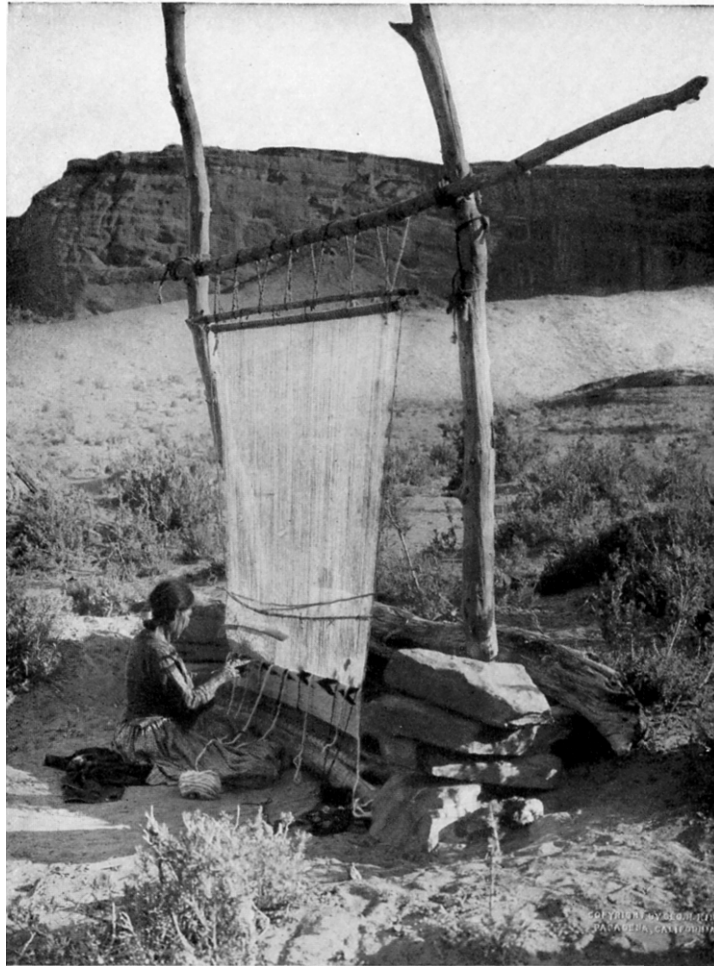


THE STORY OF TEXTILES



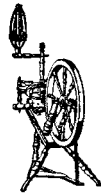
AMERICAN INDIAN WEAVING
(From a photograph by George R. King)

A woman of the Navajo Indians at Canyon de Chelley, near Gallup, New Mexico, United States, weaving a blanket with yarn she has carded and spun of wool from sheep raised by her tribe, and dyed with fast colors which the Navajos make of native vegetables. These Indians, who raise thousands of sheep and horses and are also skilled as primitive silversmiths, decorate their blankets with rude-colored designs, and weave them so closely that often the blankets will hold water. It illustrates a most primitive form of weaving that has been practised for centuries.

THE
STORY OF TEXTILES

A BIRD'S-EYE VIEW OF THE HISTORY
OF THE BEGINNING AND THE
GROWTH OF THE INDUSTRY
BY WHICH MANKIND
IS CLOTHED

BY
PERRY WALTON



TUDOR PUBLISHING CO.
NEW YORK

COPYRIGHTED 1925
BY PERRY WALTON
NEW EDITION, JUNE 1936
REPRINTED, JANUARY, 1937

MANUFACTURED IN THE UNITED STATES
BY MONTAUK BOOKBINDING CORPORATION

FOREWORD

As clothing has from time immemorial been one of man's necessities and almost as essential to his welfare as food, it is not surprising that the textile industry has long in value of output been second only to the production of food-stuffs. Important, however, as the industry is, its history, so far as the writer knows, has never, at least in America, been published. Aside from its importance the industry possesses much of interest not only for the student, but also for the man of affairs. Different branches of the industry, such as wool, silk, cotton, and linen, have been treated separately, but nothing has been written about the origin and growth of the industry as a whole.

This book, of which some explanation is necessary, is an effort to fill this gap. Although a complete history of the industry has not been the aim of the writer nor the desire of the publisher, the purpose has been to present to those interested in the textile industry a bird's-eye view of the leading facts which have marked the progress of the industry up to the firm establishment of the manufacture of textiles on American soil, together with such intervening facts as are necessary to give one a comprehensive view of the subject.

The book deals largely with the development in England and America, because in these two countries originated the inventions that have brought the industry to its present efficiency, and in them also was evolved the factory system

which has so greatly revolutionized social life in England and America.

All of the facts have been verified by careful investigation, some of which has gone back to original sources. As far as it goes, this brief history endeavors to be authoritative and comprehensive. Much attention is given to the American development, particularly that relating to the cotton industry.

To cover the subject as it deserves would require more space than could be contained in a single volume. And, while a more complete history might be more interesting to the student, it would be less so to the textile man for whom this has been primarily written, because of the necessary introduction of a mass of minor details that would be too tedious for him to peruse. The writer hopes that the man interested in the textile business, whether he be a manufacturer or a clerk behind the counter, may obtain from these pages a clear view of the development of America's leading industry, without having to give the subject the time that a fuller narrative would require.

Mr. John S. Lawrence, for whom this book has been prepared and by whom it is published, is a partner of the firm of Lawrence & Co., one of the largest commission houses for the distribution of textile products in America. Many of its former members have filled important places in the establishment of the industry in the great textile centres of America.

The writer desires to acknowledge the courtesy shown in facilitating the preparation of this book by C. J. H. Woodbury, Sc.D., secretary of the National Association of Cotton Manufacturers; L. W. Jenkins, Curator of Ethnology, Peabody Museum, Salem, Mass.; W. P. Wilson, Sc.D., Director Commercial Museum, Philadelphia; Miss

S. G. Flint, of the Textile Department of the Museum of Fine Arts, Boston, Mass.; and also to acknowledge his indebtedness to the following authorities: "Silk Industry in America," by L. P. Brockett; "Manual of Power," by Samuel Webber; "Loom and Spindle," by Mrs. Harriet Hanson Robinson; "Illustrated History of Lowell," by Charles Cowley; "Introduction of the Power Loom and Origin of Lowell," by Nathan Appleton; "Draper's Dictionary," by W. Beck; "The American Cotton Industry," by T. M. Young; "Introduction and Early Progress of the Cotton Manufacture in the United States," by Samuel Batchelder; "The Textile Industries of the United States," by William R. Bagnall; "History of the Cotton Manufacture in Great Britain," by Edward Baines; "Fabrilla: A Substitute for Cotton," by Stephen Merrill Allen; "Historical Sketch of the Town of Pawtucket," by Rev. Massena Goodrich; "The First Cotton Mill in America" (in Essex Institute Historical Collections), by Robert S. Rantoul; "A Compendious History of the Cotton Manufacture," by Richard Guest; "History of Lynn," by A. Lewis and J. R. Newhall; "Economic and Social History of New England," by William B. Weeden; "Lancashire Worthies," by Francis Espinasse; "Brief Biographies of Inventors of Machines for Textile Fabrics," by Bennet Woodcroft; "Life and Times of Samuel Crompton," by G. J. French; "Memoir of Cartwright," by his daughter; "History of Lawrence," compiled by H. A. Wadsworth; "Annals of Providence," by William R. Staples; "History of New Bedford," by Leonard Bolles Ellis; "History of Manchester," by Maurice D. Clarke; "The Cotton Industry," by W. B. Hammond; "The Cotton Manufacture of Great Britain," by Andrew Ure; "Memoir of Patrick Tracy Jackson," by John A. Lowell; "Memoir of Samuel Slater,"

by George S. White; "Memoir of Eli Whitney," by Denison Olmstead; "The Factory," by Jonathan Thayer Lincoln; "State of Rhode Island and Providence Plantations at the End of the Century," by Edward Field; "History of Philadelphia," by Scharf and Westcott; Chambers's "Book of Days"; "A Comprehensive History of the Woolen and Worsted Manufactures," by James Bischoff; and "History of Manufactures," by Bishop; also "The Report of the Tariff Board on Schedule K" and articles in the *Encyclopædia Britannica*, *Universal Encyclopædia*, *Encyclopædia Americana*, the *Textile Manufacturers' Journal*, the *Textile World Record*, the *Fall River Herald*, the *Fall River News*, and the various census reports relating to linen, wool, cotton, and silk.

Thanks are also due The Macmillan Company and the Houghton Mifflin Company for permission to use reproductions of illustrations from their publications; also to Job L. Spencer for the illustration of the Old Slater Mill, from a sketch by his son; to the Rhode Island Historical Society for the courtesy extended in securing the portrait of Moses Brown; to the New Haven Colony Historical Society for the portrait of Eli Whitney; and for the facilities extended in the preparation of this work by The Commercial Museum, Philadelphia; A. H. Baldwin, Chief of the Bureau of the Department of Commerce and Labor, Washington, D.C.; Dr. F. H. Bowman, of Manchester, England; Miss Henrietta C. Cattnach; Miss N. L. Kingman; George R. King; Chicopee Manufacturing Company, Chicopee Falls, Mass.; the Draper Company, Hopedale, Mass.; and to Potomska Mills, New Bedford, Mass.

CONTENTS

	PAGE
CHAPTER I	
BEGINNING OF TEXTILES	13
Prehistoric Evidences of the Art—Textile Industry among the Ancients—Early Existence in North and South America—The West's Textile Indebtedness to the East.	
CHAPTER II	
FLAX, LINEN, WOOL, COTTON, AND SILK	24
Flax and Linen—History of Linen—Production of Flax and Linen—Wool—Efforts to improve Wool—Early Use of Wool—Cotton, the Plant, Growth, and Distribution—Early History—Columbus and Cotton—Silk—Early History of Silk—Silk Industry in America.	
CHAPTER III	
FACTORY SYSTEM	59
Growth of the Factory System—Earliest Record of English Factory—English Names derived from Industry—Causes of the Concentration in Lancaster—Separation of Agriculture and Spinning and Weaving—Early Relationship of Employer and Employee—Inventions and the Factory System—Influence of Factory on English Social Life.	
CHAPTER IV	
ERA OF INVENTION	71
Era of Invention—Early Improvements in Textile Machinery—John Kay—Paul and Wyatt—James Hargreaves—Richard Arkwright—Samuel Crompton—Edmund Cartwright—Inventions of Knitting Machines—Ipswich Mills—Joseph Marie Charles Jacquard—Machines for spinning Flax—James Watt—Eli Whitney—Improvements of the Basic Machines, and Further Inventions—Bleaching—Dyeing—Printing—Mercerizing Process.	

CONTENTS

	PAGE
CHAPTER V	
AMERICAN INDUSTRY BEFORE THE REVOLUTION	122
<p>American Industry—Earliest Traces of the Industry—Fostering Legislation—First Cloth made and First Mill erected at Rowley—Slave Traffic and Importations—English Efforts to hamper the Industry—First Worsted Mill—Skill attained in Textile Work—Bounties and Monopolies to stimulate the Industry—The Spinning Craze—Approach of the Revolution—Improvements in English Textile Machinery—Condition of the Market immediately after the Revolution—American Effort to secure English Machines—England and Cotton—Starting of Cotton Cultivation in the South—Origin of Sea Island Cotton and Beginning of its Cultivation in the South.</p>	
CHAPTER VI	
AMERICAN INDUSTRY AFTER THE REVOLUTION AND BEFORE SLATER	148
<p>First Manufacturing in Pennsylvania—First Cotton Mill in New England—First Textile Trade-mark—First Textile Advertising—Boston Sail Cloth Factory—Commencement of the Cotton Industry in Rhode Island—First Woolen Mill—Washington inaugurated in Suit of Domestic Woolen—First Woolen Mill operated with Power Machinery.</p>	
CHAPTER VII	
ERA OF SAMUEL SLATER	168
<p>Slater's Arrival in America—Goes to Providence—Starts First Cotton Mill with Arkwright's Machines in America—Payment and Discipline of Employees—Starts his Second Mill; the First with Arkwright Machinery in Massachusetts—First Commission Houses—Shepard starts Mill at Wrentham—Other Mills start—Whittenton Cotton Mills—Start of the Industry in Connecticut—Spread of Industry through Influence of Slater—Gilmore's Loom—Beginning of Power Woolen Mills in Rhode Island—Southern Development.</p>	

CONTENTS

9

PAGE

CHAPTER VIII

ERA OF LOWELL, APPLETON, MOODY, JACKSON, AND BOOTT, 192

First Complete Cotton Mill in the World—Lowell visits English Mills—Organization of the Boston Manufacturing Company—Care of Employees—Sale of Goods—Waltham versus Rhode Island System of Manufacturing—The Foundation of the City of Lowell and the Starting of the Merrimac Manufacturing Company—Naming of Lowell—Starting of First Mills.

CHAPTER IX

OTHER TEXTILE CENTRES 210

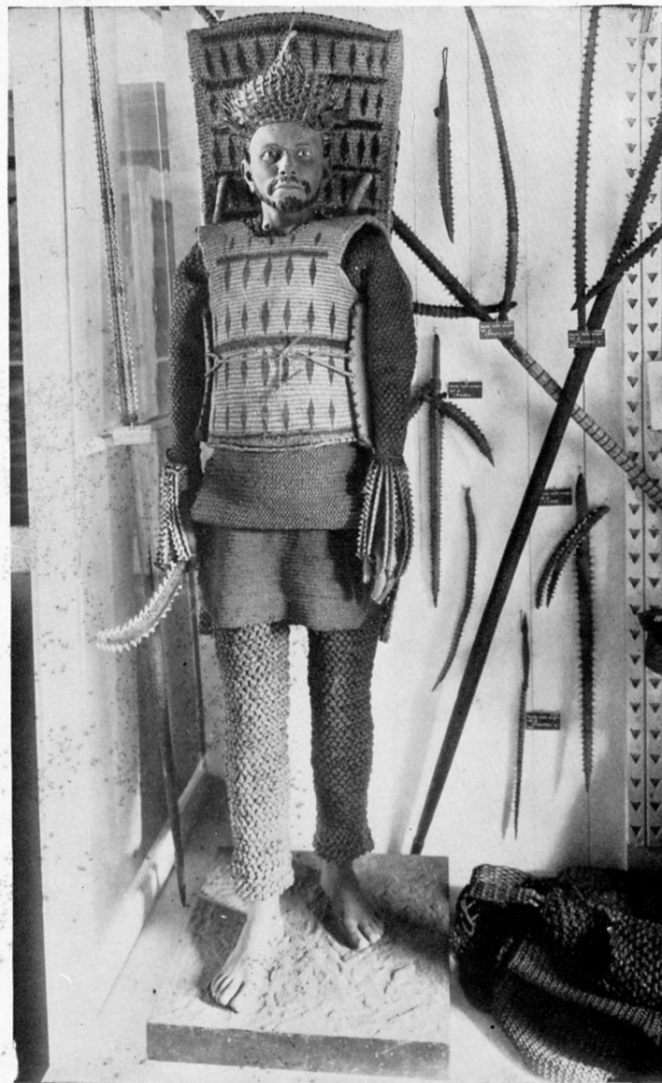
Philadelphia the Greatest Textile-producing City of America—Silk Industry in Philadelphia—Development of the Woolen Industry—Textile Machinery—Carpet Industry—Later Growth—Foundation of Lawrence—Beginning of Fall River—Colonel Durfee's Mill—The Troy and Fall River Mills—Early Looms, Work, and Wages—Other Companies—Providence—Paterson, N.J.—New Bedford—Manchester—Amoskeag lays out a Town—New York—Amsterdam—Woonsocket, R.I.—Conclusion.

INDEX 253

ILLUSTRATIONS

AMERICAN INDIAN WEAVING	<i>Frontispiece</i>
	<i>Facing Page</i>
WARRIOR OF GILBERT ISLANDS, SOUTH PACIFIC OCEAN . .	13
GREEK AND ROMAN METHOD OF SPINNING AND WEAVING .	16
NAVAJO WOMAN MAKING YARN OF NATIVE WOOL	20
SPECIMENS OF NORTH DAKOTA GROWN RUSSIAN SEED- FLAX; CUTTING HEMP	24
LINEN MUMMY CLOTHS	28
EGYPTIAN TUNIC; PERUVIAN TUNIC	32
THE COTTON PLANT	36
FABRICS WOVEN BY THE BAKUBA TRIBE	40
THE EGGS, CATERPILLAR, COCOONS AND MOTH OF THE SILKWORM	44
ENLARGED REPRODUCTIONS OF TEXTILE FIBRES	48
JAPANESE SPINNING AND WEAVING	52
THE MULE	56
ANCIENT EGYPTIANS SPINNING AND WEAVING	60
BOWING OF COTTON, AS PRACTISED IN INDIA AND CHINA; A HINDU WOMAN SPINNING COTTON YARN ON THE PRIMITIVE WHEEL OF INDIA	64
DOMESTIC FLAX WHEEL; HINDU SPINNING AND WEAVING, HINDU WEAVER AT HIS LOOM	72
JOHN KAY	76
SIR RICHARD ARKWRIGHT	80
SAMUEL CROMPTON	84
DR. EDMUND CARTWRIGHT	88
CARTWRIGHT'S LOOM	92
AMOS A. LAWRENCE	96

	<i>Facing Page</i>
ELI WHITNEY	100
DISTAFF SPINNING	106
HANDICRAFT CARDING, ROVING, AND SPINNING BY THE HAND WHEEL	112
PEG WARPING	118
WARPING	124
THE LOOM THAT PRECEDED THE POWER LOOM	130
HIGH'S JENNY	136
THE IMPROVED JENNY	142
A HANDICRAFT WEAVER AT HER LOOM	148
ARKWRIGHT'S ORIGINAL WATER FRAME WITH THE SPECIFI- CATIONS ON THE ORIGINAL PATENT PAPERS TAKEN OUT BY HIM ON JULY 15, 1769.	154
THE OLD SLATER MILL, PAWTUCKET, R. I.	160
CARDING, DRAWING, AND ROVING AS IT WAS IN SAMUEL SLATER'S EARLY MILLS	166
SAMUEL SLATER	172
MOSES BROWN	178
WASHINGTON'S VISIT TO THE FIRST COTTON MILL AT BEVERLY, MASS., OCT. 30, 1789.	184
FRANCIS C. LOWELL	190
NATHAN APPLETON	196
P. T. JACKSON	202
A MODERN MULE SPINNING-ROOM	208
SAMUEL WETHERILL	214
ABBOTT LAWRENCE	220
INTERIOR VIEW OF A MODERN RING SPINNING-MILL	226
AMOS LAWRENCE	232
INTERIOR VIEW OF A MODERN WEAVE-ROOM	238
MODERN AUTOMATIC NORTHROP LOOMS	244



WARRIOR OF THE GILBERT ISLANDS, SOUTH PACIFIC OCEAN
(From an Exhibit in the Peabody Museum, Salem, Mass.)

His armor is woven of cocoanut fibre, and is a protection against the native weapons which are edged with swords' teeth. The mat at his back is a protection against stones thrown at the enemy by the warrior's wife, who follows in the rear. This shows a most primitive form of weaving.

THE STORY OF TEXTILES

CHAPTER I

BEGINNING OF TEXTILES

PREHISTORIC EVIDENCES OF THE ART—TEXTILE INDUSTRY AMONG
THE ANCIENTS—EARLY EXISTENCE IN NORTH AND SOUTH AMER-
ICA—THE WEST'S TEXTILE INDEBTEDNESS TO THE EAST

A bit of cloth—whether it be woolen or cotton, linen or silk—is one of the most interesting evidences of man's climb from days of savagery to twentieth-century civilization.

As one notes how finely spun and how intricately woven are the threads and how beautiful often is the design, the wonder grows that a piece of cloth can be so dexterously fashioned. And yet, as one reads of the painstaking efforts—spread over many centuries—which man has put forth to attain perfection in spinning and weaving, the wonder fades into admiration for the infinite pains he has taken to perfect the art. Civilization's pathway is strewn with the evidences of the labor to compass a mastery of the industry. Older far than recorded history is the tale of fabrics.

To find its beginning, we must go beyond the dawn of history into the darkness of prehistoric times; for, when man first began to scratch his deeds on the rocks of his dwelling-place, fabrics, more or less perfect, were being fashioned, ornamented, and dyed.

Even the archæologist cannot fully enlighten us. No matter how deeply he may delve into the most remote past

to which he can sink the plummet of his research, evidences of spinning and weaving are found among the vestiges of the rude home of prehistoric man.

PREHISTORIC EVIDENCES OF THE ART

The art was practised in the earliest Stone Age. How much farther back it was a domestic art it is impossible to learn, owing to the perishable nature of the materials from which many fabrics were fashioned. According to some authorities it may have been contemporaneous with the discovery of fire for cooking and the building of shelter. Others are sure it is older than the fashioning of domestic utensils by the art of Pottery.

It is believed that sinews and intestines of animals, strips of skin, flax, hemp, wool, the bast of the linden, and the fibre of the palm and cocoanut and other trees, and various wild grasses were used in the making of mats, baskets, nets, and rude fabrics at the dawn of the earliest era of the Stone Age, if not before,—many thousands of years before the beginning of civilization.

Evidences of the industry have also been found among prehistoric or savage races in parts of the world so widely separated that it is quite certain a knowledge of the industry sprang up independently, in different places.

It is fair to conjecture that thousands of years before the dawn of civilization some savage matron, sitting in front of the cave or rude hut which sheltered her, wove the original basket from the rushes of a brook that perchance may have gurgled at her feet, or may have cut strips of skin from the animal her lord and master had slain, and plaited them into the original fabric that was the beginning of textiles. It does not require much stretch of the imagination to conceive of this taking place in the different parts of the world where the industry began.

Flax fabrics dating back to a period thousands of years

ago have been unearthed in England. The ruins of the Lake Dwellers of the Stone Age in Switzerland have produced them. Textiles of much beauty that belong thousands of years before Christ have been discovered among the earliest ruins of Peru, Mexico, and Egypt, and in the cave dwellings of New Mexico and Arizona.

The ruins of the Swiss Lake Dwellers, which were discovered in the winter of 1853-54, abundantly prove that the art was known in the earliest era of the Stone Age,—the period of the mammoth and cave bear. The winter of 1853-54 was cold and so very dry that water in the alpine lakes of both Switzerland and Northern Italy receded so far that the dwellers on many of them saw evidences of ancient dwellings built on poles projecting from the lakes. Some sections were dyked, and many excavations commenced which unearthed village after village that had been covered by the mud of centuries. Wangen in Lake Constance, a village in Lake Mosseedorf, Robenhausen in the bog of Lake Pfaffikon, and Auvernier in Lake Neuchâtel were the most interesting.

Some of the lowest villages were many feet down, and belonged to the earliest Stone Age. In them were found crude but serviceable fabrics of bast, flax, and wool, and signs that the growth and manufacture of cloth of flax and wool at so early a date was an important industry. Spindle whorls were without number. Flax in all stages, from the unprepared straw with seed capsules in perfect preservation to excellent specimens of plaited and woven fabrics, was unearthed, and some of it was ornamented with rude human figures. Strings, yarns of flax in bales ready for the spinners, rope and cordage, were also found.

Specimens of these fabrics may be seen in many museums, and show that the Lake Dwellers of the oldest Stone Era plaited, wattled, and wove cloth, and knew all the operations, from binding and tying, basket and mat plaiting, to weaving. Basket making on a finer scale, with the flax

twisted into a thread, probably led to the textile industry which these prehistoric people practised.

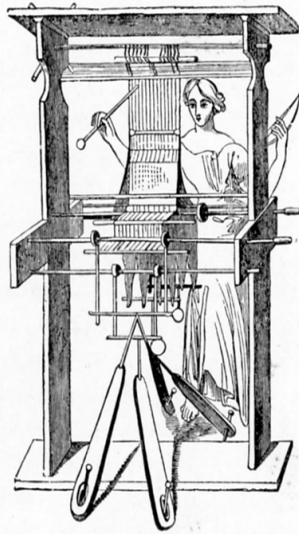
So perfected had the industry become by the time the Bronze Age arrived that rude spindles and looms were employed which were very similar to those used to-day by some of the uncivilized tribes, and the art had reached a state where various designs were worked into the fabric with needle and thread.

Evidences of a similar textile industry have been found in the barrows of the early Britons, where bodies were discovered that were wrapped in plaited woolen cloth. Similar fabrics, of an era so many thousands of years ago that archæologists cannot accurately fix the date, have been discovered in the homes of the ancient Cliff Dwellers of South-western America.

TEXTILE INDUSTRY AMONG THE ANCIENTS

At the dawn of history, wool, flax, cotton, and silk were being woven in the East with the greatest skill, and which was the first material used in weaving is not known. It is probable, however, that the possession of flocks and herds led to the spinning and weaving of wool before either cotton, flax or silk was so used; and the fact that here and there ancient records speak of fabrics of cotton and silk as if they were rare luxuries would indicate that linen and woolen fabrics were too common to receive much attention, and that those of the other materials were relatively novel.

The earliest ancient history describes Eastern nations as having already attained a high degree of skill, not only in the spinning and weaving of fabrics, but in their dyeing and ornamentation. On the walls of Nineveh, Babylon, Thebes, and the ancient cities of Peru and Mexico, throughout most of the ruins of Assyria, Persia, Egypt, and among similar ruins of both North and South America, is depicted the whole process of the textile industry, from the raising



GREEK AND ROMAN METHOD OF SPINNING AND WEAVING
(From old Woodcuts)

of the sheep or growing of the flax to the spinning of the yarn and weaving of the fabrics.

The Bible in Genesis and Exodus refers to the art, Homer, Herodotus, Confucius, and Pliny, all relate traditions of how and when it originated. It is a fact established by thousands of hieroglyphics and confirmed by the oldest of Eastern historians that the Chinese, Hindus, Assyrians, Babylonians, Persians, Egyptians, and Hebrews practised spinning and weaving with great skill at a very remote period.

One Chinese tradition is that silk weaving was practised in Kiang Nan, China, in 2640 B.C. Another is that cotton originated in India, and that shawls and carpets were first woven in Persia. Fabrics of wonderful excellence were wrought by the Egyptians certainly twenty-five hundred years before Christ, and probably three thousand. At this early period the dwellers along the Nile wove linen cloth of a fineness that is still unequalled. About one Egyptian mummy was found linen cloth containing 540 warp threads to the inch, while the best woven in England up to a recent date had but 350 threads to the inch.

It is said that the Egyptians put a shuttle in the hands of their goddess Isis to signify she was the inventress of weaving. Joseph in Genesis about 1600 B.C. records that Pharaoh "arrayed him in vestures of fine linen." Another early reference to weaving is in the Bible (Leviticus xiii. 47-59) which speaks of the warp and woof of woolen and linen garments, their defilement from leprosy, and the necessity of their being burned by the priest, and shows that in 1500 B.C. the Israelites knew the art. Mummy cloths from the pyramids have borders of blue and fawn color which were made of threads colored in the yarn. Fabrics of many textures and degrees of fineness were commonly used by the Egyptians for clothing, draperies, banners, and for many ceremonial uses. Wool, flax, and cotton were all known and used by the Egyptians, as

their tombs attest; and the process of dyeing was well established.

According to Pliny, the Assyrians believed Queen Semiramis invented weaving, although he gives the honor of the invention to the Egyptians. Among the Greeks, Minerva is shown with a distaff, and is recognized as having first taught man the art. Again, the Mohammedans say that the art originated with a son of Japhet; while the Peruvians point to Mama Oello, wife of Manco Capac, their first sovereign, as the originator. The absence of any authentic written records means unmistakably that it was prehistoric among different peoples about the same time.

Homer, the Greek poet, who lived 850 B.C., was the first historical writer to tell of weaving. He describes Penelope waiting for the return of her husband Ulysses from the Trojan War. Ulysses had endeavored to escape being called to war by feigning madness, but his trick was discovered, and he was compelled to serve away from home more than twenty years.

In the mean time the chieftains of Ithaca and the neighboring island wooed Penelope. Loving Ulysses, however, and hoping for his return, she refused to accede to the pleasure of the suitors, who remained, wasting Ulysses' means, insulting his son, and bribing the servants.

"Wait," said she, when they became impatient, "until I have woven a winding sheet for old Icarius, the father of Ulysses, so that I shall not lose my threads."

And she is described at her loom undoing each night the day's work, so that the web might never be finished. This went on for three years until her maids revealed her strategy, and she was driven to desperate straits to keep off the suitors. Ulysses finally returned in time to save her, and husband and wife were united. And thus it was that Penelope became among the Greeks and Romans the goddess of weaving.

EARLY EXISTENCE IN NORTH AND SOUTH AMERICA

The art in North and South America seems to have sprung up independently of the rest of the world, and also at a prehistoric date. The ancient Peruvians and ancient Mexicans wove cloth of wonderful fineness and with a finish not unlike lustrous silk. Many of the beautiful shades cannot be surpassed by the best skill of to-day.

Pizarro, the conqueror of Peru, found the art in 1533 had reached a perfection beyond the best artisans of Spain. The wool was furnished by the small llama and the alpaca, long domesticated, and by the vicuna and guanaco, which ran wild among the fastnesses of the Andes. A wild kind of cotton was also employed. Both sides of the fabric were woven alike, and the design and brilliant coloring of some of the specimens in the museums show a skill and art even now rarely excelled by the best artisans.

The resemblance between the Peruvian fabrics and those found in the tombs of the Egyptian kings is striking. In both cases the textile industry had reached equally high development. The Peruvian spindles were of wood, and had solid sun-burned clay whorls of beautiful finish. Yarns were twisted by wetting and rolling between the fingers and part of the body. The needles used were made from wood, bone, or copper. Among the fabrics thus woven were vests, smock-like outer garments similar to the poncho, loosely woven cloths, loin girdles, head coverings, and sandals, home drapings for walls, doors, awnings, banners, and blankets. The ceremonial fabrics were of high color.

These fabrics of the Incas are at least one thousand years old. Color and design are of a high order, and are as beautiful to-day as when woven, showing that even the use of dyes had been highly developed. Geometric, conventionalized animal and human figures are shown on mummy cloths. Both cotton and wool were used, and

the material was woven upon simple hand looms from yarn spun in the crudest way.

Some of the American Indians wove fabrics of a high order. Blankets made by the Navajos of Arizona and New Mexico are of so close a texture they will hold water, and in design and brilliancy of color are most striking, although woven in a primitive manner, by hand.

The beautiful white "Tappa" cloth of the South Sea Islands was made in a peculiar way, especially by the natives of the Marquesas Islands. Instead of being woven, it was beaten together. The exterior green bark was stripped from the branches of the so-called "cloth" tree, a species of the mulberry, which grows luxuriantly in those regions, and the remaining fibrous substance was then removed from the stick to which it had adhered. A quantity of this fabric wrapped in large leaves, and secured by fibrous cords to prevent its being swept away, was placed in the bed of a running stream. After two or three days' immersion the bundles were opened and the fibres pulled out and exposed to the air. Each piece was inspected to ascertain whether it was ready for the remaining operations. If not, it went back to the bed of the brook until the conditions were such as were desired.

When evidences of decomposition were shown by the fibres becoming soft and flexible, the natives knew that the material was in the proper condition for the next step of the operation. The different strips were then laid in layers upon a smooth surface, such as the prostrate trunk of a cocoanut-tree, and were beaten with a kind of heavy mallet, made of ebony, in shape somewhat like an old-fashioned razor-strop. Upon the surface of the hammer were shallow parallel indentations, which varied in depth on different sides, so that it was adapted to the several stages of the operation. The hammering thus produced the corduroy stripes that were prominent in the "Tappa."

The fibres of the "Tappa" were thus beaten, and layer



NAVAJO WOMAN MAKING YARN OF THE NATIVE WOOL
(From a photograph by George R. King)

after layer was put on until the whole was merged into one mass. The beating then continued, water from time to time being added, until the material reached the required thinness, according to the purpose for which it was to be used. It was then placed on the grass to bleach, and came out a dazzling whiteness; or it was impregnated with vegetable dyes, which gave it a permanent color. Brown and yellow were generally the common tints.

According to Captain Sylvanus Nickerson, who commanded the clipper ship "Huguenot" when she was lost in 1880 off the island of Java, the Malays of some of the islands of the Ombay Straits still weave their garments of cotton which is grown in the same row with the corn, with little or no cultivation, and without any effort to separate the plants. They take the cotton as it comes from the boll, and, making it into a ball, twist the fibre with the fingers, pulling it from the ball. As fast as the cotton is twisted into the required thread, the crude thread thus formed is wrapped on a piece of bamboo about five or six inches long. When a sufficient quantity has been prepared, it is put on the loom for weaving. The loom consists of two upright posts, or sticks, driven into the ground at the distance required to give the fabric a certain width. The warp is wrapped about these sticks, and the weft thread is worked in and out with a crude needle and pounded into position.

The method of weaving practised to-day by the Navajos is the same as that employed by the hand weavers of India and China, and is virtually identical with the method that has been used from the beginning by primitive weavers the world over. The warp is stretched between two parallel poles suspended between upright posts, and the weft threads are drawn in and out of the warp with a rude wooden needle somewhat like a fisherman's needle and beaten together with a stick. Seated upon the ground, and with no pattern save that in the mind's eye, geometric

designs and quaint figures are worked in the fabric with threads of beautiful colors.

Basket weaving of hemp and the soft bast of linden was quite generally known by the savages at Wellfleet. Among the Algonquin Indians feathers of the wild turkey and other birds, and white hair of the moose were beautifully woven into hempen garments and articles of utility. In 1785 Eli Twichel, of Bethel, Me., received from Milloket, an old Indian woman of Oxford, a twofold pocket-book which she had woven of hemp and beautifully embroidered with long white hair of the moose. It shows admirably the high state of art reached by the Algonquins, and is now in the Maine Historical Society.

THE WEST'S TEXTILE INDEBTEDNESS TO THE EAST

As civilization spread from the East to the West, so Asia and Egypt passed on to Greece, Italy, Spain, and the rest of Europe the knowledge in its higher form of spinning and weaving. Italy and Greece first used the information thus obtained, and then taught Spain, France, and Flanders the art of weaving woolen and cotton goods.

At a late date in ancient history Germany had obtained the art, and its people were secretly practising it in caves and vaults, as if they were either afraid of it becoming known or, being a warlike people, were too proud to have it said that they labored at the loom. England and North-eastern Europe received the knowledge from Germany.

By the tenth century the manufacture of woolens had attained such perfection in Flanders that one author said, "The art of weaving seems to be a gift bestowed upon them by nature," and another, that "all the world was clothed from English wool wrought in Flanders." Count Baldwin III. of Flanders had established the first weavers and fullers at Ghent shortly before 961, and also instituted yearly fairs at Ypres, Bruges, and other places.

The invasion of England by William the Conqueror, in 1066, found the Angles and Saxons already spinning and weaving the wool of their flocks, and considerable skill had been attained, though it had not reached the high level of the Continental work, particularly as practised by the people of France and Flanders. As the invasion brought in its train a large immigration to England of the Flemings, who settled in the western part of England along the Irish Channel and in what is now Lancaster, their skill raised English spinning and weaving to a level little below that of the Continent, and made their part of England a great seat of the industry. It received further impetus during the reign of Henry I. from further immigration of workmen from Flanders. And still more Flemish weavers, because of their great skill in weaving and spinning, were induced by Queen Elizabeth to settle in England; and so was the foundation laid in England of what has become the greatest textile manufacturing centre in the world. And now let us glance at the history of the raw and manufactured products of flax, wool, cotton, and silk.

CHAPTER II

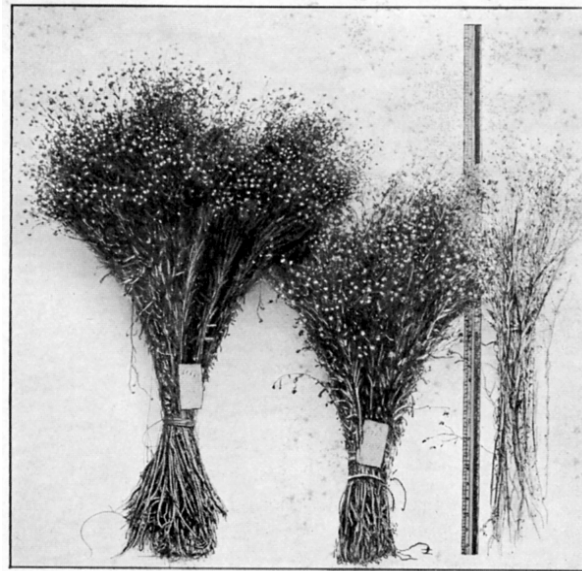
FLAX, LINEN, WOOL, COTTON, AND SILK

FLAX AND LINEN—HISTORY OF LINEN—PRODUCTION OF FLAX AND LINEN—WOOL—EFFORTS TO IMPROVE WOOL—EARLY USE OF WOOL—COTTON, THE PLANT, GROWTH, AND DISTRIBUTION—EARLY HISTORY—COLUMBUS AND COTTON—SILK—EARLY HISTORY OF SILK—SILK INDUSTRY IN AMERICA

Flax, the term used to denote the plant and the fibre, divides with wool the distinction of being the material first used in spinning and weaving. The plant belongs to the botanical order termed Linaceæ, and is known scientifically as *Linum usitatissimum*. It is an annual with stalk rising two to three feet and more in height, has narrow lance-shaped leaves and branches at the top with a bright blue flower on each branch.

Flax has been cultivated for thousands of years in Mesopotamia, Assyria, and Egypt, and is wild in the region between the Persian Gulf, the Caspian and Black Seas.

The stalk is a woody cylinder, more or less pithy and hollow when dry, and is enclosed in bark consisting of long, strong, silky fibres, cemented together by a kind of glue and encased in an outer bark or skin which adheres as if glued to the fibre. The fibre, when freed from all else so far as possible by the process of rotting, to destroy the glue, breaking to free it from the woody part of the stalk, scrutching to whip out the small particles of bark and stalk that adhere, hatchelling to straighten it and free it from tangles, is nearly pure bast of a light gray and brown color, inclining to green. It is exceedingly tough, adapted to spinning and weaving, capable of being bleached to snowy whiteness,



SPECIMENS OF NORTH DAKOTA GROWN RUSSIAN SEED-FLAX



CUTTING HEMP

(From illustrations furnished by the United States Department of Agriculture)

and will take more readily than cotton a variety of colors by dyeing.

The ultimate filaments vary from one six hundred and fiftieth to one five thousandth of an inch, are hollow, thick-walled, and nearly solid cylindrical cells, terminated by exceedingly attenuated points. They are semi-transparent, of a silky lustre, and under the microscope the walls of the tube appear like a double line through the centre. The cells are jointed like stalks of bamboo. When the fibre is separated, it is either dressed flax or tow. The seeds, small and glossy green, are called linseed, and furnish the linseed oil of commerce. As the gum joining the mature flax fibres is insoluble by methods that are profitable, the thread for linen cloth is made from the green flax. If the seed is allowed to mature as a source of oil, the flax straw is useless for linen; for all attempts to utilize flax straw have as yet been without commercial success, though the ripened flax straw has been known to withstand without decay the weather for about a century, showing its great lasting qualities.

In the preparation of flax for spinning, it is soaked in water or exposed to the dew until the woody part rots or rets away from the bast interior, which is then separated from the woody enclosure. The heckle, a many-toothed steel comb, then removes the coarser tow and separates the filaments of the flax. Upon the number of hecklings, so called, depends the fineness of the flax, for the fibres are united into a roving which is spun into a continuous thread.

HISTORY OF LINEN

Linen, the general term for the material spun from flax or hemp, antedates existing records belonging to the earliest eras of the prehistoric ages of which traces have been discovered, and has been found in the villages of the Lake

Dwellers and in other parts of the world where ruins have disclosed the remnants of fabrics.

The Finns introduced flax into North Europe, the West Aryans brought it to West Europe, while the East Aryans conveyed it to Hindustan. In ancient Europe the priest, only, wore linen habitually. Frequent references to it may be found in the Bible to show the esteem in which it was held. It is said in Genesis that hail destroyed the flax and barley. Herodotus refers to it as an article of Egyptian export. The wrapping of most of the mummies, some of which are three thousand to four thousand years old, is of linen. In Homer the mother of Nausicaa is depicted as spinning purple fabrics at early dawn by the hearth.

The garments of the Hebrew, Egyptian, Greek, and Roman priests were often made of fine linen. Bengal cultivated the flax, and the Hindustanee spun and wove it into linen at an early date in ancient history, as did also the ancient Thracians. In mediæval times Italy and Spain and France were celebrated for their linen fabrics. Charlemagne in the eighth century A.D., like many a modern, wore linen underwear. The Moors of Spain brought the industry to a state of high perfection and exported their fine linen to Constantinople and India.

Flanders, Brabant, some of the German towns, and France were making linen fabrics by the eleventh century, and before 1250 Flanders had begun extensive exportation to England. Ypres, which as early as 960 was one of the seats of the industry, has given us the word "diaper," or cloth of Ypres, which then denoted a great fineness of manufacture. The King of France in 1394 sent the fine linen of Rheims as a ransom to the Sultan for some noblemen who had fallen into his subjects' hands. The famous Bayeux tapestry is of linen body with the designs in wool.

Among the Anglo-Saxons linen and wool were both spun

and woven, and history mentions the skill of the daughters of Edward the Elder. Fine linen was made in Sussex and Wiltshire as early as 1253. A guild of linen weavers was organized in 1386 at London. The linen industry, however, did not flourish in England as it did on the Continent, so that in 1677 it was proposed to establish spinning schools as they then existed in Germany. As many as two hundred girls from six years upwards sat under the supervision of a woman who in a pulpit directed the pupils, and tapped with a long white wand any child who neglected her work. When this did not suffice, she rang a bell, and the offender was taken away and whipped.

Irish linen weaving began in the eleventh century, but it received its great impetus from Louis Crommelin, who had been driven from France by the revocation of the Edict of Nantes in 1685, which instituted religious persecution. From this period also begins England's supremacy in the textile industry, for the religious intolerance that the edict entailed drove three hundred thousand of the best French artisans from their native country. It was not until 1725 that machinery was used in Irish weaving, and not until 1828 that flax was spun by machinery.

Linen had begun to be woven in Scotland in the reign of Charles I., and by 1688 had become an important Scottish industry, which had already raised the apprehensions of the English weavers; for the Scotch packmen who went into England in 1684 to sell goods were sometimes whipped as malefactors and required to give bonds that they would abandon the trade.

Linen was also one of the Puritan domestic industries, and as linsey-woolsey gave its name jointly to a fabric composed both of flax and wool. Linen has never been successfully woven in America except in the coarser forms of crash and towelling. Scotland, Ireland, and Belgium produce the finest linen; Russia, the largest amount of flax; and Coutraï, Belgium, the flax best prepared for

spinning. Most of the American-grown flax is raised for seed only.

PRODUCTION OF FLAX AND LINEN

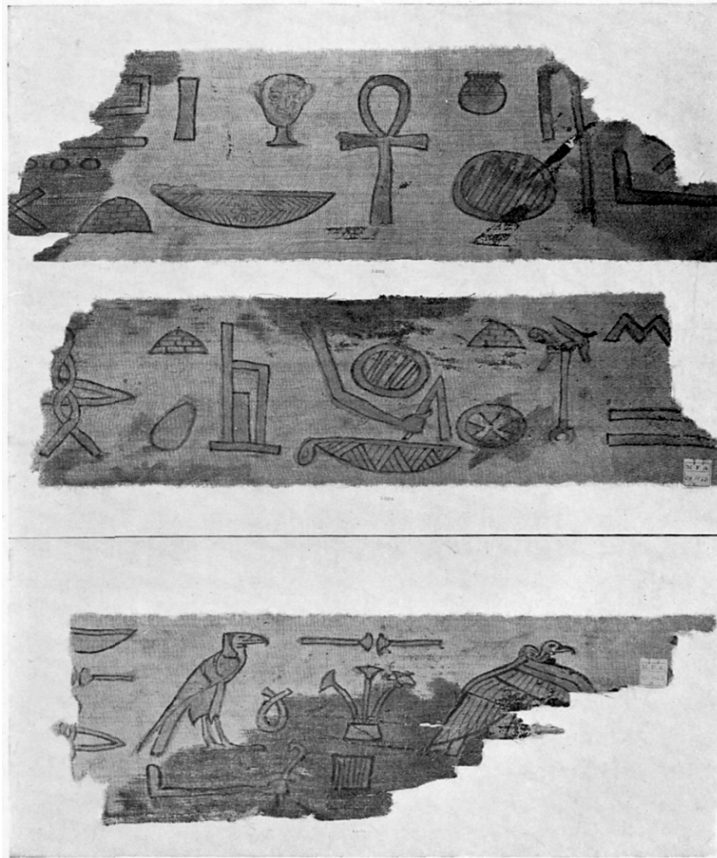
America has never been able to equal the Continent in its production of the finest linen, none of the growers of flax giving the attention to the proper preparation of the fibre which has made that of the Belgian, Irish, and French growers so superior. Most of the Western farmers grow their flax for the seed. The tedious process of the separation of the fibre from the stalk and its preparation for the yarn require the cheapest form of labor to make it profitable, and for this reason more than any other America has not yet raised the flax fibre in quantities that would be commercially successful.

The total production of flax for the year 1909, or the last year given by the census of the flax-producing countries, was 1,872,127,000 pounds, of which Russia produced 1,594,000,000; Austria - Hungary, 104,332,000; France, 46,340,000; Italy, 44,800,000; United Kingdom, 26,934,000; and the United States but 4,000,000 pounds. The number of establishments producing flax, hemp, and jute products in America in 1909 was 149, the value of the product was \$58,946,000, the capital invested was \$73,393,000, and the number of employees was 26,361.

Russia, Austria, Germany, France, Belgium, Holland, England, Scotland, and Ireland are great producers of linen to-day. The best yarn probably comes from Holland, Belgium, France, and Ireland. The United States occupies a relatively low standard as to the amount of products turned out.

WOOL

The date at which prehistoric man discarded the pelt of skins for the woven fabric of wool or linen marks the origin of the textile industry. Wool was probably the



LINEN MUMMY CLOTHS

(From an Exhibit in the Boston Museum of Fine Arts)

Specimens from Egypt, date about 1545-1350 B.C. The hieroglyphics are painted yellow and outlined with black.

first material spun by early man; for flocks and herds and a pastoral existence was the first upward step in civilization from the primitive conditions of savagery. Primitive sheep were covered with hair, and the wool which now characterizes them was a downy undercoat. As time progressed and the art of spinning and weaving developed, the food value of sheep decreased as their wool value increased, and the hairy flocks were bred out and sheep with true wool succeeded. Even now the growing of hair among the wool of old or neglected sheep is an atavistic return to the original condition.

Although the best quality and greatest quantity of wool comes from sheep, it is also found on many fur-bearing animals, such as the angora goat, cashmere goat, camel, alpaca, and the llama. No less than six or eight qualities of wool come from a sheep, each kind having its particular advantage for manufacturing. As a rule, hair is the longer and the exterior fibre, while wool is the short fibre next to the skin. Wool is pliable and warm and has the property of felting.

EFFORTS TO IMPROVE WOOL

When and where efforts were first made to improve the wool production of sheep is not known, but evidences exist to show that the Romans about 200 B.C. had begun the attempt which resulted in a breed of Tarentine sheep with a long, heavy, and fine staple wool. In "De Re Rustica" of Columella, written about the middle of the first century, he states that his uncle Marcus Columella, a farmer of Spain, succeeded in greatly invigorating his delicate Tarentine ewes by crossing them with African rams. The Tarentine fleece had been either brown or black, but by this outside breeding Columella succeeded in procuring not only much more vigorous stock, but a heavy, white, fine wool.

The cross-breed thus accomplished was the original of

the Spanish merino, and with modifications and crossings has been the parent stock of the fine-wool sheep of Europe and America. Pedro IV. of Castile in the fourteenth century and Cardinal Ximenez in the sixteenth century renewed the stock with Barbary rams. The Spanish stock was imported by Louis XIV. of France with great difficulty, owing to Spain's refusal to allow sheep to be imported and improved, resulting in the French merino, one of the best long-wool breeds. Importation of the same Spanish breed to Germany, cross-breeding, and climatic changes have produced the fine Saxon wools, so advantageous for the best broadcloths. To this merino origin may be traced the French sheep of Naz, which produce wool of such silky lustre.

The first mention of sheep in England is in a document of 712, where the price of the animal is said to have been placed at one shilling "until a fortnight after Easter." By the beginning of the thirteenth century England was the great wool-producing country of Europe, and was furnishing the weavers of Flanders their wool to such an extent that it was considered good policy for Flanders to keep peace with England.

Sheep were first introduced into America at Jamestown in 1609, and the colonial government in all the colonies encouraged the raising of sheep. President Washington imported the best breeds of sheep from England, and promoted the bringing to this country of the most experienced spinners and weavers from England.

The merino strain was introduced into America between 1801-12 by William Jarvis, Colonel David Humphreys, and others, and with the various merino strains make up the flocks prized for their wool. Colonel Humphreys, while United States minister to Spain, had conceived the idea of introducing merino sheep into America, and April 10, 1802, shipped from Lisbon one hundred sheep, nine of which died on the way. The remainder were sold to the farmers about

Derby, Conn., for a hundred dollars per head and greatly improved the strain of American sheep.

The Australian and Cape Colony sheep which produce the best wool have the merino strain. Where the food-producing qualities have been considered as well as the wool, the wool is apt to be medium or coarse in quality. This is true of the South-western and Pacific States flocks, and the South American breeds. The best English strains are the Leicester, Border Leicester, Lincoln, Cotswold, Kent, Devon, Longwool, South Devon, Hampshire, Wensleydale, Roscommon and Oxford Down.

Henry Dudding, of Riby Grove, Lincolnshire, England, in 1906 sold a Lincoln ram raised by him for about seven thousand dollars. The same year Robert and William Wright, of Houghton Heath, Lincoln, sold their flock of 950 Lincolns to Señor Manuel Cobo, of Buenos Ayres, for about one hundred and fifty thousand dollars.

Wool is divided into pulled and clipped or fleece wools. The two latter are cut from the living sheep, while the first is pulled by the roots from the pelt of the dead sheep. The clipped wools make up the greater part of the market and are divided into long and short staple, or combing and clothing wools.

Clothing wools are used for broadcloths and heavy cloths, the finer combing wools for the thinner fabrics for women's wear. Medium wool is used for worsted goods, alpacas, mohairs, and the like, while the coarser goes into carpets, blankets, and similar goods.

The production of wool in the principal sheep-raising countries in 1909, as given by the Report of the Tariff Board, was 2,490,600,000 pounds, divided as follows: Australia, 718,000,000; Continental Europe, 420,000,000; Argentina, 401,200,000; United States, 328,100,000; New Zealand, 223,000,000; United Kingdom, 142,000,000; Uruguay, 127,400,000; and British South Africa, 130,900,000.

The number of sheep raised in America in 1910 was

51,809,068, and in the United Kingdom, 31,164,587; in Argentina in 1908, 67,211,754; in Australia in 1909, 91,676,281; in New Zealand in 1911, 23,996,126; South Africa in 1910, 31,102,467; Uruguay in 1910, 26,286,296; Russia, 82,672,123; Ottoman Empire, 41,000,000; British India, 21,824,000; China, 18,900,000; France, 17,357,640; Spain, 15,471,183; Austria-Hungary, 13,991,500; Italy, 11,160,000; Canada, 2,598,470.

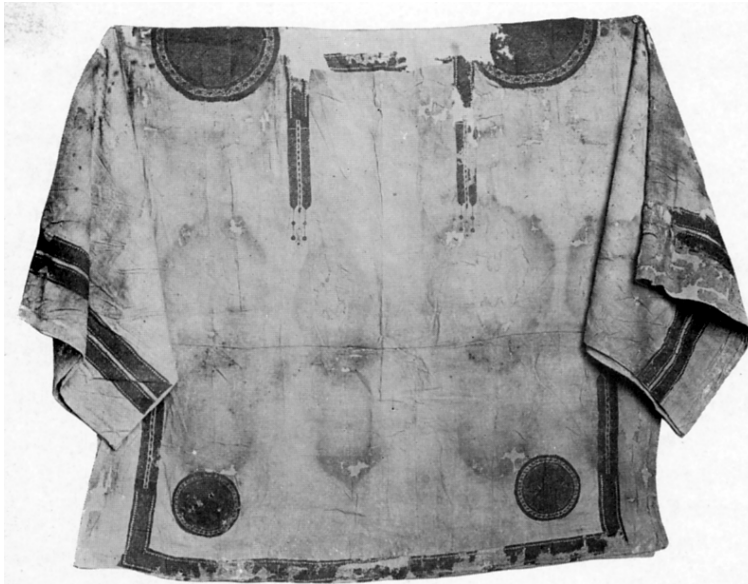
The value of manufactures of wool in America in 1909 was \$507,219,000; the capital invested was \$506,323,000, ranking next to cotton; the number of establishments was 1,126; and the number of employees, 208,739.

EARLY USE OF WOOL

The spinning and weaving of wool has been practised, as we have seen, from a most remote antiquity, and in the Far Western America as well as in remote Eastern Japan and China. Remnants of wool as well as linen are found in the barrows of the Britons and also in other tombs. The art is frequently referred to by ancient writers, and, when we enter the mediæval age, we find more frequent references to it in the many statutes that were passed regarding it and its regulation.

Sheep were domestic among the Britons long before the advent of the Romans, and some use was made of sheepskin and wool. But the Romans certainly taught the Britons more perfect weaving and spinning. The Romans established a wool factory which supplied their army, and the Britons were quick to learn. It was not long before the product of Winchester looms had a reputation abroad, and it was said, "The wool of Britain is often spun so fine that it is in a manner comparable to the spider's webs." The fibre was in great demand in the Low Countries.

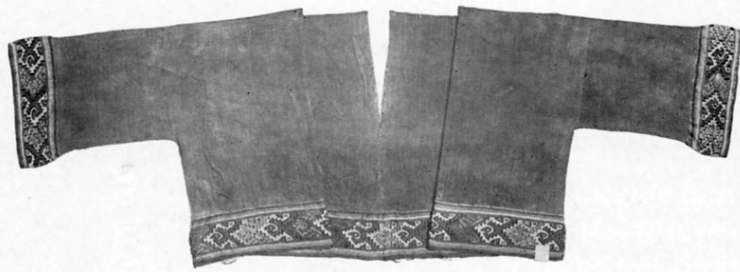
The Angles and the Saxons brought with them to England a knowledge of rude spinning and weaving, and Alfred's



EGYPTIAN TUNIC

(From an Exhibit in the Boston Museum of Fine Arts)

A tunic from a Coptic grave in Egypt dating from the first to the seventh century A.D. Into the garment of plain basket weave are woven with reddish-violet wool and white linen threads circular medallions and bands of ornaments. The garment was made in one piece and sewed together under the arms.



PERUVIAN TUNIC

(From an Exhibit in the Boston Museum of Fine Arts)

Woven with cotton, decorated with borders of tapestry weaving of colored wools. The red wools are dyed, while the yellow and brown are the natural color of the Vicuna and the alpaca wools. It shows the high skill reached by the Peruvians in the textile industry before the Spanish Conquest.

mother is referred to as skilful in spinning. Although early English history is full of allusions to the textile industry, the English products could not compare with those of the Continent. At various times, beginning with the reign of William the Conqueror, who allowed Flemish weavers to settle at Carlisle under the protection of the queen, there were immigrations of skilled Flemish workmen caused by the Continental wars and persecutions, and little by little these immigrants established the higher industry here and there in England.

Henry II., who reigned from 1154 to 1189, inaugurated the cloth fair in the churchyard of the priory of St. Bartholomew, established guilds of weavers, and granted the city of London the exclusive rights to export woolen cloth. An act passed in 1189 prohibited the mixing of Spanish and English wool, and another in 1197 regulated the dyeing of wool to be sold. Edward I. "settles his sons to schole and his daughters he set to woll-worke," and in 1279 a petition asserts that the wool exported to Flanders was nearly half the land in value.

Edward III. gave special attention to wool industries, bringing weavers, dyers, and fullers from Flanders, and prohibited, under pain of life and limb, the exportation of wool. English wool had been in great demand in Flanders, Brabant, and France, and was second only to Spanish wool. The practice of creating large sheep farms, with the consequent number of people thrown out of employment and the increased price of agricultural products, led in 1489 to legislation restricting sheep raising. This shows that England's woolen industry at this early date was an important one, for she was then beginning to export her woolen fabrics.

The statute books of Edward III. and IV. and the subsequent rulers of England contain frequent references to wool and its manufacture. Efforts to prevent the exportation led to much smuggling, and it was not until the reign of Queen Elizabeth that the free exportation of wool was

permitted. In 1660 acts prohibiting the export of wool were passed again, and those remained in force until 1825.

The impetus which the English textile industry received from the immigration of weavers, particularly from France, was undoubtedly great, and much of the skilful knowledge of Lancaster and Manchester and Bradford and the other towns in the great textile centre may be traced to the French weavers whom France's disastrous intolerance drove from home.

Wool was the principal staple used in the English industry until the middle of the eighteenth century, when the inventive genius of Kay, Hargreaves, Arkwright, Cartwright, and Crompton gave such an impetus to weaving, particularly of cotton, that it was not long before cotton had wrested from wool its long supremacy.

COTTON, THE PLANT, GROWTH, AND DISTRIBUTION

"Cotton supplies nine-tenths of the material employed in the manufacture of clothing," said M. Jean de Hemptinne, of Brussels, in opening the International Congress of Cotton Manufacturers in Brussels in June, 1910. It is the most valuable of all plants, and grows generally in tropical and sub-tropical regions. The commercial crop for 1910, estimated in five hundred bales, was 18,321,000 pounds, of which two-thirds were grown in the United States. The name is derived from the Arab term *qutun*, and in its transmission through other languages changed into the English name, "cotton."

Botanically, it belongs to the genus *Gossypium*, of the Malvaceæ, or Mallow, order, and, excepting the caravonica-tree, is a small, bush-like plant with broad, three-cleft leaves and with seeds that grow in capsules, or bolls, surrounded by a soft white or cream downy fibre which can be readily spun. These fibres are unicellular hairs which are attached to the seed, and each hair is the outgrowth of a

single epidermal cell of the outer coat of the seed. Under the microscope these hairs, or fibres, are round when green, but, when dried, are flattened and twisted, not unlike an empty twisted fire-hose. This characteristic differentiates true cotton from the false flosses which have no twist, and also aids greatly in the spinning of the fibre.

The best cotton has a long fibre and is known as "Sea Island cotton," because it is grown on the islands off the coast of South Carolina, Georgia, and Florida, while the shorter fibre cotton is grown on the mainland and is called upland cotton. Egyptian cotton ranks next to Sea Island cotton in value. Sea Island cotton originated in the Lesser Antilles.

The seed is sown in April, and the fruit, or bolls, covered with the fibre, are gathered in September and October. Not alone is the cotton of value, but the seed now furnishes the valuable cotton-seed oil and a meal which, as a food for cattle, has great fat-producing qualities and is also rich in fertilizer, while the fibre of the inner bark is almost as valuable as jute. The cotton-producing countries of the world in the order of the value of their output are as follows: Southern United States, British India, Egypt, Russia, and Brazil.

EARLY HISTORY

History cannot tell us at what date cotton was first spun and woven into fabric; for cotton, like wool, was being made into clothing when history began. In different parts of the tropical world vegetable growths akin to cotton were in use in prehistoric times, and at the dawn of history cotton's manufacture into fabrics was already well established in the Orient, particularly in India and in China.

Cotton has been for thousands of years the staple fabric of the East, and where warmth was required it was padded by the Chinese into thick garments. It was probably exported from India to Palestine and Egypt, where it

became indigenous, and gave rise to flourishing ancient textile industries, along with flax and wool.

An early mention of cotton is in the Bible in King Solomon's time, 1015 B.C. to 975 B.C. Herodotus, the father of history, in 445 B.C. makes the first historical mention of cotton. In speaking of the people of India, he says, "They possess likewise a kind of plant, which instead of fruit produces wool of a firmer and better quality than that of sheep: of this the Indians make their clothes."

Cotton was brought from India by Alexander in 500 B.C., and from then until about the birth of Christ it was in use on the shores of the Mediterranean. Cæsar and the Roman army wore clothing made of it, as did the Roman people. It was imported from India by the Romans, though it was an article of common manufacture in Upper Egypt, where garments were made for the Egyptian priesthood. It was also spun and woven on the Island of Tylos in the Persian Gulf and in many other parts of the Eastern world.

Pliny, the Roman naturalist (A.D. 23-79), says that Egyptian priests, as well as the common people, wore cotton "woven into beautiful garments from down wool spun into thread, the wool of which was cotton growing in upper Egypt toward Arabia." The same authority asserts that the origin of the manufacturing of cotton cloth was in the weaving establishments founded by Semiramis on the bank of the Tigris and Euphrates.

Arab traders were the first to import it in any quantity to Italy and Spain. Arrian, an Egyptian Greek of the second century A.D., in his "Circumnavigation of the Erythræan Sea," is the first writer to mention it as an article of commerce. At as early a date as the first century the Arab traders were bringing Indian calicoes, muslins, and other cottons to ports on the Red Sea and thence to Europe. It was said of Omar, one of the caliphs of Mahomet, that "he preached in a tattered cotton gown, torn in twelve places."



THE COTTON PLANT

(From F. H. Bowman's "The Structure of the Cotton Fibre," courtesy
of The Macmillan Company)

The leaves, the bud, the flower, and the boll of cotton, showing the cotton
ripe in the boll ready for picking.

The first cultivation of cotton in Europe was probably by the Moors in Spain, in the ninth century in Valencia; and it continued to be raised and spun in different parts of Spain during the tenth century, and until the Moors were expelled. Fustians and dimities were first wrought in Spain, and from Spain the industry spread to Venice and to Milan in the fourteenth century.

In the latter part of the thirteenth century Marco Polo speaks of cotton as vegetable wool growing on trees, and early engravings represent the trees with sheep's heads at the ends of the branches. He also states that cotton was manufactured in all parts of India and some parts of China, and was woven, even at this early date, of colored threads. By the fourteenth century the industry had begun in Venice and Milan, where the warp, though sometimes of cotton, was usually of linen.

Cotton was evidently known and used in England at a very early date, and was probably imported from the Spanish Arabs. In the Wardrobe Act of 1212, twelve pence is mentioned as the price of a pound of cotton for stuffing the acton of King John, and shortly after cotton wool is described as being used for candlewicks. By 1430 it was being imported into England in large quantities, and the Netherlands had also a large trade in cotton with Italy and the Levant, and from this time on frequent mention is made of it in England.

Owing to the confusion of fustians of wool with fustians of cotton in the early mention of the cotton industry in England, it is impossible to fix the exact date at which the manufacture of cotton began there. The earliest reference which has been found that fixes a date is in the will of James Billston, who is described as a cotton manufacturer, and whose will was probated at Chester, 1578.

Another early reference to cotton is in a petition to the Earl of Salisbury, made presumably 1610, asking for a continuance of the grant for reforming frauds committed

in the manufacture of "bombazine cotton such as groweth in the land of Persia, being no kind of wool."

A petition of merchants and citizens of London engaged in buying and selling fustians made in England, dated probably 1621, shows that "divers people in this kingdom, chiefly county of Lancaster, for twenty years past were making fustians of a kind of bombast or down, being a fruit of the earth growing upon little shrubs or bushes, brought into this kingdom by Turkey merchants from Smyrna, Cyprus, Acra and Sydon, but commonly called cotton wool, and also of linen yarn, most part brought out of Scotland, and other some made in England, and no part of the same fustian of any wool at all, for which said bombast and yarn imported, his Majesty has a great yearly sum of money for the custom and subsidy thereof."

It says further that "40,000 pieces of fustian were made in England, the subsidy coming to eight and ten pence per piece, and thousands of poor people worked on these fustians."

In 1503 sixpence a yard was paid for russet cotton for the "Queen's Choare," and in the household books of Lord William Howard in 1612-40 both cotton and wool are mentioned. Lewis Roberts, captain and merchant of London, speaks in his "Treasures of Traffic" in 1641 of the Turkey Company bringing cotton and cotton yarn from Cyprus and Smyrna.

In this ancient record of trade Manchester is thus early depicted as the centre of a flourishing textile industry, and it is spoken of as buying yarn of the Irish, weaving it, and returning it to Ireland to sell. England had then already begun its export trade, buying cotton from India, Cyprus, and Smyrna, and making it into fustians, vermilion, dimities, and other stuff, and sending the surplus product abroad.

The East India Company had begun the importation of calico from Calicut, India, in 1631; and for a long time

it was judged to be a soft linen. In 1663 the question was raised what revenue tax it should bear, and Pepys's Diary, Feb. 27, 1663, refers to the question as follows:—

“Sir Martin Noell told us the dispute between him as a farmer of the additional duty and the East India Company, whether callico be linnen or no: which he says it is, having been ever esteemed so; they say it is made of cotton woole and grows upon trees, not like flax or hemp. But it was carried against the company though they stand out against the verdict.”

The result is not known, but the importation was small. The section of England about Manchester was thus early the seat of a growing textile industry, which was later to dominate the entire textile world; and the industry sprang up here through the settlement at an early date of the Flemish spinners and weavers from Flanders, who quickly followed in the train of William the Conqueror. Then again the religious persecutions in Europe during the Middle Age, particularly the revocation of the Edict of Nantes in France in 1685, as we have seen, drove many thousand skilful Huguenot weavers to England, thus strengthening the English industry at dear cost to industrial France.

Of so little importance was cotton in England that prior to the nineteenth century it was an insignificant article of commerce, and in 1736 it was regarded chiefly as an ornamental plant. At the accession of George III. in 1760 the whole importation did not amount to more than 200,000 pounds, and in 1782 it did not exceed 2,000,000.

COLUMBUS AND COTTON

The first mention of cotton in America occurs in the journal of Christopher Columbus, who, under date of Oct. 12, 1492, describes the natives of Watling Island, where he first landed, bringing, among other things, skeins of cotton thread out to his ship.

“Afterwards when we were in the ship’s boats,” he continues under the same date, “they came swimming toward us, and brought us parrots and balls of cotton thread and spears, and many other things which they exchanged with us for other things which we gave them, such as strings of beads and little bells.”

Under date of Oct. 13, 1492, he says the natives were ready to trade for everything down to bits of broken crockery and glass. “I saw one give sixteen skeins of cotton for three of ceotis of Portugal, equal to one blanca of Spain, the skeins being as much as an arroba of cotton thread. I shall keep it and shall allow no one to take it, preserving it all for your Royal Highnesses, for it may be obtained in abundance. It is grown on this island, though the short time did not admit of my ascertaining this for a certainty.”

He subsequently found trees of cotton of sufficient fine quality to be woven into good cloth. He also saw handkerchiefs of fine cloth very symmetrically woven and worked in colors. Under date of October 16, he speaks of seeing, on the Island of Fernandina, cotton cloth made into mantles. Speaking again under date of October 16 of cotton, Columbus says of the natives, “Their beds and bags for holding things are like nets made of cotton.” Here Columbus says they “saw married women wearing breeches made of cotton, but the girls do not, except some who have reached eighteen.”

This is especially interesting because it shows that very early the American natives, particularly those of the South, not only raised cotton, but wove it into fabrics and garments of various kinds. Balls of native cotton spun on distaffs by natives of Guiana, South America, and similar to those spoken of by Columbus, are to be seen in the museum at Georgetown, Demerara.

Magellan found the natives of Brazil using cotton lint for making beds in 1519 when he circumnavigated the globe. Emperor Charles V. received from Hernando



FABRICS WOVEN BY THE BAKUBA TRIBE, AFRICA

(From the Boston Museum of Fine Arts)

Specimens of fabrics woven by the Bakuba tribe of the Congo River section. Both show no evidence of contact with civilization. The pink grass cloth is of a plain weave. The black and white design, also of grass, has a pile like velvet.

The plain piece is made from grass cloth, especially for chiefs.

Cortez cotton goods of different kinds from Mexico at the time of Cortez's conquest. They comprised cotton mantles, white, black and white, red, green, yellow, and blue; waistcoats, handkerchiefs, counterpanes, tapestries, and carpets of cotton, some of the colors of which were extremely fine. In fact, cotton was in use among the Algonquins, for Champlain says that the Indians whom he encountered at Lake Champlain July 2, 1609, wore arrow-proof doublets made of strips of wood bound together with cotton.

So far as is known, the first mention of cotton growing in the United States proper is by de Vaca, who found it in 1536 in what is now the States of Louisiana and Texas. The English colonists sowed the first cotton-seed in Virginia in 1607. In 1620 a pamphlet, called the "Declaration of the State of Virginia," stated that cotton wool was to be had there in abundance, and in 1621 cotton is quoted at eightpence a pound. Many travellers mention the cultivation of cotton in America during the seventeenth century and early half of the eighteenth century. It is mentioned in Virginia in 1649, in South Carolina in 1664, 1682, 1702, 1731, and 1741, and in Georgia in 1735, 1738, and 1749.

It was regarded, however, as a garden plant rather than for domestic use in most localities except parts of South Carolina and Georgia, and it was not until after the Revolution that its cultivation began, as we shall see later, on a large, systematic scale in the South. There were two causes which militated against Southern cotton growing during this country's connection with England. The first was the discouragement by England of the establishment of any industry in this country that would compete with the English cotton industry; and, secondly, there were no means of cleaning the American cotton from the seed even after it was grown, so that it was only when the Revolution cut off trade with England that the Southern cotton growers, stimulated by the home demands, set about growing

cotton systematically. The story is told in a subsequent chapter.

The first manufactory of cotton in America, as well as the first establishment of the textile industry in America, by the whites occurred at Rowley in 1643, and is described by Edward Johnson in his book "Wonder-working Providence of Sion's Saviour in New England," published at London in 1654.

It may be interesting to glance at these statistics relating to the cotton industry.

The world supply of cotton for 1909 was 8,505,191,000 pounds, of which the United States produced 5,157,691,000, or 60.6 per cent.; British India, 1,801,000,000; Egypt, 455,500,000; Russia, 360,000,000; China, 300,000,000; Brazil, 180,000,000; and Turkey, 16,000,000.

The value of the United States crop the same year was \$700,000,000. Two-thirds of the crop of this country is sent to foreign countries. No less than 9,000,000 persons are employed in its production, handling, and manufacture. 6,000,000 of those thus engaged are farmers and farm laborers, 1,000,000 are otherwise engaged to some extent in the United States, and at least 2,000,000 are employed in other countries in its transportation and in the manufacture of which it is the basis. The capital engaged in the United States manufacturing industry in 1909 was \$821,109,000, and the value of the output was \$629,699,000. There were 1,322 establishments engaged in the manufacture, employing 387,252 persons.

The number of cotton spindles and mill consumption of the world for 1910 were as follows: United States, 29,189,000 spindles, using 4,799,000 bales; United Kingdom, 53,397,000 spindles, using 3,372,000 bales; India, 5,657,000 spindles, using 1,653,000 bales; Germany, 10,200,000 spindles, using 1,660,000 bales; Russia, 8,250,000 spindles, using 1,457,000 bales; France, 7,100,000 spindles, using 951,000 bales; Japan, 2,005,000 spindles, using 1,028,000 bales; China, 765,000 spindles, using 315,000 bales; Brazil, 1,000,000

spindles, using 370,000 bales; and, including countries of minor importance, a total is reached of 134,526,000 spindles, using 18,321,000 bales of 500 pounds each.

Of the number of cotton spindles in the United States in 1910 Massachusetts had 9,853,610, or 34 per cent. of the whole country; South Carolina was second, with 3,793,387, or 13 per cent.; North Carolina was third, with 3,124,456, or 11 per cent.; Rhode Island fourth, with 2,455,304; Georgia, 1,860,905; New Hampshire, 1,350,455; Connecticut, 1,332,991; New York, 1,024,114; Maine, 1,010,535.

Massachusetts leads in the consumption of cotton, North Carolina is second, South Carolina third, Georgia fourth, New Hampshire fifth, Alabama sixth, and Rhode Island seventh.

SILK

The derivation of the term "silk" points authoritatively to the East as the place of origin of the most costly of all fabrics. It comes with various changes from Seres, the name given the ancient Chinese and the inhabitants of Eastern Asia by the Greeks, Syrians, and Persians; and in the Greek it took the name *serikon*, which in Latin became *sericum*, and by the insertion of l for r, in the language of the West, changed to *selicum*, *silic*, and eventually silk.

The Greeks and Romans supposed it was a woolly substance spun from the leaves of trees, and for fifteen hundred years after it became known in Western Europe the opinion that it grew upon a tree or was obtained from the bark continued to be the belief. Not until the sixth century did two Nestorian monks, who brought silkworm eggs from China to Constantinople, make the truth known.

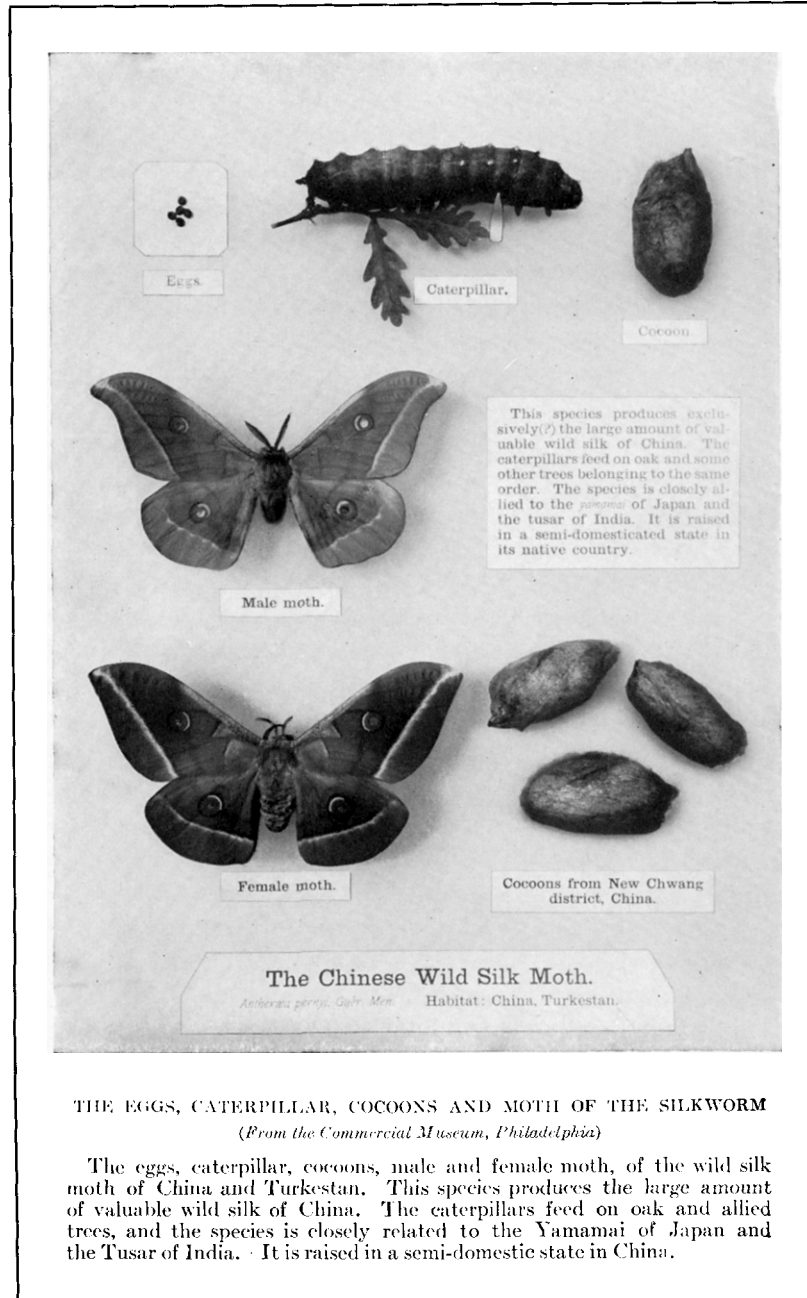
Silk is a liquid substance secreted from their food by various insects of different families, but principally by the spider and the silkworm of the Bombycidae family. It is held in cells or tubes on each side of their bodies and drawn out through minute orifices called spinnerets. As these

threads, from two to six in number, are pulled out, they harden to form a stronger thread. The thread is used by spiders as a method of locomotion or as a net to trap their prey; while others, and many of the caterpillars, weave it into cocoons to protect their eggs and into which they may withdraw when about to go into the chrysalis state, as in the case of the true silkworm.

The number of insects that yield silk is very large, there being no less than one hundred species of the spider family. None except the true silkworm produces a silk that can be spun profitably, although the silk of the spider family is of most exquisite quality, and has often been used for making small articles of silk. The small amount of the product and the difficulty of controlling spiders make such use impracticable.

The best silkworms are those which feed on the leaves of the white mulberry-tree, and go through their changes but once a year. The life history of the silkworm is like that of the whole moth family. The female, after coming from the cocoon, lives three or four days or a week, and then lays four or five hundred small whitish or yellow eggs. A gummy substance holds them to the leaves or other object on which they may be laid, and, when their food is ready, they are hatched and at first are not over one-twelfth of an inch in length. They go through the various changes of moulting and casting their skin about four times in twenty or fifty days. At their full growth they are about three inches in length, and then they find a place to spin their cocoon, finishing it in three to six days and going into the chrysalis. In twenty to forty days the insect emerges from the cocoon, and in a few days is ready to lay her eggs. The cocoons are unravelled, reeled, carded, spun, doubled or redoubled, cleaned, and twisted into the thread for weaving or sewing.

The greatest producer of manufactured silk is probably China, though no complete statistics are available; and



Eggs

Caterpillar.

Cocoon.

Male moth.

This species produces exclusively(?) the large amount of valuable wild silk of China. The caterpillars feed on oak and some other trees belonging to the same order. The species is closely allied to the *pernyi* of Japan and the tusar of India. It is raised in a semi-domesticated state in its native country.

Female moth.

Cocoons from New Chwang district, China.

The Chinese Wild Silk Moth.
Antheraea pernyi, Guér. Men. Habitat: China, Turkestan.

THE EGGS, CATERPILLAR, COCOONS AND MOTH OF THE SILKWORM

(From the Commercial Museum, Philadelphia)

The eggs, caterpillar, cocoons, male and female moth, of the wild silk moth of China and Turkestan. This species produces the large amount of valuable wild silk of China. The caterpillars feed on oak and allied trees, and the species is closely related to the Yamamai of Japan and the Tusar of India. It is raised in a semi-domestic state in China.

second to China is the United States, for since 1905 France has fallen into third place; while the nations that are most productive of raw silk in the order of their output are China, Japan, and Italy. In 1909 the world produced 85,048,000 pounds, of which China raised 35,697,000; Japan, 30,135,000; Italy, 9,373,000; France, 1,486,000; Austria-Hungary, 838,000; and British India, 513,000. The value of the silk manufactures of the United States for 1909 was \$196,475,000, capital invested was \$144,799,000, and the number of employees was 104,261.

EARLY HISTORY OF SILK

Like wool, cotton, and flax, the date of the origin of silk is uncertain. Very early it was in use in the East, and well into modern times it continued to be the fabric used exclusively by the nobility, or royalty. In fact, the earliest historic reference has a royal setting, and comes from the East. According to Chinese history, silk was used in China thousands of years before Christ.

The Chinese legend regarding the discovery of the use of silk in a "summary of the principal Chinese treatises upon the culture of the mulberry and the rearing of silkworms," compiled and translated from Mr. Stanilas Julien's French edition of Chinese Treatises, printed 1836 at Washington, D.C., is as follows:—

"This great prince Hoang-ti was desirous that Si-ling-chi, his legitimate wife, should contribute to the happiness of his people. He charged her to examine the silkworms, and to test the practicability of using the thread. Si-ling-chi had a quantity of these insects collected, which she fed herself in a place prepared solely for that purpose, and discovered not only the means of raising them, but also the manner of reeling and of employing silk to make garments."

"It is through gratitude to so great a benefit that posterity has deified Si-ling-chi, and rendered her particular

honors under the name of 'The Goddess of Silk-Worms.' To the present time it is said that the empress of China, on a certain day of the year, goes through the ceremony of feeding the silkworms and rendering homage to Si-ling-chi, as 'Goddess of Silk-Worms.'"

The date of this, according to Chinese chronology, was 2700 B.C., but more accurate records make it about 2640 B.C. Whichever date is correct, it is certain that the manufacture of silk products goes back to a very early date.

To the Empress Si-ling-chi the Chinese also ascribe the invention of the loom. It was not until the third century A.D. that the Japanese learned of the manufacture of silk through the Coreans, and then they sent Coreans to China to engage people to teach the art to the Japanese. Three Chinese girls were brought back, who taught the Japanese court and people the art of plain and figure weaving.

The art subsequently spread to India, where it was introduced by a Chinese princess, who carried the silkworm eggs and seeds of the mulberry-tree concealed in the lining of her head-dress; and by India the silk was made known to Europe. For many centuries, however, the Chinese had a monopoly of the industry, and Tartar caravans carried loads of silk, which they sold to Persian and Arabian traders.

The knowledge of silk was brought to Europe by Alexander the Great (356 to 323 B.C.) when he returned from India; and Aristotle gave full particulars of the silkworm, describing it as a horned worm which he called Bombyx. It passed through several transformations and produced Bombykia. According to Aristotle the Island of Cos was a flourishing seat of early silk manufacturing.

The knowledge of silk brought by Alexander seems, however, to have been lost, for the Romans later obtained silk from the Greeks and thought that it was a fleece that grew upon trees. This became the early belief of the

western world. Nearchus evidently confused silk with cotton; Virgil supposed silk was carded from leaves; Dionysius thought it was combed from flowers; while Pliny (23-79 A.D.) describes the Bombyx, but makes it a native of Assyria.

It is impossible to say when silk came into use among the higher classes at Rome, but there is authority for believing that it was first worn in Rome during the supremacy of Julius Cæsar (61-44 B.C.), and from then on became the dress garment of the Roman nobility. Its price was very high, selling for its weight in gold. Nevertheless, silk had such a vogue among the wealthy classes that the Emperor Tiberius prohibited men from wearing it on the ground that it was effeminate, and Roman satirists denounced the wearing of the transparent silk of Cos by either sex because of the indecency. Emperor Heliogabalus, in 222 A.D., shocked his subjects by appearing in a garment of thin silk, while Emperor Aurelian in 273 A.D. refused the plea of his wife for a single garment of purple silk on the ground of extravagance, saying that a pound of silk sold for its weight in gold, and that wearing it would be an example of extravagance.

Ammianus Marcellinus, 380 A.D., stated that silk had come within the reach of the common people. A decree of the Emperor Justinian (518-565 A.D.), that silk should be sold for eight pieces of gold per pound, or about \$15, together with a war with Persia whose traders were the carriers of silk, cut off all importation and ruined the silk merchants.

The situation was relieved by two Persian monks, who had become familiar with the silk industry while on a religious embassy to the Chinese, and who informed Justinian that they could secure from China the means of establishing the industry. Accordingly, at Justinian's command they returned to China, observed carefully the whole process of the industry, and 536 A.D. brought back to Constanti-

nople the seeds of the mulberry-tree and the eggs of the silkworm concealed in hollow staves, and thus was the silk industry established in Europe. Byzantine silk soon came much in demand for ecclesiastical purposes.

The silk industry spread from Constantinople to Thebes and other Grecian cities, and the Arabs and the Saracen princes, who obtained the knowledge of silk-making from the Persians, introduced it into Northern Africa, Spain, Portugal, and Sicily. By the tenth and eleventh centuries the output of Spain and Sicily was large, and workmen subsequently carried the industry thence to Italy.

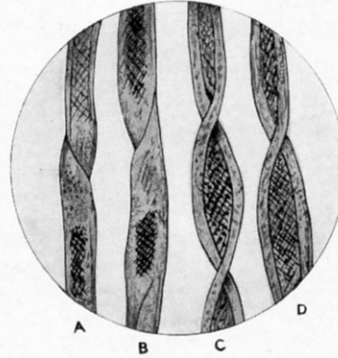
The conquest, by the Venetians in the twelfth century, of Constantinople, where the rarest kinds of silk were made, transferred the early European silk industry to Venice, whose looms then began to supply Europe. The principal seats of the silk manufacture in the fourteenth century were Lucca, Modena, Bologna, and Florence. Genoa also had a flourishing trade.

By 1251 silk garments were generally used by the higher classes in England. A thousand knights appeared in silk at the marriage of Henry III.'s daughter, and silk was worn by the wealthiest citizens. The earliest official recognition of silk in England occurs in an act of Edward III. (1336-60) which restricted merchants to manufacture or trade in a single line of goods, and made imperative a declaration of the line they would engage in before a certain date. Again in 1455 an act was passed prohibiting the importation of silk for five years.

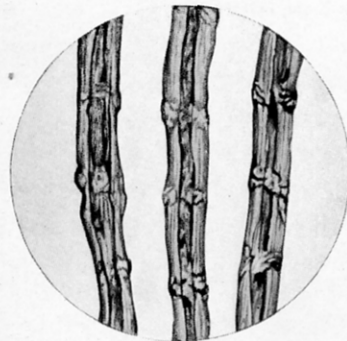
Although the silk trade was begun at Tours and at Lyons, France, in the thirteenth century, it was not until the close of the sixteenth century that the silk production was well established there. It is said that the first white mulberry-tree planted in France was brought there by Guipape de St. Aubon from Syria, about 1147, on his return from the Second Crusade, and was planted three leagues from Montmeliart. This tree was still standing in 1810. From the twelfth



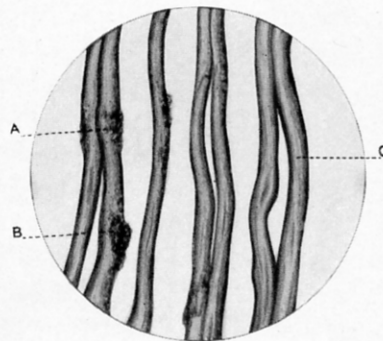
Fine wool fibres, magnified 300 times.



A and B, wild African cotton; C and D, rough Peruvian magnified many times.



Flax fibre x 200 diameters.



Silk fibre x 300 diameters. A and B show the gum on the fibre; C, the clean fibre.

ENLARGED REPRODUCTIONS OF TEXTILE FIBRES

(From F. H. Bowman's "The Structure of the Cotton Fibre," Courtesy of The Macmillan Company)

century on, efforts were made by the French kings to establish the production of silkworms and the growth of the mulberry-trees, but without success until the reign of Henry of Navarre.

This energetic monarch planted about Paris a large grove of mulberry-trees under the direction of Ollivier de Serres, a skilled agriculturist, distributed the eggs, and offered bounties for silk and the most productive trees. The experiment failed, and the people, irritated by the loss of profit, rooted up the trees, destroyed the worms, and gave up the industry.

Persisting, however, the king converted a large orange grove on his own estate into a mulberry grove, and soon had a quantity of silk. His success shamed the people who had given up silk growing, and they resumed the work again under skilful teachers, and soon acquired success; but it had cost the king about two hundred and fifty thousand dollars.

Colbert, the great minister of Louis XIV., kept a guardian eye over the silk production; but the Edict of Nantes almost ruined the industry, as it drove almost four hundred thousand Huguenots, most of whom were engaged in the work, from France to England, Germany, and Switzerland, and of this number almost one hundred thousand went to England.

The first efforts to start the industry in England were unsuccessful, but the introduction of the Italian method of throwing, or twisting, silk soon made it possible for English silk to replace the French in the European market, and it was years before France regained her supremacy. Silk had, however, by the middle of the sixteenth century come into common use among the nobility in England, and Queen Elizabeth and her court were the first to wear silk stockings.

“I have written into Spain for silk hose both for you and my lady, your wife, to whom it may please you, I may be remembered,” wrote Sir Thomas Gresham, April 30, 1560, from Antwerp to Sir William Cecil, Elizabeth’s great

minister, and the hose sent soon after were black. Until the time of Henry VIII. stockings were of ordinary cloth, and the king's were yard-wide taffeta.

Sir Thomas Gresham sent Edward VI. a pair of long Spanish silk stockings. In the second year of Queen Bess's reign "her silk woman," Mistress Montague, gave the queen a pair she had knit of black silk for a New Year's gift. After the queen had worn them a few days, she was so pleased she sent for Mistress Montague and asked her "where she had them," and if she could help her to any more, who answered, "I made them very carefully of purpose only for your Majesty, and seeing these please you so well I will presently set more in hand."

"Do so," quoth the queen, "for indeed I like silk stockings so well, because they are so pleasant, fine, and delicate, that henceforth I will wear no more cloth stockings," and from that day she wore silk.

Among the other weavers which the Edict of Nantes drove from France to England was a large number of silk weavers, and the manufacture of broad silks began in England during the reign of James I.

Such a foothold had the industry obtained by 1701 that acts were passed prohibiting the importation of silk from France, China, Persia, and India because there were as good made in England. It was not until 1715 that a silk throwing mill was established in England.

The silk machinery used in England until the beginning of the eighteenth century was crude and ineffective. Much of the organzine silk warp was imported from Italy. In 1717, however, John Lombe went to Italy, and, disguised as a workman, secured employment in one of the mills. By bribing workmen, he obtained an opportunity to examine the machinery privately when it was not working, and thus learned all the details of construction. He was discovered eventually, and obliged to flee with his accomplices to England. He secured patents for fourteen years, and in

1719 erected a silk mill on the Derwent at Derby. In 1721 bounties were granted on home production, and in 1749 silk from Georgia and the Carolinas was admitted free of duty.

SILK INDUSTRY IN AMERICA

Long before this efforts were made to start silk culture in America. Cortez in 1531 brought the mulberry-tree and silkworms to Mexico, where both were successfully grown, silk spun and woven, and sent to Europe. By the end of the century, however, the industry had ceased.

The visionary James I. of England became very much interested in the cultivation of silk in Virginia, and in 1619 ordered the shipment of silkworms to that colony, urging their cultivation in place of tobacco, offering bounties for the silk produced, and placing penalties for the failure to plant mulberry-trees. The next year saw the industry established, and it continued thriving moderately under the stimulus of premiums offered by the Colonial Assembly until 1666, when the bounty was withdrawn. The culture rapidly decreased and soon was abandoned.

At one time the Assembly offered ten thousand pounds of tobacco to the planter who would export two hundred pounds of raw silk or cocoons in a single year, five thousand pounds of tobacco to the producer of one thousand pounds of raw silk, and four thousand pounds of tobacco to any planter who would devote himself exclusively to silk raising.

It is not known that the premiums were ever earned. Some silk was sent abroad, and there is a tradition that one of the King Charles of England had a robe made of it. Even after the culture of silk was abandoned in Virginia, there are stories of men appearing in silk waistcoats or with handkerchiefs of their own raising, or ladies appearing in a gown of native grown silk.

The failure of Virginia seemed only to spur on some of the other colonies to engage in silk culture, and the other

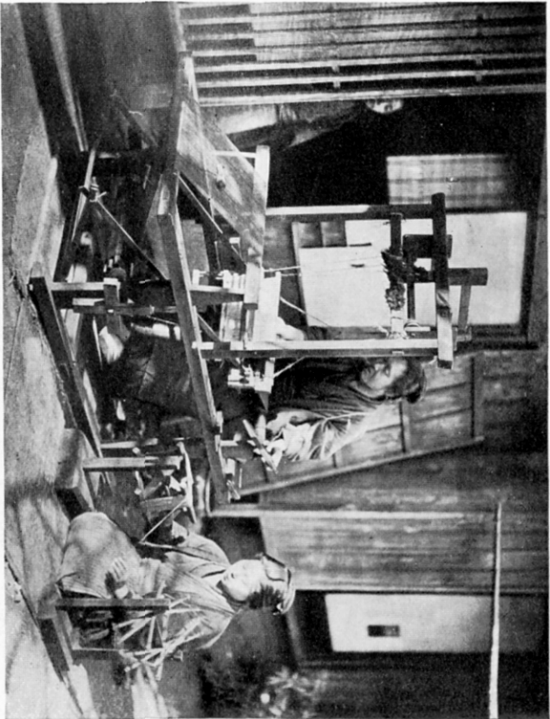
colonial governments offered various inducements for the spread of the industry. By 1712 the colonial exports averaged five hundred pounds annually. In 1732 Georgia's colonial government allotted a piece of ground as a nursery for white mulberry-trees, and granted lands to settlers on condition they plant one hundred white mulberry-trees on every ten acres cleared.

The result was that in 1735 Governor Oglethorpe took eight pounds of silk to England which was used as a dress for Queen Caroline. The industry became established in South Carolina in the same year, and in 1762 began in Connecticut, although as long before as 1734 the Connecticut General Assembly had passed an act for the encouragement of silk raising, which was to continue in force for ten years.

The removal by the English government in 1749 of all duties on silk imported from Georgia or Carolina led to increased importations, and by 1759 large quantities of raw silk were being sent by the colonies to England, often commanding higher prices there than the best Italian silk.

A reeling establishment was founded at Savannah in 1750, and the good quality of the Georgia silk was doubtless due to a visit made the year before by Signor Ottolengi, an Italian expert, who was sent to Georgia to establish a silk filature for reeling, doubling, cleaning, and twisting the silk. The quantity of the cocoons received at the filature was so great that in 1759 the export of raw silk from Georgia exceeded ten thousand pounds, and the quality was so good as to bring three shillings more per pound in London than any other silk in the world. The silk culture reached its height in Georgia in 1759, and by 1772 had practically ceased. It was not long before cotton had driven silk culture from the South.

Half an ounce of mulberry seed was sent to every parish in Connecticut in 1766, and for a time the legislature offered a bounty on mulberry-trees and raw silk. A piece of



JAPANESE SPINNING AND WEAVING
From a print in the Peabody Museum, Salem, Mass.

mantua, 60 yards in length, was spun and woven from her own cocoons in 1770 by Mrs. Susanna Wright at Columbia, Pa., and afterwards worn as a court dress by the Queen of England. By about the middle of the eighteenth century Philadelphia had become an important seat of the industry.

During the Revolution the silk industry languished, and all manufacture ceased, except enough to supply a small local demand. Hardly had the Revolution ended before the industry sprang up with great vigor under the impetus of bounties. Mansfield, Conn., had become an important silk-raising section in the latter part of the eighteenth century, and here, in 1810, the first silk mill in America was set up, as we shall see later.

In 1785 a company was formed in Connecticut for the culture of silk, and also its manufacture. The company which was formed at Mansfield and incorporated in 1789 was called "The Directors, Inspectors, and Company of Connecticut Silk Manufacturers." It included the names of many who are the ancestors of the successful silk manufacturers of to-day.

As the quality of American silk did not keep pace with the Italian, being too fine, uneven, and often defective in color, it became, about 1800, difficult to find a market for it, although by this time silk had become an article of domestic manufacture in the East, many families making their five, ten, and fifty pounds of silk annually. The silk production was greater in Connecticut and Pennsylvania than elsewhere, though New York, New Jersey, Delaware, Maryland, and Virginia also produced all of the domestic silk. The silk was badly reeled on a hand loom and roughly spun on the large wheel used for spinning wool. By 1810 New London, Windham, and Tolland Counties, Connecticut, were turning out \$28,503 worth annually, and half as much more of the waste silk.

Much of the success of the early industry was due to Edmund Golding, an English throwster, who came to

America in 1827 when he was but seventeen. He met Alfred Lilly, whom he told of his previous occupation, and who became interested in him. Golding made sketches of the silk machines used in England, and finally Mr. Lilly, Captain Joseph Conant, William A. Fiske, William Atwood, Storrs Hovey, and Jesse Bingham formed a copartnership, in 1827-28, under the name Mansfield Silk Company, to install and operate machines for making silk. Lilly took charge of procuring the machinery, much of which he made in his own shop and obtained some from regular machinists. It was put in operation under the direction of Golding. A building and power was subsequently obtained in Gurleyville, and this mill was the first in America where the manufacture of silk was commercially successful.

The first silk mill in America, however, was probably that erected in 1810 by Rodney and Horatio Hanks, at Mansfield, where an effort was made, in a building 12×12 feet, to make sewing silk and twist by machinery they had made. But it was not practical. Great difficulties were encountered by the Mansfield Silk Company, as the machinery was crude, and was not adapted to silk as it was then reeled in America. In order to compete with Italian sewing silk, the promoters had to import raw silk from England.

In 1829 the Mansfield Silk Company was incorporated, and thus public attention was directed to it. Among the visitors was a Mr. Brown, an Englishman, who explained the process of reeling and showed how to construct the right kind of a reel. It was very successful, and American silk was found to be of superior quality and became much in demand, mulberry nurseries being established by the company in all the adjoining States. Nathan Rixford made several improvements upon Golding's machines, and for some years was the principal builder of silk machinery. The Mansfield Company was not a success, and was finally dissolved in 1839.

The Connecticut legislature offered a bounty in 1832 for mulberry culture, and fixed the price of raw silk at fifty cents a pound. Maine, Massachusetts, New Jersey, and Pennsylvania soon offered similar bounties. Mr. Golding, with Messrs. Salmon Storrs & Son, later built another mill at Mansfield and equipped it with Rixford machinery. It was successful for more than ten years.

The first successful silk dyers in the United States were Edward Vallentine and Lewis Leigh, who had emigrated from England in 1838. Many processes were improved by them. Vallentine commenced business at Gurleyville, Conn., and gained a wide reputation by the use of new colors and a permanent black. In 1839-40 he moved his business to Northampton, and died about 1851.

The first silk mill in Paterson, N.J., was set up by Christopher Colt, Jr., in 1838, on the fourth floor of Samuel Colt's pistol factory. The first loom for weaving piece goods was built in 1842 by Mr. John Ryle, the father of the present silk industry in America, who started in Paterson, N.J., in 1840. To-day Paterson is the centre of the American silk industry. The real establishment of American supremacy in silk manufacturing dates from 1860, and was the result of French silks being admitted to English markets free of duty. As the English silk throwsters and weavers were forced from their own market, they came here, bringing their skill and machinery with them, and many settled at Paterson. The industry was further favored by the tariff of 1861 and later by the import duty, which ranged from 40 per cent. to 60 per cent. The story of Paterson is told more fully later.

Manufacturing began at Philadelphia in 1815, and in 1824 the Jacquard loom was first used there. By 1830, 3,200 pounds of silk were raised in Mansfield, and in the same year the Chinese mulberry-tree was introduced because of its rapid growth and abundant leaves. Previous to this silkworms in the United States had been fed

on white mulberry-trees. In 1838 power loom weaving began.

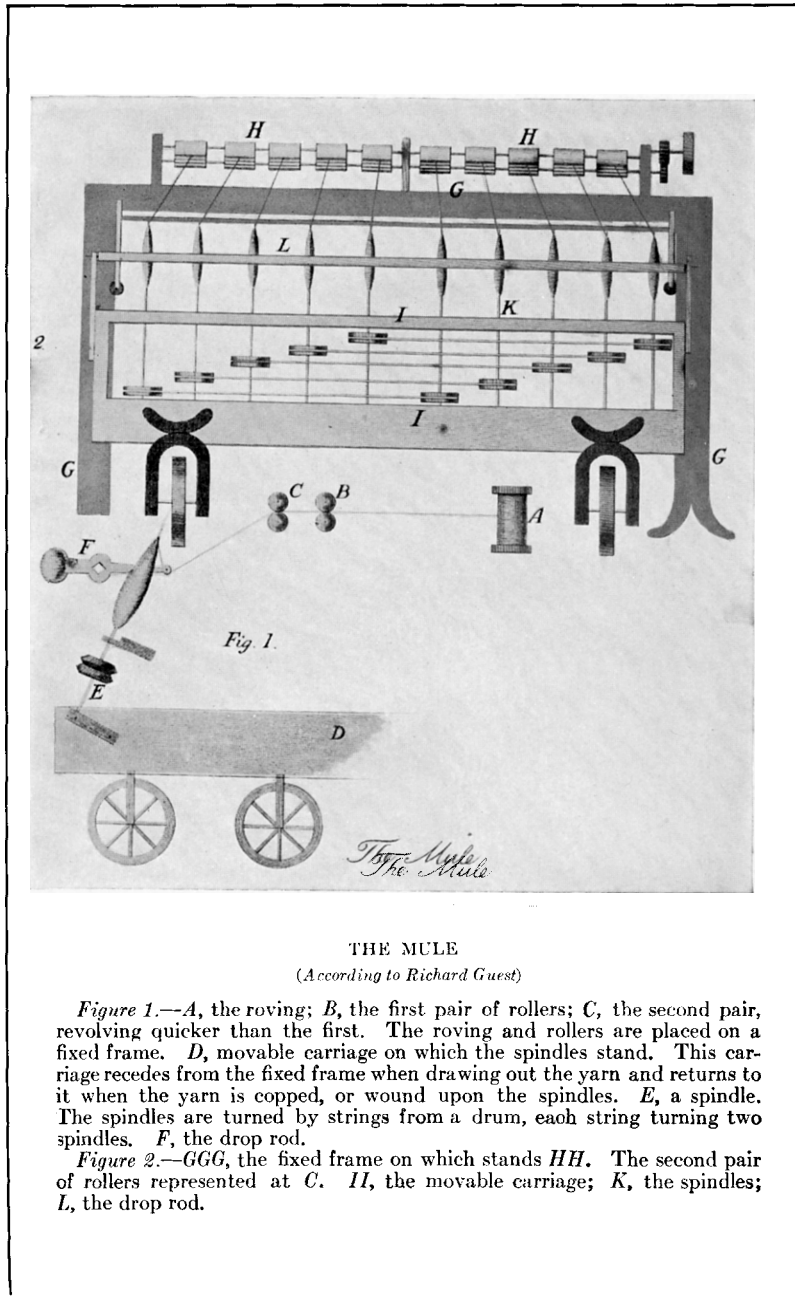
An unsuccessful manufactory of silk ribbons from American silk was started in 1829 at Baltimore, but came to a speedy end. John McRae began making silk fringes, tassels, and braids in New York City in 1830.

The beginning of the silk industry at Florence, Mass., was in 1832, when the "Old Oil Mill," which for over a century had stood as a grist-mill on the Mill River, under the direction of Samuel Whitmarsh, an early silk enthusiast, was equipped as a silk mill, with machinery made by Nathan Rixford. The New York & Northampton Silk Company was formed in 1833-34, and among those who took stock in the new company were Augustus and Samuel Russell, who had established the firm of Russell & Co., the foremost American trading house in China.

A brick building was erected and acres stocked with mulberry-trees to supply worms for the raw silk. Mr. Whitmarsh even had two hothouses, one hundred feet long, attached to his house at Northampton for raising mulberry-trees in winter. Whitmarsh became president of the company. Watch ribbons and satin vests were made: some of the heavy black vests were presented to Henry Clay, Daniel Webster, and A. A. Lawrence, who had shown interest in the enterprise.

"I shall make \$250,000 before next winter," said Mr. Whitmarsh in the summer of 1839 to John Ryle, who later became the father of the Paterson silk industry and was then a weaver in Whitmarsh's employ. Before winter the company had failed, and Whitmarsh had neither money nor credit. Although over a hundred thousand dollars was sunk by the company, it eventually paid its debts.

In 1835 the Connecticut Silk Manufacturing Company was formed at Hartford, Christopher Colt being president and largest stockholder. The company collapsed in 1838. Soon after 1844 the Nonatuck Silk Company was organized



THE MULE

(According to Richard Guest)

Figure 1.—A, the roving; B, the first pair of rollers; C, the second pair, revolving quicker than the first. The roving and rollers are placed on a fixed frame. D, movable carriage on which the spindles stand. This carriage recedes from the fixed frame when drawing out the yarn and returns to it when the yarn is copped, or wound upon the spindles. E, a spindle. The spindles are turned by strings from a drum, each string turning two spindles. F, the drop rod.

Figure 2.—GGG, the fixed frame on which stands HH. The second pair of rollers represented at C. II, the movable carriage; K, the spindles; L, the drop rod.

at Florence, with S. L. Hinckley as president and S. L. Hill as treasurer, and since has grown into the plant which makes the famous Corticelli brand of sewing silk.

To the genius and persistence of the Cheney Brothers was due the establishment of the silk industry at South Manchester and Hartford, Conn. They were sons of a farmer, and while boys had become interested in the raising of silkworms. Two became skilful artists, another became a merchant in Providence, while others continued to farm.

Ward, Rush, Frank, and Ralph Cheney in January, 1838, started at South Manchester the Mount Nebo Silk Mills, establishing also orchards, cocoeneries, and a magazine called the *Silk Growers' Manual*, which lasted from July, 1838, to July, 1840. After a short time the mill closed, but about 1841 was reopened with new machinery. Sewing silk, twist, ribbon, handkerchiefs, and later broad goods were made, and soon spun silk was being fashioned into pongees and handkerchiefs. Under the beneficial effect of the Civil War tariff the brothers were able to establish themselves as makers of the cheapest and most serviceable silks of their kind on the market. The mill was built at Hartford in 1854, and since the firm of Cheney Brothers has grown into the leading firm of its kind in America.

The silk industry of William Skinner dates from 1848, when he went from Holyoke and established his mills at Northampton. In 1854 he moved to Haydenville and built his Unquomok Silk Mills, which were among the largest in Connecticut. They were swept away May 16, 1874, by the bursting of the Williamsburg Reservoir on the Mill River. One hundred and forty-eight lives were lost, and a million dollars' worth of property, including all of the town of Skinnerville, as the village where the mill was located was called. He started again at Holyoke, and the firm has become one of the best known in the country.

A disastrous silk speculation broke out in the Eastern

States in 1836. Cuttings two feet long sold from \$25 to \$500 per hundred. All kinds of crops were displaced to make room for it: one nurseryman ordered 5,000,000 trees from France, sending \$80,000 in advance payment. After running madly for three years, the speculation collapsed, so that in 1840 trees were sold for five cents each, thousands were ruined, and the silk industry checked for years.

The high price of labor has hampered production of raw silk in the United States, so that it has not kept pace with the manufacture. Much of the raw silk comes from China, Japan, Bengal, and other parts of the East, where labor is cheap. An attempt was made in 1854 to raise silk in California. Blight of the mulberry-trees has, however, prevented successful silkworm culture in the United States, and to-day practically all of the raw silk used by the United States is imported.

CHAPTER III

FACTORY SYSTEM

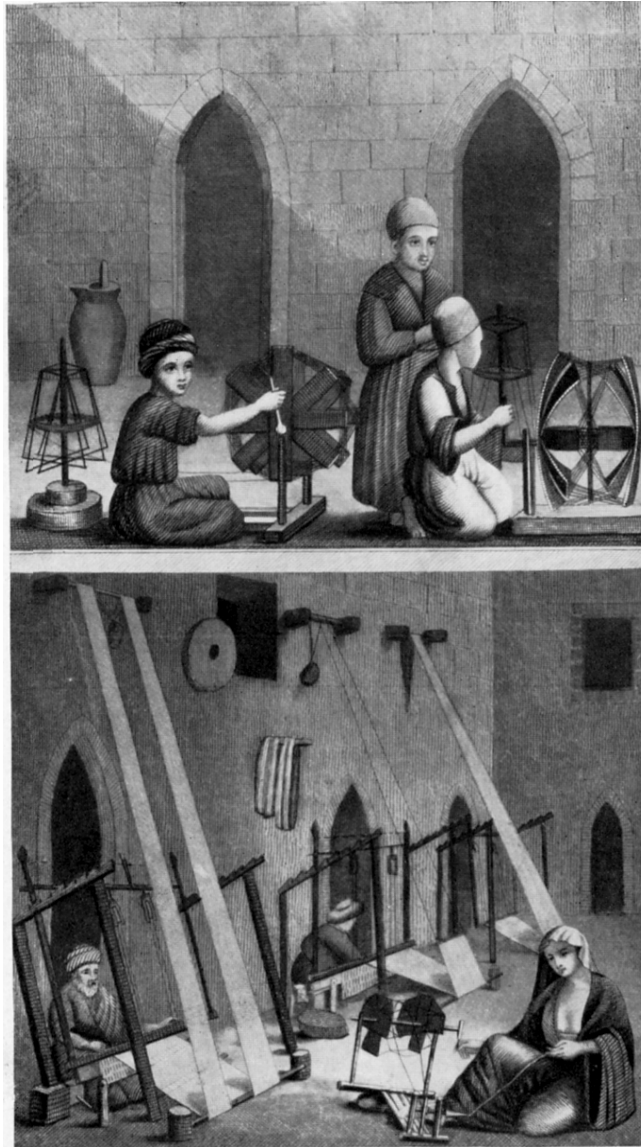
GROWTH OF THE FACTORY SYSTEM—EARLIEST RECORD OF ENGLISH FACTORY—ENGLISH NAMES DERIVED FROM INDUSTRY—CAUSES OF THE CONCENTRATION IN LANCASTER—SEPARATION OF AGRICULTURE AND SPINNING AND WEAVING—EARLY RELATIONSHIP OF EMPLOYER AND EMPLOYEE—INVENTIONS AND THE FACTORY SYSTEM—INFLUENCE OF FACTORY ON ENGLISH SOCIAL LIFE

It is not easy to find in ancient or mediæval history any perfect parallel to the factory system as we understand it and as it developed in England and in America. The modern conception of a factory—a place where products are produced by power for commercial use—had no existence prior to the invention of the steam-engine save in a very primitive way. Here and there we find organizations of workmen producing goods jointly for commercial use, but very few traces of machines are to be found save in the production of primitive textiles. There were, it is true, ancient guilds just as there were mediæval guilds. We know scarcely anything of the working of the ancient guilds, but our knowledge of the mediæval guilds is somewhat comprehensive. These had full and even despotic control, a completeness of organization with which the modern trade union is entirely unfamiliar. They fixed often not only prices, but conditions of work, and in some instances there grew up within the industrial centres controlled by these mediæval guilds industries in which men collectively worked at the production of commercial products. And here we can find traces of the factory system, at least as far as the collective labor of workmen is concerned. But the factory system as we now understand it

was the offspring of the centralization of industry brought about by a combination of three factors,—the growing skill of operatives, the combination of capital, and the use of machinery; but, as the industry of the ancient and mediæval world lacked steam-driven machinery, it never attained the true factory system.

Nevertheless, an embryonic factory system existed among the Romans in the time of the Cæsars, and is described by Ferrero. He says “that it was the duty of a woman, if she was nobly born, to know all the arts of good house-keeping, and especially, as most important, spinning and weaving. The reason for this lay in the fact that for aristocratic families, who were in possession of vast lands and many flocks, it was easy to provide themselves from their own estates with the wool necessary to clothe all their household, from masters to the numerous retinue of slaves. If the materfamilias knew sufficiently well the arts of spinning and weaving to be able to organize in the home a small factory of slaves engaged in such tasks, and knew how to direct and supervise them, to make them work with zeal and without theft, she could provide the clothing for the whole household, thus saving the heavy expense of buying stuffs from a merchant,—notable economy in times when money was scarce, and every family tried to make as little use of it as possible.”

A mediæval trace of the factory system may also be found among the silk throwsters in Italy, where craftsmen in the industry congregated in certain localities. Although the beginning of the factory system was an early specialization of parts of the industry in the hands of different persons, its growth and development were slow until the manufacture of cotton became a leading industry, and the invention of the steam-engine and textile machinery so greatly increased the production.



ANCIENT EGYPTIANS SPINNING AND WEAVING
(From an old print)

EARLIEST RECORD OF ENGLISH FACTORY

The first industry of which there is any record in England that might be called a "factory system" was run by John Winchcombe, popularly known as "Jack of Newbury." So famous did he become that he entertained Henry VIII. and his first wife Catherine in his Newbury home. Winchcombe, who died in 1520, is described in Fuller's "Worthies" as "the most considerable clothier without fancy or fiction England ever beheld. His looms were his lands, whereof he kept one hundred in his house, each managed by a man and a boy."

So great was the fame of his factory that it was described in the following poetic lines written while his firm was still a household word in fashionable London:—

"Within one room, being large and long,
There stood two hundred looms full strong;
Two hundred men, the truth is so,
Wrought in these looms all in a row;
By every one a pretty boy
Sat making quills with mickle joy.
And in another place hard by
A hundred women merrily
Were carding hard with joyful cheer
Who singing sat with voices clear;
And in a chamber close beside
Two hundred maidens did abide.

.
These pretty maids did never lin,
But in their place all day did spin!

.
Then to another room came they
Where children were in poor array,
And every one sat picking wool,
The finest from the coarse to cull;
The number was seven score and ten,
The children of poor silly men.

Within another place likewise
 Full fifty proper men he spied,
 And these were sheer men every one
 Whose skill and cunning there was shown!

.
 A dye-house likewise he had then
 Wherein he kept full forty men;
 And also in his fulling mill
 Full twenty persons kept he still."

As Thomas Fuller says, in his "History of the Worthies of England": "Well may his house make sixteen clothiers' houses, whose wealth would amount to six hundred of their estates. He built the church of Newbury from pulpit westward to the tower inclusively, and died about 1520. Some of his name and kindred of great wealth still remain." In the expedition to Flodden Field against James, King of Scotland, he marched with one hundred of his own men, "as well armed and better clothed than any, to show that the painful to use their hands in peace could be valiant and employ their arms in war."

At first fabrics were a by-product of agriculture in England, for the farm homestead was the seat of the textile industry. The males of the household raised the flocks, while the females spun the yarn and wove the fabrics; and so the industry thrived and prospered for hundreds of years, giving occupation and income to thousands of the agricultural class. As time went on, the farmers of certain sections, particularly about Bury, Oldham, Preston, Manchester, and Chester, became the more expert in the art, and soon the beginning of the factory system appears in a separation of spinning from weaving, the two originally being done by one person. And little by little there came a further differentiation of work in the process not only of manufacturing, but also of merchandising the product, and this has left its trace in many English names.

ENGLISH NAMES DERIVED FROM INDUSTRY

To the old occupation go back many names which originally indicated the part their bearer performed in the textile industry. Thus the name of Shepard, which with variations of spelling is a common one, may be traced to the shepherd or sheepherd, who cared for the flocks, and the names Shearer, Sheerman, Shurman, and the like, came from the man who sheared or clipped the sheep.

So also the names Stapler, Wool, Wooler, Woolman, or Wollsey were derived from the merchant to whom the wool was sold; and the carrying it from place to place originated those of Carter, Packer, or Carrier. The wool was turned over to Carders and Combers, Kempers, or Kemsters, and passed next to Spinners, and then to Weavers, Weevers, Webbs, Webbers, or Websters. The nap was brought out by "teasing," by the Teasers, Tosers, Teasers, or Taylors, and then dyed by the Dyer, Litter, or Lister.

The fulling or shrinking process was done by the Fullers, Fullertons, Fullersons, or Fullmans, assisted by the Walkers, who trod it with their feet, while it was beaten with bats and mallets by the Beaters, Beatermans, Bates, Batteman. In time the special work in which the workmen showed special skill gave them the names by which they and their descendants have been known.

CAUSES OF THE CONCENTRATION IN LANCASTER

The unpleasant climatic conditions of Manchester and the surrounding towns near the Irish Sea, affording the right degree of humidity for the best linen and cotton manufacture, made the section ideal for textile work and not so suitable for agriculture or outdoor work. So it was that the farmers thereabouts early turned their attention to spinning and weaving cotton.

As early as 1641 the people of Manchester were "in the

habit of buying linen yarn from the Irish, and, after weaving it, returning it for sale in a finished state. They also bought cotton-wool that came from Smyrna to work into fustians and dimities." These fustians, with tuckings, tapes, etc., made the staple trade of Manchester in the early part of the seventeenth century.

An eye-witness, writing about 1770, says: "The land in our township [Mellor] was occupied by between fifty and sixty farmers, and out of those fifty or sixty there were only six or seven who raised their rent directly from the produce of their farms. All the rest got their rent partly in some branch of trade, such as cotton or linen or spinning and weaving woolen."

SEPARATION OF AGRICULTURE AND SPINNING AND WEAVING

At this period many of the farmers of Lancashire were engaged wholly in spinning and weaving, save during the few weeks of harvest. And soon "there were a number of master [cotton-linen, fustian] manufacturers, as well as many weavers who worked for manufacturers and at the same time were holders of land or farmers."

A few cottagers held no land and worked for manufacturers, but many held small pieces of land and worked for themselves. The situation had thus assumed a phase in which farming had become wholly subordinate to the textile industry, although most of the weavers occupied small parcels of land for which they were able to pay high rents by combining a little farming with much spinning and weaving.

This relation between agriculture and the textile industry continued in a lessening degree until well into the first quarter of the nineteenth century. From the beginning of the last quarter of the eighteenth century the growth of the factory system became more and more pronounced. The development first showed itself in a severance of the



BOWING OF COTTON, AS PRACTISED IN INDIA AND CHINA



A HINDU WOMAN SPINNING COTTON YARN ON THE PRIMITIVE
WHEEL OF INDIA

Both illustrations from an old print)

agricultural connection through the concentration of the weavers in hamlets and towns, and this was brought about by the higher skill required by the finer fabrics which were more and more in demand. As early as 1727 Daniel Defoe could write of Manchester, "The grand manufacture which has so much raised the town is that of cotton in all its branches."

It was soon learned that the rough work of farming made the hands of the weaver less skilful, and the weaver found also the needed ability required close application, and that much could be gained from the study of the work of other weavers.

As the looms became more complicated with the improvements that inventive genius added, considerable mechanical work was often called for, and this necessitated being near a mechanic. Then, too, as the spinners and weavers began clustering together, the buyers of fabrics turned to these centres for their goods, so that it became easier to find a market for one's goods when one was part of a community of weavers than when one lived at a distance.

The fact that since the introduction of the industry in England a portion of the artisans did nothing but spin and weave, and were early associated in guilds, doubtless had a decided influence in bringing about a separation of the **two** occupations,—the textile industry and farming.

EARLY RELATIONSHIP OF EMPLOYER AND EMPLOYEE

How early the relationship of employer and employee sprang up it is impossible to determine, but there is little doubt that to a slight degree it was in existence from the earliest days.

The old apprenticeship system, too, had its place in fixing the relations between employer and employee. The apprentice generally lived with his employer, and thus came

in closest contact not only with his mode of life, but his method of business management. And thus, when the apprentice set up for himself, he perpetuated the system of business under which he was trained.

Contemporaneous with the growth of the factory system was the greater development of the relation of employer and employee. While there always was a time when employer and employee existed, from the first part of the eighteenth century the system grew rapidly, and was given additional impetus by the increased demand for better fabrics and the growing costliness of the complicated machinery which was invented.

By 1740 spinning was being done largely by separate artisans, who were rapidly constituting a distinct class from the weavers; and both classes were furnishing many journeymen, who were working in small shops for others or were being paid by the piece for what they made from material supplied by Manchester merchants. Still others brought their own raw material, and sold the finished products to the growing merchant class. This class of small journeymen manufacturers was eventually driven out, as the growth of the industry required more and more capital, and the consumer and producer were brought more closely together by organizations of capital. At first most weavers constructed and owned their looms. Later many hired them, and in some places lodgings were let with a loom, just as to-day lodgings are let with a piano.

As merchants began to call for different kinds of fabrics, it became the custom for the masters to provide reeds that ranged in fineness with the fineness of the loom, and also to furnish the other changeable parts. Another step toward the control of the industry by the holders of capital or the merchant class was the supplying of the warp by the Manchester merchants. The lack at first of the water frame precluded the spinning of the warp of cotton of sufficient strength for weaving, and warps were therefore of either

linen or wool and made by hand either in the neighborhood or were imported from Germany, Ireland, or Scotland. Until warping mills were introduced, the weaver prepared the warp for the loom; but, after warping mills sprang up, the merchants supplied them ready for the loom. This specialization of work was largely supported by the merchants, who also could judge what warps would be required by their fabrics, and were better able to judge the amount of goods needed. This change, from that of the weaver supplying or buying his own warp to that of the merchant furnishing the warp to the weaver making his cloth, took place about 1740, and led to the firm establishment of warping mills, which, however, existed in limited numbers during the seventeenth century.

Concerning the weft, it was found best by the merchants to give the weaver full responsibility for his yarn. The cotton wool was therefore furnished, and women and children cleaned, carded, and spun the cotton in their homes. Dealers who attempted to supply the yarn ready for the weft found that the spinners could hide defects which often gave the weavers excuse for the production of inferior goods. And frequently weavers placed the responsibility for poor work upon defects they claimed existed in the weft.

"Willowing" was the name given the cleaning process, and it was so called because the cotton spread on a light hammock of cords, called the bowstring, was beaten with willow switches. The process dated back to prehistoric times. Cotton for fine spinning was carefully washed, and was always soaked with water and dried so that the fibres would cling together.

As the weaving became more complicated and arduous, men early took the place of women, who cast the shuttle from hand to hand, as was done from remote time. In the making of broadcloths two weavers were required, as the distance was greater than one man could stretch.

All of these factors were working toward the creation of

the factory system as now understood. But the greatest factor was the invention of the steam-engine, of the fly shuttle, the spinning jenny, the mule, and the power loom, all of which made possible the production of fabrics on a scale which necessitated many artisans under one direction and the employment of larger capital than weavers could supply.

INVENTIONS AND THE FACTORY SYSTEM

The era of invention brought about a more rapid development of the factory system as well as greatly increased concentration of the industry in the centres where it was already established.

The father of John Kay, who invented the fly shuttle, had a woollen manufactory at Colchester early in 1700, and already manufacturing in mills was in process in other parts of England. A great impetus was given the movement by Richard Arkwright, who has been called the father of the factory system. It was to his executive and financial ability, quite as much as to the inventive genius he displayed in the improvement of the spinning frame, that this was due. The first practical cotton mill in the world was erected by him in 1769 at Nottingham and was turned by horses. One had already been built in 1764 by James Hargreaves, who invented the spinning jenny, but it was not practical.

Water power was already beginning to supply the power to the few mills in existence, and in 1771 Arkwright erected a new mill at Cromford, which was turned by the river Derwent, and was supplied with a cylinder card machine and a spinning frame, which could roll as well as spin, and which was called a water frame from the power that supplied it.

The machines thus grouped at Cromford made it possible for the first time to accomplish the whole operation of cotton spinning in one mill, the first machine receiving the cotton



DOMESTIC FLAX WHEEL

An old German invention, commonly called the Saxony, or Leipzig, wheel. In some instances two spindles were attached to the same wheel, enabling the spinner to form a thread with each hand.



HINDU SPINNING AND WEAVING

(Both illustrations from old prints)

wool as it came from the pod, and the last winding the cotton, twisted in firm hard yarn upon the bobbins. The labor used was largely juvenile, as it was found that children were more dexterous in tying the broken ends at the rollers, their small and sensitive fingers being more adapted for the work.

Arkwright's invention, together with Crompton's, gave the cotton industry a great boom, and factories sprang up everywhere in Lancashire, changing the rural aspect of the land into a collection of tall chimneys, brick buildings, and city streets. Everywhere operatives became merely the employees of the masters of capital.

Cartwright's invention of the power loom in 1785-86 further accelerated the spread of the factory system, as it brought spinning and weaving again under one roof.

Then there was also the application for the first time in 1785 of Watt's steam-engine to cotton manufacturing. It is interesting to note here that the first electric-driven spinning mule in Lancashire was that of the Acme Spinning Company's at Pendlebury, and was started 1895. Power was supplied from Outwood, five miles distant. Of the 2,000,000 horse-power now used in the textile mills of the United States, 500,000 is produced by electricity.

INFLUENCE OF FACTORY ON ENGLISH SOCIAL LIFE

No less than one hundred and forty-three water mills in 1788 were making cotton in Lancashire, Derbyshire, Nottingham, Yorkshire, Cheshire, Staffordshire, and were rapidly increasing. The adjustment of the factory system to English life during the last years of the eighteenth century and the first years of the nineteenth century led to much trouble, in which property was destroyed and riots occurred. In fact, Carlyle in his essay on Chartism depicts the miseries that involved the handicraft workers when machinery came into use. Thousands were thrown out of employment in the

crowded textile centres, and much suffering occurred, which led to the smashing of machines and the wrecking of mills, and it was some years before the factory system became a smooth part of the mechanism of England's industrial life.

The influence of the factory on social conditions in England is admirably described in Lincoln's monograph on "The Factory." At first in England the factory towns were sinks of unhealthy conditions. Not alone was refuse allowed to accumulate on the streets, but conveniences of the most primitive kind were lacking. A workingman's family lived mainly upon tea, bread, and boiled potatoes, to which occasionally meat of some kind was added. The members of a family ate from a common dish, more like animals than human beings. They were packed in unsanitary homes where domestic comfort was a stranger, and squalor and debauchery were common. Few over forty years old were fit for work, and it was only when Parliament took cognizance of the conditions and public opinion began to assert an influence that the terrible concomitants of the factory were removed.

It had this effect upon England. Finding the people divided primarily into two classes, dependants, or serfs, and the upper classes, it created from the dependent class the great middle class. In many cases, tradesmen and manufacturers were lifted into the nobility and an interest created in political affairs on the part of the working classes that did not exist before. It found England a nation of agriculturists and made it an empire of world traders.

By the beginning of the nineteenth century the factory system under the control of capital was firmly established, and here we shall leave it and consider briefly the era of invention which so greatly developed the textile industry during the eighteenth and early part of the nineteenth centuries.

CHAPTER IV

ERA OF INVENTION

ERA OF INVENTION—EARLY IMPROVEMENTS IN TEXTILE MACHINERY
—JOHN KAY—PAUL AND WYATT—JAMES HARGREAVES—RICHARD
ARKWRIGHT—SAMUEL CROMPTON—EDMUND CARTWRIGHT—IN-
VENTIONS OF KNITTING MACHINES—IPSWICH MILLS—JOSEPH
MARIE CHARLES JACQUARD—MACHINES FOR SPINNING FLAX—
JAMES WATT—ELI WHITNEY—IMPROVEMENTS OF THE BASIC
MACHINES, AND FURTHER INVENTIONS—BLEACHING—DYEING—
PRINTING—MERCERIZING PROCESS

The use of the distaff and spindle was the first step in the invention of textile machinery, and began at so very remote a time it is impossible to fix it. Earliest records on stone, brick, papyrus, of the Assyrians, Babylonians, and Egyptians, picture the use of the rock, or distaff, and the spindle, and Solomon, Homer, and Herodotus frequently allude to it. The distaff is said to have been introduced into England by Anthony Bonvoise, an Italian, during the twentieth year of the reign of Henry VIII., and then began the making of Devonshire kerseys and Coxal cloths.

The spindle, as it has been from time immemorial, was a round stick of wood about a foot long, which tapered at each end. A ring of stone or clay, or sometimes potato, girded the upper part of it to give it steadiness and momentum when it revolved. At the extreme upper end there was a notch, or slit, into which the yarn was caught. The distaff, or rock, was a longer, stouter stick, around one end of which, in a loose ball, the material to be spun was wound.

The spinner either fixed the other end of the rock in her girdle or carried it under her left arm, so that the coil of material was in a convenient position to draw out to form

the yarn. The end of the yarn, after being prepared, was inserted in the notch, and the spinner set the spindle in motion by quickly rolling it with the right hand against the right leg, and thus throwing it out, spinning in the air. Meanwhile the spinner drew from the rock with the left hand an additional supply of fibre, which was formed by the right hand into a uniform and equal strand. After the yarn was sufficiently twisted, it was released from the notch and wound around the lower part of the spindle, and again fixed in the notch at the point insufficiently twisted. Thus the rotating, twisting, and drawing operations went on until the spindle was full. In this way, spinning was practised in prehistoric and ancient times. And in the self-same way it is to-day done in some remote sections of Scotland. Yarns of greatest fineness and strength are still spun in this way.

The first improvement in this method of spinning was the construction of the hand wheel, in which the spindle, mounted in a frame, was fixed horizontally, and rotated by a band passing around a large wheel set in the framework. Such a wheel has been used from prehistoric times in the East, but was not introduced into Europe until about the fourteenth century.

The earliest manuscript that mentions the spinning wheel was written in the fourteenth century, and is in the British Museum. This wheel was evidently one at which a woman stood, for that which came into general use is said to have been invented in 1533 by a citizen of Brunswick, and was the first wheel at which a woman could sit. Other improvements enabling one to spin with a treadle movement, and thus allowing the spinner to work with both hands free, were added at later dates that cannot be fixed. Thus came into use the spinning wheel as our forbears used it in the homespun industries of New England and as it is still used in the isolated rural districts of Ireland, Scotland, and Europe.



HINDU WEAVER AT HIS LOOM
(From an old woodcut)

It was not long before every woman in England spun, and terms of the industry had become a part of the language. Thus spear side and distaff side of the house became the legal terms respectively for the male and female lines of inheritance. Spinster was and is still the English term for unmarried women. January 7 was jocularly called St. Distaff's Day, or Rock Day, and signified the resumption of spinning after the rest of the Christmas holidays.

EARLY IMPROVEMENTS IN TEXTILE MACHINERY

To Lewis Paul, John Wyatt, James Hargreaves, John Kay, Richard Arkwright, Samuel Crompton, and Edmund Cartwright the textile industry owes the basic inventions which have revolutionized it. It is impossible to say to whom the greatest credit is due, for there is much controversy over the question of whose inventive work takes priority,—whether Paul and Wyatt are entitled to more credit than Kay, Hargreaves, or Arkwright. One thing is certain: for thousands of years before these great, ingenious Englishmen set their minds to work upon the problem of increasing the efficiency of the spinning wheel and loom there was little change in the method and manner of making fabrics. Both spinning and weaving were substantially the same as those practised alike by the savage, by the ancient Chinese, by the Egyptians of Pharaoh's time, and by the spinners and weavers of mediæval or early modern times; and the output was limited by the amount of manual labor that could be brought to it and the capacity of the crude spinning wheel and equally crude loom upon which fabrics were fashioned.

One of the earliest attempts to improve the loom was made in 1678 by a M. de Gennes, a Frenchman. The improvement consisted of an appliance which, like mechanical hands, shot in and out of the warp, and exchanged the shuttle. Another invention was that of grinding the

shuttle through the warp by cog wheels working at each end upon teeth affixed to the upper side of the shuttle. It was known as Swivel's loom, and is described in 1724 as working twenty-four laces at a time and as having been stolen from the Dutch, from which it took its other name of the Dutch loom. A factory in which these looms were installed in 1760 at Manchester, with water as the motive power, failed because of the impracticability of the invention.

While the artisans of Continental Europe were at work upon improvements in spinning and weaving, the Englishmen about Manchester were by no means idle, and to England more than to any other nation are due the basic inventions which have revolutionized the whole textile industry, changing it from a hand occupation of meagre output to one of power machinery with an enormous production.

JOHN KAY

One of the first inventions was that of the fly shuttle, patented May 26, 1733, by John Kay, an English machinist and engineer. Kay's father had a woolen manufactory at Colchester, and the son, who was born in 1704 near Bury, and had been educated abroad, was put, while still a youth, in charge of the mill.

His mechanical bent soon showed itself in the various improvements he made in dressing, batting, and carding machinery, in the development of the Dutch boy and the inkle loom in the mill. By inserting dents of metal instead of cane he greatly improved the reeds of the loom, thus making them more durable and better adapted for the weaving of finer and stronger textures.

The first patent, a new machine for making, twisting, and carding mohair and worsted and for twining and dressing thread, was taken out in 1730, when he was but twenty-six. The fly shuttle, so called because of the speed with which

it could be operated, greatly improved the quality of the cloth, lightened the labor, and yet more than doubled the output.

By the old method the shuttle was cast through the warp from side to side by one hand, caught by the other, and the easy weft thread was driven home by the layer which was operated by the hand that had just cast the shuttle. In making broadcloth with the old loom, which had been in use from time immemorial without improvement, a weaver stood on each side of the warp.

Kay's improvements involved the invention of the race board, which he fixed to the layer under the warp by a shuttle box at each end, with a spindle and picker on each box. A cord passed from each picker to a short lever in the weaver's right hand. It compassed great improvements in the shuttle.

One hand could thus be used to throw the shuttle while the other drove home the weft. The weaver sat in the middle of the loom, and pulled at pleasure the small cord which cast the shuttle from side to side. As spinning was still done on the hand wheel, the demands for the increased output of the loom soon outran the product of the thread. This more than anything else set the spinners to work upon improving the methods of spinning, and yet it was almost forty years before machine spinning was perfected.

The Yorkshire clothiers were the first to adopt the fly shuttle. To avoid paying for its use, they formed an association called "The Shuttle Club," to cover each other's costs, should they be prosecuted. Although Kay's suits against these infringements were all decided in his favor, he was almost bankrupted by the expense to which he was put. So much opposition did the weavers display to the introduction of the shuttle that Kay was forced to leave Colchester and take up his residence in Leeds. But in Leeds the same opposition was shown, and he finally

consigned the spinning and carding machines he had invented to the poorhouse, where the inmates operated them. A mob broke into Kay's quarters, demolished everything they could find, and would have killed Kay, had not two friends smuggled him out, concealed in a sheet. His model of the spinning machine was saved by a Mr. Earnshaw, who subsequently destroyed it as "a very dangerous piece of furniture."

Thoroughly discouraged with his experience in England, Kay went to France, and there resumed making the machines which he had smuggled out of England. In 1764 his son Robert wrote to the London Society of Arts and Manufactures, asking a premium for his father because of the father's invention of the fly shuttle.

"I have a great many more inventions than what I have given," Kay himself wrote, "and the reason that I have not put them forward is the bad treatment which I had from woolen and cotton factories in different parts of England many years ago. And then I applied to Parliament, and they would not assist me in my affairs, which obliged me to go abroad to get money to pay my debts and support my family."

With the hope of securing a reward from the government, he later returned to England, but, failing in his efforts, he again took up his residence in France, where he died in obscurity and actual want. His inventions with modifications are, however, in use to this day.

One of the improvements was made by his son Robert, who worked out the drop-box in 1760, by which many different kinds of weft could be worked into the same fabric, and figured goods thus be produced.

In fact, a strain of inventive genius seems to have run through the Kay family, for Robert, too, was constantly working upon textile inventions; and some of his inventions, in modified form, are in use to-day.



JOHN KAY OF BURY
A LANCASHIRE WORTHY

PAUL AND WYATT

Lewis Paul and John Wyatt, other early inventors about whom little is known, originated the principle of spinning by rollers, and took out their first patents June 24, 1738. The patent is thus described: "The wool or cotton being prepared, one end of the roving is put between a pair of rollers, which by their motion draw in the cotton to be spun, and a suction of other rollers moving proportionately faster than the first draws the roving into any degree of fineness which may be required." Although two cotton mills, one at Birmingham and the other on a larger scale at Northampton, were built in 1741, to operate under the patent, neither was successful. Lewis Paul took out a patent on a carding machine Aug. 30, 1748, and on June 29, 1758, he patented his spinning machinery.

JAMES HARGREAVES

The first practical improvement in spinning was the invention of the spinning jenny by James Hargreaves, a poor and ignorant spinner and weaver, who is sometimes described as a carpenter, because he probably combined the latter trade with that of his textile work. Very little is known of his early life. He was a weaver, living at Sandhill, near Blackburn, England, in 1760, and had invented a carding machine. A contemporary describes him as a "broad-set man, about five feet ten." His ingenuity seems to have attracted the notice of the Peel family, for in 1760 he aided Robert Peel, of Blackburn, founder of the family, to make a carding machine based on one that had been worked out by Lewis Paul; but it was not a success.

Hargreaves conceived of his invention by seeing a one-thread spinning wheel, which his small child had accidentally overturned, continue to revolve when the spindle was thrown into an upright position, and the thought came to him

that if a number of spindles were placed upright, side by side, a number of threads might be spun at one time. He set to work upon the idea, and in three years, June 22, 1770, patented his spinning wheel, which he named after his daughter (probably the child that had upset the original wheel), a spinning jenny, and so the invention has continued to be known. The number of spindles was originally eight, but rose to twenty or thirty, and eventually to as many as one hundred and twenty.

Owing to the awkward position that the machine required of the operator, children could more readily work it, and children, therefore, were thus early set to work at textile machines. As the spinning jenny did not make thread strong enough for the warp, and the roving still had to be spun in the old way, the use of the invention was restricted.

RICHARD ARKWRIGHT

It has long been a question of dispute to what extent Richard Arkwright used the ideas of Thomas High in the working out of the next step in spinning machinery,—the perfection of a practical roller spinner. In the suits that were brought by Arkwright to establish his patents, John Kay, the clock maker of Warrenton, who assisted Arkwright in the construction of his machinery, declared that he told Arkwright of the invention of roller spinning by Thomas High, and that Arkwright knew of High's work while he was at work upon his inventions.

However this may be, to Richard Arkwright, more than perhaps to any other Englishman, the development of the textile industry about Manchester is due, and to his undoubted mechanical genius must be attributed the completion in practical shape of roller spinning and other processes of the textile industry. He found the industry largely decentralized. His financial and executive ability, as well as his mechanical bent, gave the textile industry

in England such an impetus that the rest of the world has had quite a task to overtake it.

To him also belongs the unusual distinction, not only of revolutionizing an industry, but of compassing the social rise from a barber's chair to knighthood. It was not until his perfection of the spinning frame that warp threads of cotton could be made strong enough to meet the necessary requirements.

As described in after-life by the dyspeptic Carlyle, "He was a plain, almost gross, bag-cheeked, pot-bellied Lancashire man, with an air of painful reflection, yet also of copious, free digestion."

Arkwright was one of thirteen children, born in Preston, Lancashire, Dec. 23, 1732, of parents so poor he was early forced to work, and thus had opportunity for no more education than could be scantily acquired at an evening school. Never could he read or write with ease, and, even when more than fifty, he stole four hours daily from the scanty allotment for sleep in order to learn grammar and spelling.

He was apprenticed, when a boy, to a barber, and at the end of his apprenticeship established himself at Bolton. One of the strange tales told of this period of his life is to the effect that, while in Bolton, he occupied a cellar, over the entrance to which he put this sign: "Come to the Subterranean Barber. He shaves for a Penny." After the other barbers reduced their prices to meet the competition, Arkwright later announced, "A Clean Shave for a Half Penny."

Coming into the possession of a secret chemical process for dyeing the hair, Arkwright travelled through the country, buying hair, which he dyed and sold to wig makers at larger prices than others could obtain. His childhood at Preston, where there was a manufactory of linen from yarn spun with the distaff and spindle, had probably made him somewhat familiar with the textile industry, and

this knowledge was increased by his work as a buyer of hair in a district where spinning and weaving were common in most households.

Although Arkwright was not a practical mechanic, he had mechanical ability, which enabled him to see possibilities in machines and to direct the handiwork of others. As early as 1767 Arkwright had become interested in textile machinery, for he then employed Kay, the Warrenton clock maker, "to turn him some brass and bend him some wires." It was reported that he was trying to produce perpetual motion. Accounts differ as to what first set him to work on the spinning process.

One story is that he got his idea of roller spinning from seeing a bar of red-hot iron elongated by being drawn between two pairs of rollers, the second pair moving faster than the first. Kay says that Arkwright requested him to make a model of the machine used by High. This may or may not be true, but one thing is certain: Arkwright made practical what other men had been unable to do; and, more than that, he was able to put the machinery to such practical use that it changed the face of Lancashire and the textile industry.

Arkwright had no means of financing his manufacturing, so he returned to Preston, his birthplace, and succeeded in interesting a liquor dealer and painter named Samuel Smalley. Arkwright's machine was set up in the parlor of the house belonging to the Free Grammar School, and so convinced Mr. Smalley of its utility that Smalley offered Arkwright his time and means for the marketing of the machine.

So straitened, however, did Arkwright's financial condition become during his stay at Preston that, when the "Great Election" took place, his suit was so ragged that another was given him to vote in. He and Smalley not having the means necessary to perfect the invention, and fearing the destruction of machines in Preston by mobs



SIR RICHARD ARKWRIGHT

Rich Arkwright

of workmen similar to those that had already destroyed the spinning jennies about Blackburn, Arkwright removed his machine to Nottingham, and interested some bankers named Wright. The machines not being perfected as speedily as the bankers hoped, they withdrew, and Arkwright sought aid from Samuel Weed, of Nottingham, a partner of Jedediah Strutt, of Derby, who already had patented the stocking frame. Weed, Strutt, and Arkwright formed a partnership, and on July 3, 1769, Arkwright took out the first patent.

According to the specifications of his patent he says: "I had by great study and long application invented a new piece of machinery never before found out, practised, or used for the making of weft grown from cotton, flax, wool, etc. That part of the roller which the cotton runs through is covered with wood, the top roller with leather, and the bottom one, fluted, etc., by one pair of rollers moving quicker than the other, draws it finer for twisting which is performed by the spindles, four in number, each twisting one of the four threads delivered by the four pairs of rollers." The first cotton mill in the world, as we have seen, was erected by him at Nottingham and was operated by horses.

Arkwright's success with the spinning frame spurred him on to further inventions, and the new mill, which we have also learned was built in 1771 at Cromford and run by the river Derwent, compassed the whole operation of cotton spinning under one roof, and in this mill began the employment of children in factories.

As it was found difficult to market the excellent yarn produced by the mill, a stock soon accumulated, and, to use up the accumulation, Arkwright began in 1773 the weaving of calicoes, erecting for that purpose at Derby the first fire-proof mill ever constructed, and fitting it up with the best hand looms attainable, the power loom not yet having been invented. Further patents covering the whole