THE WONDERS OF HOME

Ada Young Sutton

from her longsuffering aunt

Cam

Jan. 29th

1851

THE TEA-PLANTATION.

THE WONDERS OF HOME.

IN

ELEVEN STORIES,

BY

GRANDFATHER GREY.

With Illustrations.

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PREFACE.

I HAVE attempted in the following pages, with what success it is not for me to determine, to tell children about the Wonders of Science with which they are surrounded. My belief is that it is wise to cultivate a wholesome spirit of inquiry in the minds of the young—to lead them to seek knowledge—rather than to drag them to their lessons; and I hope that my stories of common household objects may be the means of directing the minds of many young people to the consideration of the toil and ingenuity, at the cost of which they enjoy so many comforts in their modern home. Such studies, prosecuted in a spirit of gratitude, must be powerful

for good. Indeed, Home might be made to the poetic minds of children, a second fairy land, if the marvels of ingenuity and industry with which it abounds, were laid bare to them. In the tea, coffee, and sugar; the rice and flour; the chairs and tables; the lamps and glasses; their frocks and shoes, children might be taught to read not only interesting histories but powerful sermons, inculcating strength of will, diligence, and goodness. Richter says well, that "a good action, a noble sacrifice, a galling wrong, are fit building-sites for a child's curch." In this belief I send forth my stories. I trust that they may have the effect I anticipate from them, and I ask no better success.

GRANDFATHER GREY.

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THE WONDERS OF HOME.

THE STORY OF A CUP OF TEA.

"Our household dwells amidst ten thousand hills,
Where the tea, north and south of the village, abundantly grows;
From Chinshe to Kuhyii, unceasingly hurried,
Every morning I must early rise to do my task of tea."

Chinese Ballad on Picking Tea.

THE story of the tea which is now being scalded in the tea-pot is one with which few young readers, and not many old ones, are acquainted. Most people know that tea comes from China, but here the general knowledge on the subject ends. Few people in England, or indeed in Europe, are intimate with the various processes which this fragrant leaf undergoes before our merchant-ships convey it to

our docks, and thence to our tea-caddies. The immense consumption of tea in this country—estimated lately at fifty-eight millions of pounds yearly—makes it imperative upon us all to know something of its manufacture, that we may be enabled to guard ourselves and our friends against adulterations of a character injurious to the constitution. This remark applies more particularly to young people, since they have a long earthly future to look forward to; whereas old men like myself have, in all human probability, but a short span of life to measure. Therefore, let me impress upon my young readers the responsibility of their position; let me beseech them to bear in mind that their duty to their friends, and to those who in years to come will depend upon them, as they now depend upon their friends, for guidance and subsistence, should urge them to garner up industriously all the knowledge which they are enabled to obtain in the days of their youth. Let them strive with all their might to benefit by the instruction of their teachers. Let

them walk abroad with an inquiring spirit: let their thirst for knowledge never be quenched. By knowledge I do not mean only the information to be gathered from their school-books, but also a familiarity with the history of everything about them. I always indulge my grandchildren in this inquisitiveness; and the attention with which they listen to my stories, and the interest they always take in them, induce me, at their earnest request, to print my histories for the benefit of their schoolfellows and the juvenile public. The first long story which I told them was that of a Cup of Tea. It was a frosty night—the wind was howling without: we had closed the shutters—the fire blazed upon the hearth, the children's mamma was making some delightful hot tea, and the youngest of the family was scorching himself making toast, to his infinite delight, when I began my story, which ran, to the best of my recollection, as follows:—

THE STORY OF A CUP OF TEA.

The story of the tea, which your mother has just scalded in the tea-pot, is one, as I said before, with which few people living beyond the frontiers of China are familiar. Considerable obscurity envelopes the ancient history of tea. It is supposed by some, and I think, with reason, to be the malabathrum of the ancient Greeks, though Chinese accounts place the discovery of the useful and delightful properties of tea as far back as A.D. 315, and assert also that it did not come into general use before the period of the Tang dynasty, that is to say about the beginning of the seventh century. The description given of malabathrum by the author of the Periplus favours the idea that it was the leaf of the tea-plant prepared in a rude manner; and if this be so, the native country of the tea-plant is the romantic region of Assam and Yunnan, where it has recently been found growing in a wild state.

When tea first became in general use among the Chinese, they called it *tu;* but their modern name for it is *cha.* The English word tea is a corruption of the Fuhkien dialect. The Fuhkien people, from whom the plant was first obtained by Europeans, pronounced it *tay:* the French version (*thé*) of the word is therefore more correct than the English. Botanists call tea, Thea; and it is classed by scientific men, and by the Chinese themselves, with the Camellia. In China, the tea-plant varies in height from three to six or seven feet. It usually presents a dense mass of foliage on an infinite number of small thin twigs, such as you will often find mixed with the tea, if you examine it in the caddy. In Assam, where, as I have already told you, it may be found wild, it often grows to the height of thirty feet. The twigs of the plant are carefully pruned, to increase the quantity of leaves, and develope the branches laterally, so that the shrubs are usually of great circumference in comparison to their height. The leaf in its natural state is of a dark green

colour, and of an oval shape. The flowers of the tea-tree grow singly, and are white and without scent. The seeds of the tea-tree very much resemble hazel-nuts, their kernels being enclosed in a hard husk, and so oily as to decay soon after ripening. The oil extracted from these seeds, though acrid and bitter, is useful to the Chinese for various purposes. The leaves are first gathered from the plant when it is about three years old; though it is not full-grown before it is six or eight years old. The tea-plant is grown throughout the entire kingdom of China. The demand for tea has become so great that the cultivation of cotton has been partially abandoned in order to meet the demand for the fragrant leaves of the Bohea hills, Fuhkien, Chehkiang, and Kiansu. Every cultivator of the soil in China, be his land extensive, or limited in extent to a mere garden, cultivates a few dozen shrubs, and either cures the leaves himself, or plucks them to sell to his richer neighbour. Indeed the cultivation of the tea-plant is almost exclusively

in the hands of small cultivators. In China there are few extensive landowners; but each little farmer raises carefully his proportionate crops of cotton, silk, rice, and tea, on his own ground.

The seeds of the tea-shrubs are thickly planted in nursery beds. They are sown thickly, because from their oily and acid nature, as I have already told you, many of them fail. When the nurslings are a foot or more high, they are transplanted into rows about four feet apart. A rich sandy earth, with a fair proportion of vegetable mould in it, and in an elevated situation, is generally chosen for the propagation of the tea-plant. It is also necessary that the soil be plentifully watered. A loamy soil, with a sandy, loose covering, generally produces an abundant crop of leaves, and in the Ankoi-hill plantations in the Fuhkien province, much of the tea is coloured with the iron contained in the land. No preparation of the ground is necessary, nor is much care usually taken to preserve the shrubs in a healthy state. The result of this want of

care is, that in the neighbourhood of Canton particularly, and in other parts of the Empire, the tea-shrubs are often covered with lichens, and sometimes bored and destroyed by worms. The Chinese might, in this matter, call to mind their excellent proverb that, "trouble neglected, becomes still more troublesome." You must not, however, fall into the vulgar error of supposing that this pig-tailed race so jeered at by ignorant persons, are the idle, barbarous, and ridiculous people they are commonly represented to be. I should indeed be sorry to hear my grandchildren join in this ignorant outcry against a great and industrious people. I do not mention the carelessness of the Canton tea-growers for the purpose of prejudicing you against Chinamen generally; on the contrary, I am rather anxious to impress your minds with the gigantic results of their untiring industry. Not only have these people rendered every available piece of land in their country useful to the general good of the community, but they have terraced their native

hills almost to their summits, and propagated cotton, tea, and rice, hundreds of feet above the level of the sea. They practise upon a vast scale all the rural and manufacturing arts, and maintain in perfect internal harmony, a community which may be moderately computed at about three hundred millions of souls.

Their customs may at first appear ridiculous in the eyes of foreigners; nor is this to be wondered at. The fundamental principle of their government is self-dependence. The stupendous fabric they have raised, their perfect internal harmony, and the progress of their arts and literature, are evidence of the wisdom of their rulers. To a China-man, or to a *tsin jin*, as they love to call themselves, China is the world. Beyond the boundaries of their empire is to them a void; and the general belief to this day among the masses of the Chinese people is that their country is *Tien Hia*, meaning Beneath the Sky, and denoting the World. The common name for their country in the present time is Chung Kwoh,

or Middle Kingdom, a name given to it from an idea that it is centred in the middle of the earth. These things certainly denote the ignorance of the people respecting their geographical position; but they also account fully for the singularity of their manners. Unaccustomed to mix with foreigners, or even to admit them to the mysteries of their social customs, they have lived altogether isolated from the great family of man, and have, consequently, contracted habits and customs differing essentially from those of other nations. Let me, children, guard you from indulging in ignorant raillery against a people to whose wisdom the world owes the inventions of the compass, porcelain, gunpowder, and printing.

Well, to return to the tea-plant: as I have told you, when the tea-shrub is about three years old, the Chinaman gathers his first crop of leaves from it. Three crops of leaves are gathered from full-grown shrubs during the season. The first picking takes place about the middle of April, or whenever the tender leaf-buds begin to open, and while the leaves

retain their youthful down. These young leaves produce the finest tea; and the down that remains upon them has given rise to the erroneous notion that they are the petals of the tea-flower. The second gathering is made in the early days of May, when the shrubs, if the weather have been propitious, are densely covered with full-sized leaves. The Chinese pay particular attention to the state of the weather, as they believe that excessive dews, or the entire absence of moisture, mildews or withers the leaves, thereby affecting the quality and quantity of the crop. The average annual produce of a single full-sized plant is said to be from eighteen to twenty-four ounces; and it is estimated that a thousand square yards of land devoted to tea-shrubs generally contains between three hundred and four hundred plants. The Chinese are very particular as to the locality where their tea has been grown. They have a decided preference for the produce of the Bohea hills; and pretend to discriminate between the leaves of adjoining plantations. The produce

of esteemed nurseries is collected with the most scrupulous care; and it is affirmed on the authority of native dealers that the price of these particular lots vary from 4*l.* to 25*l.* per pound.

The leaves are collected by handfuls. They are stripped off the twigs with the utmost rapidity, and men, women and children, are indiscriminately employed to do this labour. Each picker has a basket slung round his neck, in which he conveys the leaves he has plucked to the curing-house. One person can, on an average, pick from twelve to fifteen pounds of leaves in a day, for which labour the wages are about sixpence. The third crop of leaves is collected about the middle of July, and there is also a fourth gleaning in August, called *tsin lu*, or "autumn dew," from the name of the season in which it takes place; the three previous crops are called respectively first, second, and third springs. The two last crops yield very inferior leaves, which are seldom exported; but are probably reserved for the use of the poorer Chinese.

Now though it is reasonable to believe that the tea-plant puts forth more healthy, and therefore more valuable foliage in favourable situations, than when planted in an unfavourable soil, or exposed to the inclemencies of the weather, yet it appears to me that the delicacy of the leaf and its flavour depend to a great extent on the care bestowed upon it after it is picked. Chinese authorities, in fact, declare that the mode of curing the leaf has as much to do with the delicacy and richness of its flavour, as its age, or the nature of the soil from which it has been nourished. A few of them go so far as to assert that some sorts of tea are quite changed from their original flavour by the curative processes to which they are subjected. You will not fail to observe, children, that as the leaf grows old, its flavour increases in strength and loses in delicacy. Your mother will tell you that the flavour of Pecco and other fine kinds of tea, is more delicate than that of Souchong and Congo. Well, the cause of the superior qualities of Pecco

is its extreme youth. Pecco and all the fine kinds of tea are produced from the leaf-buds of the tea-plant; while Souchong and Congo are the full-blown, mature leaf of the plant. No tea-grower would cure the delicate leaf-buds of the tea-plant on the hot-pans where the coarser, because older leaves had been roasted.

After the leaves have been gathered and housed, they are carefully assorted, and the yellow and decayed ones thrown aside. The sound leaves are then thinly spread upon bamboo trays and placed in the wind upon frames, where they are left until the leaves begin to soften; then, while lying upon the tray, they are gently rolled and rubbed until red spots begin to appear, when they are tested by pouring hot water upon them. If the hot water turn the colour of the edges of the leaves to a pale yellowish tint, the leaves are considered to be ready for firing. The process of working or rolling is tedious and laborious; so much so that the Chinese call the tea so treated *kungfu cha*, or worked tea.

Congo is a corruption of *kungfu cha.* You may then remember that congo tea means rolled or worked tea. The leaves having been properly rolled and tested, are next subjected to the action of heat. The iron pan having been previously heated, the workman takes a handful of leaves and sprinkles them carefully and thinly upon it, and waits till each leaf has popped, when he dexterously brushes them off into a basket, before they have had time to become charred. The pans are the iron boilers used in cooking, set in mason-work in an inclined position and at a convenient height; three or four are put into the same form, and heated by means of a flue passing lengthwise under the whole. The testing and rolling which I have described to you, is dispensed with in the curing of very common tea; and the fresh leaves are at once thrown upon the hot pans, and then turned over and kept in motion by a workman before each pan, while another carefully attends to the fire.

The mouth of the man who is watching the

leaves is carefully covered: this precaution is necessary to keep out the hot-dust which rises in clouds from the leaves. During the first firing an acrid greenish juice is forced out, and is partially evaporated, or given off in the form of vapour; but as it is pressed out on the bamboo tables by the workmen, it affects and irritates their hands. Four or five minutes' heating is sufficient for the first firing.

When the leaves have undergone this first firing they are thrown upon tables made of split bamboos laid alongside each other with their round sides up. The workmen take a handful of the hot leaves in their hands, and roll and knead them upon the table, in order to drive the oily green juice completely out. This juice is allowed to run through the interstices of the table on the ground.

When the leaves have been thus rolled and kneaded they are shaken out loosely upon basket trays, and exposed to the air to complete the drying;

the object being to dry them gradually that they may not lose their brittleness, nor become too crisp under the scorching rays of the summer sun. When satisfactorily dried in this manner, the leaves are thrown in large quantities into the pans to undergo a second firing. This time the pans are heated in a less degree than before; and the leaves are thrown about constantly to prevent scorching. If well rolled previously, this operation tends to make the leaves shrivel and twist; and as they grow hotter they are stirred with a brush, and tossed about till they are completely dried. This second firing is generally of an hour's duration. The leaves are sometimes placed in trays over a charcoal fire covered with ashes, after exposure to the air, and left for two or three hours. This process makes them of a darker colour than when rapidly fired in the pans.

These processes, however, are occasionally varied. For instance, after the leaves have undergone the first firing, rolling and drying in the air, they are

sometimes scattered upon a fine sieve and placed over a charcoal fire covered with ashes, to prevent the smoke from reaching the leaves. They are then removed to a coarser sieve, and the fine and coarse leaves are in this way partially separated before they are packed for market. This mode of drying gives the leaves a greenish hue, varying in degree according to the length of time they are exposed to the air and fire. The common sorts of black tea are left in the sun a much longer time than the finer teas are allowed to remain. This common black tea is exposed to the air sometimes as long as two days, until a partial decomposition has begun from the effects of the heating and rolling. When intended for exportation this tea is thrown a second time into the roasting pans, and rolled about till it is partially charred, to prevent the possibility of its turning mouldy in the course of its voyages.

I have described to you the common mode of curing tea, but I must not omit to tell you that

the Chinese adopt many means to give peculiar flavours to particular leaves. Thus, the fine leaves of Hungumey are placed under cover till they almost begin to ferment, and then are exposed to the sun before the first roasting. The round fillets of gunpowder tea are rolled singly, while damp, into compact balls. Scented tea is manufactured by placing fresh flowers of the Olea, Aglaia, and other odoriferous plants, in a basket under that in which the fine tea is placed over the fire, for the last drying, and then stirring them a little without mixing the two. It is necessary to pack the tea which is scented in this manner, directly it is cured, or it will lose its peculiar flavour. Only the finer sorts of tea are thus treated, but Chinese exquisites are extremely particular as to the kinds of flowers used, and the degree of flavour imparted. In fact a Chinaman is as particular about the quality of his tea as an Englishman is about the age and beeswing of his port. Many people in England affirm to this day that black and green

teas are made from different plants ;—that the shrub from which green tea is plucked differs from that whence black tea is gathered. Now this is undoubtedly a gross error. The Chinese, who are the tea-growers, attribute the difference in the colour of their teas to the mode of preparation. Green tea is stronger and lighter than black tea for this simple reason, that it is less worked and less roasted, and therefore preserves more of its native oil, strength, and colour, than black tea, which is almost charred for exportation. We might as well hold that a baked potato and a boiled potato could not possibly come from the same root, since the baked potato was a dark brown and the boiled potato but the palest yellow. Green tea is made by simply drying young leaves over a gentle heat and old ones over a hot fire, for about half an hour. By this mode, it stands to reason, that more essential oil will remain in the leaf than if it were rolled, and roasted a second time.

All kinds of tea are repeatedly tested during

the various stages of manufacture, by pouring boiling water upon a few leaves, in order to observe the colour, aroma, taste, and other desirable qualities of the infusion. As many,—such is the original strength of the leaf—as fifteen drawings can be made from the best leaves before the infusion produced becomes limpid.

Chinese writers on tea are unanimous in directing the amateur to observe ten things in his choice of green tea. They insist particularly that the leaf must be green, firmly rolled, and pulpy; that there must be no broken leaves or dirty twigs; that the infusion should be greenish, oily, and send forth a delicate aroma; that the weight of the parcels, the taste and hue of the dry leaf, and its smell when strongly breathed upon, should be carefully attended to. Merchants are in the habit of testing Ankoi teas with a loadstone; especially since the rumour has gained ground that the effects sometimes felt upon the nerves after drinking green tea, are owing to its being cured upon copper. This

notion is however, in all probability, an erroneous one. The injurious effect of green tea is, in my opinion, to be attributed in part to the greater proportion of oil remaining in the green tea; but far more to the injurious nature of the substances used to impart an artificial and uniform colour to it in order to make the lots present a marketable appearance. You must understand, children, that the operations of firing and rolling give various shades to the leaves in proportion as they come more or less in contact with the iron, or are exposed to the sun;—and it is the object of the manufacturer —with the view of disposing of his property at a high price—to render these tints uniform. Well, he does not scruple to add to his means at the risk of his fellow-creatures' health; so when the leaves are in the pans the second time, he causes them to be drugged, first with turmeric powder to give them a yellow tint, and next with a mixture of gypsum and Prussian blue, or gypsum and indigo firmly combined, which mixture imparts the desired bloom to

the yellow leaves. This imposition cannot be too severely condemned. It appears that at Canton, when there was an unexpected demand for some particular descriptions of green tea, it was ascertained that even black tea was coloured to simulate the required article.

The names given to the various sorts of tea are for the most part derived either from the place of their growth or from their peculiar property or appearance. Thus Bohea is the name of the place where this tea is grown, and not a term for a particular sort among the Chinese; *Sunglo* is also a general term for the green teas which come from the hills of Kiangsu. Considering the great labour of preparing tea and the distance it has to travel from the provinces to the capital of China (often a thousand miles) it is surprising to find that good tea may be had at Canton for about one shilling per pound. The tea that is packed on the Bohea hills, or in the fertile regions of Kiangsu, is seldom disturbed till it is unpacked from those

quaint, rudely-painted cases, in which the Chinese dispose of it, in New South Wales or in the Highlands of Scotland. I believe that the manufacture of the tea-cases you see in the windows of grocers' shops furnishes employment to thousands of poor Chinamen at Canton. Very poor people in China, who cannot afford to indulge in the national drink, substitute for it an infusion of the dried leaves of a species of Rhamnus or Fallopia. The refuse of the packing-houses is sold to the poor at a low rate, under the names of "tea-endings" and "tea-bones"; and if a few of the rarest sorts do not travel beyond the boundaries of the Chinese Empire, but are monopolized by his Celestial Majesty, and his bald Mandarins, and clump-footed ladies, neither are we called upon to consume the poorest products of the tea-plantations. You have listened so attentively to the story of my cup of tea, that if your mother has any left in the teapot you shall all taste its good qualities for yourselves. I know you are all longing for your mother's as-

sent. Well, if she promises to give you a treat for to-night, will you think with equal indulgence of the people from whom we derive this luxury?

You will promise me not to indulge in ignorant laughter at the expense of this great and original nation. Recollect this—that to them our customs are as absurd and unaccountable as theirs are to us. You laugh at their pigtails: well, depend upon it, they, that is to say the ignorant and thoughtless portion of them, would grin delightedly at your abundant crop of hair. To them, my children, you would all be little unaccountable monstrosities: recollect this, and learn never to laugh in ignorance.

See, the tea is made for you: drink it, and try to remember how much labour and anxiety have been gone through to fill those little cups.

THE SUGAR-PLANTATION.

THE STORY OF A PIECE OF SUGAR.

You will all be glad to hear the story of a Piece of Sugar. You are too fond of the result to be indifferent as to the means employed to attain it. The sugar which is used for domestic purposes in England, and indeed throughout the world—except perhaps in France—is, as I need scarcely tell you, a sweet, crystallized substance, extracted in a liquid state from the sugar-cane, of which there are several species. But sugar is also obtained, though in smaller quantities, from beet-root. The French make more beet-root sugar than any other nation. Sugar may be obtained from many vegetable substances; in fact in smaller or larger quantities, from almost any species of the vegetable kingdom. The sap of the maple, sycamore, and birch, for instance, contain a large proportion of saccharine, or sweet

matter. Saccharine matter is obtained in various forms from animal substances, and may be detected in the sweetness of new milk, and is reducible to crystallized sugar like that we commonly consume. Then there is honey-dew, or aphis sugar, and the honey of the bee, which may be said to be compounded of both animal and vegetable substances, that is of the pollen which the bee draws from the flowers, and the animal secretion with which it kneads the dry pollen into the moist, sweet substance we call honey. Saccharine, or sugar matter, also exists in great abundance in many ripe fruits, as you may guess from the sweetness of those delicious Jargonelle pears we received last autumn from Guernsey. You may have noticed too, how dried fruits, such as the fig and grape, are surrounded with hard, dry sugar, which has been pressed from the fruit in the process they have undergone to keep them sound. Many clever men in France and Spain have tried to extract sugar equal in quality to that taken from the sugar-cane, from grapes; but with little

success. The sugar that has been pressed from grapes has always been found coarse, and much inferior to cane sugar in every respect.

The oldest description in existence of the process of extracting sugar from the cane, gives an account of "sweet honied reeds" called Zucra, which were found in great quantity about the meadows of Tripoli by the Crusaders, about the year 1108. These reeds were sucked by the Crusaders' army, who were greatly pleased with their sweet taste.

Most authorities on the subject agree in attributing the first cultivation and manufacture of the sugar cane and sugar to the Arabs; and it is also generally believed that sugar first came into extensive use about the beginning of the eleventh century. There are many conflicting statements made by writers of various nations as regards the countries which may claim the sugar-cane as an indigenous or native plant; but, wherever the sugar-cane may have been indigenous, there is no reason to doubt the fact, that the manufacture of sugar, de-

rived first from China or India, was introduced into the western world by the Spanish and Portuguese. The Venetians were the first Europeans who refined sugar. The height to which the sugar-canes usually grow, their colour, and the length of their joints, vary, as you may well imagine, with the character of the soil from which they derive their nourishment, as well as with different species, and the mode of culture to which they may have been subjected. But I think I may safely tell you that they vary in height from eight to twenty feet, and are divided by short bulging joints at regular intervals. Long narrow leaves sprout from each joint, but as the canes become full-grown, the leaves from the lower joints wither and fall off. The outer part of the cane is hard and brittle, as many a schoolboy too well knows; but the inner part consists of a soft pith which contains the sweet juice. The juice in each joint has no connection whatever with the juice in the joint immediately above or below it. The canes are usually propagated by

cuttings or slips, consisting of the top of the cane, with two or three of the upper joints, the leaves being carefully plucked off. These slips are planted in holes dug by hand, or in trenches made by a plough, about eight to twelve inches deep, the earth being banked up upon the margin and well manured. The distance between the holes or trenches must be such as to afford free access to a current of air between the rows and plants, as well as to allow room for the planters to weed the ground between the canes. The planters generally allow about four feet between the rows, and two feet between the plants. Of course there are many methods adopted by the sugar-planters of various countries; but in our own West Indian possessions, where sugar is most extensively cultivated, the mode of planting is generally as follows:—two or more slips are laid longitudinally or lengthways at the bottom of each pole, and covered with earth to the depth of about two inches. In about a fortnight the sprouts begin to appear above ground, when they are again covered

with earth to give them additional strength. The time required for bringing the canes to perfection is usually about eight months. In the British West Indies the slips are generally planted from August to November; and the canes are there cut about March or April. The ripeness of the cane is known to the planter by the outer part of it becoming dry, hard, and smooth; by the weight of the cane; by the greyness or brownness of the pith, and the sweetness and thickness of the sap or juice. The canes which grow immediately from the slips are called plant-canes by the planters; and the second crop of canes reared in successive years from the slips are known as rattoons. The plant-canes, however, are more vigorous than the rattoons; but the rattoons yield juice which gives less trouble in clarifying and concentrating than that of the plant-canes. Some planters have raised twenty annual crops of rattoons from one set of slips. The canes are cut as near the ground as possible, because the richest juice is found in the lower joints. One or

two of the top joints of the cane are cut off, and the remainder is divided into pieces of about a yard in length, tied into bundles, and at once conveyed to the mill.

The operation of cutting the canes is so arranged as to keep pace with the crushing-mill which presses the juice out, so that the canes may be crushed or ground while quite fresh. In the East Indies very rude and imperfect crushing-mills are used; some of them resembling mortars, made of the lower and thicker parts of the trunks of trees, in which the canes are crushed by the revolving and pressing motion of a pestle, which rests in a slanting position against the side of the mortar, and is moved by oxen yoked to a bar attached to it. The juice, as it is squeezed out, runs off through a hole in the bottom of the mortar, and, running along a spout, falls into another vessel placed to receive it. The planters who use this rude mill are obliged to cut their canes into very small pieces to make it effective.

The common cane-mills of the West Indies consist of three rollers, mostly of wood, with narrow bars of iron bound to their surface, so as to form, by the spaces left between them, grooves extending from end to end of the rollers. These rollers are placed side by side in a strong frame, with contrivances for varying, in a slight degree, their distances from each other. The moving power is applied to the middle roller, and communicated from it to the others by the action of cogged wheels. Steam has lately been introduced to the West Indies as the moving power for the working of the sugar crushing-mills, and with great success. When the mills are in action, a negro applies the canes in a regular layer or sheet to the interval between the first and second rollers, which seize and squeeze them violently as they pass between them. The ends of the canes are then turned, either by a negro on the opposite side to the feeder, or by an ingenious framework of wood, called a dumb-returner, so that they may pass back again between the second and third rollers.

As these are placed nearer together than the first and second, they squeeze the canes still more, so that on coming out from this second pressing, they are reduced to dry splinters, which the planters very appropriately call *cane-trash*, and are used as fuel in heating the vessels for evaporating the juice. Channels are placed under the rollers to receive the juice as it is squeezed from the canes which conduct it to the vessels in which it is to undergo succeeding operations. The mill I have described to you is a very defective machine, since it is impossible to supply the canes to the rollers in so regular a layer as to prevent them crossing each other. They become, therefore, broken, so that the liquor is made foul, and the rollers are exposed to irregular and destructive wear. You must have often noticed pieces of cane mixed up with the brown sugar; well, these pieces are the result of the imperfect rolling of the sugar-canes. But these rude mills will soon disappear before the progress of science. Steam will make its way in

the West Indies, as it has already here; and then let us hope that all nations will see the extravagance, if not the disgrace, of manufacturing sugar by the labour of slaves.

Cane-juice, as it comes from the crushing-mill, is a thick, dull grey-green, sweet and balmy fluid. It contains, when in this unmanufactured state, particles of solid matter from the cane which are afterwards separated from it by filtration. Directly this cane-juice runs from the crushing-mill the process of clarifying is commenced. The juice, as you will recollect, is conducted by gutters from the crushing-mill to a large flat-bottomed copper or pan, called a *clarifier*, which is usually large enough to contain from three to five thousand gallons. Underneath this clarifier there is a fire, and when the pan is full of cane-juice a little lime is mixed with it, and the fluid is allowed to get hot—but not to boil. The effect of the lime upon the cane-juice is to make the solid portions of the cane-juice stick together and rise to the

surface in the shape of scum. When the proper heat has been given to the juice, the scum rises in blisters and breaks, which is the sign for the attendant to close what is called the *damper*—an apparatus made to extinguish the fire rapidly. After an hour's repose, the liquor is ready for removal to the first of the evaporating pans. It is drawn off by a cock, in such a manner as not to disturb the scum, which will remain behind unbroken, and is, of course, removed from the clarifier before another charge of cane-juice is put into it. The clarified juice is bright, clear, and of a pale colour.

From the clarifier the liquid is conveyed to the largest of a series of evaporating pans, three or more in number, in which it is reduced in bulk by boiling — as you all know water is when boiled in the kettle. The largest of these pans is sufficiently capacious to hold the contents of the clarifier; but the others may become gradually smaller on account of the diminished bulk of the liquor,

by evaporation—that is to say, by going off into vapour, as it is removed into each of them in succession. These evaporators are placed over a long flue, heated by a fire of the cane-trash, or crushed and sapless cane, at one end over which the *teache*, or smallest, and consequently the last pan into which the cane-juice is put, is placed. In the long process of successive boilings, impurities which have escaped with the liquor from the clarifier are thrown up in the form of scum, which is carefully removed. If, during the evaporation, it be perceived that the liquor is not sufficiently clear, some lime-water is added to it, for the same purpose as the temper or lime was applied to the cane-juice when in the clarifier, namely, to make the solid particles adhere together and rise in a mass to the surface. In the least and smallest of the evaporating pans, called the teache, the liquor is finally boiled down to a thick consistency—to such a consistency as to admit of its being drawn out like india-rubber to a considerable length

without breaking. To know when the liquor or syrup is sufficiently thick and adhesive, a drop is taken from the teache between the thumb and forefingers and drawn out till it snaps asunder. When it has done so the portion suspended from the finger shrinks up, so as to remain at a greater or less length, according to the degree to which the syrup has been evaporated. When it is in the proper state for withdrawal from the teache, the thread on the finger should be from half an inch to a quarter of an inch long. This is a most imperfect test. Some planters try the state of the syrup by observing the change it will undergo on the back of a ladle dipped in the teache. When the syrup is reduced in the teache to the satisfaction of the planter it is put into coolers, where it remains to cool and crystallize.

When the sugar is taken from the coolers it is brought to the state of a soft mass of crystals, imbedded in molasses, or treacle, which you children will most likely think very delicious, but

which people generally consider to be very coarse and unfit for use. The separation of this fluid, called molasses, or treacle, from the crystals, is the next process, and is performed in a building called the *curing-house.* This is an extensive building, the floor of which is hollowed out to form a reservoir for the molasses, which is carefully lined with cement or lead. Over this reservoir is an open framing of joists, upon which stand a number of empty casks, called *potting-casks.* Each of these has eight or ten holes bored through the lower end, and in each hole is placed the stalk of a plantain-leaf which is long enough to descend a few inches below the level of the joists, and to rise above the top of the cask. The soft sugar, as it is taken from the coolers, is removed into these casks, from which the molasses gradually drain through the plantain-stalk and fall into the reservoir below, leaving only the crystallized sugar in the casks. With sugar of average quality three or four weeks is sufficient for this purpose·

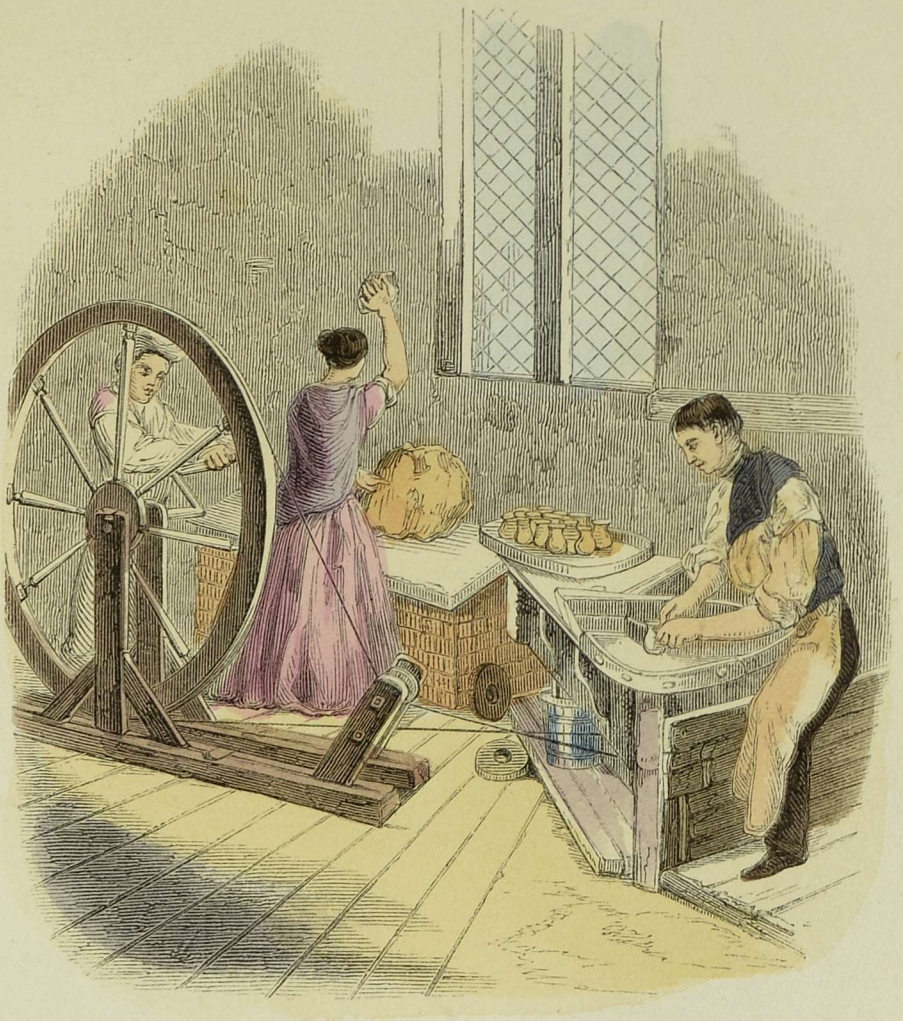
When it leaves the *curing-house* the sugar is packed in hogsheads or large barrels for shipment, as raw, brown, or muscovado sugar; and in this state it is commonly brought to us from our West Indian Colonies. As, by the process of curing which I have just described to you, the molasses is generally but partially separated from the crystallized sugar, it follows that the remaining molasses will drain through the hogshead while on board the ship; and so large is this drain after shipment, that it is said, on good authority, that one twelfth part of the raw sugar is drained from the hogsheads before they reach Europe. When the raw sugar arrives in England it undergoes the process of refining; that is to say the process pursued in the colonies is repeated with greater skill and care, making the sugar, at last, that highly crystallized white substance of which you all are very fond, and for a lump of which you beg very frequently.

Sugar-candy is the only kind of highly refined

sugar made in China and India. The Chinese export sugar-candy in very large quantities: they have two sorts of candy, one which they call *Chinchew*, and another known as *Canton;* the former being the produce of the province of Fokien, and the latter of that of Canton. Of these, the Chinchew is by far the best. Sugar-candy is mostly used by Europeans resident in the East. Candy is a sugar, which, after being refined, is suffered to crystallize slowly upon strings or twigs.

I have described to you the processes which the saccharine or sweet juice undergoes after it is pressed from the cane, in order to make it available for our use; but I have not yet directed your attention to the poor slaves at the cost of whose unrewarded labour we, for a long time, enjoyed an article which enters so largely into household consumption among us. My dear children, your young hearts would, I hope, be melted in pity were I to describe to you these poor black creatures in the misery and degradation to which their wicked and cruel

owners have reduced them. Slaves are not employed in any of our English colonies now; but human flesh and muscle are still bought and sold in the Southern States of America. You should be proud to know that every foot that presses an English shore is that of a freeman: that a slave cannot exist within the dominions of your Queen. But this blessing is not universal. Slaves—millions of slaves—are still bartered for, and sold, and beaten and worked to death, without reward, in many foreign countries. England has spent many millions of money and many valuable lives in a war against these inhuman dealers in human flesh and blood, and I trust that you will live to see the day when throughout the world there shall not be a man branded as the property of his fellow.



THE STORY OF A MILK-JUG.

THE STORY OF A MILK-JUG.

THE potter's art is of very ancient origin, for it was known in Egypt, China, and Japan, at a very remote date. Porcelain ornaments have been found on mummies three thousand years old; and the British Museum contains specimens of Egyptian jars in good preservation, of undoubted antiquity. Indeed the potter's wheel is, perhaps, one of the most ancient machines on record. Nor has the art of adapting clay to the domestic purposes of man been confined to the civilized nations; on the contrary, it has been practised by the rudest savages on the face of the earth. Vases have been found among the native Indians on the Musquito shore, and on the banks of the Black River in North America. Although all vessels made of earth may be fairly called earthenware, I think you would be corrected if you

ventured to call the milk-jug so, as the particular ingredients of which it is compounded, have clarified or cleared the clay, and converted it into china or porcelain. Before the beginning of the eighteenth century, English potteries produced only coarse earthenware, and we are indebted for our porcelain articles to the ingenuity and industry of the Chinese. But in the last century the art made rapid strides in this country, and we are mainly indebted to Mr. Wedgwood for the vast improvements in our ware which have made it celebrated throughout the world, and welcome in every European market.

English China, as manufactured in Staffordshire, is a composition made by the admixture of China clay with ground bones, and Cornish granite. Well, these materials are mixed together with water, and reduced to the consistence of cream, in which state the potters call them "slips, or slops." I must tell you that, before the ingredients are mixed together, they are separately reduced to a fluid state in vats sunk in the ground, whence they are sifted

through fine silk lawns into other vessels, and then more water is added, until a pint measure of clay slip weighs twenty-four ounces, and a pint of granite or flint-slip, thirty-two ounces; so that the potter mixes accurately by measure, as he knows that when a pint of clay-slip weighs twenty-four ounces, and a pint of granite or flint-slip weighs thirty-two ounces, that the proper quantities of clay, flint, or granite are contained in the water. The mixture of the various materials is then made in a vat, and the quantity of each material to be used is marked by notches on a rod, which the workman dips into the vat, while the slip-maker pours in the slips, until each rises to its proper mark on the mixing-rod. When the proper quantities have been poured into the vat, the whole is thoroughly stirred and incorporated, and is then pumped up into a higher vessel, from which it descends through a tap into a silk sieve, which is kept in constant agitation while the fluid is passing through it. This process is repeated two or three times, not only thoroughly

to remove all impurities, but also to ensure the perfect mixture of the various ingredients. This combined and strained slip is then pumped on to a boiler called a *slip-kiln*, the bottom of which is paved with large flat fire-bricks, under which the heat of the fire passes by means of four or five flues. The boiling heat thus imparted to the slip generates steam, which is, as you know, water given off in minute particles, and so the quantity of water in the slip is gradually reduced; and the slip, of course, gets gradually thicker, till it is about the consistence of paste, when the fires are put out, and it is allowed to cool. The next process is to beat the slip to make it closer and firmer, so that when cut, it is smooth and close like putty. It is necessary for the potter to be very careful that this process is well performed, for if the slip be not thoroughly beaten, the ware made from it will crack and peel off, and, in short, be utterly useless. Having described the operations performed in the slip-house, let us at once proceed to notice what

remains to be done to our Milk-jug. It is now only a lump of dense white paste.

A woman, called a *baller*, takes up the lump, and makes it of the proper size for the jug, and then hands it to the thrower; he receives the clay as he sits at the thrower's wheel, a revolving circular table, which is put in motion by the baller, and draws it up into a pillar, then depresses it into a flat cake. He then opens the hollow of the vessel with his thumbs, and continues to draw out the clay, or press it inwards, according to the shape of the vessel. When a rough outline of the shape is obtained, the vessel is removed from the table, placed on a board, and carried into a store-room to harden. When it is sufficiently hardened, it is turned upon a lathe resembling that used by wood-turners. The turner holds the vessel in his hand, and dexterously shaves away the clay (which is now about the consistency of soap) to the proper thickness, and cuts the mouldings, &c., polishing the whole with a steel burnisher. The shavings of

clay which the turner cuts away, are carefully returned to the slip-vats to be remixed. The Milk-jug is then passed to the handler, who having made a handle in a plaster mould, sticks it to the jug with liquid clay. Our jug is now passed to a workman who has a number of flat figures, flowers, and other ornaments in clay, which he carefully fixes round the jug, according to the drawing of the pattern, by wetting the under part of them with a camel-hair pencil. These ornamental figures are made out of flat moulds by children.

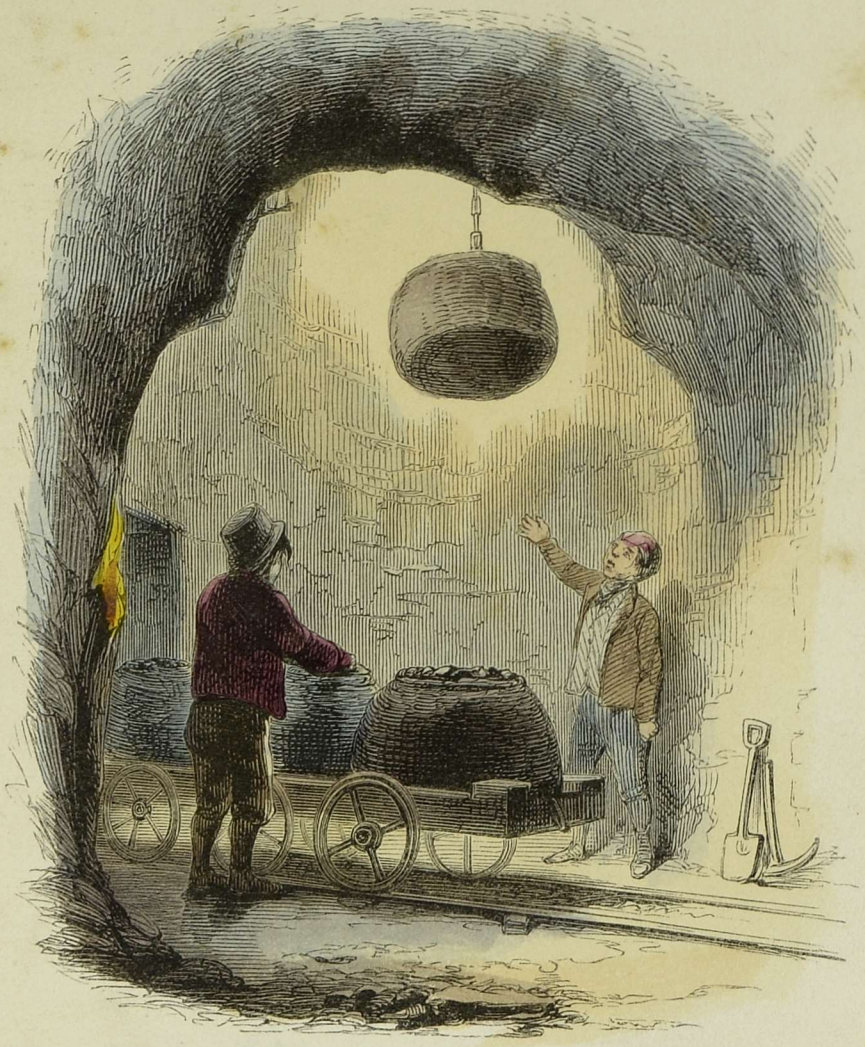
The jug being now properly shaped and ornamented, is placed on a board to dry. It is next placed in the biscuit-oven, and made white-hot, its shape being preserved by being imbedded in flint-powder. The jug is then dipped into a glaze of finely ground felspar (a mineral which may be found in any part of the world, and is the metallic part of granite) mixed with a little alkali. I have already explained to you what alkali is, I therefore hope

that it is not necessary for me to repeat the explanation. It is then submitted to a second fire of a moderate degree of heat, which not only melts the glaze on the surface, but unites with the entire body of the substance, and so hardens it, and makes it semi-transparent. The jug is then cooled.

Our Milk-jug is now ready for use. We have watched it through the many phases of its manufacture; we have seen how the skill and ingenuity of the potter have blended the earths of his country together, and fashioned from the rudest materials, this polished, elegant, and enduring vessel. Well, we cannot too often repeat to ourselves that the comforts of our home are the results of many centuries of thought and toil; that the luxuries we so often enjoy without a thought of their source, are the witnesses of our fellow-creatures' labour.

If we would look about our household in this spirit, always thankfully owning our manifold debts to

the labour of bygone generations as well as of the present generation—at least we should bear in mind and seek to do away with the misery in which our poorer brethren slave for us. So ends my Story of a Milk-Jug.



THE COAL-MINE.

THE STORY OF A LUMP OF COAL.

To tell you the story of a Lump of Coal at length would take many days: for it is a most wonderful and varied story. Indeed it embraces a history of all the wonderful inventions which have been made within the last century. It is the mother of steam—since by its power the cranks and chains and wheels which form the engine are fashioned, and the water is converted to steam. By its aid, as you have seen in our story of a Milk-Jug, the clays of the earth are formed into hard and polished vessels; and we are indebted to it for warmth in winter, and for dressing our food always. Without coal, how would the steam-engine weave fabrics to clothe us, or carry us with fairy speed along our iron-roads? Without coal, how would our vessels plough the deep, against wind and

tide, and carry our merchandize to the farthest corners of the earth, defying the power of the elements? Without coal how should we see our way along the streets at night—since from coal we extract the gas that lights us on our journey homewards?

You would not understand me were I to attempt to give you a technical analysis of Coal; but I will tell you that it is a vegetable substance which is extracted from the bowels of the earth by long and laborious exertions. How vegetable matter, to the growth of which, air and light are as necessary as to human existence, became imbedded so far below the present surface of the earth is a question which has puzzled many learned men; but it is beyond doubt that our coal-fields are only so many buried forests, converted by the gases of the earth and the process of time to that inflammable substance which we call coal. It is only very recently that the existence of wood in the state of coal has been found, with the origi-

nal texture of the wood still preserved. Not only have the branches of trees been identified in the shape of coal, but their genus has been distinctly traced.

All plants which have been traced in coal formations are called 'coal-plants.' Ferns are the most abundant of all plants in the shape of coal, almost every yard of coal being marked by these impressions, and very often containing them in great multitudes;—palms also occur occasionally. This leads us to believe that at the period of the change which must have taken place in the surface of the earth, it was covered with a rich and dense vegetation; and that many plants grew then, of which no specimens exist in a vegetable form at the present time.

An example of the most imperfectly formed coal, is afforded in what is called the *brown* or *wood coal* of Germany, which exists in large quantities in Hesse-Darmstadt, and Salzhauzen. This wood-coal is coal only half formed, and is found in

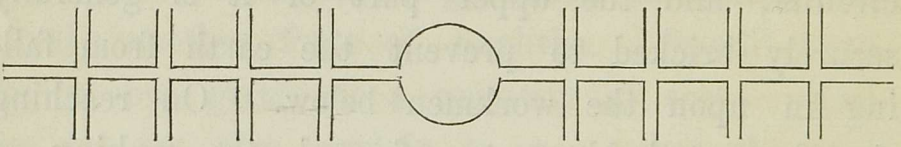
the shape of trunks and branches of trees, as well as in other forms of vegetable matter.

Beds of coal, which are found in many parts of the world, but abound in England, are called 'coal-fields.' Coal is found in these fields in strata, or layers, separated by seams of slate-clay and sandstone. Coal is esteemed according to the quantity of bitumen which it contains. Bitumen, I should tell you, such as is generally contained in coal, is a dark brown glutinous substance, and is only another form of naphtha. It will burn readily, but gives off a quantity of soot. And here let me also explain to you, that the soot which lodges in the chimney is simply so much charcoal given off from the coal in a vaporous state. And a little thought will enable you to trace the existence of this charcoal—or charred wood—to the vegetable origin of coal. Bitumen being more inflammable than charcoal, the coal which contains the greatest quantity of bitumen is the most valuable.

Let me now explain to you the mode of working coal-mines. The probable existence of beds of coal having been first carefully considered, and perhaps the beds themselves having been traced by a process called boring, the first thing that is done is to sink, or as you would say, dig a shaft or deep hole like a well, so as to cut through the various stratas or layers, between which the coal is imbedded. This shaft, or well, is usually circular, and the upper part of it is generally securely bricked to prevent the earth from falling in upon the workmen below. On reaching the first workable seam of coal, the sinking of the pit is for a time suspended, and a broad straight passage called by the miners a *bord* or *gate* is dug into the seam in opposite directions.* The breadth of the passage varies from twelve to fourteen or fifteen feet; but its height is regulated by the depth of the coal-seam, and the height of

* Sketch of the Relations between the Three Kingdoms of Nature. By Thomas Williams, Esq., M. B.

these passages is always made of the depth of the seam:—the roof exposing the strata above the seam, and the bottom, that immediately below the seam, and called by the miners the *thill.* When these bords have been excavated to some distance on both sides of the shaft, narrow passages called *head-ways*, are driven from them at regular distances, and exactly at right angles, as you will find them in my drawing.



When these headways have proceeded eight or ten yards, they are made to communicate with another bord—which runs parallel with the primary bord. And on this system the mine is extended according to the quantity, depth, and extent of the coal-seams. A coal-mine thus extended has been likened to a regularly built town (if you can conceive the houses, one uninterrupted line of

black walls); the bords and headways being respectively the principal streets, and the connecting lanes and alleys; while the intermediate masses of coal (left for the support of the roof) stand for the intermediate masses of buildings.

The water-springs, which are usually met with more or less frequently in the course of the miner's operations, are drawn to the surface by the aid of a very powerful steam-engine, erected near the shaft, and in such a manner that it may be employed to draw up the coal and rubbish from the mine in baskets called *corves*.

If the operations I have attempted to explain to you have been at all successful, that is to say, if the quantity of coal found is sufficiently great to promise a fair return for the money laid out in the operations of the miners, another shaft will be immediately sunk at some distance from the first, and the passages and headways made till they communicate with those which diverge from the original shaft. Thus a current of air

is carried through the mine. One shaft is the *downcast* shaft and the other is the *upcast* shaft. Through the downcast shaft a current of air is sent into the mine and is made to penetrate every passage and headway, and to carry away the foul air up through the upcast shaft. This ventilation is absolutely necessary to ensure not only the health but also the immediate safety of the miners. I dare say you have all heard of the frightful accidents which have been caused by the explosion of fire-damp; and of the safety-lamp invented by Sir Humphrey Davy to prevent this great sacrifice of life. Let me here explain to you that *fire-damp* is a noxious and inflammable or easily inflamed gas, emitted or given forth from the coal, and that immediately it comes in contact with the flame of a lamp, it explodes like gunpowder, and kills all who are within its reach. The word fire-damp has originated from *dampf* which is the German for vapour or exhalation. Sir Humphrey Davy's lamp is so arranged that the flame is

surrounded on all sides by an iron gauze through which flame will not pass, and which consequently prevents the flame from coming in contact with the noxious vapour of fire-damp. This invention has been and is perhaps one of the most valuable efforts of man's ingenuity. It has saved many thousand lives, and prevented the destruction of property of untold value. While the workings on the first seam of coal are thus rapidly and securely going forward, shafts are generally sunk from the first seam to one below, and afterwards to the third and fourth seams, so that a mine extensively worked, has, as it were, three or four stories. These operations may be carried on so long as seams of coal reward the miner's labour.

The mode in which the miner detaches the coal is by cutting a narrow way on each side of the huge piece he wishes to excavate, and then blasting it out by firing shot at the top of the seam. As much as one hundred tons of coal is often brought down at once by this process; and the coal is put into

corves, or baskets, drawn along a tram-road to the shaft, and then raised to the surface by the steam-engine.

I think I have now explained to you with sufficient minuteness, the operations which are carried on underground, for the purpose of supplying our manufacturers and ourselves with fuel. Let me now tell you what becomes of the thirty-five millions of tons which, it is estimated, are annually raised from the mines of England. The coal-field of Northumberland and Durham supplies nearly all the coal consumed in London, the eastern and southern counties, and the neighbourhood of the mines. Shields, Stockton, Seaham, and Sunderland are the ports from which the coal is shipped: the Tyne vessels being the larger, are laden for the London market. The Lancashire coal-field supplies Manchester, Liverpool, and the surrounding district; the South Staffordshire or Dudley Coal-field the numerous iron-works in its neighbourhood and the manufactories of Birmingham and

the neighbouring counties. The coal-field of South Wales (to give you an idea of the extent of these fields) is upwards of one hundred miles in length, its breadth averaging from eighteen to twenty miles. Ireland and Scotland also contain coal-fields but of less importance than those of England. To give you some notion of the amount of human labour expended in bringing coals to our markets I will tell you that London alone consumes upwards of three million four hundred thousand tons every year, for the conveyance of which eleven thousand nine hundred and eighty-seven ships are kept in constant activity. It is estimated also, that the iron-works of England (into which, as you recollect, I told you, in the Story of a Knife, coal enters largely) consume, in the operations of smelting more than seven million tons of this valuable fuel every year. In 1841 the number of persons employed in coal-mines was one hundred and eighteen thousand two hundred and twenty-three.

Having thus briefly given you some idea of the enormous quantities of coal consumed, let me point out to you the various benefits which we derive from the use of it. In the first place coal is, as I have already noticed, the mother of steam. We have already heard the Story of Steam, so that it is unnecessary for me to repeat my observations on that subject; but you have heard nothing hitherto of the manner in which gas is extracted from coal. I will explain the process to you.

The existence and inflammability of coal-gas, may be said to have been known for nearly two hundred years; but although its existence and properties were known so far back, it was not till the year 1792 that any attempt was made to turn this knowledge to useful account. In this year Mr. Murdoch, an engineer living at Redruth in Cornwall, erected a little apparatus, which produced sufficient gas to light his dwelling and offices; and in 1778 he erected extensive gasworks to light the premises of Messrs. Boulton and Watt at Soho.

This was the first application of gas in a large way, but it attracted little attention till 1802, when Messrs. Boulton and Son used it for their illumination in commemoration of the peace. The wonderful brilliancy of their illumination, as compared with those produced by the dull flame of oil, made a great sensation throughout England, and gas from that time began to be gradually introduced throughout the country. In 1807 Pall Mall was lighted up by gas, and for some years this was the only street in London so illuminated; but its use was gradually extended till not an alley in the metropolis was left dark to shield the doings of dishonesty. Gas has been very properly called the city's most vigilant policeman. Coal-gas is distilled by placing a quantity of coal in a closed vessel and subjecting it to the action of a fire, when a dark oily substance is given off through a tube into another vessel made to receive it. This dark oily substance consists of water, coal-tar, and spirit, or gas. To get rid of the water

and tar, the mixture is allowed to cool, when the water and tar settle, and run off, leaving the spirit behind. This spirit is still impure, as it contains a gas which is injurious to health and of an unpleasant smell, called sulphuretted hydrogen gas. To get rid of this gas, the spirit is passed through vessels containing lime, to which it is the property of the sulphuretted hydrogen to adhere, leaving the spirit to pass off in the shape of the pure gas which is now in use throughout the civilized world.

You now know the two great purposes to which coal is applied. We might follow it into every industrial occupation of man. Its use is universal. To stop the supply of coal would be to bring our manufactories to a stand-still, to darken our streets, to stop the railway-engine, and the paddles of our steam-boats. You will, by pursuing this train of thought, to its utmost bearings, see how the operations of mankind, like the steam-engine, though complicated and apparently

independent of one another, are one unbroken chain of dependent actions, which the absence of the minutest crank or wheel may bring to a dead stop. So ends our Story of a Lump of Coal.

THE STORY OF SOME HOT WATER.

THE STORY OF SOME HOT WATER.

My children, the Story of Hot Water is perhaps the most wonderful history in the world. It is as interesting and startling as the most marvellous tale in the Arabian Nights; and it is, let me assure you, one with which all young persons should be acquainted, for it is destined, in all probability, to have great influence over the progress towards good of the rising generation. I have lived to behold the accomplishment of many scientific wonders: I can remember the first steamboat, and the first railway; and Harry can remember the first electric telegraph. A few years ago it was impossible to travel from London to Paris in less time than five days; now the journey may be performed in twelve hours, or half one day. You may now breakfast in London and sup in Paris. A message by means of the

electric telegraph may be sent from Paris to London in less time than five minutes. These are among the wonders which have been revealed to the world through the labour and ingenuity of learned men. And now we are progressing towards greater discoveries. You, children, will most likely live to see the day when a message from China will be delivered in London in the course of five minutes; and you will enjoy daily communication with people living at the remotest corners of the earth.

We are told, by men whose learning entitles them to our belief, that the power of steam was not entirely unknown to the ancients. I hope you all know that steam is water made into vapour, or, as I heard one of you the other day call the vapour that was rolling out in large white clouds from a kettle of boiling water,—into smoke, by the action of heat. For the future do not let me hear any of you be guilty of such a blunder. Know that smoke is the gas which proceeds from burning coals or wood, and that steam is the vapour which rises

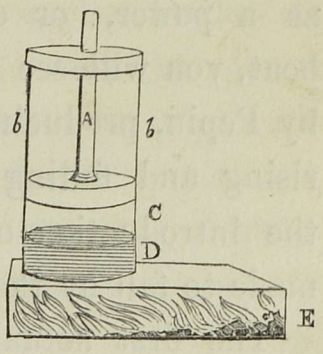
from boiling water. Among the ancients, steam was a power very little understood: and the only evidence of its subjugation to the purposes of man before the Christian era, is given to us by Hero of Alexandria, who has left us the description of a machine, in which a continued movement is given to a wheel by a blast of steam playing upon it.

It was about the beginning of the seventeenth century, that De Caus, a French engineer, invented a machine by which a column of water might be raised by the pressure of steam confined in the vessel, above the water to be elevated; and in 1629, an Italian named Branca contrived a plan of turning mills by a blast of steam. These projectors, though their inventions were rude, and possessed little power or usefulness, served to turn the attention of thinking men to the means of making the immense power of steam useful to the human race. So far back as 1663, the celebrated Marquis of Worcester gave to the world an account of the expansive force of steam. Let me read to you the

passage from his book, called "A Century of Inventions." "I have taken a cannon, and filled it three-quarters full of water, stopping firmly up both the touch-hole and the mouth; and having made a good fire under it, within twenty-four hours it burst, and made a great crack." With this experience the Marquis contrived a rude machine, which, he tells us, drove up water to the height of forty feet.

The next name which I shall mention to you in connection with the application of steam to useful purposes, is that of Denis Pepin, a Frenchman. You understand that if you fill a kettle full of water, stop up every hole, and then put it on the fire, directly it boils, steam will be produced; and the kettle that is only large enough to hold the water, cannot also contain the steam which occupies fifty times the space it takes up in the shape of water, and that therefore the steam pressing with great force on all sides of the kettle, will at length cause it to burst with a loud noise. Well, the great

discovery which Pepin made was that of obtaining the sudden return of the steam to water, or as it is generally called, its condensation by cold. As heat turns water into steam, so cold again reduces steam to water. The result of Pepin's studies was the idea of obtaining a moving power by means of a piston (*a*), working in a cylinder, or tube (*b*). To obtain this he constructed a tube or cylinder, into which he introduced a rod, or piston, fitting nicely as one joint of an opera-glass fits into the other in our days. Well, at the bottom of this cylinder he placed some water, and under the water a fire: the consequence was that directly the water boiled, and steam was made, the steam, wanting room to expand, forced the rod, or piston, up. When the piston had been raised, Pepin removed the fire, and so, as by the action of cold the steam again became water and



C. Steam. D. Water. E. Fire.

returned to its compact body at the bottom of the cylinder, the piston fell. Though Pepin did not live to perfect his ingenious invention, his labour produced the basis upon which all our steam power has been obtained. If you go into any of the factories where steam is employed as a power, or examine the engine of a steam-boat, you will see that piston and cylinder invented by Pepin, producing the power of the engine by the rising and falling of the piston, as it is raised by the introduction of steam into the cylinder, and made to fall by the reduction of the steam to water.

The first actual steam-engine of which we have any undeniable record, was constructed by Captain Savery, an Englishman, for the purpose of raising water. This was in the year 1699. Captain Savery's engine, however, from the expense of working it, and the constant danger of explosion, soon fell into disuse. It was in fact a very rude machine, as the condensation of the steam was not sufficiently ensured. These discoveries and inventions, however,

served to turn the attention of very many clever men to the improvement of the steam-engine. In 1705, Thomas Newcomen, an ironmonger, and John Cawley, a plumber and glazier, constructed an engine in which the condensation of the steam was effected by the application of cold water outside the cylinder. The improvement of their first engine is due to Newcomen, who, having noticed that the piston rose and fell three or four times with great rapidity without the application of cold water, examined this piston, and found a hole in it, through which the water intended by him to keep the cylinder air-tight, issued in a little jet or fountain, and instantly condensed the steam under it : this led him to introduce a pipe stopped by a cock, into the bottom of the cylinder, through which cold water was supplied from a reservoir. This engine, known as Newcomen's engine, required the constant attendance of some person to open and shut the condensing cocks or valves, a duty which was generally fulfilled by boys, called cock-boys. When I

tell you that we owe a most important improvement in the steam-engine to the desire of a boy named Humphrey Potter to join his comrades at play, when he should have attended to the condensing cock, I shall not, I trust, make any of you hope to do good by neglecting your duty. You know that the primary action of the steam-engine is the rise and fall of the piston or rod in the cylinder or tube; I have explained to you that in Newcomen's engine, the condensing or reducing of the steam was brought about by the introduction of cold water, through a pipe at the bottom of the cylinder, and I have also said that this cold-water pipe was stopped by a cock. Well, the duty of the cock-boy was to turn the cold water on through the pipe at the bottom of the cylinder, directly the steam had forced the piston up. This must have been very irksome duty for the poor boys; at least it appears that Humphrey Potter found it so, and, in order to be able to leave the engine without stopping it, he tied the handle of the cock, by a string to the piston,

so that when the piston rose, the cock was turned on, the cold water entered the cylinder, the piston fell and the cock closed again; and in this way the steam-engine was first made a self-acting machine.

I must now tell you about a man who will make no mean figure in the annals of your country, I allude to James Watt. It was in repairing a working model of a Newcomen's steam-engine for the lectures of a learned professor of Glasgow University, that Watt's attention was first seriously called to mechanical invention. At the time of which I speak, Newcomen's engine was the most perfect one in existence. The moving power was the weight of the air pressing on the upper surface of a piston or rod working in a cylinder or tube; steam being used to raise the piston with its load of air up again, and then to form a vacuum, or empty space, by its condensation when cooled by a jet of cold water, which was thrown into the cylinder when the piston was raised. The great improvement which Watt introduced was the condensation of

the steam in a separate vessel. He perceived that as it was necessary in Newcomen's engine to introduce cold water into the cylinder in order to condense the steam, the cylinder must necessarily be cooled also, and that consequently, when the next blast of steam came, much of it was wasted by the coolness of the cylinder, which in fact condensed the steam, and therefore weakened its power. Watt at once perceived that the only method to do away with this defect was to draw the steam off directly the piston was raised, by making a vessel void of air, near the cylinder, communicate with it, into which the steam could be drawn off, leaving the cylinder perfectly empty, and so giving more force to the descent, or, as it is called, the down-stroke of the piston; and at the same time keeping it warm for the next blast of steam. These improvements gave additional power to the engine, and prevented the waste of steam. In Newcomen's engine, not only was the cylinder cooled by the introduction of cold water, but it was allowed to be full of air,

and partially condensed steam, so that the fall or down-stroke of the piston lost much of its force. Watt improved upon this also, and emptied the cylinder of air, so that, in his engine, the interior of the cylinder offered a perfect vacuum, or empty space, to the fall of the piston. In the minuter, though important parts of the engine, Watt made many improvements. He perfected the construction of his engine, so as to regulate its power with great exactitude, by introducing a certain quantity of steam, and no more, for each up-stroke of the piston. He is, in short, justly esteemed as a man who contributed largely to the progress of his fellow-creatures. He died at his house at Heathfield, in the county of Stafford, on the 25th of August, 1819, in the eighty-fourth year of his age, having made a large and well-deserved fortune by his noble labours.

My children, were I to attempt to trace for you a history of the various applications of the steam-engine to the different branches of industry, we should find ourselves involved in a story of the progress of the

world for the last thirty years. Such a subject is one too grave and too important to you to be chatted about round the fire. It is a subject which you will have to study seriously in your books: I shall not therefore touch upon it. To give you an account of the wonders steam has achieved, would be to count almost every comfort and luxury which we enjoy. Dr. Lardner, whose book on the steam-engine you shall all read when you are a few years older, tells us that the steam-engine has increased the sum of human happiness, not only by calling new pleasures into existence, but by so cheapening former enjoyments as to render them attainable by those who before could never have hoped to share them; the face of the land, and the surface of the waters, are crossed with equal facility by its power; and, by thus encouraging and helping the intercourse of nation with nation, and the commerce of people with people, it has knit together countries far away from each other by bonds of friendship not likely to be broken. Knowledge and affection are kept up by its power

between people thousands of miles away from one another; those more advanced in learning shedding the blessings of knowledge over their barbarous and distant brothers. By this means,—by the subjugation of the force of hot water to the will of man,—has the progress of this century been brought about, and you may be thankful, my dear children, that you are born in a time when the tree of knowledge is shedding its fruit all over the world, making men friends, and nations welcome neighbours. This is the story, the great story of some HOT WATER.

THE STORY OF A PIN.

Very few children know how much ingenuity and labour are spent upon a pin They are accustomed to see hundreds of pins every day, yet they never pause to inquire how they are made, or who makes them. Yet, I can tell them, the story of that little instrument called a pin is a very interesting and instructive one. There is no account in existence of the first pin that was ever made—but this is very certain, that it was made long before the time of Henry the Eighth, who, my young readers I trust remember very well, reigned about three hundred years ago, for he would not allow any to be made that were not properly pointed. In the olden time, pins were made of many substances, of boxwood, bone, or silver, now they are usually made of brass. Ten persons are generally employed

to make one pin, and it is well known that these ten people can, within the space of eight hours, make five thousand five hundred pins. It may at first appear very astonishing to you, that so many pins may be made within this short space of time; but if you take the trouble to think upon the subject, and to consider how, by dint of persevering practice, a little girl will learn to knit with marvellous quickness, you will cease to feel any surprise at the rapidity and dexterity of practised pin-makers.

The first thing to be done in the making of a pin, is to draw out a quantity of brass to a wire of the thickness of the pin to be made. This operation, though it would seem to be more properly the business of a wire-drawer than of a pin-maker, is generally performed in the pin-factory, as it is found, for some particular reason, to be more conducive to the interests of the proprietor to draw his own wire to the requisite thickness. When the wire has been properly drawn out, it is wound up

into coils of a certain and equal size; and then, to burn off any dirt or impure substance that may cling to it, it is dipped into a mixture of acid and water, which has the effect of instantaneously removing anything that may adhere to the metal. In the same way, if you dip a dirty brass rod into vinegar, or rub it with vinegar, the action of the sour or acid liquid will cause all the dirt to come from the brass, leaving the rod quite bright and clean. Well, when the wire that is to be made into pins has been cleaned, it is straightened and cut into pieces of equal length. A number of these lengths are then taken together, and, by means of a large and powerful pair of shears or scissors, which are worked by the foot, they are cut into shorter pieces, each piece being a little longer than six pins joined together. The next thing to be done is to point these pieces of wire, and for this purpose two revolving wheels, like those you see the knife-grinders use in the streets, only much smaller, and made of steel instead of stone, are provided. The man

whose business it is to point the wires, places himself before these steel wheels, and taking several of these pieces of wire in his hand, applies their end to the first wheel, which has the coarser surface of the two wheels, in order to prepare the way for the action of the finer wheel; and, while he holds the ends of the wires to the first wheel, contrives by a dexterous movement of the thumb and first finger, to make the wires revolve in his hand, so that every side is presented to the action of the wheel and a rough round point is made. The next step is to submit these rough points to the action of the fine wheel, which polishes them to the smooth sharp points which pins generally have. Having done this, the same workman who makes the points, takes a powerful pair of shears, or scissors, and cuts the wire the length of a pin from the points he has made, and then proceeds to sharpen the end of the remaining wire to make the stem of another pin, and so on till he has made six stems, to the length of which, my little readers will bear in

mind, the wires are generally cut. The stems of the pins are now complete, and in a state to receive their head. For this purpose they pass into the hands of another workman, whose sole employment is to fasten the heads on to the stems. But first of all, we must follow the operations of the man who makes the heads. Here I must beg that my young readers will follow me with great attention, as the process I have to explain to them is a very troublesome and difficult one. Well, in the first place a piece of wire called the mould, the same size as that used for the stems, is attached to a small, revolving axis. At the end of the wire nearest the axis is a hole, through which is placed the end of a smaller wire, so that when the wire that is attached to the axis is made to turn round, it twists the thin wire round it, and when this has taken place the workman cuts the thin wire, and allows the head which has been formed by the winding of the thin wire to fall from the thick wire into a compartment made to receive it. You may

see for yourselves, by examining the head of a pin attentively, that it is made of a thin wire wound carefully, neatly, and smoothly round the stem of the pin; and you may judge for yourself how dexterously the workman must perform his labour, when I tell you that in the course of an hour he makes five thousand five hundred pins' heads.

When a quantity of heads have been properly prepared, another workman takes them, together with an equal quantity of stems, and proceeds to fasten the heads upon the stems in the following manner. The workman is provided with a small upright stake, upon which is fastened a steel die, containing a hollow the exact shape of half the head. Above this die is suspended a moving die, containing another hollow exactly the size of the other half of the head, which, when at rest, remains suspended about two inches above the lower one. Well, being thus provided, the workman takes one of the stems between his fingers, and dipping the pointed end into a bowl containing a number of

heads, catches one upon it and slides it to the other end. The head when first slipped on in this way is simply a piece of thin twisted wire; well, to give it its proper shape, and make it even and smooth as you see the heads of pins, he places it in the lower hollow, which as you know, is exactly the size and shape of half the head; he then causes the upper die, containing the mould for the other half of the head to fall on the lower half, and so quite close the pin's head in, and press it to its proper shape. This he repeats two or three times, for the purpose of fastening the head firmly on the stem of the pin.

The pin is now finished as regards shape, but it is still an ugly, dark, dirty colour, and quite unfit to pin ladies' ribbons. To cleanse and whiten it, therefore, is the next business of the manufacturer. When a quantity of pins are finished they are boiled in what the workmen call "a pickle," which is a mixture of sulphuric acid and water, similar to that which I have described to you in a previous

page. This mixture has a large proportion of acid, because it is necessary by its action so to bite into and roughen the pins, as to make them take easily the coating of tin which is afterwards given to them.

After being boiled for half-an-hour, they are washed, and then placed in a copper vessel with a quantity of grain tin, that is to say, powdered tin, and a mixture of tartar. The mixture of tartar, acting upon the tin, and upon the pins, causes the tin to adhere or stick to the pins, so that when they are taken out of the copper vessel, they are quite covered with the tin, and present a brilliantly white appearance. They are next sifted or shaken in a sieve to disengage any loose tin that may adhere to them, and then carefully washed. To dry them, the workman throws them into a bag half-full of bran, in which he shakes them for some time, when he throws them into a wooden tray and for the second time shakes them well, for the purpose of disengaging the bran, which

flies off, leaving them beautifully bright, quite clean, and in fact, ready for use.

You will see, by this story, that a great amount of labour is requisite to produce a pin: and that you owe the use of this little, but most useful instrument, to the combined strength and ingenuity of many people. Women and poor little children, as well as men, are employed to make pins; and, perhaps, if you reflect upon this, and remember that every pin wasted by you, has been made with much trouble and weariness, by a little boy not bigger than yourselves, you will feel less inclined to waste wantonly what has been produced with so much labour, and, may be, at the cost of a fellow-creature's health.

You have noticed that when your mother has lost anybody very dear to her, she has worn black clothes, and dressed you in black also: and I should think that the black pins which she used on those sad occasions, did not escape your attention. I think you would be glad to know how these pins are made: I will tell you. The best black pins, that

is to say, those that have a dark, very dark purple hue, are made of steel tempered to a deep colour, instead of brass; while those which look perfectly black, but which, after a severe rubbing, become white, losing their outer coat, are common pins dipped in a black varnish instead of the solution of tartar and tin. You now know the exact difference between the manufacture of a common pin, and a mourning-pin. May you, children, seldom have occasion to use a black pin, or forget the poor little workmen, whose hard toil provides you with a white pin. The poor little fellows who work from morning till night in the pin-factory, barely earn sixpence a-day. We are told, and on very good authority, that the number of pins made daily, in England alone, is more than fifteen millions. This astonishing number, I am inclined to think, is rather below than over the actual number manufactured; I am rather led to believe that as many as twenty millions are made every day in this country. Be this as it may, I think I have told you enough to

interest you in the Story of a Pin: and I do hope that for the future, you will bear in mind what is so often told to children, that the most insignificant thing is the result of industry, — and that even a pin is made at the cost of much labour and ingenuity.

THE STORY OF A SASH.

THE STORY OF A SASH.

I AM glad to see Jenny with her new sash. She deserves the very pretty present her mother has made her. She has been a very good girl. I like to see children behave well, not for the sake of getting a reward in the shape of a present, but for the delight of knowing that they are doing their duty to their parents as well as to themselves. I am very happy to hear that Jenny is so pleased with her mother's gift. She is very proud of the sash, I dare say; but can she tell us all about it? No! Well then, children, gather round the fire, throw on a shovelful of coals, and let me tell you

THE STORY OF JENNY'S SASH.

I hope you all know that silk comes from the silkworm. You recollect that when Harry kept

silkworms, they used, when they had grown to a certain size, to retire into a corner of their box, and gradually cover themselves with a fine yellow silk thread. You noticed them moving their heads to and fro, from one corner of their little prison to the opposite corner; and you could, I should think, see the thread of silk which they seemed to be unwinding from two holes in their head. Well, of that thin and brilliant web, Jenny's strong sash is made. The processes which that thin and frail thread has to undergo, before it is strong enough to be worn, are, as you may imagine, manifold, and I think very interesting. Well, as you have seen, when the silkworm has grown to a certain size, it seeks a corner in which to form its nest, or as silk-merchants call it, its cocoon. Bear in mind the meaning of the word cocoon, as I shall use it frequently in the course of my story. This cocoon is formed by the labour of the worm, as you have also seen. Gradually the worm becomes quite hidden from sight, but still it labours on, spinning more

and more length of filament, or silk, from the two holes in its head, and disposing the rich and glossy thread round the interior of its hollow dwelling. This nest, Harry knows, assumes the form of an egg. At length the worm inside becomes exhausted, and ceases to spin: its nest or cocoon is finished. Let me not forget to tell you that the two threads spun out from two holes in the worm's head are, by a peculiar movement of its mouth and front legs, fastened together, and fixed by a gummy liquid which comes from its mouth. The worm, if not interrupted, usually spins out the whole quantity of its silk in one thread of enormous length.

Silkworms are reared in large quantities in Italy, France, India, and China. Harry can tell you that they are fed upon mulberry leaves: and I dare say he remembers Cowley's verses on the mulberry-tree, where he says:—

"Her fruit is rich, but she doth leaves produce
Of far surpassing worth and noble use.

* * * * *

They supply
The ornaments of royal luxury:
The beautiful they make more beauteous seem,
The charming sex owe half their charms to them;
To them effeminate men their vestments owe;
How vain the pride which insect worms bestow!"

Do you hear that, Jenny?

"How vain the pride which insect worms bestow!"

Always remember, when you feel proud of your sash, when you look with joy upon its beauty,—that you owe it to the labour of a poor worm. In Italy and China, the rearing of silkworms is the occupation of one class of persons, while the winding of the silk from the cocoons is the occupation of another distinct class of people. Those persons who rear silkworms sell the cocoons to the winders or reelers. All cocoons, however, are not of equal value; the cocoon proprietor therefore separates them into different qualities, to which he gives

separate names. For instance, the most perfect cocoons he calls "good cocoons;" next in point of value come the "pointed cocoons," which are inferior in worth to "good cocoons;" because they are apt to break in the winding; then come "concalons," or large, loose cocoons; then "doublets," so called from imperfection in the thread; then "soufflons," which are very imperfect cocoons; and so on, each kind bearing a value proportionate to its soundness or the facility with which it is likely to yield an untangled silken thread.

The Chinese pay great attention to the condition and feeding of their silkworms, and are particular as to the time of preparing them for spinning their cocoons. They allow the worms three days to spin; and in six days they stifle the worm, which during that time, has been changed to a chrysalis, or, as Harry says, a grub. This is done by burying the cocoons in a jar, underground, lined with mats and leaves, interlaying them with salt, which kills the grub, and keeps the silk strong and bright.

Packed in these jars the cocoons can be carried any distance without receiving injury, and may be kept unwound for some time. Another mode of destroying the grub, is by steaming it. The steam not only destroys the grub, but prepares the silk for the winder. The Italians kill the grub by exposing the cocoon to the burning rays of the summer sun. Some rearers destroy the poor silkworm by putting the cocoon in a moderately heated oven. This is a terrible end for the poor silk-makers! How many worms must have been baked, Jenny, to make your sash! When the insect is killed, the external loose covering of the cocoon, better known to you as floss silk, is opened, and the hard cocoon is pressed through the opening.

When the winder, or reeler, has purchased the cocoons from the rearer, he proceeds to prepare them for the process of unwinding and forming them into hanks or skeins. With this view the cocoons are thrown into a vessel full of warm water, and there left till the gum, which the worm uses as a cement

to keep the cocoon together, is so far softened as to permit the thread to come off. The reeler then takes a whisk of fine twigs bound together, and cut off evenly at the ends; and with this she (for the reelers are generally women) presses and stirs the cocoons till the loose ends of the silk adhere to its points; she then gently raises the whisk with the threads of silk clinging to it, disengages them one by one, from it, and draws their ends through her fingers, to remove any floss or dirt that may cling to them. Then, supposing the thread which she is about to form to consist of ten filaments, she collects the threads of ten cocoons, and passes them through small eyes or holes in a reeling machine. The first, we will suppose, forms two groups of five threads each, each group passing through one eye, which is presently combined with the other group of five threads, making one solid thread of ten filaments. This solid thread is then wound upon a square reel; the cocoons, still immersed in the warm water, being carefully softened, which will allow

them to yield their filaments freely. As fast as the cocoons are exhausted, others are thrown into the water, and their threads gathered up, and united to the solid thread. You now know how the silk leaves the form of cocoons, and becomes a skein, or as the manufacturers call it, a hank. Well, in the form of hanks, or skeins what manufacturers call "raw" silk is imported into this country to be woven into ribbons, satins, and velvets.

The Chinese assert, and they have abundant proof of their assertion, that silkworms were reared, and silk was manufactured into clothes as far back as 780 years before the Christian era. Indeed many of their learned men are bold enough to maintain that the silk of the silkworm was manufactured by the Empress Síling, wife of the Emperor Hwangtí, 2602 years before the Christian era. An old Chinese record is said to contain these lines:—

"The legitimate wife of Hwangti, named Siling shé, began to rear silkworms:
At this period Hwangti invented the art of making clothing."

The Chinese esteemed the produce of the silk-worm so highly that they worshipped a goddess of silk-worms. We are also told by old Chinese writers that in ancient times emperors did not disdain to plough the lands, nor empresses to cultivate the mulberry-tree to feed the silkworms, as an example of industry to their people. There can be no doubt that the Chinese were the original manufacturers of silken goods; and at the present day, perhaps a third of the population of that immense country is clothed with the filaments of the useful silkworm. The finest silk in the world comes from China, and is called *toatle* by the Chinese.

The hanks or skeins of silk brought over to this country vary considerably in size, shape, weight, and colour. The Chinese silks are the whitest. Indian silks are imported in small skeins, Italian raw silk in larger skeins; and the Persian silks, which are the least valuable of all the silks that come to our English market, are

imported in skeins weighing usually a pound each.

We must now carefully follow these skeins (or raw silk) through the processes called silk-throwing, which they must undergo to be brought into a proper state for the use of the weaver, and the stocking-maker. Formerly *silk-throwing* was an art in the hands of foreigners only, until John Lombe, an English workman, went to Italy, and by bribing the men engaged in the silk-throwing mills there, gained sufficient knowledge of the machinery used by the Italians, to guide him in the construction of the famous old Derby mill, which he built in 1717 at a cost of 30,000*l.* This was the first silk-throwing mill ever erected in England; and so well did it succeed, that it did great harm to the Italian silk-throwers, who, in revenge for John Lombe's forbidden visit among them, are reported to have bribed two Italians to poison him with slow poison. John Lombe lingered two or three years in agony after the arrival of two Italians at

his mill, and then died, as people supposed, killed by these foreigners.

Derby, ever since Lombe's time, has maintained a great reputation for its silk manufactures. Lombe's machinery has been improved by degrees; so that now some of the silk-mills are great examples of factory economy. You have all heard of the poor Spitalfields' men; but you must not confound their employment with the silk-throwsters. Spitalfields is famed for the weaving of silk, while Manchester, Derby, Macclesfield and Congleton are noted for silk-throwing mills. Let us now follow some skeins of silk through a throwing-mill. You must first understand that the hanks or skeins of raw silk are taken to the mill in bales or bundles. The appearance of these bales when opened, is very brilliant, from the brightness and richness of the silk. The process which these skeins undergo depends, of course, on the purposes to which they are to be applied afterwards. For instance, there is a kind called *dumb singles*, which is silk simply wound

and cleaned: this is used principally in the weaving of gauze, and other light fabrics; another kind is known as *thrown singles;* this is a silk which has been wound, cleaned, and thrown, and is then used in the weaving of sashes, and common silks. This is then the process which Jenny's sash has undergone. *Tram* is silk which, besides being wound, cleaned and thrown, is 'doubled,' that is two or more threads are twisted into one; this thick thread is used for the weft, or cross threads of velvets, and flowered silks, and what are called corded silks. You will understand from what I have told you that the operations to which silk is submitted, differ according to the purposes to which it is to be applied. For instance when the weaver wants a thick cord, the silk is wound, cleaned, and doubled or trebled; if, on the contrary, he wants a thin thread to make gauze and very fine silk material, the silk is only wound and cleaned.

So that you will see, the operations to which the raw silk is submitted before it is given to the

weaver, may be classed as cleaning, winding, doubling and twisting, or throwing. After a slight washing- or soaking, comes the process in which the winding-machine is used. The term 'winding' refers, let me remind you, to the hanks or skeins of raw silk, as well as to the manufactured article. You have often held skeins of silk for your mother to unwind, well in silk-mills, instead of using little children's hands to wind from, the manufacturer uses a wooden contrivance. This wooden frame is called a *swift* in the mill, though its movements are slow when compared with the quick motions of those reels on to which the silk is wound.

You recollect that the hanks or skeins which come from various countries, are not all of the same size. I hope Harry recollects, for example, that the Persian skeins are the largest of all foreign skeins, and that the silk is of inferior quality. The *swifts* are therefore made of different sizes, to suit the diameter of the skeins. The

skeins of raw silk are opened and spread separately round these swifts; but when the manufacturer wants to make a thick skein from the raw hank, he twists several skeins round one another, so that they form one thick thread on the reel below. To show you, my children, to what a wonderful state of perfection machinery has been brought in your own country, I will tell you there is in some parts of the operations I have described to you, a very pretty little contrivance, which refuses to work when anything is going wrong. It is a dumb tell-tale, a warning which immediately tells the woman that something requires her attention. When the delicate silks of thread are passing from the revolving swift to the revolving reel, if the thread happens to be bad or weak at any part it will probably break, and if this breakage were to remain unnoticed, it would seriously injure the manufactured article. For instance, suppose four skeins from the *swift* are being turned into one, and one of the four break, the other three, if not

instantly stopped, would continue to form a threefold thread only, which would of course be much thinner than the fourfold thread previously made. Well, the little tell-tale guards against this, by stopping all the bobbins of one group instantly, when any one of the threads breaks. Each thread passes through an eye in the end of a short lever; and when a thread breaks, the lever loses a temporary support, falls, and by means of a sort of catch stops the movement of the reel or bobbin on which the doubled thread is being wound. This stoppage, of course attracts the notice of the person who is watching the machine, who mends the broken thread, and the ingenious tell-tale then allows all to go on smoothly till another breakage calls for its attention and warning.

Hand-twisting is not yet quite supplanted by the giant steam. There are some kinds of twisted silk, which are required to be thicker and stronger than the ordinary varieties: this strong and compact silk is generally manufactured by a process called

hand-twisting. This operation is performed by young, active boys about Harry's age, but by poor little fellows less fortunate than he, who have to work hard for their dinner and supper, and only get very coarse food after all their labour, while he has the best of everything, and has nothing to do for it. Well, these poor boys are employed in running to and fro, carrying silken threads in their hands. At one end of a very long room is a large wheel turned by a man. On one face of the wheel, near the circumference, are about a dozen hooks ranged in a circle. Several threads of silk, twelve or a lesser number, are fastened to these hooks, and the other ends of the twelve threads are carried to the distant end of the room by the boys. At that end they are fastened to hooks attached to a machine made to move very slowly along the floor, so as to enable the threads to twist without breaking. Matters being in this way prepared, the wheel is turned, by which the hooks on the wheel are made to go round very fast, and so the

threads fastened on them become twisted one round another very closely, making at last a strong cord.

All silk is either dyed or bleached at some stage of the processes which it undergoes while in the manufacturer's hands; but it is generally either bleached or dyed soon after the twisting is finished. Before it is dyed, it is made up into hanks a second time, and scoured, to remove the gum which may still stick to it. Before this scouring, the silk is rough and unpleasant to the touch, and is unfit to receive dye. It is boiled for three or four hours in strong soap and water; by which means the gum is got rid of, and the silk comes out soft and glossy as you find it in the shape of ribbon. The silk is next washed in a current of clear water to remove the soap. It is now ready for the weaver; either in the shape of thin thread called warp and weft for weaving, as yarn or thick thread for hosiery and gloves, as sewing silk, or in thread fit for the weaving of velvets, &c. It is not pos-

sible at the silk-throwing mills to manufacture all the silk brought to this country.

You recollect when we were talking about the cocoon of the silkworm, that I told you about its outer covering being of a coarse and harsh quality of silk, and that this coarse silk was called floss-silk. As this floss-silk has no connected thread it is sent to the silk-spinning mills, which are situated chiefly in Manchester, where it is spun into yarn (like hemp for ropes), to be manufactured into inferior silk articles. The process of manufacturing floss-silk has not been long carried on; but it now forms a large trade in the country. Jenny's sash was not made of floss-silk: certainly not. It was wound and twisted on the spinning-machine I have drawn for you, and most likely woven by a weaver at Coventry. You have seen poor weavers in the streets plying their trade to move the charity of passers-by; well, by one of those weavers, probably, Jenny's sash was made. There is a large body of them at Coventry. You know that most

woven fabrics consist of threads crossing each other at right angles; the long-threads (for instance) of Jenny's sash, being called the *warp*, and the cross threads the *woof*. If Harry keeps silkworms next summer, I hope he will take more care of them than he took with the last he had; and be the more mindful of them, from knowing how greatly they contribute to the delight and comfort of his mother and sisters.

SHEEP-SHEARING.

THE STORY OF HARRY'S JACKET.

You will be surprised to hear that Harry's jacket was stolen from the back of a sheep:—that what once formed a great winter-coat for one of these gentle creatures, has been altered to a jacket for young Harry. This is, however, literally the fact. Whether a sheep has been clipped to clothe a lamb, or a lamb has been denuded to adorn a sheep, it remains for Harry by his conduct to determine.

You may well imagine that the wool passes through many hands after it is sheared from the back of the sheep, and before it comes home in the shape of a jacket. Many, many hours of hard labour have been employed to furnish Harry with his new blue jacket. Yet he puts it on gaily and thoughtlessly, without for a minute pausing to remember the points of its wonderful story. When he looked upon the tall

and dingy chimneys of Leeds, Huddersfield, and Halifax, and complained of the black fumes they sent abroad obscuring the air, and shutting out the distant landscapes, it never once occurred to him that the smoke and bustle, which so disgusted him, was necessary to furnish his back with the new jacket for which he had made such clamorous demands. Young people, and, indeed older folks, are apt to fall into the same ignorant error.

The wool of English sheep is not much used for broadcloth; for it is a curious fact, that, in proportion as the flesh of the sheep improves, and becomes better mutton, the wool grows coarser, and less adapted to the purposes of the cloth manufacturer. This may perhaps be accounted for by reference to the hair or wool of other animals. So far as I know, you will generally find that the most muscular animals have the thickest and strongest wool or hair. Take for instance the lion; and you will find that he is covered with strong, coarse hair: the bear again has a coat of strong, thick fur; on

the other hand, those animals which possess less strength—as the leopard, the hare, the otter, and others, have furs of the finest and smoothest texture. This peculiarity is not less remarkable in the human species, among whom you will generally know the strongest man, by the coarseness and quantity of his hair.

Formerly we derived the greater part of the wool employed in our cloth manufacture, from the Spaniards, whose flocks produced the finest wool to be procured. Afterwards the Spanish sheep were introduced into Germany and Saxony, and then the German wool gradually supplanted that of Spain; and now, both the German and Spanish markets are threatened with total annihilation, by the superiority of the wool of our Australian sheep. These sheep are commonly considered to be one of the handsomest races in existence, and form the chief property of the farmer in that part of the world. German wool is still extensively used for fine fabrics, but Australian wool, on account both of its cheapness and quality,

enters generally into the large bulk of our woollen manufactures.

The wool is conveyed to the factories in packages of various shapes and sizes.

The wool from one sheep is called "a fleece." The weight of each fleece varies, of course; but, on an average, those from foreign sheep weigh from two to two and a half pounds. The foreign wools are usually imported, tied up in small bundles of three or four fleeces each. The coarser English fleeces weigh, on the average, from five to eight pounds. When one of these bundles of wool is opened, the locks are all found entangled and matted together, in a dense and solid mass; and they have to be separated and loosened, before anything can be done with them. When the workman, into whose hands the wool first falls, has separated and softened the matted locks, he begins to sort the wool into parcels of different qualities. To do this, he must be a most expert workman, as the process demands the utmost nicety of touch, and very long experience.

When I tell you that the wool-sorter will sometimes take up one lock of wool, and in the course of a minute, distribute it in fifteen compartments, each compartment containing wool of a quality or colour different from the rest, you will not be surprised to hear that it takes long hours of practice before the sorter can instantaneously, by simply passing a lock of wool through his fingers, separate the soft fibre from the strong, the regular from the irregular, the soft from the rough, and the clean from the dirty. If you or I were to take up the same lock, and pass it through our fingers, it would be with the utmost difficulty that we should be able to divide it into two sorts, whereas the practised sorter, as I have told you, will, without hesitation, find wool of twelve or fifteen different and distinct qualities in the selfsame lock. This is another instance of the many useful results which are purchasable only by persevering industry. As the sorter separates the various qualities of the wool, he throws them on a wire-grating, subdivided to separate the

distinct varieties; and the dust and dirt shaken from the wool during the sorting, fall through the grating into a trough beneath, and are afterwards sold for manure. The wool thus sorted into distinct qualities, is next scoured in a mixture of hot water and pearlash, as a means of removing some of the grease, which it retains from the sheep.

The first process, by which the locks of wool are separated, and the fibres loosened one from another, is performed by a machine called a *willy*, or by the workmen—a *devil*. This willy is simply a number of combs fixed in a hollow receptacle, which catch the wool as it revolves within the machine, and tear them open, fibre from fibre. Before, however, the wool is submitted to this rough combing, it is oiled, to render it soft and easy to work.

When the wool has undergone the processes I have described to you,—that is, when it has been sorted, scoured, oiled, and combed, it is conveyed at once to the spinning-room. Here the clatter of wheels, and the rapid and intricate movements of machinery, will

at first bewilder the stranger on his entrance, and make the scene appear but a vast confusion of cranks, and wool, and workmen. But should he remain to examine and analyse the activity and labours which go forward in the spinning-room, he must be struck at last with the beautiful harmony and simplicity of the means which effect such rapid and wonderful results. He will see young children directing the mighty machines in their potent labours, and with their tiny fingers bidding the leviathan to work, or cease working. In the spinning-room the wool undergoes three processes:—being submitted to the action of the *scribbling-machine*, the *carding-machine*, and the *slubbing-machine*. The *scribbling-machine* consists of several cylinders, or rollers, on the surface of which are innumerable points (precisely similar to those you have seen on the roller of a musical-box). Well, these cylinders are so placed, that the teeth or points of one cylinder, while revolving, nearly touch the teeth of its neighbour, so that anything placed on the first cylinder, is caught

up by the second cylinder (when the cylinders are revolving), and so on to the third and fourth cylinders. This being the arrangement, a girl takes the oiled wool by handfuls from a basket, lays it on an apron at one end of the machine, and spreads it as smoothly as possible over the surface. By the motion given to this apron, the wool is carried on to the first cylinder, where it is caught by the teeth, and carried round till brought within the grasp of the second cylinder, which tears it from the first, and carries it round to the third cylinder, when it is torn from the second cylinder; and so one cylinder, like a rapacious neighbour, tears the wool from the cylinder nearest to it, till at last, torn into a light downy substance, it falls from the *scribbling-machine*.

This downy layer of wool is next cast upon the *carding-machine* by a girl called a card-filler; who weighs the wool and puts a certain weight of it on the apron called the feeding-apron of the machine. This process determines the thickness of the cloth, and therefore requires great nicety in laying the

wool equally on all parts of the surface of the apron; and can only be intrusted to a girl whose fingers, by dint of long practice, have acquired a nicety of touch almost equal to that which I have shown you to be necessary to the wool-sorter. The action of the carding-machine, which is too intricate for you to understand without the aid of a model, is to lay the fibres of the wool in what are called pipes of equal size. These pipes are in the shape of small skeins of thread, and are joined together by means of the *slubbing-machine*, which catches the pipes, or, as they are sometimes called, cardings, at one end, draws out a small portion, pulls out that small portion to many times its former length, and winds the "slubbing" or soft twist which it has thus made on a spindle or reel. Children, called "pieceners," are employed to join fresh cardings to the old ones as the machine gradually consumes them; so that the spindles become filled with an unbroken thread of slubbing:—one ounce of wool yielding from one to two hundred yards.

The wool has now reached that state when it is ready to be spun into yarn for the weaver. This is done by machines called *mule-spinning machines*, which repeat the process of the slubbing-machine, drawing out the slubbing to a thinner thread, and then twisting it as cotton-yarn and silk are twisted, and which process I have explained to you in the Story of a Sash.

We now have the wool in the state of spun yarn, and it now remains for us to follow it to the weaver's. Some of the yarn is for weft or cross threads, the rest for warp or long threads. Some of the yarn is dipped into a warm size made of parchment or leather cuttings to stiffen it. The process of weaving cloth is much the same as that of silk and cotton; and, as I trust that you have not forgotten our Story of a Sash I shall not weary you by stopping to explain the matter over again. Cloth-weaving is still generally performed by hand-loom weavers: the Steam-Giant has not yet relieved cloth-weavers from their hard labours.

In regulating the width of the cloth, attention is paid to the remarkable shrinkage which takes place after the weaving is completed. For instance, a piece of cloth to be sixty inches wide when sold to the tailor, must be woven nearly one hundred inches wide;—and the length must be allowed for in the same proportion.

So far the manufacture of cloth has presented no very material difference from the processes employed to adapt cotton and silk to the purposes of man: I must now draw your attention to the *milling*, *fulling*, or *felting* which the woven cloth undergoes, and which gives to it its peculiar texture, concealing the *weft* and *warp*, and presenting to the eye, a smooth, even, and silken surface. Fulling consists in beating the fibres of the cloth until they become so locked in each other that they appear one solid mass. This process is performed by *fulling-stocks*, which are receptacles in which a huge, oaken hammer rises and falls with immense force, by the power of a steam-engine.

Before the cloth is placed beneath these hammers, it is copiously sprinkled with liquid soap, it is then folded up into a pile, and submitted to the action of the hammer for the space of three entire days, being taken out twice each day to be re-soaped. This long process is necessary to make the fibres thoroughly interlock: it also narrows and thickens the cloth. It is now scoured, and stretched out to dry.

The cloth is now in a rough state; and it undergoes many finishing processes before being ready for use. The chief of these are *cutting* and *raising*. The process of *raising* is performed with teazle-heads, which are rubbed sharply over the cloth and have the effect of raising the nap more speedily and thoroughly than any brush that has been devised for the purpose. This process is sometimes performed by a steam-engine; and in this case the teazle-heads are fixed upon a cylinder and the cloth made to pass over them.

The nap of the cloth being thus raised it is *cut*,

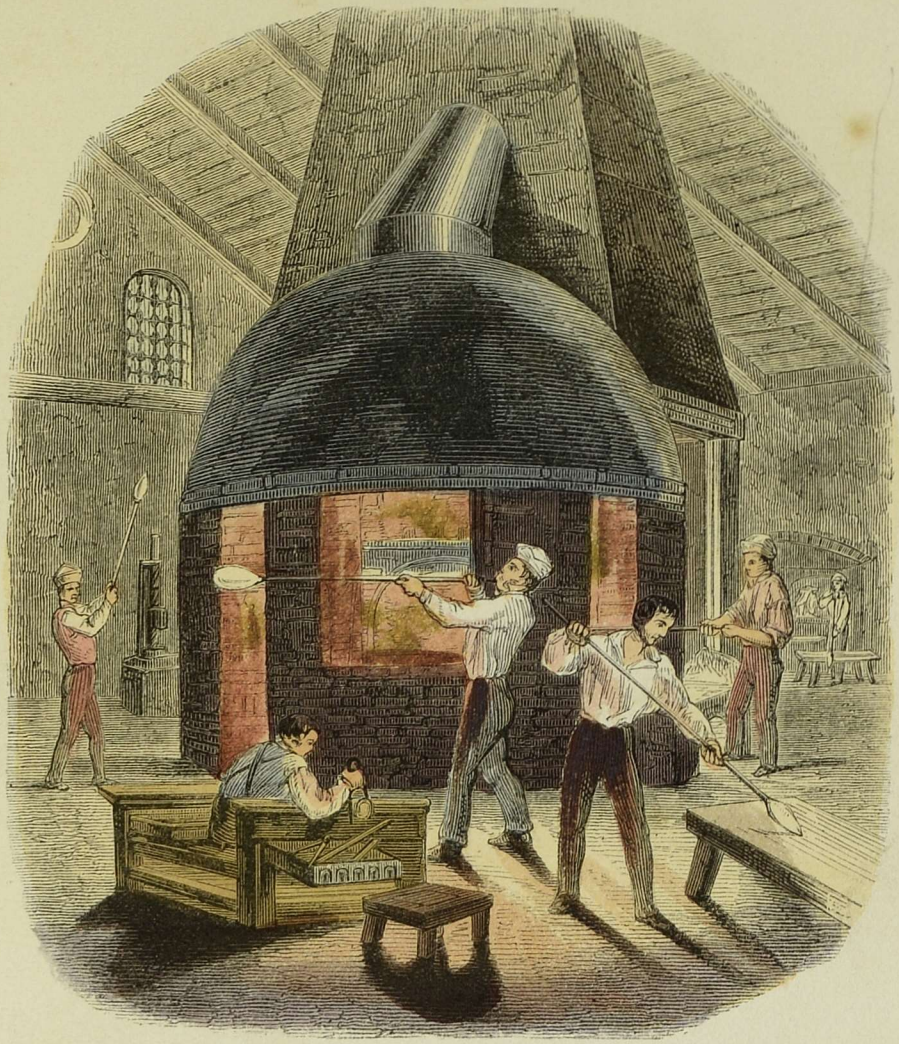
or *cropped*, to produce an even surface. This used to be performed with marvellous dexterity by manual labour, but it is now generally effected by steam-power. The process is simple enough; the surface of the cloth being made to pass a revolving spiral cutter, which mows the uneven surface and makes it smooth and even as you behold it in Harry's jacket. According to the quality of the cloth, the raising and cropping are repeated more than once, so as to produce different degrees of fineness of surface.

I have omitted to mention the dyeing process. Cloth is dyed either before it is spun or after it comes from the weaver's hands: in the latter case it is called *piece-dyed* cloth. There are many more processes used to perfect cloth; such as boiling it to impart a certain glossiness; *burling*, or picking it to remove dirt and other imperfections; *inking* any little white hairs and fibres that may have escaped the action of the dye; pressing it between hot plates and mill-board; *steaming* it or

passing it over cylinders covered either with brushes or a kind of plush, &c.

And now the cloth is ready for the tailor: the tailor is prepared for orders; Harry's father gives him directions to make Harry a jacket, and he sits diligently to work. I shall not describe the operations of the tailor; you have all seen patterns of dresses, and frocks, and jackets, and know how the tailor takes his measure, and cuts his cloth to the shape of the customer. And as for sewing, I hope that Harry and all his companions have often, very often seen their sisters with needles in their hands. Thus ends our Story of Harry's Jacket.

And when he puts it on let him give a passing thought to the skill and labour of those who manufactured it.



THE GLASS-HOUSE.

THE STORY OF A TUMBLER.

I HAVE promised to tell you the Story of a Tumbler; and, I can assure you, it is a very interesting one. I dare say you have often seen glass-blowers, with the gentlest breath, blow glass into all sorts of graceful shapes; and you have, in common with most people who know nothing of the manufacture of this proverbially hard and unbending substance, wondered to behold the workman bending, cutting, and twisting it like so much paste. But I must first tell you to what accident we are said to owe the invention of glass. The story is marvellously old, and very romantic. It is said that some ancient mariners who had a cargo of salt in their vessel, having landed on the banks of the river Belus, a small stream at the base of Mount Carmel in Palestine, and finding no stones to rest their pots on,

placed under them some lumps of salt, which being heated by the fire, mixed with the sand of the beach, and produced a liquid, clear, and transparent stream of glass. Be this as it may, it is very certain that the Egyptians were acquainted with the art of glass-making for many centuries, since many glass ornamental beads have been found on mummies, which had been embalmed more than two thousand years ago. Though the art of glass-making has been so long known, its application to the useful purposes of life is of comparatively recent date. It is not long that the poor of the country have, in their humble dwellings, enjoyed the blessings of light. Two hundred years ago, glass was so little used in Scotland, that only the upper windows of the royal palaces were furnished with it, the lower part having only wooden shutters to admit or exclude the air at pleasure. Several attempts were made in the sixteenth and seventeenth centuries to introduce the manufacture of glass into England but without success; and it was not till

the latter end of the last century, that a company was established for the manufacture of cast-plate glass in the country. I give you this history of the art of glass-making, because it appears to me that all young people should be as far as possible conversant with the progress of the arts which contribute to their personal comfort; for they are likely to be proportionately thankful for the luxuries which they enjoy in this civilized and enlightened age, when they are able to contrast the comfort of their homes with the rude, dark, and cheerless abodes of their ancestors.

Glass may be briefly described as a compound of silex or flint, and an alkali, such as pearl-ash, barilla, soda, &c. I am afraid that you would scarcely be able to understand me, if I attempted to explain to you the chemical properties of alkalies; suffice it, therefore, that I inform you to this extent, namely, that pearl-ash, from which flint-glass is always made, is a substance extracted from burnt wood, which has the power of combining itself with silex or sand,

thereby forming a liquid and transparent substance, through the action of intense heat. A very strong and long-continued heat is necessary to purify the glass, and cast off any impurities which may be found either in the silex or the pearl-ash. When all these impurities have been thrown off by the action of the intense heat, the glass, or metal, as it is called by the workmen, appears colourless and transparent; and the temperature of the furnace is gradually abated, when, as fast as the glass cools, it gets thicker and thicker till it assumes the consistency of paste, in which state it is used by the blowers, it being just soft enough to yield to the slightest pressure, without cracking or breaking. Throughout the wide range of manufacturing wonders, there is, perhaps, no process which excites so vividly the surprise and admiration of the beholder, as that of modelling flint-glass into all the various objects of convenience, utility, and ornament for which it is employed. To see a substance, which when it is sent home in the shape of some useful

domestic article, is proverbially brittle, blown with the faint force of the human breath, pulled, twisted, cut with a common pair of scissors, and then joined again in a moment, never fails to excite the utmost astonishment in all who behold the operation for the first time. Glass of every kind would be even much more brittle than it is—so brittle, indeed, as to crack and break with the least heat or cold, if it were not subjected, immediately after it is fashioned into the shape it is always to keep, to the process which is called *Annealing*.

Annealing consists, with respect to glass, in heating it, below the point at which it softens, in what are called *annealing ovens*, which are hotter at one end than at the other; and gradually passing the glass from the hotter end of the ovens to the cooler end. By this process the glass is gradually cooled and made as hard as you find it in the shape of a tumbler. You have most probably noticed that when boiling water is suddenly poured into a glass vessel it often cracks, or quite breaks

that vessel; this is caused by the action of the sudden heat abruptly disturbing the particles of which the glass is composed, and causing them to separate. The process of annealing, by reducing the temperature round about the glass very gradually, prevents this concussion of particles, and binds them firmly and hardly together in one solid, compact mass.

Do you wish to recognize at a glance, the materials from which the tumbler you see before you was originally made, behold them in my sketch of the solitary tree that rears its head in the arid barrenness of the parched desert, and in the plains of sand stretching as far as the eye can reach. By the ingenuity of man, a handful of the hot desert sand, and a branch of the tree, have been, as by a magician's wand, changed to a crystal vessel as clear as spring water.

You have read with gaping wonder, of the marvels wrought by fairy power, as told in the Arabian Nights: but, children, believe me, in your own

home there are, if you would but trouble yourselves to discover them, wonders far surpassing any you have read of in fairy tales. The great book of Nature is full of wonders, which can only be penetrated and brought to light by dint of perseverance and study. Around you, behold the results of the laborious ponderings and labours of your forefathers! The comforts you enjoy have all been purchased at the price of many lives, of anxiety, trouble, and persecution. The marvellous wonders of your home are so many monuments of perseverance and martyrdom in the cause of art or science!—they are wonders that should make you humble, thankful, and anxious to contribute your full share towards the happiness of your fellow-creatures. To produce this tumbler, how many weary hours have been spent, how many people ruined! You are accustomed to use these brilliant vessels daily; well, all I ask is that you sometimes bestow a thought upon the weary workers, at the cost of whose labour you are enabled to possess them. A tumbler, after all,

is but a lump of sand and burnt-wood mixed up together: but it is also an evidence of the power God has given to man to adapt the simple properties of Nature, and make them subservient to his comfort. Every day men are able, by constantly searching after them, to find new wonders, and new powers in the bowels of the earth, the veins of the trees, and in the gurgling streams; he has already dug from beneath the soil, fuel to warm him in the winter, and iron with which to make his tools; from the veins of plants he has extracted juices to heal him in sickness; and he has directed the running brooks to grind his bread by turning his mill-wheels—and then he has cast the water into boilers, and so given birth to the giant—steam. He has, for ages schooled the winds to waft him round the world, and of late years subdued the lightning to be the messenger of his wants and wishes. These are not wonders wrought by wicked fairies, but every-day marvels which the hard labour and study of those about you, are constantly bringing to light

for your benefit; and you must work and strive hard, that you may be able when your turn comes to go abroad into the world, to contribute your part to the welfare of your fellow-creatures. While in your youth you reap the benefit of your ancestor's toil, you must study diligently that you may presently be able, in your turn, to accomplish some useful work for the benefit of those who will be children when you are old and grey. Think of this, children, and remember the good lessons contained in our Story of a Tumbler.

THE STORY OF A KNIFE.

A KNIFE is, perhaps, without exception the most useful implement used by man. The rudest savages as well as the most civilised nations are indebted largely to the ancient discoverer who found that a hard substance with a thin edge would divide a softer substance; that keen-edged iron divided wood, and wood divided earth. Indeed we must have inherited this knowledge from our first parents, who were sent forth to earn their bread by the sweat of their brow. Knives have been made of wood, stone, and iron; but in modern times those made of iron have altogether superseded both wooden knives and stone knives. England has long been famous for the keenness and strength of her blades. The Indians roaming in the Wilds of America, and the aborigines of New Zealand, both set a high value

upon the cutlery of Sheffield, and shape their bargains with Europeans accordingly.

I need scarcely tell you that the knives which are used at table, are made of iron,—that is to say of iron which has undergone a certain process, and is known to most people as steel. I cannot, for it would take up too much time, pause to describe to you the mining processes by which iron-ore is extracted from the bowels of the earth; I will simply tell you now that when iron is first brought to light, it is mixed up with a quantity of earth, from which it is afterwards detached by the operation of smelting-furnaces, from which the pure metal runs in a liquid state, into a vessel placed to receive it, leaving the earthy matter that was mixed with it behind. This pure metal is rolled into bars and rods. Steel is made by combining carbon or charcoal with the iron. You may wonder to hear that it is possible to make this combination: but if you will take the trouble to examine the plumbago in a pencil you will find that there is a large proportion of charcoal

mixed up with the metal. It is in fact the charcoal which marks, while the metal imparts brilliancy to the mark. Well then, in steel there is a larger proportion of iron than charcoal; while in plumbago there is more charcoal than iron. English manufacturers are very particular in their selection of iron for the manufacture of steel; and the metal which they esteem most valuable for this purpose is Oregund iron, which comes from Dannemora, in Sweden. Our finest cutlery is made from the metal extracted from the Dannemora mine. Nearly all the produce of this mine finds its way to Sheffield, to be made into steel. When the iron arrives in Sheffield, it is first taken to the Steel-Works, where it is placed in a *converting* furnace. This furnace contains two long troughs, each measuring about twenty feet in length; and they are so placed that an intense fire may be kept continually in contact with them, and so raise whatever may be placed in them to a high heat. On the bottom of each trough is strewn a layer of coarsely powdered charcoal, then

a layer of bars; then another layer of charcoal and another of bars, and so on till the troughs are full, when they are covered over with a clayey substance called *wheelswarf* to exclude the air, and so prevent the charcoal from burning away. A fierce fire is then kindled and kept up for many days without intermission. During this time the iron is almost in a state of white heat, the charcoal is equally heated, and the iron seems gradually to absorb the particles of charcoal into the very heart of the bar. The harder the steel is required, the longer is this heat maintained; and it is necessary that the workmen should exercise great judgment in order to make the steel of the exact hardness demanded.

When the bars are removed from the converting-furnace, they are called *blister-steel*, because their texture is coarse and uneven. The next process is called *shearing*. Shearing is performed in a *tilt* or *tilt-house*, a building firmly built to resist the vibration caused by the heavy falls of the shearing-hammers. Within the *tilt-house* are furnaces for heating

the blister-steel to prepare it for the huge and massive *shear-hammers*. These hammers are of an enormous size, and remarkable construction, consisting of a mass of iron faced with steel, with a heavy iron-bound wooden handle, which is moved rapidly up and down by a steam-engine. The bars of blister-steel, before they are heated, are broken up into pieces about a foot long. Having been broken, they are raised to a white heat, and then placed under the tilt-hammer, which is smaller and less heavy than a shear-hammer, by which they are beaten out to thirty inches in length. To change these pieces into shear-steel, that is to say, into steel of close particles,—half-a-dozen are piled one upon another, and fixed firmly at one end in a groove or handle. This group is then placed in a furnace moderately heated,—and is afterwards transferred to a second furnace, when a fierce fire brings it to a white heat. The workman attends scrupulously to the equalization of the heat, as the value of the steel greatly depends upon the nicety with which this part of the manufacture is

conducted. When sufficiently heated, the group is taken out by the handle, and placed under the largest or shear-hammer, where it is beaten on all sides till it forms one dense, solid, compact bar of steel. To effect this, the force of the hammer's blows must be tremendous. In some cases, when the steel is required to be of particularly fine quality, this process is repeated. The shear-steel thus beaten, is found to have lost all the flaws and blisters which it contained as blister-steel. Of this shear-steel, ordinary table-knives are made.

To make a knife, a length of steel is cut off from a bar sufficient to make a blade, and forged, that is to say, heated and beaten into shape, much in the same way as you have watched the farrier heat a lump of iron and beat it into the form of a horse-shoe. Well, the piece of steel is heated in the fire, and beaten into the form of a blade. When this has been done, the rudely formed blade is welded by heat and pressure, to a rod of iron, of sufficient length to form what is called the shoulder of the knife, and the "tang," or

part which goes into the handle. The end of the iron is heated, and beaten into the shape of a tang; and the shoulder (which is the thick part immediately touching the handle) is next brought into proper shape by hammering it into a die or stamp, called a *swage*. This being finished, the whole is heated a second time, and is further shaped. The blade is then made red-hot, and being plunged perpendicularly into cold water, is suddenly cooled; which has the effect of instantaneously compressing the particles of the steel more closely together, and so hardening them; and a gradual heating afterwards, to a certain point, gives the "temper," or elasticity, best fitted for the purpose to which the blade is to be applied. When the blades are thus prepared, they are ground all over on a large revolving grinding-wheel, till the surface is made level, the edges straightened, the point rounded, and the edge made finer. The knives are ground a second time upon a finer grindstone, called the *whitening-stone*. In some of the larger Sheffield houses, these grinding-stones are

turned by steam-power. Well, when the knives have been sufficiently ground, they are ready for *glazing*, or polishing. This process is performed on a wheel called a *glazer*, made of a circular piece of wood, and coated on the edge, either with leather, or with a hoop of a metal made of lead and tin mixed. The knife is now ready to be fixed in a handle, or, as the Sheffield people say, a *haft*. The manufacture of *hafts* is a separate business. Ivory hafts for table-knives are made by sawing up elephants' tusks into the most useful pieces they can make, by means of a circular revolving saw. The saw cuts the ivory into long pieces, which are afterwards cut to the requisite shape, polished, and pierced, for the reception of the tang by hand. Into a handle so prepared, the blade is fastened with glue, and the knife is ready for use.

You will have noticed that a table-knife goes through many hands before it is placed on the dinner-table for our use. Even so far back as Chaucer's time, Sheffield was famous for the quality of its cutlery;

for the poet mentions a Sheffield THYTAL in one of his poems. In the present time there is scarcely a civilized man, who has not heard of the perfection to which the manufacture of steel goods has been brought in this wonderful hive of human industry. Perseverance, ingenuity, and indefatigable labour have won the battle:—and Sheffield is now famous, through the unflagging labour of many generations. Thus ends our Story of a Knife.

THE STORY OF THIS BOOK.

And now, my dear children, for the Story of this Book:—the story of all books is the same; the materials and processes, at least, differ so little, that the story of the book you hold in your hands will give you, with some few slight exceptions, a fair notion of the history of all.

The first person concerned in the production of the book is the author. His labours vary much in their nature and severity:—some books are entirely works of fiction and imagination ; some contain facts, the result of great reading; some speculations on scientific matters; and some are translations from other languages, or compilations from other books.

The author having completed his manuscript, takes it to the publisher, who arranges the matters necessary for its production.

The paper is the first thing required for our book:—and before telling you about the modern process by which the beautiful leaves in your book are produced, I will say a few words about the ingenious substitutes used by those who lived in the darker ages, to transmit their history and laws to their descendants. The Egyptians, of whom you have read and heard, used the inner bark of a kind of reed which grows on the banks of the Nile; this reed is called the *Papyrus*, and from it we derive the word *paper*.

Many materials have been used, from time to time, for the manufacture of paper; but the best of all has been found to be linen rag, of which the paper you have in your book is made; and I think that some description of the processes by which dirty rags of all colours and thicknesses are made into the beautifully white substance you see before you, will interest you much.

Linen rags are not only collected in this country for this purpose, but also imported in large quan-

tities from abroad; and, some of them being in a very dirty state, the first processes when taken to the mill, are to cut them to pieces and wash them. The latter is done by putting them into a large copper with a mixture of carbonate of soda and quick-lime ; in this they are boiled for eight hours or more, according to their quality. When cool they are taken to the engine-house to be reduced into pulp. They are here placed in vats, in which a large roller, with projecting iron teeth, is made to revolve over a plate or block of wood, also provided with teeth ; and a good supply of pure water passing through the vat—the roller being set in motion,—the rags are again cleansed and cut and torn by the teeth till they are at last reduced to a pulp, which then flows through a pipe into the bleaching-house, and is left for a time in what is called the draining-chest, for the superfluous water to run off.

It is then placed in stone chests and subjected to the action of the gas called chlorine, which is

possessed of great bleaching properties; and after being thoroughly acted upon by it, and all colour removed, it is taken to an hydraulic-press, where the liquid is pressed out. It is then again washed by an engine like the former one, and passes through the beating-machine, where it comes into what is called *stuff*, and is ready to be made into paper.

Paper is made from the stuff by two processes. The oldest, which I will describe first, is called making *by hand*. The pulp is placed in a vat—a stone vessel about six feet square and four deep,—and is kept in a proper consistence by means of a small revolving-wheel called a *hog*, which is kept warm by means either of a steam pipe or a stove. The moulds into which the pulp is received, and where it first assumes the character of a sheet of paper, are of two sorts,—*laid* and *wove*.

A *laid* mould is a mahogany frame with wooden bars running across it, at the distance of about an inch and a half from each other; across these are *laid* a number of wires about fifteen or twenty

to the inch, and a raised wire laid along each of the cross bars interlaces the other wires and gives to the *laid* paper its ribbed appearance. In a *wove* mould, the only difference is that its surface is covered with wire cloth, *wove* for the purpose, and containing from forty-eight to sixty-four wires to the inch. The water-mark which you have often noticed in paper, when you have held it up to the light, is produced by wires bent to the shape required and sewn to the surface of the mould.

Both moulds are furnished with a *deckle*, or moveable raised edging, which prevents the pulp from flowing over and leaving a rough edge. The stuff in the vat being properly prepared, one of the workmen, who is called a *vat's-man*, takes one of the moulds and plunges it four or five inches into the vat; and taking up a quantity of the stuff upon it, he raises it to a level, shaking it so as to distribute the stuff and form a uniform fabric:—in this process, the mould being raised, the water runs through the wires, and the superfluous stuff escapes over the sides.

More water having been drained from it by the mould being placed in an inclined position, the sheet of paper is then placed on a piece of felt; and so the operation goes on till many sheets have accumulated. They are then taken to a press, where more water is squeezed out; after this the paper is pressed as many times as may be required by its quality, to remove the impressions of the wires, and being then sent to the lofts to be dried, it is there hung upon hair ropes, called *tribbles*. The next process is sizing, as until that is done the paper is soft and unfit to write on—this is done by dipping the sheets in a hot gelatinous solution; when they are again taken to the drying-room. When dry the paper is conveyed to the *salle*, or finishing-room, where it is sorted. After this it is again pressed, and then made up into reams of twenty quires each, and once more put into the press, where it is allowed to remain for ten or twelve hours. It is then packed and is ready for use.

But the invention of a most beautiful, though very

complicated, machine has, to a great extent, superseded the old and slow process of making by hand: —by its means a continued flow of pulp is kept up, made into paper, dried, polished, and each separate sheet cut round the edges and made ready for use. This wonderful machine is the invention of M. Louis Roberts, and was introduced into this country about forty years ago, and here brought to perfection by the exertions of a few spirited individuals, who have reaped little or no advantage from it.

The operation by which the author's writing is multiplied, and produced in even and uniform letters on the paper in any number of copies required, is, as you know, called printing. Before its invention all records, poems, or works of any kind, had to be written and copied, and re-copied, with much labour and a great loss of time. From this cause knowledge could not be diffused as it now is, and was consequently confined to the monks and others who possessed manuscripts, and kept them solely for their own use, or only made such copies as

they thought fit. The invention of printing is now generally ascribed to Gutenberg, of Mayence, a city in Germany, in the year 1441; but the origin of it is surrounded by some mystery, arising from the desire of the early printers to keep their art a secret. The first printing done in England was at Oxford, in the year 1468, but it was with wooden types:—William Caxton introduced metal types, such as are now used, in 1474.

I will now give you some account of a printing-office and the different operations carried on in it. The size of the page and type in which the book is to be printed having been settled, the manuscript is placed in the hands of the overseer of what is termed the *case* department; who takes it into the composing-room and distributes it to the compositors. Each compositor stands at a sort of *frame*, on which are placed two *cases* divided into unequal compartments, containing the letters according to the proportions in which they are required; for of course, you know, that there are a great many more

of some letters wanted than of others. The compositor places the part of the manuscript, or *copy* as it is termed, that is given to him, on the upper part of the case, and takes in his left hand the *composing-stick*—a small iron or brass frame, one side of which is moveable, so that it may be adjusted to the width of the page required. He then, one by one, places the letters of each word in his stick, receiving them with the thumb of his left hand. The letters are arranged on a thin slip of polished brass, of the same height as the type, called a *setting-rule;* which, as each line is completed, is shifted from behind to receive the next. In each letter there is a nick, which must be placed outwards in the composing-stick. A good and well-practised compositor is always distinguished by the uniformity of the spacing in his lines—the words must not be too close together in some instances, or too far apart in others; and this task of equalizing the spaces is often very troublesome. When the compositor has filled his composing-stick, he lifts out the

lines by the aid of the setting-rule, and places them in what is termed a *galley*. In lifting the type, *a handful*, as it is called, is occasionally broken—in which state it is termed *pie*;—when the whole has to be re-set. The compositors have sometimes among them one who is termed a *clicker*, whose duty it is to form into pages the type as it is set up by his *companions*. When a sufficient number of pages are made up to constitute a *sheet*, they are arranged on the *imposing-stone* in their proper order; and a stout iron frame, called a *chase*, being placed round the whole, each page is firmly wedged between pieces of wood or metal—to regulate the margin,—called *furniture*. This is now termed a *form*; and such is its compactness, that, though composed of perhaps 50,000 or more pieces, it may be moved about with ease and security. A *proof* is now pulled—that is, a single impression is taken at the press.

It can hardly be expected but that, in the course of composing, some mistakes will arise. It is the duty of the *reader* (corrector of the press) to mark

these on the proof-sheet; which is then placed in the hands of the compositor for correction, who proceeds, with the aid of a sharp instrument, called a *bodkin*, to change wrong letters; also to insert any words which may have been omitted, and remove such as may have been superfluously introduced—in which latter processes, the lines will require being re-adjusted in the composing-stick. Sometimes the omission of a sentence will involve the re-arrangement of one or many pages. The corrections now being completed, the reader has another proof, termed a *revise;* this he compares with his *first-proof*, and so ascertains that all his corrections have been properly made. A proof is now sent to the author, by whom it is seldom returned without many alterations: — the process of correction and revision has then again to be gone over. When approved by the author, the proof-sheet is finally read, and placed in the compositors' hands for correction—as a *press-proof;*—then comes the *press-revise*, and the labour of the compositor is ended. I must tell you that the

compositors are a very intelligent class of men, very much more so indeed than any one who has not had to do with them would believe; and the readers are often men of very superior education, of high classical attainments, and great general knowledge.

We must now go to the press-room:—the business here is to produce clean and well-printed sheets from the forms prepared by the compositors. I dare say you will think this is not a very difficult job, and that the pressman is as much a machine as the instrument with which he works; but this is not the case—the pressman must have an eye for colour, or the sheets will be of unequal blackness. Equality of colour depends not only on the equal distribution of the ink, but on the evenness of the impression—the production of which is termed *making ready*:—these combined operations test the skill of the workman. Where pictorial illustrations on wood, &c., are introduced, with the ordinary qualifications of the pressman must be combined an eye for artistic effect, to do justice to the designs.

In the process of printing, the paper having been brought from the wetting-room, where it had been *wetted down* to facilitate its receiving the ink, is placed on a wooden stage termed a *horse.* The form being made ready, and inked by means of a *roller* —composed of a soft elastic substance, a sheet is taken from the *heap* by one of the pressmen and laid on an iron frame, covered with stretched parchment, termed a *tympan;* at the top of this is a slight iron frame, so far covered with paper as to protect the margin from any ink which may have lodged on the furniture in the process of rolling, termed a *frisket* ; which being turned down upon the tympan, and both on the form, the whole is passed beneath the *platten* or pressing surface; when, by pulling the handle of the lever, an impression on one side is produced. In printing the second side, great accuracy is required in the backing or *register* of the pages:—in this process the pressman is aided by two small steel *points* fixed to the tympan, which, in printing the first side, or *white paper*,

pierce the sheets—thus furnishing an index for *perfecting;* as, in working the second side, or *reiteration*, the sheets are replaced on the points, which indicate the position of the pages on the first side.

There is, however, a more rapid and wonderful mode of taking impressions from the forms:—this is by machine-printing. If paper is made by machinery with a rapidity and perfection scarcely credible, the mode of printing by steam seems almost, from its wonderous rapidity, correctness, and equality of colour, the work of magic:—thousands of impressions are thrown off in an hour, with only a boy to feed the machine with paper, and another to receive the sheets as they are printed. So elaborately curious is this application of mechanism in its construction, that you must see it—fully to understand its operation.

The number required of each sheet being printed, the heaps are, after inspection by the *press* overseer, passed to the *hanger-up;* who by the aid of what is termed a *peel*, places the sheets on *poles* to dry. This

being effected, the heaps are placed in succession—according to the letters of the alphabet, termed *signatures*, printed at the foot of the first page of each sheet,—on a long bench, to be gathered—lads are employed to do this,—which is an operation requiring care and cleanliness. After the gathering is completed, the duty of the *collater* commences:—the heap being placed before him, he, with a sharp-pointed bodkin, lifts the sheets separately, to ascertain that one only of each has been taken, and that none have been omitted. The gatherings, when passed by the collater as correct, are folded in the centre, and pressed by the ordinary screw-press—unless the sheets have, for greater smoothness, been previously placed between glazed boards, and submitted to the far greater power of the hydraulic-press. The books are then warehoused:—ready for delivery to the publisher's order, which is usually presented by the bookbinder, whose duty it is to prepare the book for sale, by putting it into a neat strong cover, such as you see on this book; or sometimes in a more expensive

and elegant one. Now I will tell you something of the process by which he does it.

If you were to see a sheet of this book as it came from the press, you would find that the pages do not follow one another in regular order ; so that, the first thing to be done is to have the sheets folded:—this is usually done by females, who use a bone or ivory knife to press the folds as they are made. The next thing is to collect the folded sheets into a volume:—they must be placed, of course, in proper order—this is ascertained by the *signature* at the bottom of the first page of every sheet, as described in the account of printing. When the book is thus placed together, it is ready for sewing:—in sewing, a kind of press is used, called a *sewing-press*, which has two upright bars rising out of a flat board, these being connected at the top by a cross-bar; from this bar a number of strings are drawn tightly down, and fastened at the bottom ; the sheets are laid with their backs close to the strings—having been previously pressed, and an incision made with a

saw for the reception of each string, or *band* as it is called ;—the sewer then passes the needle backwards and forwards through the centre fold of each sheet, twisting the thread round each band. The book being sewed, the next thing is the cover or case:—it consists of two parts; the board which stiffens it, and the cloth or leather which hides the board from sight. When cloth binding is adopted, the case is completed before the book is placed in it : —prior to which process the book has a thin coat of glue on the back—to strengthen it, the edges are trimmed, and the back is rounded while the glue is damp; after which, it is lined with linen, and grooves being made for the reception of the boards, it has then a final lining of paper. When bound in leather, the boards are first fixed on the book, and then the material is placed over them. Some books have their edges marbled, some have them sprinkled with different colours, and some have them gilt—the edges having been first cut smooth with an instrument called a *plough;*—the sides and

backs are also ornamented in different ways, according to the expense to be incurred in *getting up* the volume. Our book being now ready for sale—my task is ended.

And now, my young friends, I must say farewell:—there still remain many more Stories relating to the "WONDERS OF HOME" which I could have told you, but these may suffice to awaken in your minds an interest in the objects by which you are surrounded, and to cause you to think of those to whose skill and labour you are indebted for so many comforts and pleasures.

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