LEAVERS LACE

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A Hand Book of the American Leavers Lace Industry

Prepared under the Direction of

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from a study made by

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Foreword

IN THE SPRING OF 1948, Professor Vittoria Rosatto, Head of the Department of Design and Weaving of the Lowell Textile Institute in Lowell, Massachusetts, received copies of a little promotional booklet on Leavers Lace published by the American Lace Manufacturers Association, Incorporated, and based on a study made by Mrs. Breene L. Wright of the United States Testing Company.

Professor Rosatto, always on the lookout for something new in the field of textiles, wrote the Association commenting that, from an educational standpoint, the booklet should go much further in developing the interest in lace which it aroused. She wanted to know all there was to know about this "Aristocrat of Textile Fabrics."

Conversations between the officers of the Association, Professor Rosatto and the faculty of the Institute resulted in a plan under which the Institute would furnish the skilled research men and the Association would pay for the research so that a booklet might be forthcoming which would tell the whole Leavers Lace story and which might also be used as a text book for actual teaching.

In July, 1948, Professor Edward L. Golec of the Department of Design and Weaving and George G. Armstrong, Jr., an Instructor in the same department, at Lowell, came to Providence and, with the cost of the project defrayed by the Association, went into the lace mills to make their study, Professor Golec armed with a note book and Mr. Armstrong equipped with his camera, and both filled with insatiable curiosity.

The result of their weeks of labor lies before you As practical lace manufacturers the officers of the Association believe the work is competent and enlightening. The history of the industry, in England, on the Continent and in the United States is the joint work of Professor Golec and the Executive Director of the Association. The technical portion of the book is the work of Professor Golec and Mr. Armstrong, carefully checked for accuracy by Mr. Harold G. Truman, Manager of the New England Lace Mills, a Lace Draftsman in his own right, and by Mr. Bert Edson, Designer and Mr. Leonard Truman, Superintendent of the New England Lace Mills.

The illustrations in the book are almost entirely the work of Mr. Armstrong supplemented here and there, when necessary, by reproductions where the original subject could not be photographed.

The Leavers Lace Trade in the United States owes a debt of gratitude to President Kenneth Russell Fox of the Lowell Textile Institute and to Dean Simon Williams, also of the Institute but most particularly to Professor Rosatto who worked unceasingly in the supervision, correction and amplification of this book.

"LEAVERS LACE" is submitted to the industry, the Textile schools of the United States and to the general public with the hope that it may fill a gap in the history of the Textile Industry too long neglected.

AMERICAN LACE MANUFACTURERS ASSOCIATION, INC.
EDWARD F. WALKER, *Executive Director*

Providence, Rhode Island
January 15, 1949.

HISTORY OF LACE

Lace, "The Aristocrat of Textile Fabrics",

is truly the fabric of romance.

"No textile fabric," says the historian, "has contributed more largely to the elegance and luxuries of life than lace, the most delicate of them all." Lace is a decorative, open-work fabric formed by looping, interlacing, braiding or twisting threads of various fibers. It is not usually purchased for its wearing qualities nor for the purpose of preserving bodily warmth, but is used almost exclusively for glamour. It is purely a luxury fabric and is one of the highest forms of textile artistry and skill.

Although lace as a textile fabric is known to all, comparatively few know the story of its origin, development, and present day manufacture. It is the purpose of this book to present the story of lace so that everyone may better understand and appreciate this marvelous fabric.

Possibly the earliest use of the word "lace" as the designation of a textile fabric, is to be found in an ancient rule for English Nuns, which dates from 1210. It developed its meaning as applied to decorative open-work in the 16th century, before which period the word was used in conjunction with another word of a qualifying nature, shoe-lace, corset-lace, sleeve-lace, etc., and it was also applied to the fancy braids or ties used in trimming clothing. A passage in "Much Ado About Nothing" indicates that in Shakespeare's time the word "Lace" was generally used as a verb denoting "to decorate with trimming."

The story of lace begins far back in the mists of antiquity. Its origin antedates recorded history. It has been said that the toothed or serrated edges of leaves furnished the inspiration for the production of lace. The French word for lace, "dentelle" derived from the word "dent", meaning tooth, is supporting evidence of this theory. It may well be, however, that lace was the result of a desire by primitive people to reclaim fabrics already worn, by darning and repairing them so that the repair itself would add to the beauty of the fabric. It is more probable, however, that the knitting and twisting of threads of the frayed edges of garments produced a fringe which was the beginning of lace.

There are biblical references to the making of "nets of checker work" and mention of nets is made by Homer, but the earliest existing examples of lace have been found in Egypt and Peru. The tombs of Egypt have furnished specimens of ornamental meshes which date from 2500 B. C. and specimens of net and lace, pre-dating the Christian Era, have been found in Peru. The designs of these Peruvian laces consisted of diagonal serrated stripes with fretted key devices, stepped effects, and chevrons, crosses, roundels, squares, lozenges and representations of the condor, puma, duck and fish. These laces are made of vicuna, wool and fibres of a species of cactus plant. The meshes, supposed to have been made with a shuttle, are the same as those known today as "filet", and "English Antique."

In the Cluny Museum in Paris there is a piece of Coptic lace which was made between the third and seventh century, A. D. It is a bobbin lace resembling Cluny. The bobbins were found with the specimen. The fancy needle-work and weaving of Copts during this period includes nets, picot edges, drawn-work and twisted lace. The patterns consisted largely of geometrical shapes and the materials were flax and wool, the latter in various colors.

During the immediate Pre-Renaissance Period in Europe, the greatest developments in lace-making appear to have been made in the Byzantine Empire and the islands of the Grecian Archipelago and it is from these sources, according to general belief, that lace was introduced into Venice. As a matter of fact the Greeks may be credited for having given to lace its special character. At Portici, there is an ancient statue of the Goddess Diana wearing a robe edged with lace one and one-half inches wide.

Whatever the reason for the beginnings of lace, it is quite apparent that it was evolved or invented for decorative rather than utilitarian purposes. It is equally safe to assume that it did not spring full-grown from the mind or fingers of some early experimenter. Lace as we know it today is the result of centuries of gradual development from crude beginnings to the exquisite creations which today add glamour and beauty to the garments they decorate. This decorative and glamourous feature of lace has always prevailed, although some consideration is given today to the strength of the lace in relation to the strength of the fabric with which it is used.

Hand-Made Lace

There are two fundamental systems of hand-made lace:

1. Needle point lace 2. Bobbin or Pillow lace

Naturally, the first lace was manufactured entirely by hand and the finest type of hand-made lace is known as needle point. It bears a close relation to the art of embroidery from which it no doubt sprang. As near as can be ascertained, the first hand-made lace, as we know lace today, was manufactured in Venice.

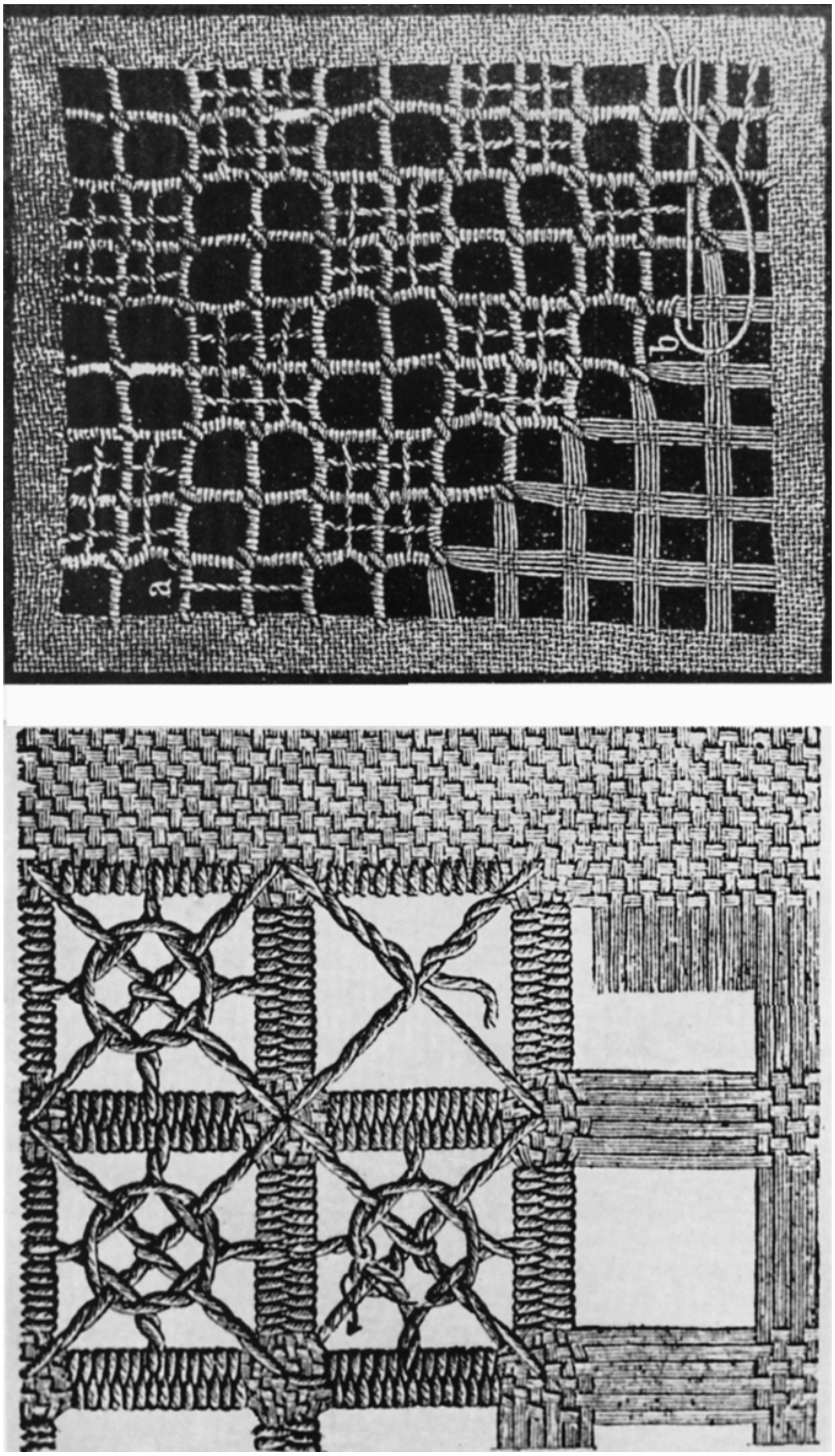
With the fabrics, introduced into the Venetian Empire from the East, as a foundation, the Venetians began to develop lace as it is known today. Reticella, Gothic or Greek lace was the first adaptation to be developed. This fabric was so-called because the pattern was based on repeated squares or reticulation of stiff geometrical open work, and is sometimes called "needle work guipure." Reticella was the application of needle point to cutwork. Cutwork, as distinguished from drawn-work, was based on the principle of actually cutting out a piece of the fabric and filling in the open spaces with embroidery. In drawn-work, threads were simply withdrawn and then replaced with an embroidered pattern.

Lace-making, as it is known today, implies a simultaneous production of pattern and fabric and based on no pre-existent fabric.

The Venetians abandoned the foundation fabrics about the year 1530 and relied upon the needle. When the cutwork character was abandoned and the artist depended entirely upon the needle stitch, the resultant fabric was called "Punto in Aria" or "Stitches in the Air". This was the beginning of Point Venise or Venetian Point Lace. Only two types of stitches were used. Upon the pattern or foundation, a series of threads were laid lengthwise, then through these the needle made loops and cross stitches. The variation of patterns was produced by the greater or lesser distances between the stitches and in the size of the stitches themselves. By such simple means the most beautiful of all laces were made. The design took floral forms and was independent of squares.

Some early types were named Rose point, Venetian point, and Maltese point. In Rose point, the guipures are raised in relief showing rich embossment. Venetian and Maltese are formed of flat figures, the latter being remarkable for the masses of finely combined threads.

Brussels and English point are later forms. Brussels point lace is composed of many separate parts, about 2 x 2 inches, as each motif cannot be greater than the length of the forefinger of the worker. After the pieces have been completed, they are connected together by a fine groundwork of thread in the form of a regular mesh. At various crossing points of the ground, spots or figures are made, adding to the richness of the lace and concealing the connecting threads.



Hand-made lace; top, drawnwork squared; bottom, cut and drawnwork

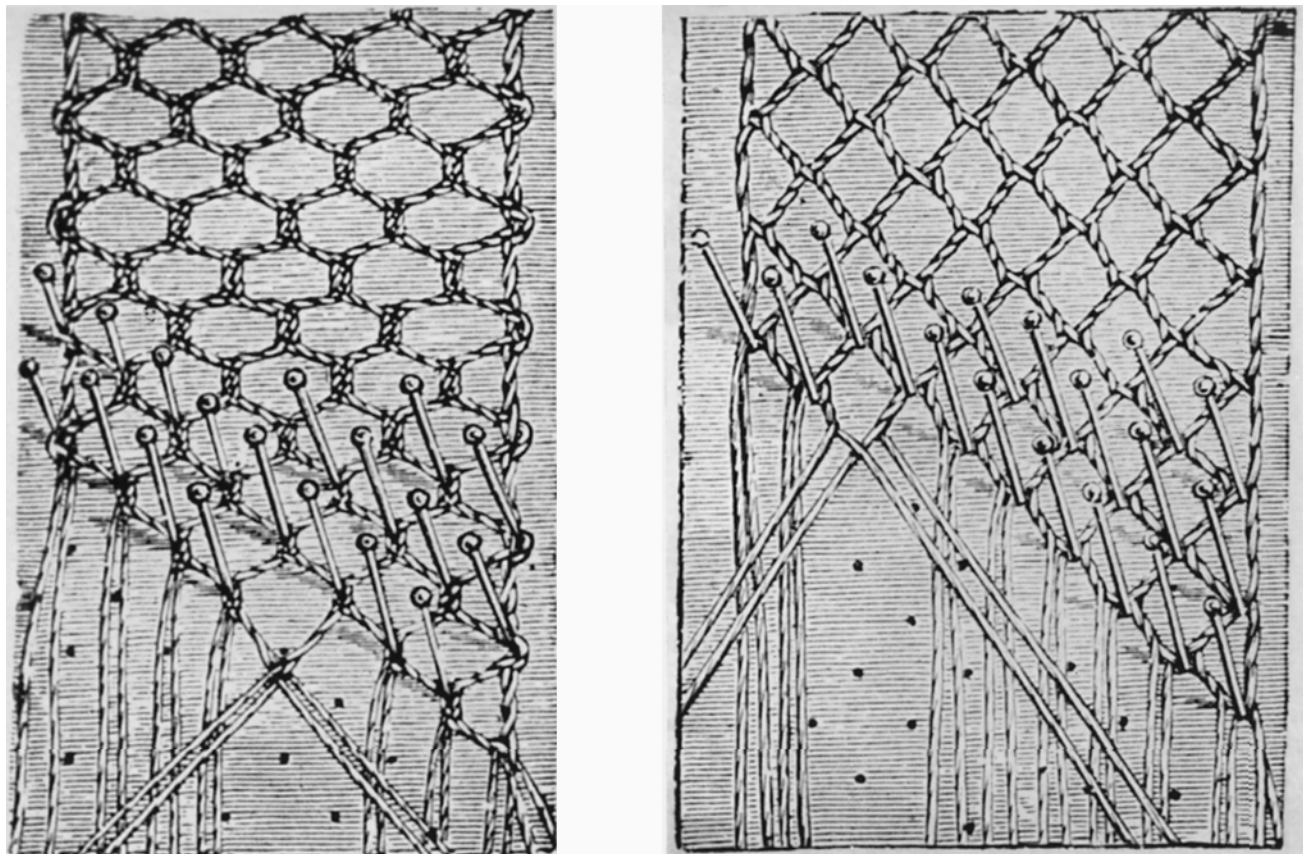


Diagram of hand made lace showing left, bobbin lace made with Mechlin formation and right, bobbin net showing diamond form in Lille lace

Hand-made lace: Cluny lace on the pillow

Pillow or Bobbin Lace

Almost simultaneously with the beginnings of needle point lace in Italy, the art of lace making commenced in Flanders by an entirely different process — the pillow, bobbins and pins. As a matter of fact, Flanders hotly contests Italy's claim of priority, even in the manufacture of needle point lace.

All early Italian laces were needle point and all early Flemish laces were pillow and bobbin laces. Mixed laces in both countries are of a later date. Italy copied pillow lace from Flanders and Flanders copied needle point lace from Italy. From Italy and Flanders the art spread throughout Europe.

The first approach to mechanical production of lace was made by the invention of pillow lace. It is claimed that this method was discovered by Barbara Etterlein Uttmann of Annaberg, Germany in the year 1561. It soon spread among all the wives and daughters of the miners in that district, who found making this lace more productive than their former embroideries and that they supplanted them as an article of commerce.

Pillow or Bobbin Laces are made as follows:

A pattern is pricked out in parchment or strong paper and is passed on to the worker who pins it firmly upon a pillow or broad cushion. The tools of the lace maker are small sticks (bobbins) about 4" long, pins, and thread. Sufficient thread is wound on each bobbin and these are hung in pairs at the beginning of the pattern. The worker places the cushion on her lap or on a frame and begins by sticking pins into certain of the pricked holes of the paper. She intertwists and crosses the threads by passing the bobbins in and out, over and under each other, in a given order, letting those bobbins hang, which are temporarily out of use. When all the holes of one part have been filled with pins, and the required amount of mesh made according to the pattern, a stitch is taken up through one of the pin holes with the needle pin, forming a loop. The proper bobbin is passed through this loop and the thread is secured by a knot. Going from point to point, the lace maker forms the complete pattern joining all together at various points by meshes of threads.

It is interesting to note here that tatting and the manufacture of fish nets bear a close resemblance to the manufacture of hand-made bobbin lace.

European Centers of Pillow Lace Manufacture

Knowledge of Barbara Uttmann's invention spread rapidly all over France, Belgium, Italy, Saxony, and Holland. In many instances, the bobbin method was combined with the point method to develop new techniques and styles. It was an easy way to produce ground meshings for Brussels and other point laces.

In the year 1666, under King Louis XIV of France, a royal ordinance decreeing measures for the protection and nurturing of the pillow lace industry was passed. By this means, France became the leading manufacturer of pillow laces and she holds that leadership to this day.

Throughout Europe, the manufacture of hand-made lace had become a great industry. Each community sought to establish its design and its leadership in the process of manufacture and processes were perfected and the fabrics were recognized and automatically referred to by the name of the community or the land of their origin. Thus, we have laces called Alençon, Chantilly, Cluny and others. These names which were characteristic of a type of pattern and construction of fabric have carried over into modern machine-made lace.

Leading centers of hand-made lace manufacture in France are Caen, Bayeux, Lille, LePuy, Bailleul, and Alençon.

Belgian lace centers are Brussels, Antwerp, Malines, Ypres, Bruges, Ghent, Mirecourt, Courtrai, Alost, and the villages around these places.

Saxony, Bavaria, North Italy, Spain and Portugal all produce small quantities for export.

Hand-Made Lace in The U. S.

About 1786, hand-made lace was produced commercially in this country at Ipswich, Massachusetts. Production was about 40,000 yards of silk lace per year. Today there is no hand-made lace produced commercially in the U. S.

The Origin and Chronological Development of Lace Machines

Date	
	Needle Point Lace—*Vague origin.*
1561	Pillow or Bobbin Lace — *Barbara Etterlein Uttmann of Annaberg, Germany.*
1586	Stocking Frame—*Rev. William Lee of Calverton, England.*
1758	Jedediah Strutt produced lacy material on the stocking frame by dropping stitches.
1775	Warp Knitting Frame—*Crane of Nottingham, England.*
1795	Lacy material produced on warp knitting frame.
1802	Net machine — *Robert Brown of New Radford, England.*
1808	Bobbinet Machine—*John Heathcoat.*
1813	Leavers Lace Machine—*John Leavers.*
1824	Jacquard applied to Leavers machine.
1835	Go-through System of working carriages—*Thomas Alcock.*
1841	Jacquard application improved—*Hooten Deverill.*
1849	Perforated steel bars—*James Oldknow.*
1875	Go-through System adopted.
1891	Porcupine Roller—*W. H. Smith.*

The Origin of Lace Machines

Machine production has taken the place of hand processes in all industries wherever possible and lace manufacture is no exception.

The object of the inventors of lace-making machines was to cheapen the cost of lace production in order to obtain a large quantity of the fabric for a small amount of labor. By their success, the utility of lace has been greatly increased. Imitating the fine products of needle point and pillow laces, the machines have brought beauty into homes which otherwise would have been bare of such niceties and luxuries.

It is interesting to note that the transition from hand-made lace to machine-made lace is comparatively recent.

The origin of the lace machine will be found in the kindred trade of hosiery. In 1758 the earliest machine-made lace was produced by Jedediah Strutt of Nottingham, England. He accomplished this by using a stocking frame or knitting machine, which was invented in 1586 by an English clergyman named William Lee. By arranging for loops to be missed when desired, Strutt was able to make a material which was lacy in appearance.

In 1770, Robert Frost improved on Strutt's invention to produce a figure on a hexagonal mesh. In 1777, he made further improvements to produce a square mesh.

In 1780, Frost and Holmes made net which was embroidered by hand and which was the first step toward machine-made lace. Caillon, working independently, had produced the same thing in France about 1780 and from this date, when the French commenced to build their own machines, down to 1810, the list of their inventions is an index of the extraordinary interest taken in the matter.

Warp Lace Frames

A great advancement toward the lace machine was made in 1775, when a hosiery mechanic named Crane discovered that knitted fabrics could be made upon a warp machine, which had a separate thread for every needle instead of one thread for all the needles. In 1795, attempts were made to get an openwork material of lacy appearance. One of the special merits of the warp machine was its ability to use any kind of thread. The warp threads acted as pillars upon which the traversing threads could be carried. These points favored the lace manufacturers very strongly. An obvious limit to the power frame was the absence of wide traversing power.

France, Italy, Germany and Spain took up the machine and the French mounted fine appliqué work on the knitted netting.

Underlying all the efforts of the lace machine inventors, sometimes conscious and often unconscious, the desire to produce pillow lace by mechanical means was ever present. To change the direction of a thread or a group of threads, up and down, backwards and forwards, while forming a basic fabric seemed almost beyond human skill.

The warp frame supplied one factor in the desired structure, for in all pillow laces, half the waved lines proceed from end to end of the piece. The difficult matter was to find a means of combining with these the other half of the threads in fast meshings while following oblique and various directions. At the beginning of the 19th century, it seemed an impossibility. But within a few years, this difficulty was solved.

In 1786, Flint invented the point bar; in 1796, Dawson applied rotary movement to the machine and cams and wheels to move the bars. The bars kept the warp threads at equal distances and cams moved them following the requirements of the twist. A little later, Brown and Copestake made Mechlin net on the warp machine. Lindley invented the lace bobbin in 1799 and Irving and Skelton devised the spring which regulates the speed at which the thread is withdrawn. The machinery was in a state of transition and slowly but surely the crude stocking frame was evolving into the highly elaborate lace machine.

In 1802, Robert Brown of New Radford, Nottinghamshire, made a notable advance toward machine lace when he was granted a patent on a machine for producing nets of all sizes. It was, in fact, the first twist net frame and it formed a fresh starting point for mechanics in their quest for a lace-making machine.

From the time of the first appearance of net until the early part of the 19th century, the history of its manufacture is marked by records of perpetual endeavor to produce an article which would not unravel. A fast, runproof mesh was desired and many attempts by many men were identified with the efforts made to attain this end, but the problem of producing a stable fabric remained unsolved. So great was the mystery and so many the number of abortive attempts made during a span of 40 years that the projectors were ranked amongst enthusiasts seeking to obtain perpetual motion. In 1804, Edward Whittaker invented a machine which he claimed could produce imitation pillow lace. Whittaker's frame had half the threads drawn from a warp beam and half the threads wound on bobbins mounted on a carriage.

In 1808, John Heathcoat patented his first bobbinet machine, which was a further development and an improvement on Whittaker's invention. The bobbinnet machine was so called from the threads which cross the warp, being supplied from bobbins which worked threads from a semi-circular frame and made narrow strips of net 3″ in width and joined together. The advantages which would accrue from the production of wider breadths were so apparent that Heathcoat entered upon the task of devising means to attain this end. An examination of the hand-made net demonstrated that part of the threads worked in the same direction throughout the piece. He, therefore, placed all these threads on a main beam, which enabled him to reduce the width of the beam to the same width as the lace, whereas, previously the width of the semi-circular frame which held the spools from which the threads worked was many times the width of the net produced.

Heathcoat's second patent was taken out in 1809, and he started a factory at Loughborough, in Leicestershire, England. The newly patented machine produced strips of 18 inches in width, and as early as 1810, several thousand people were occupied in making the net and tambouring and running in patterns with the needle. With the exception of the Jacquard, this machine combined the essentials of all subsequent lace machines. The size of the machine was gradually increased to produce pieces of 30, 36, and 54 inches in width.

Before 1816, England was so covetous of its net trade that laws were passed to punish, by banishment or death, anyone exporting a lace machine. In 1816, however, the separate parts of a machine, mixed with old iron, were smuggled into France and the industry was soon firmly established there. Heathcoat established a factory of his own in Paris in 1818, which he transferred to St. Quentin in 1826.

The whole tradition of lace making was uprooted upon the expiration of Heathcoat's patent, and from 1823 to 1825, there raged what was known as the "twist-net fever". Many persons, some gifted with mechanical ability and others, entirely lacking this ability, tried all sorts of schemes to get around or improve on the Heathcoat patent.

In 1813, Heathcoat modified his own machine to the extent that the bobbins traversed a definite width and returned again, instead of traveling the full width of the machine. The narrow breadths of lace which were produced were called "Quillings." The most important and far-reaching changes made in the construction of the machine, however, were devised by John Leavers, who, working with his two brothers and his nephews, conceived the idea of placing all the carriages in one tier, with one fixed, constant motion in one gait instead of traversing the machine as in Heathcoat's machine. This arrangement is the chief ground of difference between Heathcoat's patent and Leavers' machines. Leavers did not attempt to patent his machine for fear of infringing on Heathcoat's patents. He was engaged by a lace firm and built the machines for them.

The Leavers machine dates from 1813 and essentially the same principle is in use today in the modern Leavers machines. The first machine was 18″ wide; by 1825 this width had been increased to 60 inches. These early machines traveled 80 to 90 motions per minute. They were used solely for making plain net until in 1823, J. Bertie and R. Biddle devised a method of making breadths on them. The essential difference in operating the carriages made the production of a fancy lace possible, an achievement that could never have been possible with carriages traversing the whole width of the machine.

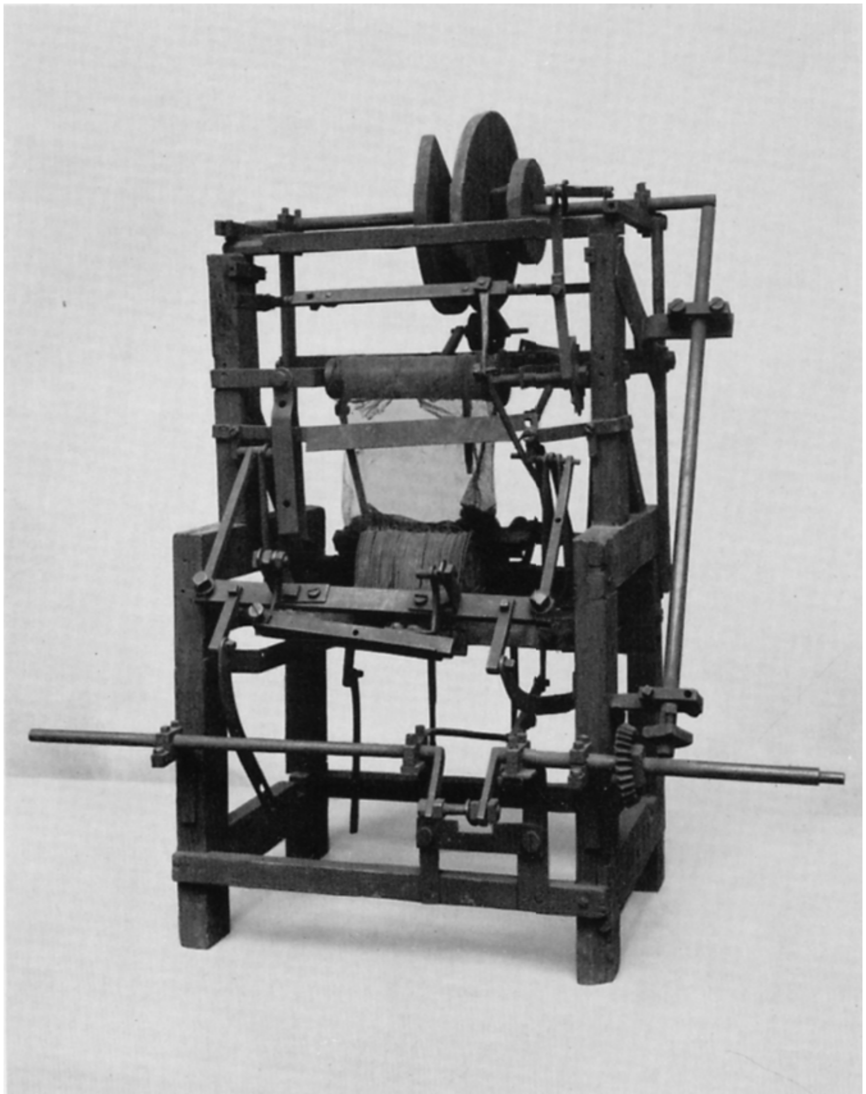
The invention of Joseph Marie Jacquard, the Jacquard motion, was applied to the lace machine as early as 1824, but it was not until 1837 that Ferguson applied it to the bobbins of the bobbinet machine, using two guide bars, and making possible an endless variety of patterns. His complete machine was produced in France, because he could not obtain the protection of patent laws in Nottingham.

In 1841, Hooton Deverill applied the Jacquard motion to the Leavers machine acting on the warp threads in independent bars. The machines, at first, were narrow and being operated by hand power, produced slowly; later the rotary system doubled the speed, and finally the power-driven machine gave a more rapid and regular production. Before becoming the present enormous machine, the primitive machine went through many changes, the complicated construction today being an evolution of a century based on Heathcoat's machine of 1809. Since the application of the Jacquard, the alterations have been improvements and refinements, rather than inventions, and the products of the machine have developed constantly, improving in quality and decreasing in price.

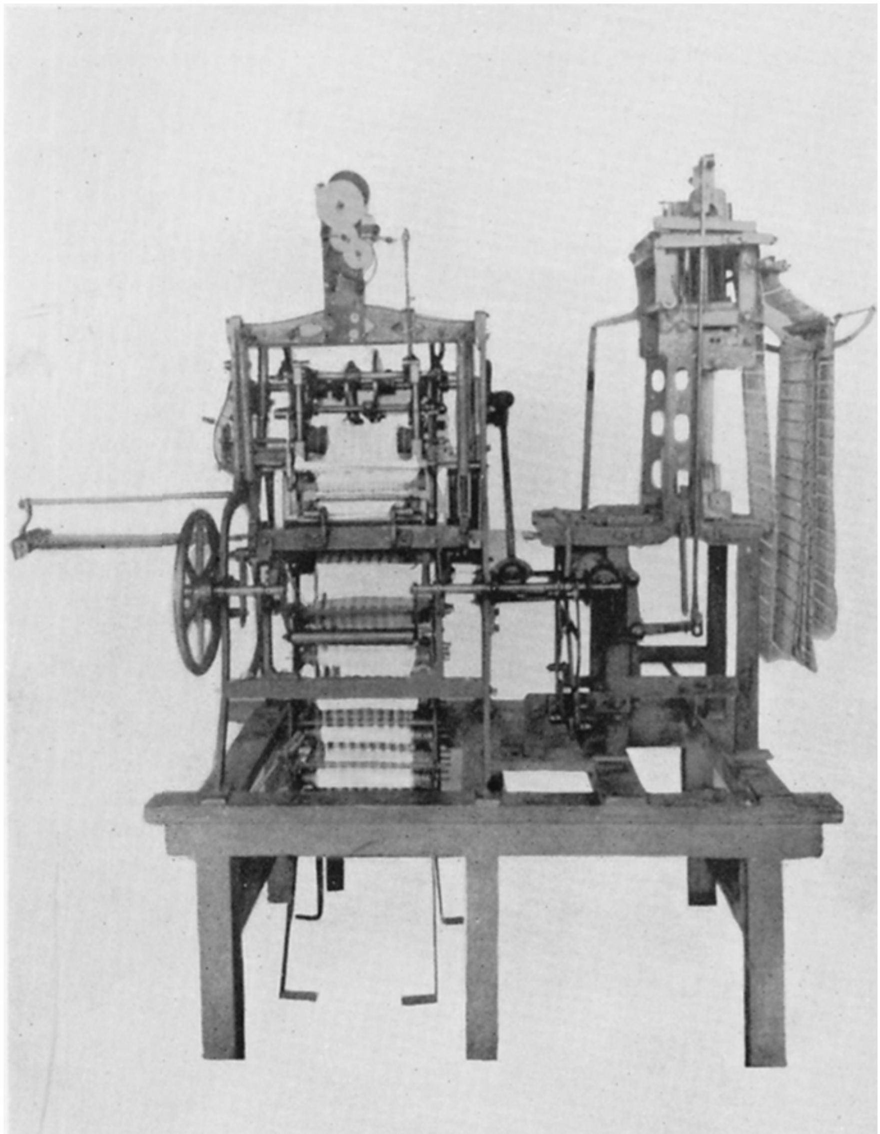
Machine-made lace, at first, was a plain net composed of meshes of uniform size and shape, made the full width of the machine and cut up into such lengths and widths as were appropriate to the uses for which it was intended. It was embroidered, by hand, more or less richly, but the product was still in its infancy. A little later, this same net was made in bands of different widths, first of cotton and later of silk. Attempts were made to imitate various kinds of net; little by little and after numerous trials and combinations, machine-made fancy lace was created.

One of the more recent improvements on the Leavers machine is known as the "Go-through" principle. In a machine, so equipped, landing bars are discarded. Instead, the machine carries the bobbin threads twice through the warp threads at one revolution of the crankshaft, considerably increasing the working speed. Most of the machines in use to-day are operating on the "Go-through" principle.

Machine-made lace is a triumph of mechanical ingenuity, and a greater amount of inventive genius has been devoted to its production than has been bestowed on any other branch of the textile industry. The possible variety of the products of a lace machine is, like most arts, infinite and many sided. Machine-made lace constantly sought to be an imitation, more or less perfect, of hand-made lace under most of its forms and in all its styles. There was a vast field to explore, and the problem was to make the machine produce the finest and most delicate fabric in existence and to supply by the parts of an ingenious apparatus the delicacy of touch and the dexterity of clever hands. Without irreverence toward those clever and patient people to whom the world owes the art of making hand-made lace, it may be said that the stock bequeathed by them has been so carefully improved by machinery that the accumulated interest now exceeds the principal.



First Leavers Machine



First Leavers Lace Machine with Manchester Jacquard
which made 8 widths of 1″ lace at a time

Leavers Lace Industry in the United States

The lace industry in the United States is comparatively recent and was slow in developing. The reason for this was that the exportation of lace machines from England was prohibited and the only way that the machines could be brought to this country was piece-meal. Having smuggled the parts to the United States, they were assembled by people who had worked on them in England.

The first "machine lace" factories in the United States were established early in the nineteenth century in Medway and Ipswich, Massachusetts. But the real development of Leavers lace in the United States did not get under way until 1909. At this time there were only about 100 Leavers machines in this country.

Because this country had no way of producing suitable mosquito netting, many American soldiers died from malaria during the Spanish American War. So, for the purpose of promoting the manufacture of netting in this country, the Tariff Act of 1909 provided for the free entry of Leavers lace machines for 17 months (from Aug. 6, 1909 to Dec. 31, 1910). As these very expensive machines were not (and are not) made in this country and as the normal duty upon imported Leavers machines was 45%, the provision for their free importation resulted in a rapid expansion of the industry.

Practically all of the "twist-hands", as lacemakers are called, are either men who learned their trade in England or France or the sons of such men. Comparatively few American lace makers have been developed other than those sons or relatives of British immigrants who were born in this country. The process of learning to make Leavers lace is long and difficult. The Amalgamated Lace Operatives of America, Leavers Section, the twist-hand's union, feel that a three year apprenticeship is the minimum and that more time than that is required to make a thoroughly trained, all around twist-hand who can work on any type of lace satisfactorily. It is a highly-skilled operation and the highest paid of any comparable occupation in the textile industry.

There are 54 lace mills and 730 Leavers lace machines in the United States today, manufacturing all types of Leavers lace in most gauges up to fifteen point.

The Leavers lace industry in this country employs 5000 people and does an annual business of approximately $30,000,000.

Yarns Used in Making Leavers Laces

Cotton, silk, spun silk, rayon, nylon, linen, ramie, worsted, mohair, and metal threads are all used in making Leavers lace.

However, spun silk, linen, ramie, worsted, mohair, and metal threads are not commonly used, except when required for some special type or novelty fabric.

Cotton accounts for about 90% of the lace production. Silk and synthetics make up the remaining 10%. That is the picture as it stands today, although some lace manufacturers claim that the use of synthetics is gradually increasing, especially in the case of nylon.

Cotton Lace Yarns

Lace yarn has become a trade term denoting a high, possibly the highest, grade of cotton yarn manufactured. Cotton lace yarns have more twist than warp or filling yarns used for weaving. The twisting process, essential to lace making, subjects the yarns to an abnormal strain which demands a much higher grade of yarn than is necessary for knitting or weaving.

Most of the yarns are right twist. However, reverse twist yarn is used in bobbin-fining set-outs and center gimp set-outs, in which case one warp with right twist and one warp with reverse twist are used.

Counts of 120/2 and up are made of Egyptian cotton and are imported from England in most cases. Most of these yarns are gassed and prepared, but all are at least gassed. They are used in the unbleached state. The reason for using these yarns in the unbleached state is that bleached yarns do not have the strength of unbleached yarn and require greater care while the lace is being made.

Cotton Lace Yarns

Count	*Twist Per Inch*	*Type*
20/2	19	Carded Domestic
28/2	23	Combed Domestic
40/2	26	Combed Domestic
50/2	28-30	Combed Domestic
50/1	34	Combed Domestic
60/3	20	Combed Domestic
60/2	30-32	Combed Domestic
60/1	36	Combed Domestic
70/2	34-36	Combed Domestic
70/1	40	Combed Domestic
80/2	36	Combed Domestic
100/2	38	Combed Domestic
120/2	35-42	Combed, gassed, prepared, Egyptian cotton, Imported
140/2	42	Combed, gassed, prepared, Egyptian cotton, Imported
160/2	42	Combed, gassed, prepared, Egyptian cotton, Imported
180/2	46	Combed, gassed, prepared, Egyptian cotton, Imported
200/2	46	Combed, gassed, prepared, Egyptian cotton, Imported
220/2	46	Combed, gassed, prepared, Egyptian cotton, Imported

In reverse twist yarns the Turns Per Inch are the same as in right twist.

Preparation of Yarns

The yarn is flattened to an oblate shape by a calendering process making it more flexible and polishing it in the process. The yarn is usually greased with cocoanut oil or some other lubricant, and when the wound, pressed, bobbins are placed in the oven and steamed, the lubricant prevents the steam from caking the yarn. Gassed and unprepared yarn is round and does not give the same amount of yardage on the bobbins.

Lace yarns are used for four (4) different purposes:

1. In brass bobbins
2. On warps
3. On beams for gimps
4. On beams for outlining threads.

Brass Bobbin Yarns

80/2 to 220/2 Egyptian and Sea Island cottons. Brass bobbin yarns should have strength, evenness, regularity of twist, and compactness. While bobbin yarns are usually 2-ply, there is a growing tendency toward the use of single yarn.

Warp Yarns

Should be elastic, smooth, clean and uniform in twist.

60/2 to 200/2 right twist and reverse twist—gassed.

Gimp Yarns

Gimps are threads from a beam used to fill in the objects of a design. 40/2 to 100/2. In Cluny laces, the beam threads may be as coarse as 20/2.

Outline Threads

Also known as liners, thick threads, or cordonnet.

Usually heavier than other yarns in the pattern in order to afford a contrast in outlining the design. Counts used are 20/2, 30/3, 40/3 and 60/3.

Cotton Yarns Used in Making Specific Styles

Manufacturers disagree as to the counts of yarn furnishing the best results. The appearance of the article is the paramount consideration in choosing yarns for bobbin-fining laces, as the pattern is made from the brass bobbin yarns.

Independent beam laces do not show the bobbin yarn at all and, the finer the yarn used, compatible with strength, the greater will be the economy in manufacturing, because the set of bobbins will not require changing as often. This reduces cost of winding and waste in stripping.

Two warps are used in bobbin-finding laces, one right twist and one reverse twist. Reverse twist is subject to less strain and usually is 20 counts finer.

Independent beam laces are usually made with yarn counts of the same weight for net gimps and outline threads, with stronger yarn on the beams for making fronts, back edges and lacers.

Style	*Gauge*	*Right Twist Warp*	*Reverse Twist Warp*	*Brass Bobbins*	*Beams*	*Lacers Purls, Etc.*
	8	80/2	100/2	120/2, 60/1	20/2, 30/3	60/3
Bobbin-fining	9, 9½	100/2	120/2	120/2, 60/1	20/2, 30/3	60/3
	10	120/2	140/2	140/2, 70/1	20/2, 30/3	80/3
	10½	140/2	160/2	160/2, 180/2, 90/1	20/2, 30/3	80/3
	12	180/2, 200/2	200/2, 220/2	200/2, 220/2	40/2, 60/3	100/3
	9½, 10	....	....	140/2, 70/1	80/2, 90/2	80/3
Vals & Alençon	12	....	....	160/2, 180/2, 90/1	120/2, 140/2	100/3
Ensor net & Torchon	14	....	....	220/2, 260/2	200/2	120/3
Cluny	7, 8, 9, 9½	....	....	120/2, 140/2	20/2, 24/2, 30/2	20/2
	7, 8, 9, 9½	....	....	60/1, 70/1	40/2	24/2

Silk

Up until World War II, there had always been a substantial use of silk as material for Leavers lace. It is being used again today, but it is meeting stiff competition from the synthetics.

Raw silk is a continuous thread, hundreds of yards in length, made by reeling into one thread 3 to 12 cocoon filaments held together by the natural gum or "sericin" of the silk itself. The silk used for warps in the lace industry is chiefly extra-classical Italian and is imported duty free.

Silk counts used are the following deniers. 16/18, 20/22, 24/26, 26/28, 28/30, 30/32, 34/36, 38/40, 40/42, 40/44, and 44/48. The most common denier used is 30/32.

Organzine is frequently used for brass-bobbin yarn. It is made by doubling threads, which have been well twisted as singles, and giving them a firm twisting in the opposite direction. Standard organzine twist for 13/15 denier is 16 turns per inch in the single and 14 turns per inch in the ply. It is usually made from Japanese silk.

Silk used for warps contains the gum, but silk for brass bobbins is degummed, otherwise, in steaming after pressing, the yarns would be cemented together. Loss in weight by degumming is 20% to 25%. Loss in strength is slight.

Rayon

Rayon and nylon are being used in ever-growing quantities in the lace industry. The rayon yarns used in lace have far more twist per inch (12 to 16 turns), than do rayon yarns used in weaving (0 to 3). Semi-high tenacity

Viscose is most commonly used for the basic lace fabric. Acetate rayon is used for the lacer threads, that is, the threads which hold the individual breadths or bands together while the lace is being made. The use of acetate lacers eliminates separation of breadths by hand. Acetate lacer threads are removed by dissolving them in an acetone bath.

Single yarns used are mainly 150 and 300 denier. Two-ply yarns in those sizes, as well as counts finer than 100 denier, are also used, together with some 3-ply denier yarn.

Worsted

Some worsted yarns are used but the amount is negligible. The end use of lace makes the wool fiber unsuitable for the purpose. Worsted counts used are 2/26, 2/35, and 2/40.

Rubber

Medium elastic yarns of 125% to 200% elongation are used as warp threads in the manufacture of wide elastic nets and laces for foundation garments. Because of their open structure, such fabrics give a 2-way stretch effect, although the elastic yarn is present only as warp, held together by inelastic binding threads.

Metal Threads

Metallic yarns of some types are also used to a very limited extent for evening wear fabrics.

Tinsel and laminette are made with a 2-thread cotton core, around which is wound a flat copper or brass wire coated with gold or silver.

The metal is wound around the cotton core in the opposite direction of the twist of the yarn with 36 and 38 turns to the inch for tinsel wire and laminette respectively.

Yards Per Pound of Metal Threads

Type	*Number*	*Yds./Lb.*
Tinsel	7	3,629
	8	5,443
	10	7,711
	12	11,340
	14	13,608-14,969
	16	24,948-27,216
Laminette (Lamé or Lahn)	4	1,814
	9	4,082
	10/11	4,536-4,990
	13	5,897
	17/18	7,711-8,165
	22/23	9,979-10,433

(Laminettes are defined by the number of meters per kilogram. Example: #4 is 4,000 meters per kilogram, etc.)

The Manufacture of Leavers Lace

There are many basic types of machines which produce lacy fabrics. Leavers Machines, however, are the only ones producing true, machine-made lace, chiefly narrow, fancy laces for the ornamentation of women's wearing apparel. However, a considerable amount of all-over dress goods, veilings and fabric used in women's underwear is also produced.

The Leavers machine makes such perfect laces that it takes an expert to distinguish a hand-made lace from the Leavers product.

In this work, only the Leavers machine will be discussed because other machine-made lacy fabrics are either embroidery or lace types, made on a different principle.

The manufacture of lace, from the yarn to the finished article may entail up to 32 different processes as shown on the flow chart of Leavers lace manufacture. These processes naturally fall into four groups.

1. Preparatory work on the yarn (1 to 9).
2. Actual making of the lace on the machine (10).
3. Finishing processes (11 to 25).
4. Preparatory artistic work (26 to 31).

It is apparent from the flow chart that the machine may be approached from two directions, the drafting room (26 to 31) or the yarn room (1 to 8).

We shall take the yarn room approach, starting with a skein of yarn and following it through to the finished lace, ready for its end use. The designing and drafting phase of Leavers lace manufacture will come last since this procedure will not disrupt the continuity of the manufacturing processes involved from yarn to finished lace.

Preparatory Work on The Yarns

1. Slip Winding

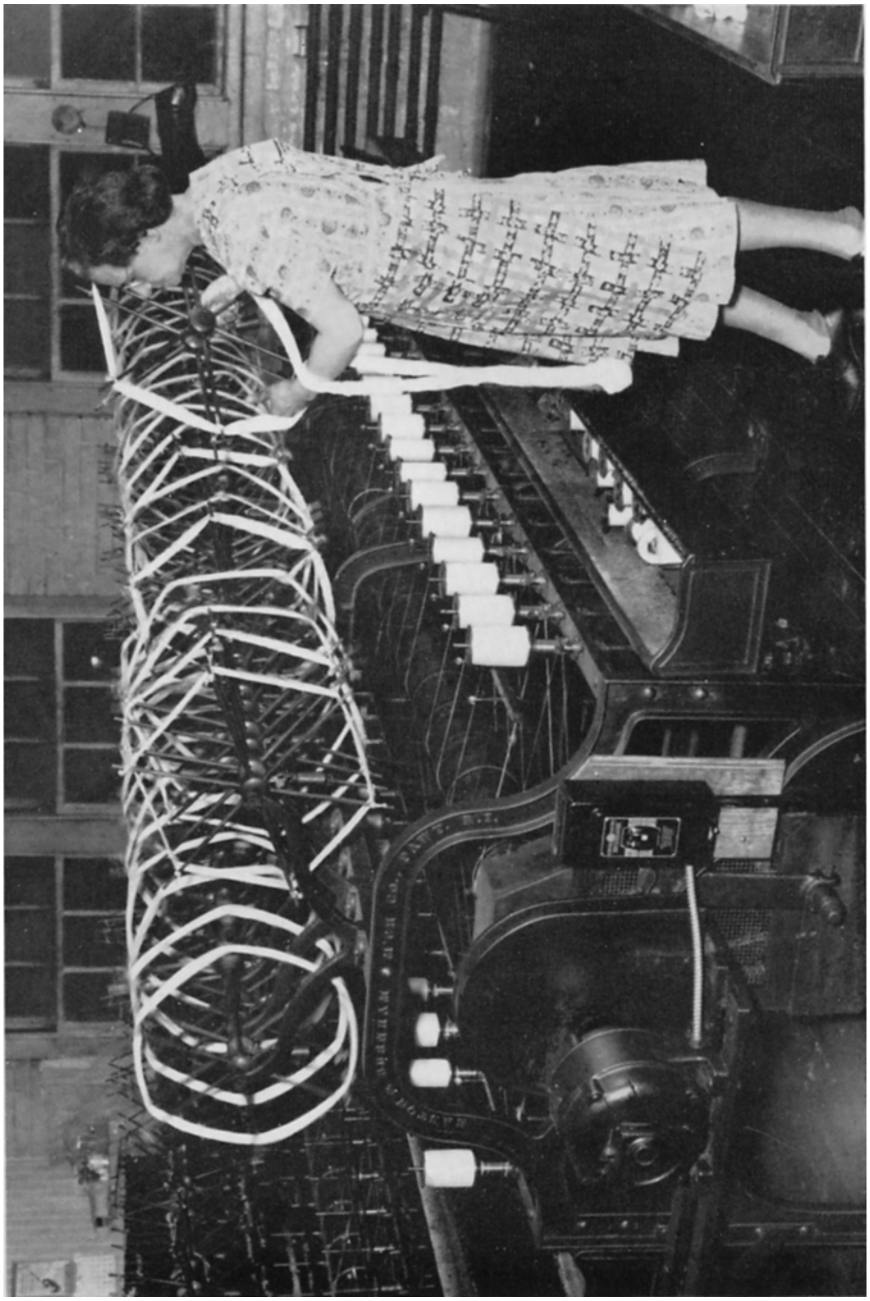
This operation is better known as spool-winding, or simply winding, in other branches of the textile industry.

Imported yarns are received in skeins packed in bales. Domestic yarns are usually received on cones or tubes and are packed in cartons.

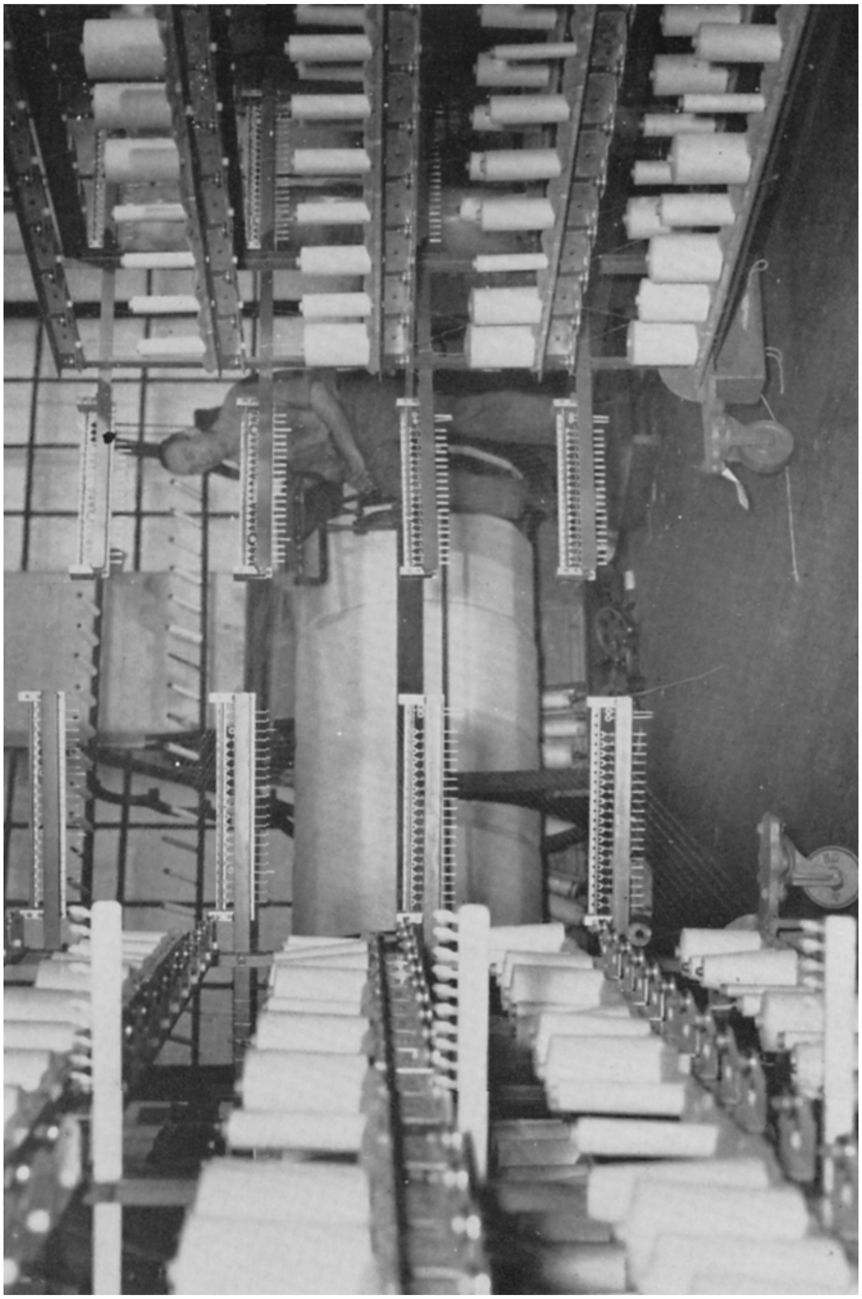
All skein yarns are spooled. Cones are spooled for the warping process and for brass-bobbin winding units equipped with jacks, which are stands holding banks of spools.

Cones, as received in the yarn room, are used for the beaming operation and for brass-bobbin winding units equipped with modern high speed warping creels.

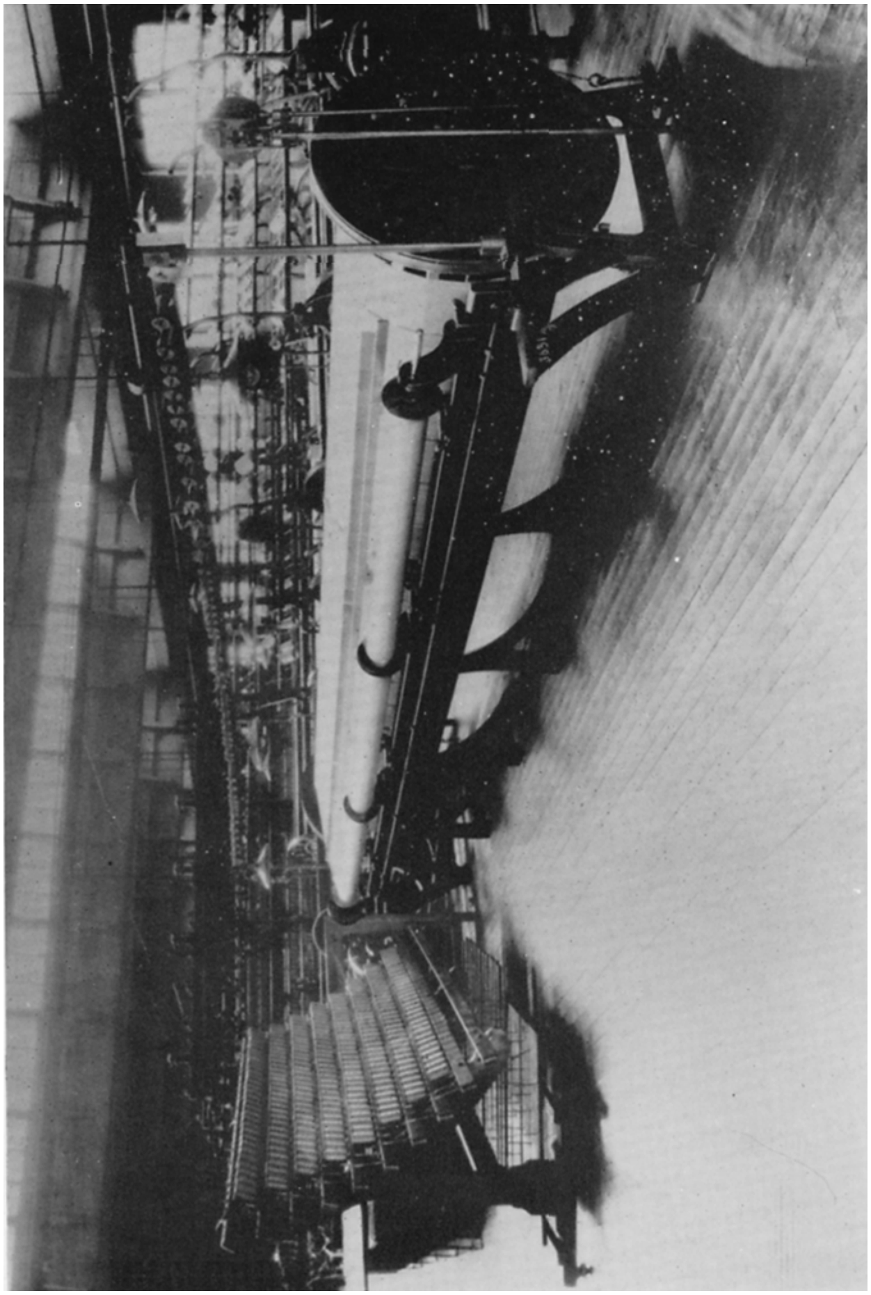
Slip winding of yarns for use in Leavers lace machines does not differ to any great extent from the same operation performed for other types of textile machinery.



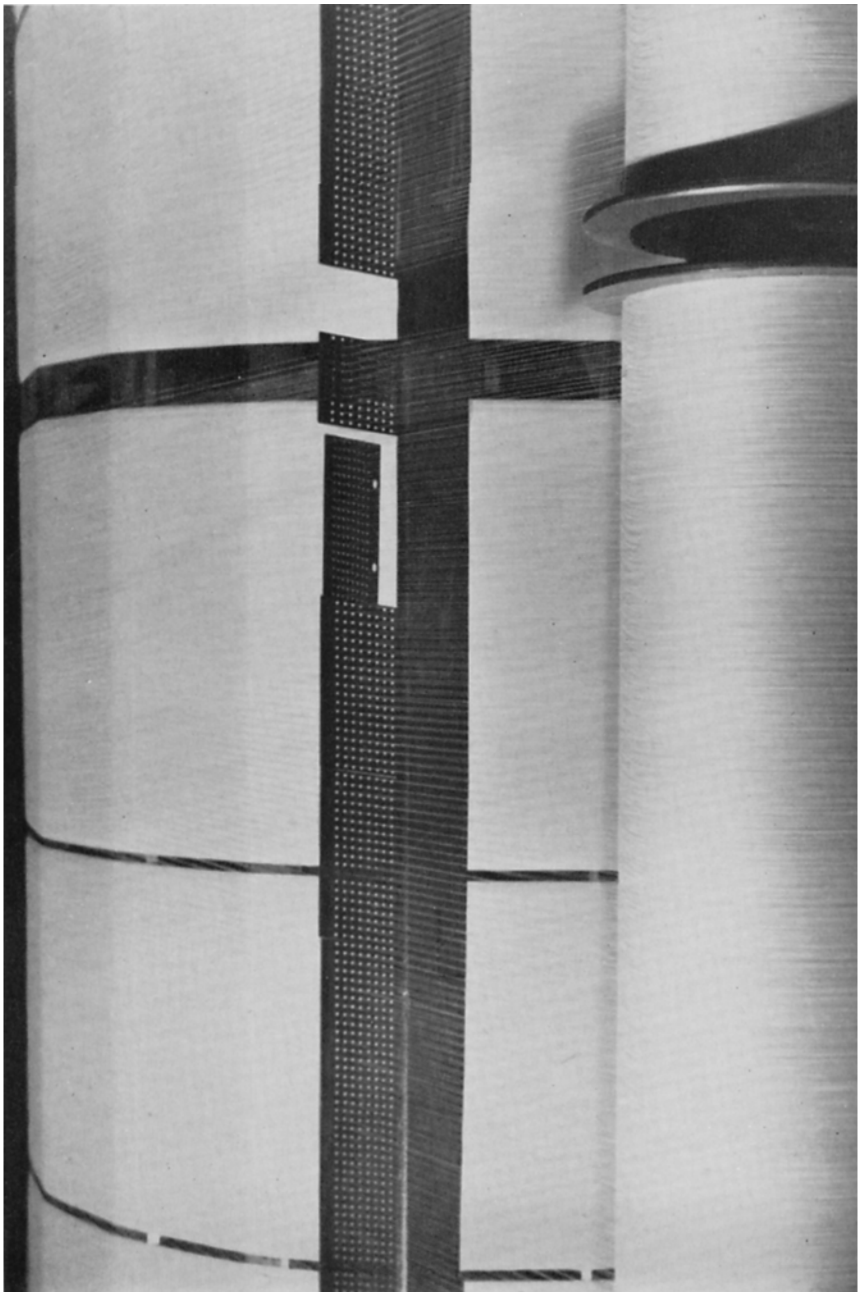
Slip winding



Warping from creel



Warping mill



Section of the warp showing the position of the brasses

Beaming

2. Warping and Beaming

Warping or the placing of the requisite number of threads on the main warp beam comprise two operations, the winding of the threads from the spools to the warping mill, and the running back of the threads to the warp beam. The threads for a full warp are placed on the mill by successive windings through perforated metal plates called "brasses". When all the threads are on the mill, the ends are fastened to the main warp beam, the mill is weighted by means of leather belts, in order to maintain an even tension, and by a reverse motion the beam revolves and unwinds the threads from the mill around itself. This process is identical to the warping process in weaving plants where the warping mill is known as a reel and is somewhat larger.

Lighter beams or independent beams, about 1⅝″ in diameter, with one thread per breadth (one lace band), may be wound directly on the beams from the spools, the required tension being maintained by passing the threads round the mill or a small roller, the threads being traversed to the same extent as the width of the individual breadth of lace. In some mills the threads are run from cones to the warping-mill (reel) and then by a reverse motion are unwound on the beam.

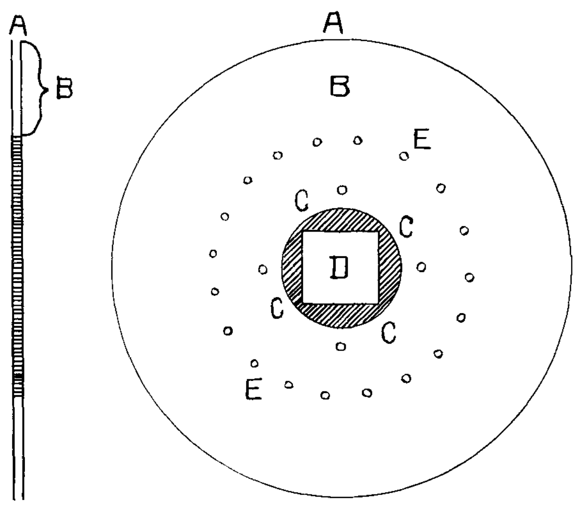
3. Brass Bobbin Winding

The yarn processing, which is unique to the lace industry, is the winding of the brass bobbin. The term "bobbin" as used in a lace mill refers *only* to the brass bobbins.

Brass bobbins consist of two thin rolled discs, grooved on the under surfaces and riveted together, face to face, with a narrow space between them. The bobbins are quite thin, and the thickness depends on the gauge of the lace machine. Each bobbin has a square hole in its center for use in placing a number of them together on a square spindle when the operation of filling them with yarn is performed. The circle of rivets round this square hole acts as a base upon which the yarn is wound. A brass bobbin-winding machine supplies a number of bobbins, 120 or more, with the same number of yards of yarn. The required tension and regulation of the threads is obtained by passing them around a cloth-covered roller and between the jack or creel and the brass bobbins. The threads are stretched over the bobbins, carefully slipped into the circumferential grooves and the revolution of the square shaft fills the bobbins.

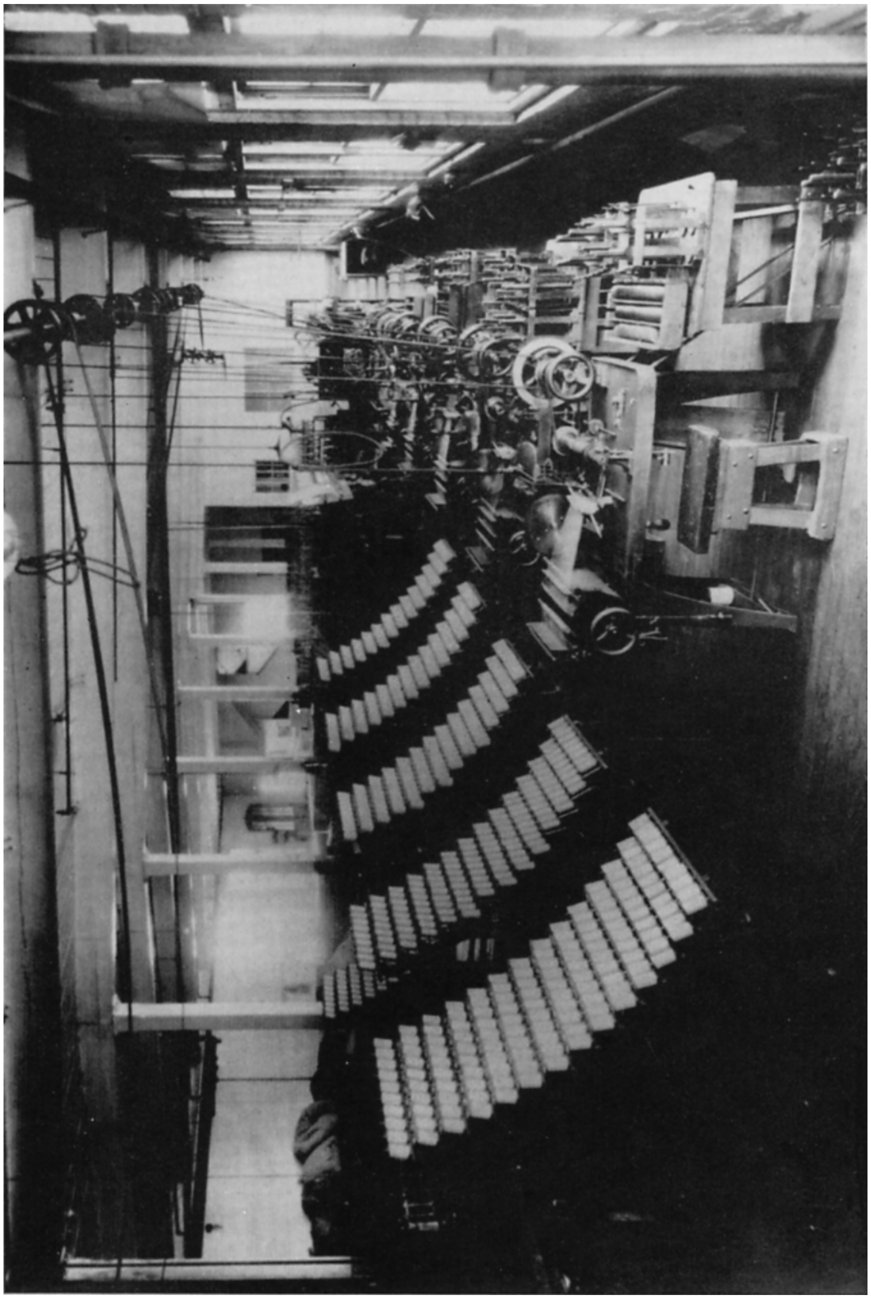
The length placed on the bobbins is shown by an indicator and is superimposed in one layer from start to finish. The length varies from 75 to 120 yards or more, depending on the count of the yarn, the age and size of the bobbin. The length placed on the bobbin increases with the fineness of the yarn. The maximum length for the different counts is not put on new bobbins. Shorter lengths are wound on new bobbins until they have been used several times. This is done in order to prevent the bobbins from becoming damaged or defective during pressing.

When the bobbins are full the shaft is removed and a new shaft on which empty bobbins are already mounted is placed in position, the threads from the full bobbins are passed over the empty ones and inserted in the grooves, the thread is cut between the empty and full bobbins, and the new shaft of bobbins is filled as before. The number of bobbins in a set for a 9½ point, 224 inch machine requires the filling of 36 shafts of 120 bobbins each or a total of 4320 bobbins.



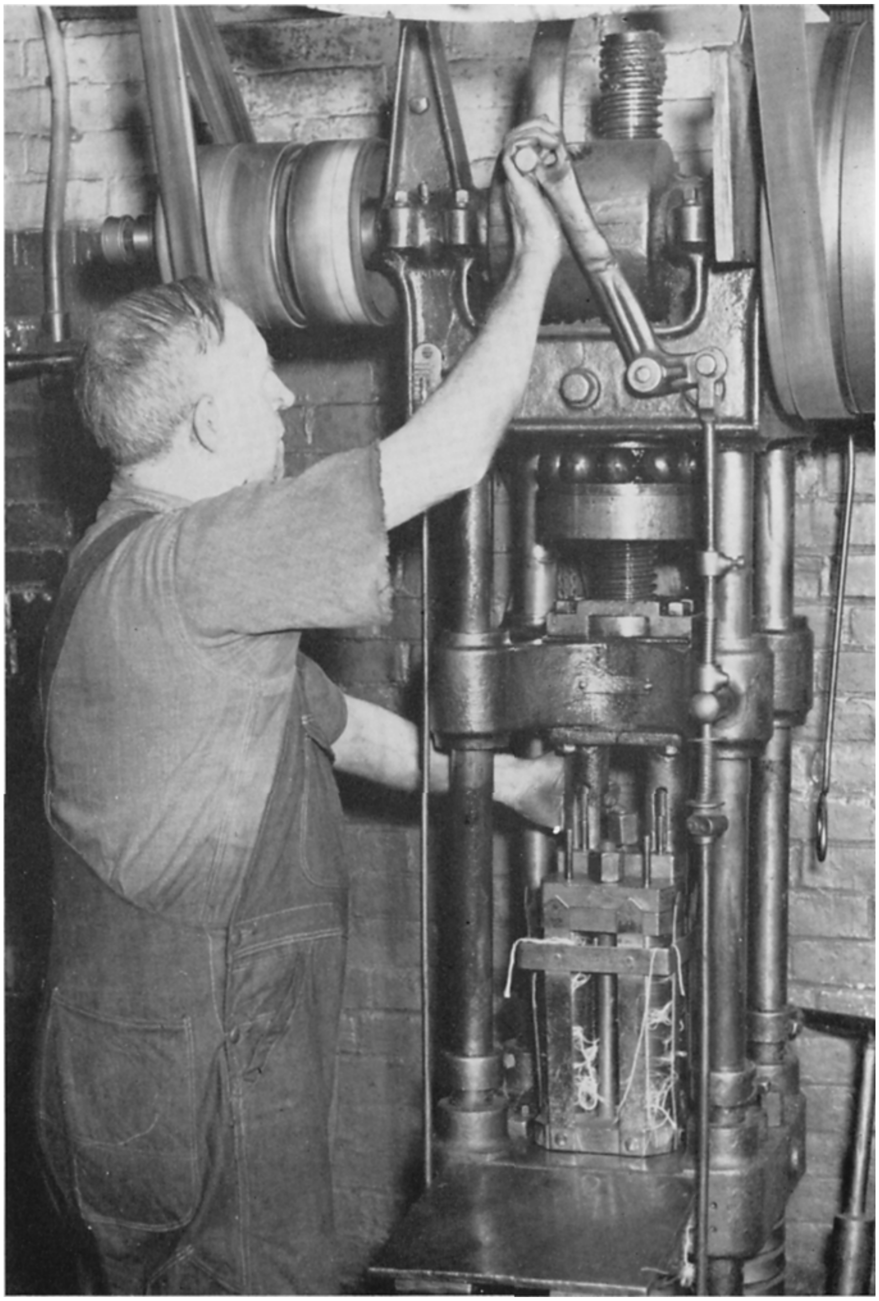
BRASS BOBBIN

(a) Lip of the bobbin
(b) Part containing the thread
(c) Body
(d) Square hole for winding spindle
(e) Rivets holding the discs together

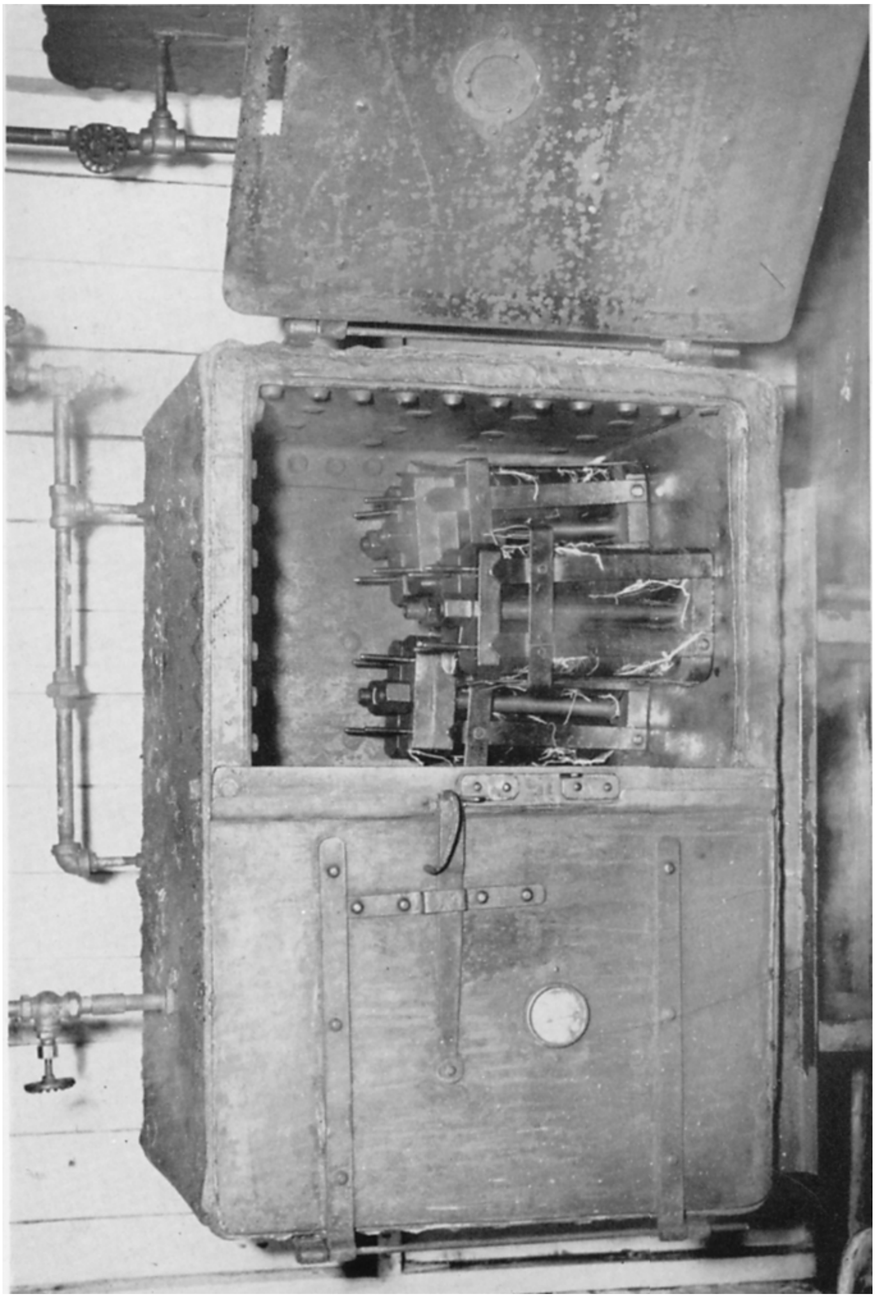


Battery of brass bobbin winders

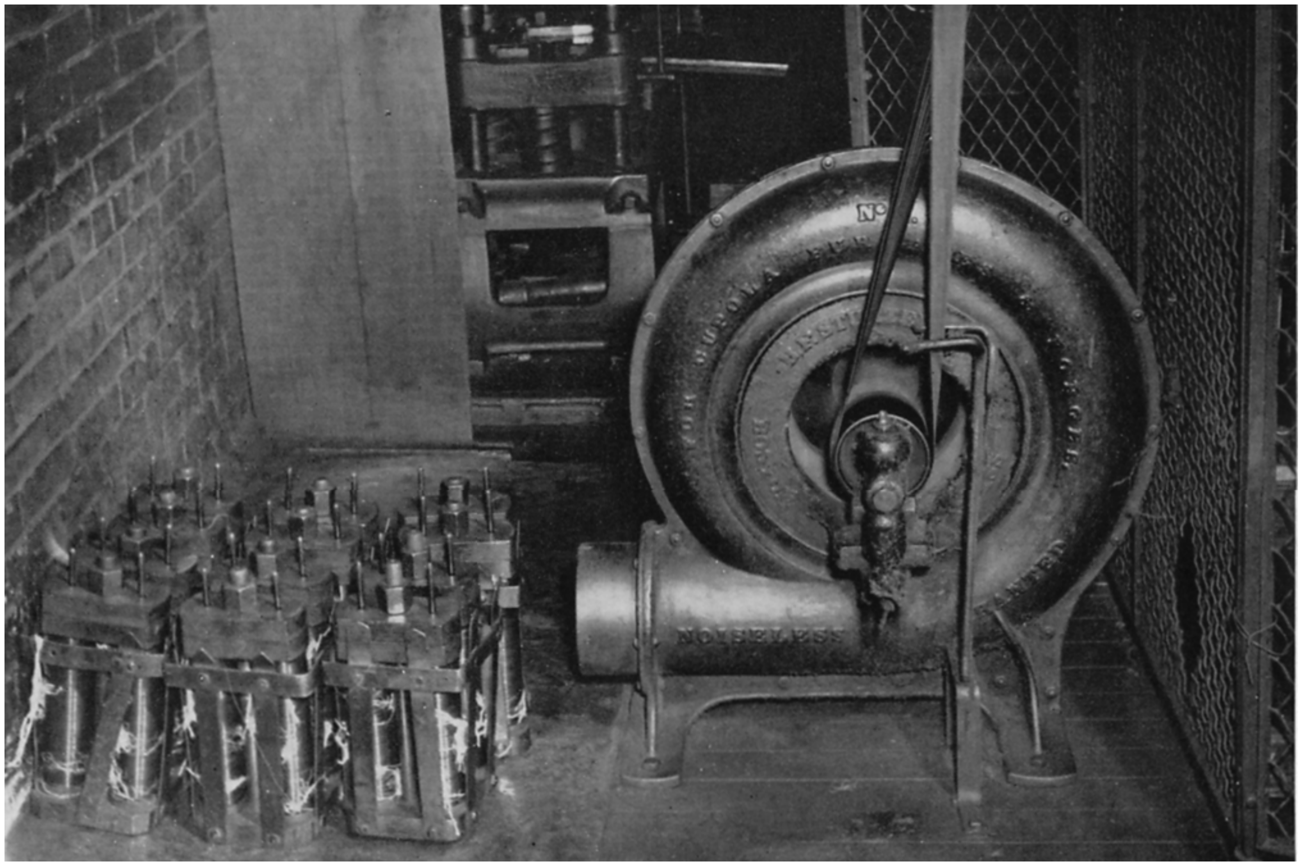
Dropping ends in brass bobbins



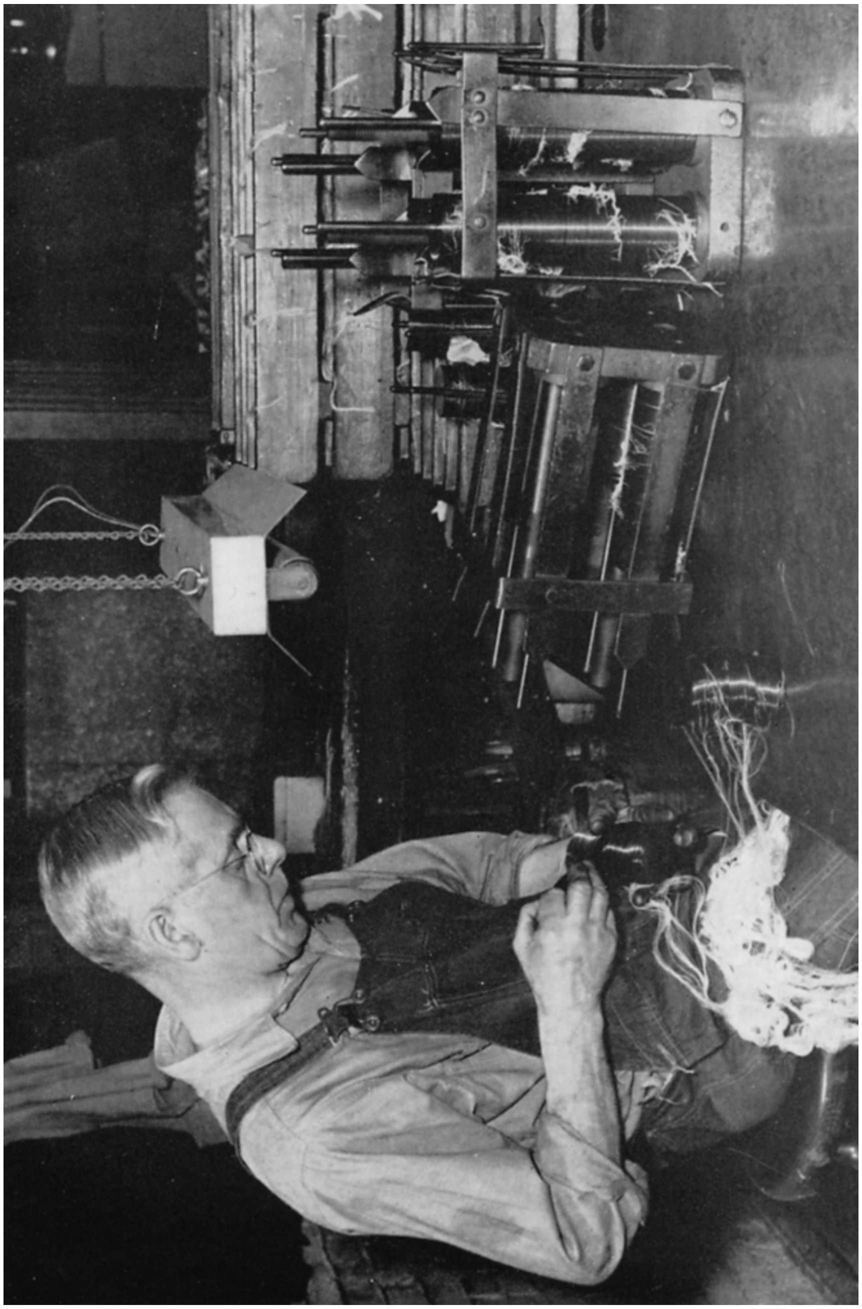
Pressing filled brass bobbins



Steam bobbin oven



Cooling filled brass bobbins after steaming



Inspecting filled brass bobbins

4. Bobbin Pressing

When the bobbins are filled with yarn they expand and need to be pressed flat again before use on the machine. In this operation 2 or 4 stacks of bobbins are placed on steel pins in a metal cage and pressed by power. On the average, the stacks are compressed about 25% and the compression is maintained by a flat metal plate dropped over the steel pins (before pressing) on which a nut is screwed down tight preventing any expansion when the pressure is removed. The pressure applied is sometimes up to 20 tons per square inch. In general, the finer the gauge of the lace machine, the greater the pressure, because finer gauges mean more bobbins per inch in the machine. When new bobbins are being pressed for the first time, the pressure is usually less than one ton and this is gradually increased over a number of pressings until the proper pressure is reached. This procedure is followed in order to eliminate or reduce the number of defective bobbins.

5. Steaming and Cooling

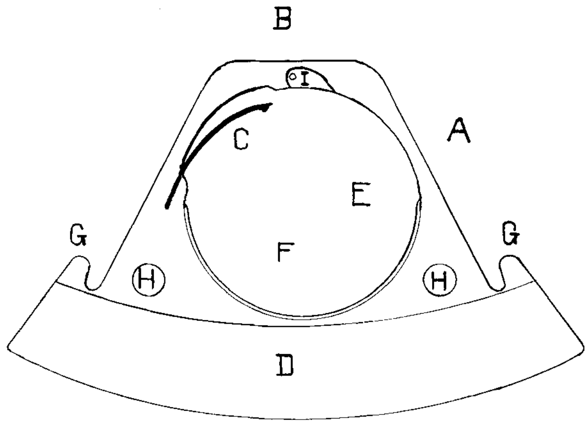
The cages of compressed bobbins are placed in an oven and subjected to live steam (40 to 45 lbs. pressure) for about one hour. They are then cooled by rotating fans or a blower to retain their close formation.

6. Bobbin Inspecting

When removed from the cooled cages, the bobbins are inspected and wide bobbins, due to irregularities of yarn or tension, are removed and sent to be stripped. The other bobbins are then ready to be placed in carriages and threaded.

Carriage

A carriage is a thin steel holder with a base shaped on the arc of a circle, and has a circular hole at the center into which the bobbin is entered. A verge (F), at the bottom of the hole, fits into the groove of the bobbin and serves as a rail, in the course of the revolving which results from the running off of the thread, and a fine spring (C) at the top of the carriage holds the bobbin in position by aid of a knob which enters between the sides of the bobbin and acts as a brake when the thread is withdrawn. At the end of the flat carriage is a nib (G) into which the catch bars, which actuate the carriages, fall. The bottom of the carriage is slightly thinner than the upper part and is known as the blade (D). The blade runs between the combs of the machine.



CARRIAGE

(a) Breast
(b) Hole for bobbin thread
(c) Spring to hold bobbin in place
(d) Blade
(e) Space for bobbin
(f) Verge to hold bobbin
(g) Carriage nibs
(h) Holes to lighten carriage and through which a rod is passed to remove 20 or more carriages from the machine at once
(i) Milled out part to allow bobbin thread to pull out centrally

7. Threading

Threading is done by hand, the bobbin being placed in the opening of the carriage, the verge and spring knob inserted, and by means of a hook fixed into a metal block the thread from the bobbin is drawn through a small hole in the top of the carriage. A good threader will thread 800 to 1,000 bobbins per hour.

When the bobbins are wound they are of the same weight and each contains the same number of yards of yarn. The threads of a score or more carriages are taken in the hand and the carriages thereby lifted are gently shaken. The carriages in which the springs are weak descend lower than those in which they are tight, and the carriages are sorted into groups — tight, medium, and slack — and these are worked as units in different parts of the machine to avoid the streaky effect which would result in the lace if carriages of different tensions were mixed. The operation of the lace machine empties the bobbins of the yarn, and the length withdrawn from each bobbin differs according to the amount of bobbin-fining which is made or according to the number of threads around which the bobbin thread is required to twist. All the bobbins, therefore, are not emptied at the same time, and when they commence to run out in considerable numbers (every bobbin that runs out makes a hole in the lace), it is customary to remove the whole set from the machine. These bobbins are then sent to the stripper to remove the remaining yarn.

Placing bobbins in carriage