work for us; and when death overtakes them they leave us their skin for leather with which to make our footwear. The hen gives us her eggs, and the dog places his intelligence at our disposal. But if there is one animal who is more than another, comes to us from the good God above, it is surely the sheep, the gentle creature that yields us its fleece for our garments, its skin for our warm coats, its flesh and its milk for our nourishment. But its most precious gift is its wool.

"From wool are made mattresses, and it is also woven into cloth such as merino, flannel, serge, cashmere, and, in short, all the various fabrics best fitted for protecting us from the cold. It is by far the most desirable material for wearing apparel, cotton, notwithstanding its importance, coming only second, and silk, valuable though it is, being very inferior in respect to serviceability. More than with anything else we clothe ourselves with what we strip from the innocent sheep; our finery comes for the most part from its fleece."

"But wool is very far from beautiful on the creature's back," commented Claire; "it is all matted and dirty, often fairly covered with filth."

"It must take a good many processes," remarked Marie, "to change that foul and tangled fleece into the beautiful skeins of all colors with which we embroider such pretty flowers on canvas."

"Yes, indeed, very many," rejoined Uncle Paul. "I have already told[5] you how sheep are washed and sheared, and how the washing leaves the fleece white or brown or black according to the color given to it by nature. White wool can be dyed in all possible tints and shades, from the lightest to the darkest, whereas brown or black wool can take only somber hues. White wool, therefore, is always preferable to any other; but, beautiful as it is when freshly washed and relieved of all impurity, it is still far from having that snowy whiteness so desirable if it is to remain undyed. It is bleached by a very curious process which I will now describe to you.

"You have all doubtless observed that when sulphur burns, with a blue-violet flame, it gives forth a pungent odor that irritates the mucous membrane of the nose and throat and causes a fit of coughing."

"That must be what we smell when we light a match," Claire interposed. "If you breathe in the least little whiff of it, it is perfectly horrid."

"Often enough it has set me to coughing unless I was on my guard," remarked Emile.

"Yes, that is it," their uncle replied. "Sulphur, in burning, becomes an invisible substance which is dissipated in the atmosphere and betrays its presence only by a detestable odor of the most pungent quality. Invisible, impalpable, like the air itself, this something that we know merely as a disagreeable smell constitutes nevertheless a real substance the existence of which cannot be doubted by any one who has once been thrown into a fit of coughing by inhaling it. It is called sulphurous oxide, a new name to you and one to be kept in mind. It will be worth your while to remember it, as you will presently see."

"Sulphurous oxide, then," said Marie, "is burnt sulphur; and it is something that can be neither seen nor felt, but that nevertheless does really exist. Whoever breathes it is immediately convinced of its existence by the penetrating odor and by the fit of coughing that follows."

5 See "Our Humble Helpers."

"To what possible use," continued Uncle Paul, "can we turn this disagreeable gas, this invisible substance that makes you cough worse than if you had the whooping-cough? I will tell you. Despite its repulsive qualities, it is what we have to depend upon for giving to wool the whiteness of snow. An example will demonstrate its efficacy to you. Go down to the meadow and pick me a bunch of violets."

The violets were soon gathered from under the hedge bordering the meadow. Then Uncle Paul put a little sulphur on a brick, set it afire, and held the bunch of violets, which he had slightly sprinkled with water, over the fumes. In a few moments the flowers, attacked by the sulphurous gas ascending from the blue flame, lost their color and turned perfectly white. The change from violet to white was plainly visible to the eye.

"How curious that is!' exclaimed Jules. "Just see how the violets whiten as soon as they come over the flame and feel the sulphurous oxide, as you call it. Some were half white and half blue; but the blue has disappeared and now the bunch is all white, without having lost any of its freshness to speak of."

"Let us now," suggested Uncle Paul, "try one of the red roses there on the mantelpiece."

Accordingly the rose was held over the burning sulphur, and its red color faded away just as the blue of the violets had faded, giving place to white, much to the wonder of the children, who watched with breathless interest this marvelous transformation.

"That will suffice for the present," Uncle Paul resumed. "What I have just shown you with violets and roses might be demonstrated with innumerable other flowers, especially red and blue ones: all would turn white on being exposed to the sulphur fumes. You will understand, then, that these fumes, which we call sulphurous oxide, have the peculiar property of being able to destroy certain colors and hence to act as a bleaching agent.

"If, therefore, you wish to bleach wool, to remove the slight natural discoloration that stains its whiteness, you proceed exactly as you have just seen me do with the violets and roses. In a room with all its doors and windows carefully closed the wool in its natural condition-that is, before it has been spun into yarn-is