Whittaker was a dissipated fellow, and he (James Hood) having expended £500 on the attempt, declined further dealings with him. Whittaker's frame had half the threads drawn from a warp beam and half the threads wound on bobbins mounted in carriages."

On this statement Mr. L. Allsopp, the well-known solicitor of Nottingham, has indorsed, "James Hood knew nothing of either Whittaker's machine or of bobbin net lace." Mr. B. Thompson, in corroboration of Whittaker's claim to having made net by machinery, said that—

"He had made, in conjunction with Whittaker in 1804-5, bobbins and carriages for a machine intended to make lace, and that they were of the same sort and use as those described in John Brown's patent of 1811, and without which that machine could not make lace."

It will be observed that none of these persons speak of a portion of Whittaker's threads being put on a warp except James Hood, who on that point was certainly misinformed, as the following testimony will amply shew.

Whittaker's machinery was shewn to Mr. Sylvester, a competent civil engineer, who thus speaks of its arrangements and powers:

"There was no provision for taking up twist by points, as Whittaker seems to have been fully employed in contriving to effect the twist. No provision was made for shogging by a side movement of the bobbins when in one row, except by lateral contact from pressure on the end ones, thus moving the whole row sideways. This was the probable reason that he only used four or five bobbins, though his comb bar was two feet long and the bobbins four to the inch. He could not effect a crossing to unite the pairs of threads he had twisted together. On his machine that was impossible, and he always spoke of it as the 'desideratum.'"

Mr. Sylvester further stated—

"That having examined the machinery constructed by Morris, Robert Brown, John Moore, E. Whittaker, and Charles Hood, he found that none of them had two distinct set of threads that could traverse, and none of them required bobbins. Whittaker never finished a machine of any kind; his materials when in Charles Hood's hands produced some lace; but it was made without bobbins, was straight down, and therefore without traverse."

Mr. Joseph Harvey, well-known as having accurate knowledge of lace machinery, after inspection of this range of machines, fully coincided in opinion with Mr. Sylvester. Thomas Roper, a setter-up, stated that—

"Whittaker, thinking that Buckinghamshire lace might be imitated by machinery, concocted a plan with B. Thompson, of machine notoriety, for constructing a model; and being supplied by a Nottingham house with money, they so far succeeded as to complete an imperfect model on which they made the twist mesh, but got no further."

Charles Hood, in 1813 and again in 1817, declared—

"That Whittaker had made a kind of machine of wood, tin, and iron. One part consisted of what he called bobbins; they were like a lark whistle, and about three or four to the inch. He tried during a year to make it work but could not. He shewed Charles Hood lace which he said had been made from it, but it could not have been so; no doubt it had been made on a pillow. Whittaker's machine being useless, as one for making bobbin net, he returned to Nottingham."

Charles Hood was the brother of James Hood, and a frame-smith employed by Taylor and Hood. He appears to have been a clear-headed mechanic. When James Hood began to doubt Whittaker's ability to perfect his machinery, Charles Hood inspected it and said that—

"He found there was no beam used, nor any division of threads, nor any means of crossing them; and judging him after a year's unsuccessful efforts unable to devise such a plan, he proposed to James Hood to take the thing out of his hands and begin afresh on a method of his own. Upon this proposal, in 1806, he, his brother, and John Wallis, of Loughborough, set to work to produce a bobbin net machine. At first they used rivetted bobbins and carriages, which were lifted over one another by pullies, the frame being a horizontal one, and thus a twisting process was carried on. They had only one comb bar, which was divided into two parts, each to receive half the bobbins and reverse them alternately; every other bobbin being raised half the height of the carriage, and then some sharp iron pins entered small eyes or holes in the bobbin, by which the lower bobbins were raised to the height of the top bobbins and put into their place; the top bobbins took the place of the lower, by which means the twisting was made. The next time half the number of bobbins, consisting of every alternate two bobbins, the two middle bobbins of every four bobbins, namely, a higher and a lower one, were taken up by the iron pins and changed as before, by which the crossing was made. The above movements were repeated, but the threads only passed through the like course returning to their first position, not traversing beyond it."

In conclusion Charles Hood stated—

"That Heathcoat's was the first traversing machine he ever saw or heard of. In his own attempt he carried up the twist and the crossing a distance of two yards or more, by means of a row of wooden and afterwards of iron pins or points. The machine was still

imperfect, and he never made lace of greater breadth than nine inches and in pieces of two yards in length. Altogether he produced about twenty yards on the two frames which he constructed."

An original outline of this lace is given on Plate III., shewing the machinery. Further proceedings he said were stayed from want of funds. This plan of C. Hood was eventually nearly allied to those of John Moore and others, in its mode of getting the twist and using yarn in lengths of only a few yards, tied at one and weighted at the other extremity. Blackner must be under a mistake when he says, "he had a bobbin and carriage made he believes in 1803, by a person named Hood." Hood nor any one for him speaks of such an invention at that date—a silence, if the fact were so, altogether incredible amidst the discussions then and since carried on.

G. Henson said, "Hood making twist net moved his carriages by hand with long fetchers; he tried to take up twist by spoon ticklers, but he could not traverse the carriages." The mention by Charles Hood in his evidence, of Mr. John Wallis, of Loughborough, led the author to seek an interview with his son, Mr. John Wallis, jun., residing at that time (1846) at New Lenton. He was well known as a very conscientious man, and one who would certainly declare the truth so far as he knew it. He stated that—

"He remembered Whittaker's unsuccessful effort to make bobbin net lace at Loughborough, and had no doubt that he never made lace on his frame. It contained a comb bar, inserted into which were bobbins like the drawing (Plate III.) each placed in a slit in its carriage, and held there by a spring. Every other one of these was lifted over the next and then let down into the vacant space. The others were then caused to do the same. The threads were all fastened at the further end of the machine, and the twist thus obtained was pushed up by the hand. It was after a while evident that Whittaker (who had been in France and professed to have got his ideas of making bobbin lace by machinery there) knew not how to perfect his machine so as ever to make lace upon it, so he was sent away, and Charles Hood was entrusted with the further prosecution of this effort by Taylor, James Hood, and Wallis. In a while he made two machines on which some narrow strips of twist net were made, the first of which was sold to Mrs. A. Brewin, of Loughborough. In this machine there was only one system of threads; there were bobbins on which the brother of John Wallis, jun. used to wind the threads; there was a comb bar and a row of pins upon a cushion to force up the twist. The produce was not a traversed but a straight down twisted net.

"Charles Hood was very dissipated, and would very likely talk at the public-house of what he was doing. If through Bailey or other workmen of Heathcoat's, the latter heard something of Whittaker's bobbin and carriage, while he himself was endeavouring to invent a bobbin net machine, it was not surprising nor unfair. Heathcoat was on rather intimate terms with Wallis, sen.; but the latter often in after years declared the former never put an enquiry, or shewed any anxiety for information as to Hood's proceedings, or referred to his own. He had been four or five years in getting his first patented machine to work; and the only reason they had for supposing he had been assisted in getting so entirely different a one as that described in the second patent, was its appearance in the short space of nine months after the first.

"My father gave up supplying Charles Hood with money. James Hood treated him haughtily, and sent £20 through another hand to Charles Hood, with the message 'that if the lace could not be made as fast and as cheap as warp-lace, it would not do;' on which Wallis stopped the concern. Whether anything could ever have been made of it under the most favourable circumstances, his father could never determine. Some time after, Charles Hood told him that Heathcoat was willing to buy the machines for £5, the price of old materials. He agreed to the sale, and that Charles Hood should have the proceeds."

The following circumstance which occurred during preparations in 1817 for the trial, Heathcoat *v.* Grace, for infringement of Heathcoat's patent, will confirm what has been related in reference to Whittaker's proceedings. Thomas Abell, a Nottingham lace maker, saw one Weston in the Fleet prison, a month before the trial, who told him that he had a model of a machine at home which he had bought from Mr. Taylor, late partner with Mr. James Hood, and for which Mr. Wm. Morley had once offered ten guineas, and he now wished to sell it to either of the parties in the pending suit. This was communicated to Mr. Boden, Mr. Heathcoat's partner, and the model was sent for from Nottingham. Messrs. Abell, Boden, and Farey inspected it, and the bobbins sent with it. Weston said he had had it in his possession about five years. Taylor being in the rules of the Fleet was sent for, and stated "that the model was a similar one to that originally made by Whittaker for Hood and Taylor, but abandoned after a considerable outlay Charles Hood stating that it never could make lace and was useless, which opinion was indorsed by the judgment of several others from Nottingham. The model before them was made in 1811-12,

after Taylor's partnership with Hood had expired. Not being a mechanic, he could not say if lace could be made on it, but a coarse kind of lace had been made on it by *hand*." On Abell's telling Weston that this model being made after Heathcoat's patent had been taken out would be of no use in the cause, Taylor said "it was a pity they had not said it was made before, and they could make it a few years older, if material." Messrs. Boden and Farey corroborated this account of the interview, and Farey repeated the opinion he had expressed in 1815, that Taylor himself understood nothing of the capacity of Whittaker's machinery to make lace.

In the *History and Topography of Nottingham*, p. 84, the following passage occurs in relation to the efforts of inventors in that place about the beginning of the present century:

"Certain clever mechanics were exerting their ingenuity in an endeavour to improve the manufactures of fine lace, amongst whom Messrs. Lindley and Whittaker were very conspicuous. Whittaker was a shrewd man and had made many improvements in lace machines, but did not produce any very striking result; nor indeed were the experiments of Mr. Lindley much more successful, although he claims the merit of being the inventor of bobbins and carriages. The labours of both these gentlemen were however eclipsed by the efforts of Mr. Heathcoat, who produced a machine to work by using many of the bobbins and carriages, for which he obtained a patent in 1809. Upon this it was insinuated by certain individuals (perhaps envious ones) that Mr. Heathcoat had borrowed the inventions from Messrs. Lindley and Whittaker, and that instead of being the projector of the machine, he had merely embodied the ideas he had stolen from others. The credit of the invention is now however pretty generally allowed to Mr. Heathcoat, whose machine they called the 'Old Loughborough.'"

In addition to Lindley, Whittaker, and Hood, there were, it is said, twelve or thirteen other mechanics who spent several years partly or wholly in pursuit of a solution of the problem of forming mechanically a twisted and traversed web of lace. Several of these persons were men distinguished above the rest for their ingenuity and misfortunes. Two of them, Simpson and Green, died of disease of the brain brought on by unremitting and unrequited study. None of them could employ a bobbin and carriage so as to make the real net lace. So difficult is this that there is probably

no more instructive lesson in mechanics than to make the experiment, and then compare its results with the mode in which this was at last accomplished. So great was the mystery and such the number of abortive attempts which had been made during forty years to penetrate it, that the projectors were commonly ranked amongst enthusiasts seeking to obtain perpetual motion.

It was during the latter part of this series of efforts, that John Heathcoat entered upon and accomplished the task which had baffled so many other clever men. This successful mechanician therefore occupies a most important position in the manufacture of lace by machinery. Standing midway between the crowd of able men who, as inventors, preceded him about the close of the last and opening of the present century, and that numerous body of clever and useful mechanicians who have followed him down to the present time,—his invention restored and strengthened the foundations of the lace trade of Nottingham, decaying through the falling away of the manufacture of point net—and thus, by the substitution of bobbin net machinery, developing its productive powers, dispensing benefits to the neighbouring traders and work people, and by its rapid increase becoming an important branch of national industry.

CHAPTER XIV.

THE TRAVERSE BOBBIN NET MACHINE.—MR. JOHN HEATHCOAT.

Mr. Heathcoat was the son of Francis and Elizabeth Heathcoat. His mother's maiden name was Burton. His parents, it has been recently ascertained, were living at Duffield, near Derby, at the time of his birth, which took place on the 7th August, 1783. He had an elder brother Thomas, who was for many years before his death a large manufacturer of bobbin net at Barnstaple; and a sister, Anne, who was married to Mr. Thomas Hallam, in after life the director of Mr. Heathcoat's bobbin net manufactory at Paris and St. Quentin.

Mr. Heathcoat, sen., was a respectable small farmer of chiefly grazing land at Duffield. Mrs. Heathcoat was a managing housewife, of an affectionate disposition, and much beloved by her husband and children. Both were always esteemed for their real worth and amiable demeanour by their friends and neighbours. Soon after the birth of their youngest son, Mr. Heathcoat, sen. was stricken with total and permanent blindness. This great calamity disabled him from giving active personal attention to the business of his farm, which he therefore ceased to occupy, and removed about 1790 with his family to Long Whatton, near Loughborough—a circumstance which has given rise to the statement that his son John was born at the latter village. Throughout the remainder of his life, the latter part of which was passed in easy circumstances at Loughborough and prolonged to an advanced age, Mr. Heathcoat, sen. maintained much equanimity and cheerfulness of mind and temper, with pious submission under his afflicting deprivation. In this he was aided by the constant assiduity and loving care of his wife, shewn in her endeavours to alleviate his loss. He embarked some

Engraved by Wm. H. Hall

John Heathcoat

money in the purchase of warp machinery, then employed in that district to some extent in the manufacture of woollen hosiery pieces. For the use of these frames the master stocking-makers paid a considerable rent to the owners, so that the sum derived from them was often a fair portion of the income of a family in moderate circumstances.

Their children received as good an education as a village school usually afforded at that time. John was taught at one of the neighbouring places, it is not quite certain which, but from the circumstance that he was remembered to have been seen when a youth proceeding towards Hathern daily with his satchel, or returning from that side, it is probable that he acquired the rudiments of knowledge there. Wherever taught, it is related on good authority that his quickness in learning greatly surprised his master. Scarcely was the task in arithmetic or grammar given, than the correct solution and answer was returned. He was also distinguished for his thoughtful intelligence and quiet manner. He began to read as opportunity offered, and having few companions either to hinder or assist, he studied hard, acquiring and storing facts in history and science—afterwards to be used by him with surprising accuracy. His earliest letters and correct habit of speaking shewed his accurate knowledge of English grammar and composition.

It is stated by one of his relatives that Mr. Heathcoat was apprenticed to a Mr. Swift to learn the hosiery manufacture, but that the place not being found eligible for his son, Mr. Heathcoat, sen. by payment of a sum of money obtained the cancelment of his indentures.

Several other accounts agree that he was apprenticed to Mr. William Shepherd, a maker of Derby ribbed stockings and frame-smith then living at Long Whatton, and who became afterwards connected by marriage with Mr. Thomas Heathcoat. This second apprenticeship was no doubt entered upon immediately after the first was set aside. Some have supposed he was an apprentice to Mr. Samuel Caldwell, of Hathern. This is an error, as their connection began during his sojourn at Nottingham.

It is certain that Heathcoat learnt to handle tools with dexterity at an unusually early age, and acquired an exact knowledge of the stocking-frame and the more intricate warp loom. It is even asserted, by one who had his confidence, that he had at sixteen conceived the thought of inventing a machine to make lace. Of this, more will be said in its place from his own lips long after that idea was realized. Writing on the subject he says, "I was working for my bread; I tried to invent;" and during his apprenticeship he succeeded in improving some part of the warp frame. There is also no question but that Mr. Heathcoat early felt the necessity for self-help and self-culture, and set his whole faculties to work accordingly. It is evident that when but a youth, he thoughtfully weighed and cheerfully accepted the responsibilities attendant on his station in life, and prepared to meet them. He ever felt the necessity of reliance on himself; and thus, a few years afterwards, when appealing to the equitable judgment of the Lord Chancellor for protection against infringers on his patent, he says, "I had originally no property, and have risen entirely by my own ingenuity and industry."

It was during the latter years of his apprenticeship that the young inventor's duties required his frequent visits to Kegworth. At that large village there was a schoolmaster named Wootton, who taught for years many boys living in and near the place. In his school the author received valuable instruction, for which he reveres his excellent master's memory. Through various circumstances the schoolmaster and Mr. Heathcoat became acquainted by their intercourse with mutual friends. Thus far is known. Whether any closer intimacy sprung up is not certain; but from some characteristics common to them both that is probable. The schoolmaster was self-taught having learnt his alphabet from the gravestones in the churchyard, and was never at school for a day; yet he became an excellent English scholar, an algebraist, a land surveyor, an astronomer, and a mechanician; and was a noble-hearted man. He would not destroy the life of an insect or of a worm; therefore ate no animal food, and his drink was water. But it was an orrery of his own construction that was the admira-

tion of his pupils and neighbours. It never occurred to the author in after years to ask Mr. Heathcoat as to the extent of their communications with each other; but in the quiet unpretending science and mechanical skill, the high principle and kindly disposition of Wootton, there seemed answering traits and sympathies in Heathcoat that appeared near akin, and might, if developed by friendly intercourse, have assisted to strengthen the higher thoughts and incentives in the struggle of life, which animated the young aspirant after mechanical success and reward.

While all the other persons described as applying themselves to lace inventions, appear to have had one or two partners in the prosecution of their experiments, Heathcoat, from the time he entered upon this career, seems to have planned and executed his schemes alone, having neither counsellor nor co-worker in them. His first step on the conclusion of his apprenticeship was to seek work at Nottingham as a framesmith and setter-up of machines. There the most difficult and best paid work was constantly on hand, and consequently, he would find himself among those mechanics in the hosiery and lace trades who were of the highest skill and reputation in both businesses. He entered into the employment of Leonard Elliott, a man of superior skill and well known in the trade, whose shop was situated between Broad Street and Beck Lane, and continued to work with him for some time as a journeyman. At first he received 25*s.* weekly earnings; but in a few weeks he was found worth and received three guineas a-week. Mr. John Farmer, of Nottingham, then himself a working framesmith, recollects often seeing Mr. Heathcoat at work wearing his white apron in this shop. There he could not help daily hearing more or less talk, acquainting him with the sanguine hopes of the local mechanics in regard to lace machinery being made to imitate real pillow productions. Elliott related to the author, in 1849, that "Heathcoat had been brought up chiefly in setting up coarse hosiery frames of each kind. He was himself mostly employed in setting up fine warp frames. Heathcoat had obtained a thorough practical knowledge of mechanical powers and contrivances;

was inventive, persevering, undaunted by difficulty or mistakes, and consequent temporary want of success; patient, self-denying, and very taciturn. But he had surprising confidence, that by right application of mechanical principles to the construction of even a bobbin net machine, his efforts would be crowned eventually with success." To this object he gave unremitting attention during every hour of leisure that he could command. After a short continuance in the service of Elliott, he purchased from him the tools and goodwill of the business, and carried it on upon his own account. While Heathcoat was thus engaged in the occupation of making new and repairing other stocking and warp looms, he won the approbation and respect of those who gave him employment, by his talent for invention, general intelligence, and the sound and sober principles that governed his conduct. He thus obtained the highest remuneration that the business of setter-up would at that time allow. By these means he appears also to have obtained the confidence and respect of intelligent and observant artizans around him, while he was realizing funds to enable him to prosecute the experiments he had now entered upon.

It was during this period, and soon after Mr. Heathcoat had attained the age of twenty-one, that he became acquainted with, and married, Ann, the daughter of Mr. William Caldwell, of Hathern. She was a widow, and somewhat older than himself. They resided while at Nottingham, in a house on the Long Stairs, since taken down. Mrs. Heathcoat was an active, thoughtful, and clear-minded woman, and always shewed great simplicity of mind and taste. She was a notable manager and an excellent wife and mother: doing honour to her husband's choice in the guidance through very varied circumstances of her family and household. There never appeared in her any wish to forget her former station, or the early labours and trials of her life. On the contrary, upon suitable occasions, she would refer to them with becoming expressions of gratitude; and being endowed with much practical good sense, adapted herself without difficulty to the growing elevation of her position in society.

The Mr. William Caldwell, just named, was originally a Derby-ribbed stocking-weaver, but he became an excellent framesmith and a setter-up of some note at Hathern. Mr. Heathcoat's marriage with his daughter and connexion in a mechanical patent with his son, Samuel Caldwell, had some beneficial influence in his rapid progress as a mechanician, and probably led him to give up the promising business in which he had so recently embarked, and his residence in Nottingham. He had now fully determined to enter upon the course of invention on which his thoughts had so long dwelt, and although proximity to the skill existing in Nottingham might have its advantages, yet to depend on his own at some distance, would be more safe in the process of completing his contemplated invention. He therefore decided to remove for a time to Hathern, to which step he was also moved by the following circumstance.

For some years the wife of one Thomas Hancock, a journeyman to Caldwell, being a Northamptonshire woman, knowing how to make lace upon the cushion, and having the bobbins and parchments used by her in that kind of hand labour, employed herself in making lace. Heathcoat saw her at work from time to time, and acquainted himself fully with the manner of proceeding in this beautiful but intricate art. The knowledge thus acquired he was not slow in putting to use, as we shall see in his own account of the progress of his two next and most important inventions.

It has been already mentioned that Mr. Heathcoat's first improvement in machinery was patented by "Samuel Caldwell, of Hathern, Leicestershire, framesmith, and John Heathcoat, late of Nottingham, now of Hathern, frame setter-up." The patent was taken out in 1804, No. 2788, and was "for a new apparatus to be attached to warp frames, whereby all kinds of thread lace and mitts of a lacy description may be made." Several improvements were set forth in it:—

First, to place layers of flannel on the warp beam at intervals while filling it, and so to keep it soft and preserve the elasticity of the thread. Second, to make the needles more square at the hook heads, and so to admit the passage of knots in the thread without

breaking it. But principally, third, by putting on an extra guide bar and breaking out guides at intervals, and employing there the separate guides; where breadths required dividing, a lacing thread was worked in, which only required to be withdrawn, and a clear and neat pearl selvage was left on each of the edges of the breadths. For accomplishing this, a division presser, and an instrument called from its use a preventer, were added to the warp frame. In work there was a common course made and then a lapping course, usually followed by a connection course and another lapping course. According to the intended mesh there were two or three lapping courses made.

The contemplated results were found to have been anticipated by a previous invention, of which they had not heard.

In 1805, Caldwell took out a patent, No. 2879, in his own name only for a machine to be added to stocking and other plain frames. Immediately before the date of the former joint patent, Mr. Heathcoat had removed his residence to Hathern. Either on his father's account or his own he became connected with Mr. Jelbert, an attorney at Kegworth, in some warp machinery, and for a time was often at the latter place. The untimely death of this gentleman put an end to that business. Jelbert did not advance funds towards prosecuting the experiments for making a twist machine. These occupied a period of about three years, commencing 1805, for in that year one John Bailey, a frame-smith, conversant with the warp machine states, he entered Mr. Heathcoat's service as a setter-up of warp frames, and became an inmate of his family, then transferred to Loughborough.

This Bailey gave, in 1813, a clear written statement of some important circumstances which transpired under his own eye. This possesses considerable interest in tracing the course of the inventions contained in the two first bobbin net patents. It appears that Bailey first met Edward Whittaker, to whom considerable reference has already been made, at Charles Hood's, both living at Loughborough in 1805, and Hood was then in business as a frame-smith there, but not acquainted with Heathcoat. Hood informed Bailey in 1808 that Whittaker had endeavoured to make a lace machine, but after several trials could not succeed, which had induced him to advise Taylor and Hood to give Whittaker up. On Bailey informing him of this attempt of Whittaker's,

Heathcoat shewed Bailey lace that he had already made upon his own first frame. Parts of this machine the workmen had seen, and knew they were not belonging to their warp machinery, but on seeing, in January, 1808, the completed machine which their employer first patented, the mystery was cleared up. Heathcoat had sometimes expressed wonder if ever Buckinghamshire lace would be produced by machinery, and Bailey thought it impossible, as warp machines on which they were then engaged required twenty threads to an inch, whereas pillow lace must have double that number, besides allowing the necessary space for twisting the threads.

Till 1808, Bailey had not seen the machine, only the lace from the model. Now he was taken from warp frames and set to work on the new inventions for the second patent frame, and made many parts of them. The first patent frame made narrow breadths and required great width for the expansion of the threads. The construction of the second for wide nets was attended by great difficulties, as the machines differ altogether, except in the points and work-beam. When he began to assist, Heathcoat had laid aside the first machine and begun the second.

Charles Hood had continued his attempts to construct a twist net machine for two or three years; but it was Bailey's conviction, that during that time no communication had passed between him and Heathcoat. But when the latter had joined Lacey in 1808, then Hood entered into their employ as a frame-smith.

After this, by Heathcoat's desire, Bailey and one Johnson (since dead) inspected Whittaker's machinery, consisting of some bobbins and two bars, which they were of opinion could not have produced lace of any sort. Charles Hood then shewed them a machine, said to be of his own construction, and the one on which a piece of lace previously shewn had been made. There had been only one set of threads used, which were longitudinal, and in passing each other they were merely twisted once; so that being made only of threads travelling straight down, if one were withdrawn, the net would divide; it could not possibly traverse. Charles Hood at first used bobbins; but when Bailey

saw it, he was using small bits of tin to which the threads were tied, which plan he said he preferred.

In January, 1808, when Bailey saw the first patented machine, there was a skeleton model of the second, including the comb-bars, but no bobbins. From the construction of the parts, Heathcoat must have intended to use bobbins.

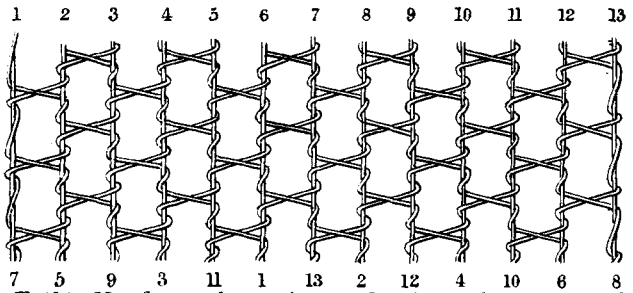
Heathcoat bought Charles Hood's tools after the bobbins for the second patent frame had been provided; and Bailey had no reason to believe that he had any knowledge of either Whittaker or Hood's bobbins to help him to construct his machine. There was no such alteration in it as to indicate that he had benefitted by seeing it in the construction of his own. Charles Hood told Bailey he received 30*s.* for Whittaker's portion, and £5 for his own. These sums were their value as old materials. Both Hood and Bailey stated, that Heathcoat never showed any anxiety to possess Whittaker or Hood's machinery; but they asserted that Hood's necessities were the sole cause of their being offered to, and so far as they knew, of their being purchased by him. He did not hesitate to express his regret in after years that he had bought them, as it proved a needless complication of the question, which arose in regard to his second bobbin net patent.

The various operations of the workers in hand lace have been described in a former chapter.

This process of making lace on the pillow is a very slow one; on an average about five meshes in a minute can be produced, where the usual number of twists are given. This may easily be conceived, by noticing that every cross and each twisting of two threads and the shifting of each pin are so many distinct movements of the hands. It is evident, therefore, that a machine having the means of acting upon every pair of threads throughout the breadth of lace desired to be made, for the purpose of crossing and twisting, and also to give motion to the pins to be successively placed in the new meshes throughout this entire breadth, would greatly increase the speed and facilitate the production of such lace.

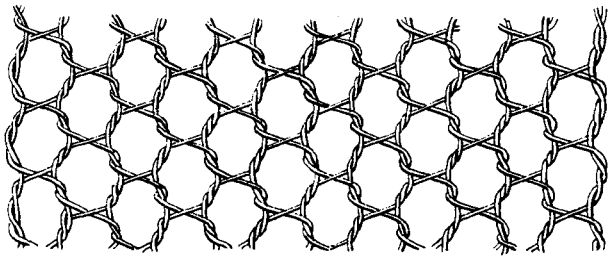
On examining cushion-made lace, half the threads

Fig. 1



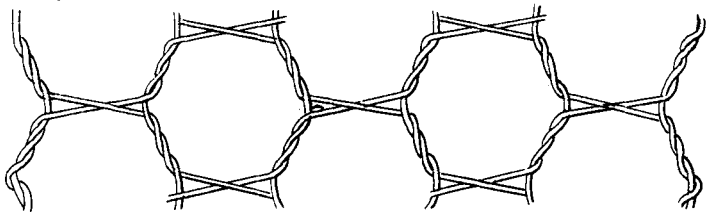
Two Twist Bobbin Net when making, shewing the diagonal traversing of bobbin or weft threads.

Fig. 2



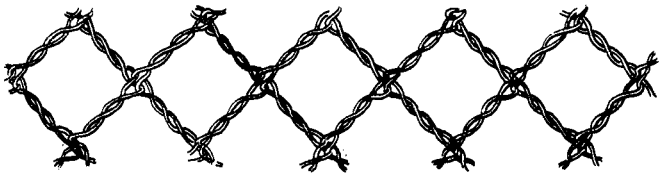
Two Twist Bobbin Net when taken off the Machine.

Fig. 3



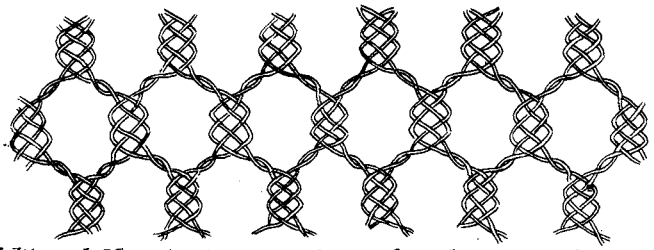
Three Twist untraversed called when traversed Brussels Net.

Fig. 4



Four Twist untraversed called Square Net, it is not crossed but platted at the corner of mesh.

Fig. 5



Called Platted Net. - having platted four thread pillars and four sides each of two theads twisted, but not traversed.

W. Metcalfe. Lithe Cambridge

are found to proceed in wavy lines from end to end of the piece, which may be called *warp* threads. The other threads lying between the former pass from side to side by an oblique course to the right and left, and may be called *weft* threads. The inventor of the machine to produce the same results, considered that if he could place the warp-threads in it under such circumstances as that they should be all capable of moving either absolutely, or relatively with regard to the other threads, so as to concur in effecting the twisting and separation or crossing before described, but without deviating otherwise either to the left or the right; and that if he could also place the weft-threads so that they should effect the twisting by similar motions at the same time, that half these weft-threads should proceed at each operation to the left, and the other half to the right-hand (a substitute being also found for the pins), he would make lace exactly as it is done on the cushion, but with many advantages as to speed and cost.

Heathcoat's first plan, patented in 1808, No. 3151, effected this for the first time by machinery, so far as *traversed* bobbin net is in question. It was accomplished upon a machine whose parts and operations may be thus described: There were two beams, the one placed under the other in the same perpendicular line. Also threads divided into two sets, one of which was intended to work longitudinally, the other diagonally. The longitudinal set were wound upon the lower beam and were passed to the upper beam to which they were separately attached, and on which the work was wound up. The diagonal threads were wound upon bobbins resembling in the part occupied by the thread those used in making lace by hand. These bobbins were so arranged between the beams, that their threads proceeded collaterally with the longitudinal threads to the upper beam, and were inserted in the same points on the beam. Each of the longitudinal threads on its way to the upper beam passed through a conical tube, at the lower end of which was a small pinion. The upper part of the tube divided into two parts, cut in the direction of its length; one part contained the pinion at one end of it, and the longitudinal thread which passed through its hollow parts. The other section contained the bobbin on which the diagonal thread was wound. When the two sections were put together, the whole consisted of a conical tube having a pinion at its lower extremity, and containing a longitudinal and a diagonal thread. The number of these tubes was equal to the number of each kind of thread. Their arrangement was such that all the pinions lay in the circumference of a circle, while the centres of the other ends of the tubes pointed to its centre. All the pinions could be moved round at once by rack work, the teeth of which cor-

responded with the pinions. This motion was to cause each pair of threads contained in each tube to twist at the same time. The crossing of the diagonal threads as observed in the process by hand, was performed in the whole breadth at once as follows:—that part of the tube which contained the diagonal threads would be removed from the rest, and the whole of these parts would be lifted up together; while they were in this position, one half of them were caused to move one place to the right and the other one place to the left; and as each section of one would fit any of the others, when the lifted parts were let down again, each tube would have changed its diagonal thread, which would effect the crossing of these threads throughout. The pins by which the uniformity of the meshes was preserved, were all placed upon a moveable bar, and could all be inserted at once. Thus the crossings were first made by one motion, which interchanged the bobbins containing the diagonal threads.

The twisting was next performed by the revolution of the tubes containing the two threads to be twisted. The pins were then all shifted at once to regulate the new meshes formed by the crossing and twisting. As a whole, this was undoubtedly an entirely new compound instrument.

This machine was calculated to make one such breadth of lace as is usually made on the cushion (which seldom exceeds three inches) and with all the expedition possible. In order to obtain pieces of cushion lace of greater breadth, the narrow pieces would be joined together by the needle. It was desirable therefore to devise the means whereby pieces of the full breadth required might be made, and so avoid the expence and unsightly effect of joinings. Upon the completion and setting fairly to work next year, 1809, of Heathcoat's second patented bobbin traverse machine, the first was at once disused; and except in the specification and drawings, no means remain of obtaining a competent idea of what it was like, as Mr. Heathcoat did not preserve one at Tiverton—a singular oversight now much to be regretted. To supply the means of forming a general idea of its construction, a drawing of this machine is given in Plate V.

In regard to various important discoveries and inventions in other departments of business, there has been reason to regret that little or no authentic information has been forthcoming of their origin, and the early steps taken to bring them into practical operation. The following papers written down at the times and under the circumstances stated, will therefore be read with interest; Mr. Heathcoat having been requested, without

previous notice or premeditation in either instance, to narrate the facts:

"Some particulars of the invention of the bobbin net machines, patented, No. 3151 in 1808, and No. 3216 in 1809 by John Heathcoat, esq., as stated by him, 18th June, 1836, to Mr. T. R. Sewell and Mr. William Felkin. (Taken down in short hand by the latter while Mr. Heathcoat was speaking.)

"When I was a boy at Long Whatton, in Leicestershire, with my mother, a girl used to come in to see her, whose cousin had been employed at the factory of one Dawson, in London, whom she described as having made a fortune by making lace upon machinery. On one of these calls this girl turned round to me and said, jocularly, 'Why can't you do so too, John?' This fixed my attention so much, that although it occurred forty years ago, it returns to my recollection even now. I do not mean to attach too great importance to this incident, yet no doubt it had an influence in the direction of my thoughts and energies at a future period of life. Point net was then made, and the lace trade excited some interest. About the time I grew up towards manhood, warp piece goods (not lace) were also beginning to be made. I worked for my bread, and I tried to invent. I did so by finding out a different mode of carrying the thread in the warp machine to what was in ordinary use, viz. passing the thread over the needles on which the loops had been formed immediately above the threads, and also over the next needle, so as to form a kind of lace. But I soon learnt that this had been discovered before, though I had then no knowledge of it. The first warp machines were making 'Berlin,' and the person with whom I then worked altered one to make 'mitts' of a lacy appearance, and approaching the lace fabric. A man about that time made four and six course warp. For a time it was supposed by many that the difference between pillow and machine lace was solely in the material used; but every body soon knew that they were unlike in some other respects, and it was ascertained that the texture was different. I set to work to inform myself in what the peculiarity in the texture of pillow lace consisted, and for this purpose obtained a sight of the process of making it. A pretty heap of chaotic materials I found it! Like peas in a frying-pan dancing about. After watching the progress of the workwoman and minutely examining the lace, I found much difficulty from the circumstance that a thread which had been carried for a time lengthwise, sometimes became a traversing one, and *vice versâ*. It was impossible under the natural supposition that this was a part of the system, and not as it really was, an irregularity, for me at first to trace the course of the threads so as to understand their ordinary and regular progress. At length I made out that one part were passed to the right-hand, another to the left, and a third seemed to be independent of them, never deviating in their course, but always passing straight through the length of the piece. This part of the threads I saw might be put on a beam for a warp; and it was this discovery that simplified my subsequent progress in attempting to mechanize the processes of the pillow.

"In my *first* attempt mechanically to make bobbin lace, the bobbins were arranged in a fan-like order on pinions, and thus

radiating they were made to twist round each other, and a row of pins forced up the crossing to close the mesh. These pins were fixed on a bar, but they spread out and contracted; lying between guides, they expanded on receding, and contracted when brought in contact with the work forcing up the twist and the crossing, until the meshes became of the right size and shape. By this arrangement and process, only very narrow strips could be made. However I constructed a machine to produce three such pieces at a time. Lord Lyndhurst, then Serjeant Copley, always said that this machine was far the most ingenious of any upon which lace was ever made.

"The value of lace is however so much enhanced by its being made of greater width, that I was determined to make it even a yard wide. At this time I had arrived at the important point, that having actually made lace as above described, I had satisfied myself my principles were sound and well based. But I now clearly found out that while half the threads must be active, the other half might be passive, and I therefore put the latter on a beam. Having thus fixed the warp, to accomplish my wish for making wider lace, I tried to bring the threads to twist in a narrower compass. I first tried a machine with the bobbins spread out; then I tried the *flat* bobbin. The first flat bobbin machine was a *single tier*. I carried up the threads by means of a steeple top on the carriage. Great difficulty was experienced in getting bobbins and carriages thin enough, the space in which they were to move being so limited. At last, I was driven to the *double tier*, and thus obtained the requisite space.

"All that I knew of previous attempts, and all that I now believe had ever been previously done, was this. Moore had by mechanical means and arrangements obtained a twist on both sides, by carrying threads over each other and then back again. I did not then know of this plan, it came to my knowledge afterwards. Whittaker made a machine in which were eight or ten threads to an inch, (and as he said) producing an article having wavy lines like blonde in effect and made entirely by the use of bobbins; but the implication in Ure's statement, that Whittaker had made thin bobbins to gain the space necessary for them to pass, is not true. His comb bar was like the jack bar of a stocking-frame, and in several respects the machine presented impossibilities for making lace. In some cases ten times too much thread would have been given off from the bobbins.

"Charles Hood's tools having been offered me for purchase, and himself desiring work as a smith, I bought them of him. On looking over these tools I found amongst them a bar resembling the jack bar of a stocking-frame. He told me that Whittaker had shown him a bit of lace said to have been made upon a machine, but which Hood stated he had ascertained was not, but was most probably made by hand. Hood asserted that lace had never been made upon Whittaker's machine, and I saw that it never could. Hood tried however to modify the machine, hoping to accomplish this end. He laid aside the bobbins, and used plates of iron to which the threads were tied; and by alternate movements he made lace; but it was like Moore's lace, it had no *traverse*. The lace was made on a horizontal plane, at one end he carried up his twist by bits of wood, which passed between the threads and drove up a twist and the crossing at the same time perhaps the space of two yards. These attempts of Whittaker and Hood were decidedly the only things of which I knew before my

patent, in which there was any approach towards making *twist* or bobbin net lace. The one had tried to make it all by bobbins, but never did nor ever could by his machine thus make it; the other made lace, but not bobbin net lace. But before then, nor to this day, have I ever heard of any one besides myself, who had entertained the idea of separating the threads, placing part in a *warp*, and using the remainder in *bobbins*, and thus making lace.

"The stocking-frame has certain parts used in my bobbin net machine; the point net frame, the warp machine, the Vaucanson loom, even the old weaving loom, and many others, have all one or more of those mechanical principles or arrangements used in my machine. I do not claim the invention of a bobbin itself; but I had great difficulties to surmount in getting one thin enough. The foundation of my invention was in getting rid of half the threads by the warp beam; but then came the enquiry how the rest were to be got to twist in the proper space. Were this now to be done, my impression is that so great was the difficulty, I should not attempt its accomplishment.

"I admit the merits of other men. Brown's with his shuttle for the fishing net machine, or Whittaker's for his bobbin. Brown's machine I never saw; his specification I had a knowledge of. I had also a knowledge of certain parts of Whittaker's. I allow them the credit of their materials; I took up their crude materials, and I claim all that is intermediate between these materials and the bobbin net machine. My claim will be allowed I am persuaded by the suffrage of every man competent to form a judgment of mechanical inventions. Is it just to deprive me of all claim to invention in this matter, while it is accorded to each of those who have followed me in respect of their modifications? For there is not any new principle involved in any of their arrangements; they have all worked upon my principles of dividing warp and bobbin threads, twisting, and crossing; and the machine, however modified, is still the same as my 'Old Loughborough' in every essential principle. I allow them credit for the application of great and very useful ingenuity; but they have only *modified* the machine, not *invented* it. I illustrate the case thus:—A child in his first successful effort to walk across a room does all in fact that a man does—neither so safely, so rapidly, or so well; but every element of locomotive power is there, and every muscle is in action; he walks as truly as a man."

These concluding observations were made by Mr. Heathcoat in consequence of a reference made that forenoon to Dr. Ure's statements in his *History of the Cotton Manufactures*, vol. II. pp. 342, &c., the substance of which has been given at p. 160, in describing Robert Brown's patent. And also because Ure speaks of Morley, Levers, John Brown, Sewell, and others, as 'Inventors,' in regard to the altered and for the most part improved machines known by their names, but has withheld that title in regard to Heathcoat, although he had allowed that:

"To him belongs the distinguished honour of solving the very difficult problem, and of practically demonstrating that a machine might be made to satisfy the wants and wishes of the trade. His first operative scheme was the result of many troublesome trials, which would have baffled a man of ordinary talent and enterprize. At length, in 1809, he had so far matured his plans as to warrant his securing their exclusive use by a patent famous for its pecuniary productions, and for its being the fruitful parent of many mechanical constructions eminently subservient to the trade and commerce of the kingdom."

Mr. Heathcoat and Mr. Sewell afterwards examined Brown's fishing net patent together at the Petty Bag Office, on the morning of this conversation, the author being with them; and Mr. Sewell on his return to Nottingham remarked to the latter, on the subject of Dr. Ure's and Mr. Heathcoat's statements—

"That if a machine to make nets by the use of bobbins be a 'bobbin net machine,' Robert Brown's may be called one; but that it possesses nothing whatever to entitle it to be called a 'bobbin net *lace* machine,' or a '*twist* machine.' With the exception of a thin bobbin inserted into a slit made in a piece of iron to receive it, it does not possess any of the essential principles or arrangements of the bobbin net or *twist lace* machine, which Mr. Heathcoat claims to have invented; and the introduction of which lies at the foundation of what is called the 'bobbin net lace trade.' The twisting of the threads is nowhere described in Robert Brown's specification; nor is the machine, as specified by him, calculated to accomplish this purpose."

In the year 1844, being on a visit to Mr. Heathcoat in London, and having some reason to fear the former statement, made in 1836, which was mislaid might be really lost, he was requested to give the opportunity for the facts to be secured, by stating them afresh to me. As he spoke they were written down; not only is the statement corroborative, it also gives supplementary matter of considerable interest. It is therefore copied from the original MS.:

"Amongst the earliest things which engaged my attention in regard to lace, was to ascertain its composition by obtaining a piece of *pillow* lace. I drew a thread, which happened to draw for an inch or two longitudinally straight, then started off diagonally. The next drew out straight. Then others drew out in various directions. Out of four threads concurring to make a mesh, two passed one way, the third another, the fourth another still. But at length I found they were in fact used in an orderly manner. This process was to answer the question in my own mind, Can this be made mechanically?

"I then saw a woman working on a pillow with so many bobbins that it seemed altogether a maze. However I at length perceived, that after certain twisting of two for instance one round the other, and then other two the one round the other, then one of each of

these pairs was selected, and they were then made to change places forming a cross, which cross was taken up by a pin, the pin being secured by a hole in the parchment placed to receive it. The twisting was then resumed between the changed and the unchanged bobbin in regard to each of the two pairs of thread. By this process there would be formed the last half of one mesh, and the crossing between that and the next, and the first half of the succeeding mesh. Now that which at first appeared to be an unmanageable and complicated mass of dependent bobbins, by process of observation resolved themselves into two great classes; those, namely, which by the workwoman were twisted with the others, yet always retained their position to them relatively in a longitudinal direction; and those which having been used in the process of twisting round the former, travelled the one part to the right, the other to the left, in the case of the formation of the crosses, constituting the top and bottom of the meshes. The result of this observation was to make this impression on my mind, that although for the making of lace on a pillow, this great division into two parts of the threads and bobbins might not be useful, yet if ever lace were made on a machine, it was quite possible to take the one half out of the dependent and mixed up condition I saw them in on the pillow, and place them upon a beam, making the twist solely by the rotation of the other threads in the passing them round these thus placed. Having got to this point, I took pack-thread and put upon a sort of frame, so as to be fixtures, that portion which I saw were to perform the office of longitudinal threads; a like number, constituting the other half of the threads, I put each on a sort of bobbin, so as to be disposable and transferable into the positions necessary to perform the two operations of making the crosses by changing places with each other, and forming the twists with those lengthwise, by being passed round them the proper number of times. Thus a succession of these operations produced a number of meshes, of a like construction with those I had witnessed made on the pillow by the female referred to.

"My first ideas of the application of machinery to this process therefore followed these processes of the pillow, with the modification of withdrawing half the threads and placing them upon a beam, and making all the evolutions solely by the use of the other threads which I placed upon bobbins.

"As to making lace of ordinary fineness, forty threads being requisite in each inch in width of lace, though I had got rid of twenty of these, I still required twenty bobbins to make an inch in width; these bobbins being similar in shape and principle to those used in pillow operations, the space they occupied in the machine I now projected and proceeded to construct, was much more than the width of the inch of lace when formed, consequently they radiated towards the point of formation, and I soon found the difficulty arising from the outer bobbins giving off too much thread, placed as they at first were in this straight line. I was compelled therefore to place them in a segment of a circle, so as that each bobbin might be at exactly the same distance from the meshes as the others, in whatever part the traverses required to form the net might place them. This circular arrangement of the bobbin threads, so as to give them equal tension during every part of the processes, has been adopted in the

original machine, and, with one exception, which has long since ceased to be used, in every modification of it until the present time. The arrangements ever since used by which the bobbin threads were made to twist, to traverse, and to close the mesh, have been in principle the same as those specified in my patents of 1808 and 1809.

"This first machine may be considered as a mechanical pillow; (see Plate V.) but while half the threads were on a warp roller beam and half on bobbins, and the crosses carrying before them the twists, were forced up by a row of pins placed on a bar to the work roller above, each operation was performed along the line of threads at once. The twist, the crossing, the traversing, and at length the whole line of meshes across the machine, were each one in succession performed and finished together.

"I consider that this my first bobbin net patent machine did for the making of lace in relation to the pillow, what the jenny did for the spinning of yarns in relation to the old long wheel. The processes were in principle the same, in the jenny as in the mode of spinning upon the long wheel, mechanically performed in the drawing out, twisting, and winding upon a cop, of a number of threads at once instead of one. This lace machine not only however performed the consecutive operations necessary for the formation of one such mesh in relation to many meshes, but required and secured the adoption of certain principles of selection and division, to be applied to a vast mass of hitherto very complicated materials, and that presented practical mechanical difficulties which I found to be of no ordinary character. Two or three years of study and experiment were employed in overcoming them.

"Though highly spoken of by Lord Lyndhurst as to its mechanical construction, yet for practical purposes this first machine was superseded by the one which was the subject of the second patent, 1809. Lace of an inch or so in width, made upon the first patent plan, was inserted in a child's cap, worn and washed to test its capacity of resistance. It was taken to Mr. Lacy, asked to be left, and was sent to London. Mr. Lacy in company with Mr. James Fisher saw me at Nottingham, or at Loughborough, where these experiments had been carried on. I was asked what width I could make it, if more than an inch or two. I had not thought of this as a thing to be desired, but said I thought I could bring my bobbins within the width of the lace, and if so I could go any width. This gave my thoughts a new direction. The division into warp and bobbins became more important than ever. Setting to work to get the bobbins into the space of the lace to be made, brought me to adopt the thin or flat bobbin instead of the round one. The next point made was to put the warp into the exact width of the lace also. My plan being for a single tier, the bobbins and carriages were put in this single row, and past altogether through the movements from side to side of the machine, then were divided for the crossings, then reunited to repeat the former motions. But the difficulty of obtaining at Loughborough well-made bobbins and carriages, the latter being very long in order to form the twist as near the work as possible, led me to attempt dividing the carriages and bobbins into two rows or sets, so as to perform their functions respectively, without periodical separation, and at once to relieve myself, by being enabled to use a bobbin and carriage twice the thickness of those previously employed. See Plates VI. and VII.

"In thus bringing the second patented machine, called from the place where its construction was finally accomplished, "the double tier *Old Loughborough*," the mental labour was very great. When puzzled and fatigued by endeavouring to overcome difficulties (which often occurred), I was enabled to exercise the happy faculty of entirely quitting the subject, and by reading or other occupation of the mind to refresh it."

Mr. Heathcoat we find has described to more than one of his other friends, that when he had decided to lay aside the first patented machine, on which indeed he had made but little net and of course received but trifling returns, he began his experiments with a view to the second by suspending common pack threads from a beam placed aloft across the room for warp threads; then he passed the weft threads by common plyers, delivering them to other plyers on the other side, and after giving them a sideways motion, the threads were repassed back between the adjoining cords, receiving by this a twist, and the meshes were then ready to be closed by hand as upon the pillow. Here was the incipient movement between the warp threads of the future bobbins and carriages. The original drawings of the different coloured threads, beam, twistings, and crossings described above, are now in the author's possession.

Thus Heathcoat invented the second machine calculated to make lace of any breadth required, and for which he took out a patent, 14th July, 1809, No. 3216. In his specification he entitles it "a machine for the making and manufacturing of bobbin lace, or lace nearly resembling foreign lace, by which means such lace would be made to much greater advantage than by any other mode hitherto practised, and from the use of which would result a considerable decrease of expence, being calculated to promote an effectual saving in time and labour, which he conceived from repeated experiments would be productive of great public utility; that he was the first and true inventor thereof, and that the same had not been made or used by any other person or persons whatsoever to the best of his knowledge and belief."

This machine had two beams or rollers similar to those in his former one; but the bobbin apparatus was very different, so much so as to constitute an entirely new machine.

The pinions described in the first machine as placed at the ends of the conical tubes, necessarily occupied a great breadth when arranged laterally, compared with the breadth of the piece of lace. If, for instance, the diameter of one pinion were one-fourth of an inch, the mesh of the lace being sometimes one-sixteenth of an inch, the breadth of the bobbin apparatus would be as four to one, to the breadth of the lace. This would be exceedingly inconvenient in making broad pieces. The great extent to which the radiation of the bobbins expanded the area of the working in that part of the former machine, gave it the name of the *fantail*, by which it was generally known. There would also have been far too great friction to be overcome, arising from giving revolving motion to so many tubes.

This induced Mr. Heathcoat to make his bobbins so thin as that the whole number required should not occupy more space than the breadth of the piece of lace.

This bobbin, with the carriage in which it is placed for conveyance to and fro and from side to side of the machine, will be easily understood by the Figure 2, Plate IX. The bobbin (wheel) contains a certain space between its sides into which the diagonal thread is wound. The longitudinal threads are wound upon the lower beam, and being divided into two parts, each set composed of every other thread and kept apart on their way by passing through certain upright tubes or guides placed at equal distances from each other, in order to keep the threads laterally at equal distances. They then proceed to the upper beam to which they are tied. Each set of warp threads is capable of motion to the right and to the left. The bobbins are placed in a row between the two beams, so that their threads may arrange collaterally with those from the lower beam. In this situation two bars are placed to the front and two on the back of the threads reaching from one side of the rows of threads to the other, and equal in length to the whole breadth of the lace. These bars are each divided into a number of grooves (combs) running at right angles to their length. They are so placed in back and front of the threads, as to be in the circumference of a circle. When the carriages containing the bobbins are placed in the grooves, they are not only kept at equal distances laterally, but they can be made to move like so many clock pendulums oscillating along the grooves through the longitudinal or beam threads by levers called shifting bars, which hang in the centre of the circle in the circumference of which the grooved (comb) bars are placed. The bars are called conducting bars. By one of the shifting bars the bobbins are passed half-way through the threads, and received on the other side by another similar bar.

This being understood, it will easily be perceived how the twisting is managed. When the shifting bars have passed the bobbins which contain the diagonal threads through the longitudinal threads, the comb bar which receives them on the other side, has a lateral motion given to it, equal to the space between two threads. If then the bobbins be brought back on the contrary side of each longitudinal thread, each diagonal thread will have made one twist with a longitudinal thread. If now the front comb bar be moved laterally, till each bobbin stands opposite to the space from which it first started, and the threads be again passed through to the back and brought again to the front on the other side of each longitudinal thread, the threads will have been twice twisted.

Previously to the twistings, one-half the diagonal threads must be moved to the right and the other half to the left, which has the effect of crossing these threads, and is brought about in this machine by a method as entirely different to that in the former machine, as the process of twisting differs in the two, and is as follows: A number of pins equal to the number of diagonal threads are placed in a bar at equal distances. This bar, called a point bar, is made to move backwards and forwards on an axis with pivots, by which means it can pass freely between the threads, and be withdrawn at pleasure. Previous to crossing, every other bobbin is so moved as to form one distinct row, and thus form two distinct rows of the whole; one row being a little behind the other. Then the points are made to enter the first row. They then receive a lateral movement, till the points are opposite to one division further to the left of the second row. The points are now advanced through the second row. The effect of this is, that the right side of the threads of the first row is in contact with the left side of each pin; while the left side of the second row of threads is contiguous to the right side of each pin, and the diagonal threads are crossed. This has prepared them for twisting with their contiguous longitudinal threads. There is another set of points which are in every operation used to relieve the first set. The first set have grooves in the upper side, lengthwise into these grooves the points of the second set are brought and occupy the place of the first which are thus released, and are employed in forming the new crosses in the subsequent operation. In forming the crosses as above described, the threads are crossed above and below the points. The lower cross is done away, by giving a lateral movement to each of the rows of bobbins in contrary directions.

In examining the specification and drawings of this machine, it will be observed that the number of bobbin threads, as well as the beam threads, are double to those spoken of in the above description. The difference is thus explained:—These double rows are placed one behind the other. If, however, the bobbins were of half the thickness, they might, with the same effect, stand in one row. The contrivance admits of the lace being made twice as fine as the thickness of the bobbin would seem to admit. In other words, the diameter of the mesh of the lace will be one half of what it would be, if one half only of each of the sets of threads were employed. One of the parts of this process distinguishing it from the previous attempts of Moore, Hood, and others, and that which gave the firmness and durability so important to its productions, was the traversing the diagonal threads from side to side of the net made by it. This, combined with the twists, prevented it from roving out, if one or more of the threads were broken;

and though effected by the first patent, yet may be described more clearly under this second patent. It is thus:—On the formation of every mesh, the diagonal bobbins and carriages moving to the right hand, will of necessity make the end of that row one carriage too many, and uneven at the right hand; and the left hand end one carriage too few. But the row moving to the left will have a reverse surplus carriage too much at one end, and too few at the other end of the row. By an ingenious contrivance, the machine makes a transfer of these carriages to the lacking end, back and front, and thus the full set is restored; and though each bobbin and carriage of the entire sets changes its place every series of meshes in width of the machine, the diagonal course is unbroken from end to end of the piece.

The following parts of Heathcoat's second patent machine are stated to be old. The warp beam and that on which the work is rolled when made, both being common to every weaver's loom. The wheel, brass, or bobbin, which, like the pirn in the weaver's shuttle, holds the weft thread, and which, it is said, had been used by Robert Brown, Whittaker, and Hood, and in a compressed form with a spring in the tape making machine for 100 years. The combs and comb bar in which the carriages holding the bobbins move or slide, and which are derived from the stocking-frame, and were claimed by Whittaker and Hood. The tube through which the warp threads are carried and regulated, and which are similar to those in warp frames. The points which carry up and close the work, and which are found in every lace frame except the warp; and the crank bars on which the point bars are suspended, and without which no machine of any kind can be worked. In Morris's patent of 1781, nearly all these parts were employed. Renouncing, if need be, the whole of them, it is confidently averred that no model or actual machine, or combination of these or any other parts of Heathcoat's machine, can be shewn to have been previously put together, upon which bobbin net, *twisted and traversed from side to side*, could be or ever had been made. The patent of 1808 is the first in which two systems of threads are arranged, the one longitudinal, the other

diagonal, the latter traversing in two directions. That machine was a perfect one and very quick, but only capable of producing one narrow breadth of net. In the patent of 1809, on which the net can be made of any width, the warp beam and points are the only parts which were used similarly to the former invention. It was certainly a remarkable instance of decision of character displayed by Heathcoat, when after, by three years labour of mind and body, he had succeeded in devising and bringing into operation so beautiful a machine as that first patented by him, he should, without hesitation, have thrown it altogether aside upon perceiving its confined powers, though perfect as to its product; and at once set himself to invent one on an entirely different principle, and capable of increasing the production a thousand fold.

Having ascertained by what mechanical movements twisted and traversed bobbin net was first produced, so as to resemble perfectly the hexangular meshes of pillow net, it will be necessary to trace the course of the threads forming them by the aid of the figures on Plate IV., on which are shewn meshes of machine lace.

The upper and lower crossings lie in the direction of the piece so as to be at right angles to the selvage. Figure 1 will explain the crossing and intertwisting of the threads. It will be seen that of the three series, one proceeds longitudinally from above downwards; these are the warp threads which are extended from a lower roller to the upper work beam, usually in straight perpendicular rigid lines when in the machine. When the net is formed and taken off the beam, these warp threads assume a serpentine or winding path from the tension or draught of the obliquely disposed weft threads, by which they are alternately drawn to the right and left from the interlacement. If we suppose these longitudinal threads to be inflexible wires, the fabric would have the appearance represented in Figure 2, which indeed is the shape of the net as extended on the machine while it is in process of fabrication. Another of the series of threads runs to the right, and the third to the left, both of them in oblique zigzag directions. These two sets thus disposed wind round the up and down threads, and also cross each other in the intervals betwixt the warp, both travelling in a like manner but in opposite directions. These diagonal threads taking their course to the off-side borders of the web, towards which they are constantly tending, each bobbin thread as it arrives twines itself not once only as round the other warp threads, but a twist and a-half, the carriage remaining on the outer notch of the other comb, and turns back to twist and travel in the other direction. This last operation forms the selvages of the piece.

It is important to remark that the bobbin net machine is, in principle as we have described it, capable of being modified without difficulty so as to produce equally with the old weaving and warp looms solid tissues or webs. But its high relative cost in construction has hitherto prevented its use for this purpose.

Thus John Heathcoat devised and accomplished the construction of the traversing bobbin net machine, "by far the most expensive and complex apparatus existing in the whole range of textile mechanism," and which remains in principle embodied in those of the present day, though with great improvements, some effected by himself, and many more by others to whom he was ever anxious to accord their due meed of praise, mentioning "John Brown, W. Morley, Braley, Levers, Sewell, and others, as especially worthy of notice, for their employment of genius and talents only second in their results to those by which the original machine was designed and executed." These modifications of the original machine arranged themselves under five systems, all of which were of English origin.

His success was not without its commensurate cost. It was gained by the employment of self-directed talents during years of great bodily and mental toil, carried on without aid from the skill and experience of others. He was encouraged to prosecute the task only by determination to succeed in overcoming difficulties in the progress of the work, which he found to be so great as to lead him to say, when describing them long afterwards, that "if they were to be done again, he should probably not attempt to overcome them." This is an instance of the successful application of mental and physical powers well directed and controlled, which may be advantageously pondered over by young men in every rank of life. At twenty-four years of age here stands the conscious yet modest inventor of one of the most intricate machines the world has ever seen.

Strict domestic economy and personal self-denial were necessary, and were cheerfully exemplified during this long outlay of time and money—an interval which must have called into exercise much faith and patience on the part of Mrs. Heathcoat. This seems to have

reached its culminating point when, as related by herself with gratitude in after years of prosperity, on one eventful Saturday her husband returned home, she enquired as often before, "Well, will it work?" His reply was "No! I have had to take it all in pieces again." Though kindly spoken in encouraging tones, yet it was with an almost painful calmness; and she was constrained for once to sit down and cry bitterly. Happily, she had confidence in his ultimate accomplishment of the task he had set himself. Her loving and brave heart had only to wait a few weeks more, when the hoped for result came, and she had the first narrow breadth of machine wrought traversed net placed in her hands by him, of whose talents and success, and the honourable influence to which they led, she was justly proud. That piece of net after being worn some years, was verified on oath, and an impression from it is given in Plate XIV., No. 14, in specimens of lace.

The excellence of the articles which this machine was capable of producing, was equal to its wonderful construction. See Plate XIV., No. 15. "The net," says M. Aubry, "is the king of tissues, and is a perfect imitation of the pillow mesh. It therefore soon became exceedingly popular, and has still further developed the manufactures of Nottingham, so that it has now become the centre of one of the largest manufactories in England. Ure says, *Dictionary of Arts*, p. 730, "bobbin net surpasses every other branch of industry, by the complex ingenuity of its machinery. A bobbin net frame is as much beyond the most curious chronometer, as that is beyond a roasting jack."

The guage or fineness of a bobbin net machine, like that of a stocking-frame, which is reckoned by the number of needles there are in an inch in its width, is computed by the number of bobbins and carriages that pass too and fro in each inch of the combs along the width of the machine, and the consequent number of points to take up the meshes as they are formed up to the work roller. If there are ten carriages and combs and points in an inch, then it is called ten-point. There are as coarse as four-point, and as fine as sixteen-point. The net may be made stiffer or slacker on the same

machine, and there may be therefore from ten to thirty holes lengthwise in an inch. The first machine made by Heathcoat on the principle of his second patent and called the 'old Loughborough', was a nine-point, eighteen inches (two quarters) wide. Then he constructed two ten-points the same width; then one thirty inches, followed by one thirty-six inches (four quarters), all ten-points. After the first large factory was occupied about 1810, a six quarter was built; and the labour in working this three-fold width of machine was then considered so great, that one Simpkin, a tall powerful man, was selected and put into it. He could earn £5 in three days, which was generally considered a week's work in this new and highly paid employment. Bobbin net was for some years made entirely from bleached cotton yarns, and 6*s.* 6*d.* a rack was paid for producing four quarter nine-point net. Many hands were thus earning during the first years of the patent from £5 to £10 weekly. The numbers of unemployed in the existing lace trade were thereby gradually lessened. Yet, by many, these new machines were looked upon as shortening labour, and were disliked and decried accordingly.

While Mr. Heathcoat was engaged in perfecting and preparing to patent his inventions, he became known for his talents and pleasing manners to several respectable families around him. Amongst others, to that of Mr. Brewin, whose friendship he much valued through life, and whose son, the late Mr. Ambrose Brewin, after an engagement for some years as manager, entered into partnership with Mr. Heathcoat in the Tiverton works. He became the husband of his younger daughter, and after a useful life, died much regretted some years before his father-in-law. About the year 1806, Mr. Heathcoat was favoured with the friendly regard of Dr. Peach, a medical gentleman then resident at Loughborough. To him he was indebted for scientific information and encouragement which was then of great value to him. He also introduced him to Mr. R. Blunt, who assisted in drawing the patent specifications, and to Mr. Charles Staveley a civil engineer, who made the drawings for them from the machines; and which, considering their intricacy

and the rarity of such employment at that time and in that district, reflect great credit on his skill as a draughtsman. He afterwards offered to construct the second machine from the specifications and drawings when their accuracy was impugned.

The pecuniary outlay which was incurred during the years 1807 and 1808 was beyond Mr. Heathcoat's means to sustain comfortably. Now that the second patent had to be secured, it was time for him to obtain other aid. A friend, Mr. Seddon, of Leicester, had rendered some assistance, which could not however be continued. Messrs. Boden, Oliver and Cartwright, hosiers of Loughborough, then entered into arrangements, under which he prosecuted his labours; but after a time they renounced their connection with the business, as too hazardous an investment. About this time, Mr. Thomas Hallam, who had been brought up in the lace trade at Nottingham, when the point net was becoming unprofitable as a manufacture, removed to Loughborough, and entered into the employment of Mr. Heathcoat. This occurred almost immediately after the invention of the first patented machine. He found Johnson, Bailey, Harriman, and Cross already in his service. Upon Oliver and Boden's withdrawal, and at the suggestion of Hallam, who was confidentially consulted having a knowledge of the houses engaged in that trade, Mr. Heathcoat not finding Mr. Nunn an extensive lace manufacturer at home, called upon Mr. Charles Lacy, and shewed him a sample of his new production. Lacy was in the point net trade, and closely connected with Mr. James Fisher, the eminent lace merchant in London, to whom this sample was forthwith sent. Fisher suggested the article being made on machinery suitable for producing it in greater widths, which Heathcoat intimated his determination if possible to effect. A few days after an arrangement was entered into, by which Lacy was to furnish capital, and become an equal partner with Heathcoat in the profits of the business. Heathcoat was to have the entire management of the machinery, while Lacy should fit the production for the market and dispose of it in Nottingham. Under this partnership the machinery

was so increased, as that, by 1816, fifty-five frames were at work in their factory at Loughborough. Thus Mr. Lacy became joint proprietor in the bobbin net patent. His well-known peculiar characteristics increased the dislike felt in Nottingham to the payment of tribute under the patent, which though not exorbitant, was very profitable to the patentees. Mr. Lacy unhappily embarked his share in mechanical experiments which exhausted all his gains. When that reverse occurred, the author was requested to apply to Mr. Heathcoat to head a subscription for his support. He replied, "Say to the gentlemen from me, that our partnership put between £40,000 and £50,000 clear gain into Mr. Lacy's pocket. If they should think, that after my skill and labour had done that for him without any expense on his part, I can be reasonably called upon to help him now that he has foolishly thrown it away, I will do so. I will act as they judge is right." The fact stated was considered amply sufficient, and the application was respectfully withdrawn. Mr. Fisher from that time allowed an annuity, it was said, of £200 a-year, to Mr. Lacy and his daughter for the rest of their lives.

The title to the invention of a machine whose incipient capacity was so greatly in advance of previously known means of production of lace, and which was soon found capable of improvement so as to vastly extend its powers and results, was not likely to pass unquestioned, especially as the articles made upon it were sold at prices affording unusual profits. Accordingly a number of claimants to partake of the honour of the invention arose on the one hand, and Heathcoat's specification being at once obtained, infringers quietly set to work with ability and success on the other. Much was said and written during the existence of the patent impugning the claim of Heathcoat to originality of the invention, and he was denied by some any merit beyond peculiarity of construction in his machine. We have already seen that before 1800, twisted and traversed net had not been made by machinery, that by Robert Brown's patent it could not be made, and that Whittaker and Hood's efforts were ineffectual in producing this result. The whole body of historical evidence coincides

with that forthcoming when the question as to the originality of the invention was put in course for legal decision. The opinion then given by Sir I. Brunel, adopted by the judge Sir V. Gibbs, and ratified by the verdict of the jury, is without doubt the correct one:

"That when Heathcoat had separated one half the threads placing them on the beam as warp threads, and made the bobbins which carried the other threads to act between and around these warp threads, so as to produce Buckinghamshire pillow lace, the lace machine was invented."

Notwithstanding the patentee's dislike to waste money, and time almost valuable to him then as money, in law—an injunction was applied for in 1813, against Mr. William Morley, a machine builder and then in partnership with Messrs. Kendall and Allen, by Heathcoat for infringements of his patent, he stating himself to be the inventor of the bobbin net machine. Morley replied in substance:

"That the machine was not Heathcoat's invention, such machines worked by several persons having produced similar bobbin net long before; that he had leave from Heathcoat to work them; and that their machines were materially different to his.—Heathcoat denied permission to use, and asserted that the variations were colourable and immaterial; charged them with selling the goods made by other infringers, and required their names and an account. He says they refused inspection, but he had seen a top and bottom roller of a lace frame delivered at Kendall's house. Defendants answered that some of the material parts of Heathcoat's machines were taken from older inventions. They admitted that bobbin net can be made wider from all lace machines, including Heathcoat's, than by hand, but asserted that the latter was not an original machine. They alleged that he cannot supply the market with sufficient net; that they had only worked two machines and those for but two months, the lace from which was sold by John Allen, but had ceased to make or sell any since this application, yet insisted on their right to do both."

They further say:

"That Edward Whittaker, Robert Brown, and others, were the inventors of the most important parts of this machine, and that their machines were different to the patent ones of Heathcoat's in principle, method, parts, and movements; and were not either counterfeits or imitations of his."

They nevertheless put in a schedule of bobbin net made by them, viz. 324 yards, of which 252 yards were sold for £290. 10*s.* and 72 yards were on hand. After the hearing, the injunction sought for was granted, and

the defendants became licensees under the patent. The following statements, extracted from a large mass of a similar tenor which was brought forwards in 1813, will throw further light on the points raised in this inquiry, and are otherwise of interest:

"William Flint, then aged 63, had lived nearly all his life in Nottingham where he had been a lace manufacturer eighteen years; knew the texture and mode of making Buckingham lace, and was acquainted with every kind of lace machinery used since he could remember. He invented the point net frame and sold the invention, which was afterwards patented. He never heard of any invention before Heathcoat's by which bobbin net could be made; had there been such he must have heard of it. He had tried to invent it, but did not succeed. Many others did so and without success."

"Edward Morley, for thirty years a frame smith and setter up in Nottingham, had been ten years with Frost, an eminent mechanician in hosiery and lace frames of every kind. They both knew all the meshes already produced by machinery, having been employed in devising and constructing them. Many had tried to construct a twist and traverse lace machine, but none had succeeded before Heathcoat. He must have known it if there had been. The patented invention was soon heard of, and only credited when the lace produced by it was seen—on account of previous failures. The specification was brought and many went on to construct them."

This Mr. Edward Morley became from his universal knowledge of the construction and value of hosiery and lace frames, the auctioneer or salesman through whose hands nearly all Nottinghamshire machinery that was sold for many years passed in order to be disposed of. It was from his books chiefly, that the author compiled his published account of such sales made during the preceding fourteen years to 1833—As to Robert Brown's machine Mr. John Farey, C.E., declared:

"That it could not by any modification be made to produce traversed and twisted net; nor could Heathcoat's produce fishing net; neither machine could be made to perform the functions of the other."

John Brown had, by a patent he had taken out in 1811 for a bobbin net machine, which was called from its contradistinguishing arrangement the traverse *warp*, Heathcoat's being a traversing *bobbin* machine, led the way to infringements. The construction and working of that class of machinery under Brown's patent gave apparently legal sanction to such parties; therefore Heathcoat in 1813 applied for an injunction also against him and his partners for infringement, by making and

working bobbin net frames at Warwick. In opposing this, Messrs. Nunn, Brown and Freeman, say:

"They had invented and worked their machine before Heathcoat's patent. The machines do not interfere but differ materially. Their's is also patented. They admit Heathcoat's lace resembles foreign, and made at less expence and greater advantage than by any former method, and that he may have been the true inventor of his machine. That he could not supply the market sufficiently, and that their sales equalled his. That Brown, who had been in the lace trade ten years, found out his principle in 1807, and says that he communicated it to Freeman who lived with him, the same month, upon which they proceeded to make experiments, and at length a model and lace net; the latter in June, 1808. They became partners, and, wanting capital, Nunn joined them, and they got their patent in March, 1810; having only heard of Heathcoat's at the previous Christmas. By examining carefully his specification they found the plans to differ materially, and the Solicitor General decided on granting the patent. Until then they say they had known nothing of Heathcoat's method or principle, nor seen Heathcoat, his caveat, specifications, or plans. Brown was the inventor of the machine patented by him, which they assert is not a counterfeit or imitation of Heathcoat's, almost every movement and the whole apparatus differing from his. Finally, that he has all along known of their making lace, of which he had assisted with them to adjust prices, upon which subject they put in a letter from him. And they conclude by stating that Bailey said Mr. Heathcoat and he had examined the specifications of Brown, and found them to be on different principles and no infringement of Heathcoat's patent."

The last statement Mr. Heathcoat point blank denied.

An inspection of machines was refused, as also the injunction, the Chancellor not having a caveat from Heathcoat before him, and he ordered a trial on a writ issued from the King's Bench. Models were prepared, that of the 'Old Loughborough' patent machine was made by Mr. John Gimson, and the damages were laid at £50,000. But a surprising and untoward discovery occurred, which caused the record to be withdrawn, and not only put a stop to this action, but to every other legal proceeding by Mr. Heathcoat to protect himself from infringements, until the validity of his patent had been indirectly established, by the dictum of the judge and verdict of the jury in the action Bovill *v.* Moore, tried in 1816.

The circumstances were these. Mr. Millington was working a model of Heathcoat's frame, movement by movement as the specification was read, when it was made apparent that there was a difference between the

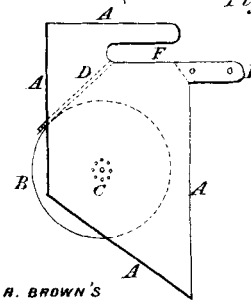
draft and engrossed specification, arising from the omission in the latter of a whole line describing five movements of the carriages which, being a repetition of the line preceding, had evidently been considered by the copyist as a mistaken repetition, and had been dashed through and left out in the engrossment. To make it sense, the word *bring* had been inserted instead of *put*. In confirmation of the practical sufficiency of the specification, notwithstanding these errors and shewing the mistake of those who said the machine was too intricate to be worked (which indeed the number and success of a multitude of infringers effectually disproved), a common workman having had the texture of the lace explained to him, made a model from the specification and drawings, on which he placed threads and made net. Being illiterate, he did not take the trouble to read the latter part of the directions, but worked on unconsciously supplying the gap.

This deficiency, though not necessarily fatal in equity or even probably so, Serjeant Copley (Lord Lyndhurst), thought might be taken as a valid objection at common law, and advised that further proceedings against infringers should be postponed.

On this occasion Mr. Sylvester, C.E., described the essential parts of both Heathcoat and J. Brown's patents to be identical. Mr. Nicholson, C.E., declared them to be so alike that if the essential part of Heathcoat's were withdrawn, the traverse warp could not be worked at all. And in this, Mr. Farey, C.E., entirely coincided. In his affidavit, John Millward, of Olney, Bucks, (aged sixty-five, and forty years in the pillow lace trade) said, "he never heard of machine bobbin net till that of Heathcoat's, nor saw a machine till a day or two before, when Whittington, Brunell and Donkin, each worked on the model. They came to a stop though working to the patent (specification). He saw they were wrong and what they had to do, and told them how the threads were further to be disposed of so as to make the lace." This 'stop' was the result of the deficiency above described.

Mr. John Bailey gave, in 1813, the following description and remarks upon the essential parts of Heathcoat's,

Fig. 1

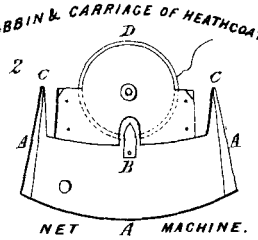


R. BROWN'S

A. Sinker
B. Bobbin
C. Pivot
D. Spring
E. Slide
F. Notch

BOBBIN & CARRIAGE OF HEATHCOATS.

Fig. 2

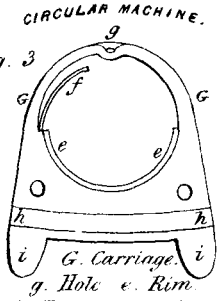


NET A MACHINE.

A. Carriage B. Spring
C. Catches D. Bobbin

BOBBIN CARRIAGE CIRCULAR MACHINE.

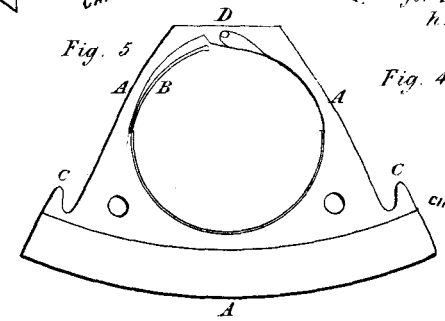
Fig. 3



G. Carriage. g. Hole e. Rim for Thread f. Spring h. Groove.

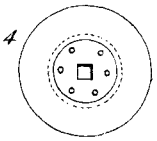
CARRIAGE OF LEVER'S MACHINE.

Fig. 5



A. Carriage B. Spring
C. Drawing Hooks D. Hole for Thread.

Fig. 4



WEFT BOBBIN CIRCULAR MACHINE.

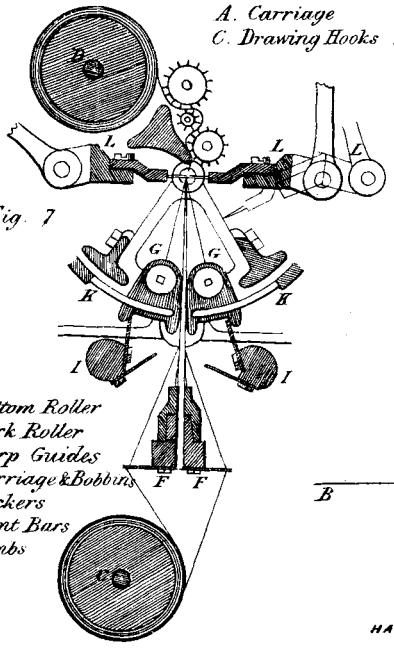
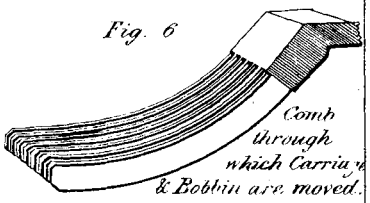


Fig. 7

C. Bottom Roller
D. Work Roller
F. Warp Guides
G. Carriage & Bobbins
I. Lockers
L. Point Bars
K. Combs

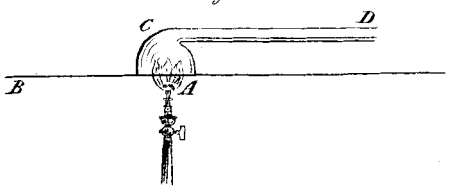
SECTION OF CIRCULAR MACHINE.

Fig. 6



Comb through which Carriage & Bobbin are moved.

Fig. 8.



HALL'S GASSING APPARATUS.

W. Metcalfe Lithog.

as compared with those of the machine patented by Messrs. Nunn, Brown and Freeman. It is very terse and lucid, giving a high idea of the talent of this artizan:

"In it an arrangement is made to place and work together forty to sixty threads in the space of one inch, by putting half the threads on a beam roller, and half individually on bobbins; and so as to pass through the beam threads first on one side and then repass on the other, and so twisting round each other. The roller threads run longitudinally, the bobbin threads diagonally. *John Brown's patent merely reverses this arrangement—the longitudinal threads are on bobbins, the diagonal are from the roller.*

"The bobbins are put into two rows to give twice the thickness to each bobbin, one row moves *behind* the other; *in Brown's, one row is placed and moves over the other.*

"The operation of twisting takes place upon one half the threads instead of the whole, and requires that the roller beam be placed farther from where the threads unite to form the lace, than the bobbins containing the other half of the threads; which last named bobbins require to be passed and repassed between the beam threads, which are held at equal distances for that purpose. *Brown's arrangements are in all these points the same.*

"The bobbins need to be guided through the threads by combs corresponding with the distances between the threads. These combs are placed in bars which are capable of a shogging (side) motion, removing the whole row of bobbins from opposite one set of spaces to opposite the next spaces, one remove to the right or left as the case may be. *Brown has comb bars and performs the same movements as Heathcoat's.*

"In order to these movements, it is necessary that the bobbins should be peculiarly constructed; so thin as that the requisite number when put into their carriages should be worked in a given space; should pass and repass the beam threads by being operated on by a shifting bar passing them half way through the threads, and another receiving them on the other side not catching the beam threads, and giving off thread with a proper tension. *Brown's are exactly similar.*

"To prevent more thread being given off the bobbins in passing backwards and forwards through the threads, than is taken up by the twist, the combs are arranged on the circumference of a circle, and the shifting or locking bars move on an axis on the like circle, of which the centre is where the work is made. *Brown has copied these parts and to attain the same object.*

"The twisting operation forms the sides; to finish the mesh, the diagonally working threads in Heathcoat's are made to cross; *in Brown's the longitudinal threads cross.*

"To secure the crossing, carry home the twist, and draw a quantity of thread from the respective sources equal to the quantity used in forming the last row of meshes, a row of points enters the threads, and the cross is carried out of the way of twisting; an upper row of points then carries the cross up to the work, close enough to make the meshes of the proper size; and the last row of points bears up the

meshes to a certain point as they are made, and at the same time draw from their various sources a sufficient amount of thread for the next course or row, and a work beam receives the net as fast as it is formed. *In all these particulars Brown's arrangements are the same, only reversed, working downwards instead of upwards.*"

The Mr. John Wallis, jun., before spoken of in connection with Whittaker's and Hood's frames, having a perfect knowledge of the bobbin net machinery and manufacture from its commencement, and being the acting partner and manager in the firm of Paget and Wallis, extensive makers of bobbin net lace for many years, the author requested his unbiassed opinion in the conversation of 1846, as to whom the merit of the invention patented by Heathcoat in 1809, really belonged. He had no doubt on that point himself; but desired to give the readers of such a work as that on which he is now engaged all the satisfaction possible. In reply Mr. Wallis stated it to be his opinion:

"That the bobbin net machine was the invention of Mr. Heathcoat; and that its diversified and intricate movements and combinations are exceedingly ingenious, and claim for him all the credit that can be given. Whatever parts others might have contrived, or schemes they might have formed, he put the machinery together, and so combined it as to produce *traversed* bobbin net, which without doubt nobody else had done."

Mr. Wallis went on to refer specially—

"To the division of threads into warp and bobbin, to the separation of the bobbin threads into two parts, and the mode of causing these sets to travel opposite ways, the introduction of the shogging (side) movement, and the exact application of the four-point bars, together with the working of the bobbins and carriages in combs adjusted in parts of the segment of a circle of which the finished web is the centre," &c.

He concluded his remarks thus:

"Possibly by his claiming the *bobbin*, his patent might have been overthrown; yet, nevertheless, he would still have been the *true* inventor of this machine. Nobody had constructed a bobbin *traverse* net machine before him; and it is not certain any one else might. For as to Brown and Freeman's 'traverse warp' machine, I do not think for a moment it was other than an inverted copy of Heathcoat's."

After a thorough examination of every other net making machine then known, and of the bobbin net machine patented by Heathcoat, and called the 'Old Loughborough,' Sir J. Brunell publicly stated in 1815:

"That the latter appeared to him one of the most complete mechanical combinations, and in which its author displayed uncommon powers of invention. Therefore he could not withhold the tribute due to him for originality and ingenuity in all the various parts he had brought into action, to accomplish a texture which had been attempted before, but, to his knowledge, without success."

A diligent examination of a surprisingly voluminous mass of papers, briefs, and evidence given on oath and otherwise, on all sides of the litigation to which Heathcoat's and John Brown's patents gave rise, has been made by the author. Lindley and Whittaker must have awarded to them their due for their bobbin; Robert Brown for his sinker and bobbin, and Charles Hood for his ability in employing these instruments, so far as he did use them, in approaching success more nearly than any of his predecessors. It may be presumed also that Mr. Heathcoat might and almost of necessity must have had his mind directed in some degree by the attempts of others. Before he had completed his own machinery, he had not however seen either Brown, Whittaker, or Hood's machinery. Most of the instruments he used were known before, but used for other combinations or for other purposes. Some had been employed in unsuccessful efforts to do that in which he succeeded. In the hands of his competitors they had proved practically useless as to the solution of the intricate problem. Whatever these might be, Mr. Heathcoat relegated the necessary parts into their appropriate position, giving them form and motion by his mechanical skill, with those additions which he found necessary to the attainment of the end he had in view. Thus we also are brought to the conclusion that he was not only the first to construct, of which no one has now any doubts, but claims of right the singular merit of having invented the twisting and traversing bobbin net machine.

It may be mentioned here, that in 1813, Mr. Heathcoat, still of Loughborough, took out an additional patent, No. 3673, for improvements in his machine for making bobbin net, or lace nearly resembling foreign lace:

These consisted of substitution of iron for wood where the latter material had been used. Also improved guides and 'turn again' were

introduced so that these brasses were not moved by hand. Straps were put instead of pulleys to give movements. The selvages were held out by roller pins or points, called spur wheels, instead of a stretcher pointed at each end; with other simplifications of the interior working parts of the machine. Also he now added to his machines the apparatus whereby the narrow breadths called quillings were made. The traversing bobbin threads were caused to turn again at intervals in the work equal to the desired width of the strip of net. A lacing thread put in while the work was going on kept the adjoining breadths united; these were afterwards drawn out when the piece was dressed, leaving a sound selvage on each side of the breadths, but not so perfect as the quillings made on the traverse warp machine.

The price paid for making five-quarters net was 3*s.* 6*d.* a rack, in 1834 it was 1*d.* A twenty-four rack piece sold in 1814 for £17, it was worth 7*s.* in 1834.

In 1813 Jeremiah Bryant, of Nottingham, improved the catch bars in the 'Old Loughborough' machine by using notched wheels instead of working them by hand, and devised a better mode of 'hogging' the twist. By these means the speed was increased.

The same year the movements of this frame were still further lessened by the combined ingenuity of William Braley, William Henson and Thomas Brookes. The machine as modified by them was long used. Henson removed soon after to Worcester.

Greenwood, a workman, so arranged the 'Old Loughborough' double tier of Heathcoat in 1815 as to reduce the motions necessary to produce the net from thirteen to six, and by so much increased the speed. This was effected by a peculiar kind of vibratory movements, but their mode of operation was so complex and delicate that only about ten of these frames were ever constructed.

These were the most successful of the many ingenious modifications of the machine patented by Heathcoat, made at that time, when every step that issued in reducing its complexity and increasing its speed, whether worked under license or through infringement, was attended by profits of an unusual amount.

CHAPTER XV.

THE TRAVERSE WARP MACHINES.

THE importance of the litigation initiated by Nunn, Brown, and Freeman, through obtaining an injunction against Moore, Longmire, and Noble, and issuing on the order of Lord Eldon, in a trial of the validity of John Brown's traverse warp patent in 1816, was very great, whether in reference to the interests of the litigants, or those of Heathcoat, and the arrangements, position, and progress of the trade at large, when influenced by the establishment of the paramount rights of the original patentee. The excitement felt upon the occasion was naturally very great; and commensurate efforts were put forth on all sides. The amount of evidence given, and much more that was prepared, added to facts from other sources, enable us to trace out the history of the traverse warp invention.

Mr. Nunn, one of the plaintiffs, was a lace manufacturer and a man of property at Nottingham. Finding that the value of Heathcoat's invention was great, he offered a reward to any artificer who could construct a machine to make bobbin net lace. He spent a good deal of money in employing Whittaker, Elliott, Rowland, Hill, and others, in trying to do so. Nunn had a copy of Heathcoat's specification, and put it into the hands of the persons he so employed. He at length met with John Brown, who had been attempting the task with Freeman. The aid of James Sneath, a frame-smith, was called in, when Brown and Freeman met with obstacles they knew not how to overcome, and, as Sneath always averred, by his assistance it was completed in 1810-11.

The steps by which this was accomplished, as stated by credible and competent persons, were as follows:

Whittaker was shewn Heathcoat's specifications by one Cockin, a workman, in 1810, and was taken by him to Nunn. With Bailey he went to see one Hill's machinery, for the purpose of trying to get from Bailey particulars relating to Mr. Heathcoat's machinery. At Nunn's request, Whittaker entered into his service for 30*s.*, or thereabouts, weekly, in order to make a twist-frame, and worked in the parlour of one Young; Rowland working in the top shop, Glazeby in the middle shop, Elliott at home, Hill at Nunn's house, and all were employed by Nunn; Glazeby's brother, a working smith, in Heathcoat's service, often coming to help them. Edward Morley shewed one Young how the bobbin net mesh is made by using a fox and goose board. Whittaker averred that Brown and Freeman had taken Heathcoat's plan for their ground work, but altered it to avoid his patent. They came, he said, to his house every night, for many weeks, in order to know what he had learnt of Heathcoat's machinery.

John Holmes lived at Birch Row, near Radford, about 1810, and Robert Harvey with him. Brown and Freeman soon came to live at the next door. Before September, 1810, Holmes often talked with Brown, who said he was trying to make a bobbin net machine, he and Freeman having each sold a point-net frame, and Brown his furniture for money, with which to make experiments, but they could not succeed. In September, he said he had begun to try again. Afterwards he stated he had got bobbin net on the machine, and shewed him some about two inches wide and five inches long, and about five meshes to an inch in quality. It was made of different coloured threads, by which their direction was indicated. Brown had often spoken of the plan of Heathcoat's machine, now saying he believed he was near it, as he had before tried with twenty-two threads to the inch in width, but had got rid of half the bobbins and made net of the same fineness as before. He then asked Harvey to join him, but he declined, fearing their want of success and the loss of his money. Brown said, Loughborough lace was good but too thick and heavy, and he had improved upon it, making the ground thinner and with

better selvages. Holmes saw his bobbins. Brown having joined Nunn in November, 1810, their acquaintance declined; and as each left their dwellings at New Radford in March, 1811, it ceased altogether. Between June and November, 1810, Brown was often absent, but Holmes did not know where.

Abraham Trivett had been, in 1813, seventeen years a lace manufacturer at Nottingham, seven years of which he was in warp goods and machinery, and is described as a "clever neat man." In 1810 he worked lace for Mr. Hayne, and talked with Lindley, his manager, about Heathcoat's patent net. Trivett and another tried to make it, but Hayne and Lindley said it would be an infringement, and had better not be meddled with. Trivett had known James Sneath for six years in 1810, as he had made several warp machines for him. About Christmas that year, he heard Sneath was trying at something with Brown and Freeman, and was told afterwards it was the traverse warp which they before long patented.

Mr. Stephen Moore states, that he remembers John Brown living near his father's house at New Radford in 1810, and shewing his father out of a window a wooden model of machinery of some kind, as something of importance. This Mr. Moore, sen., was the inventor of the traverse warp frame of the defendants. John Bailey had conversations with Nunn, Brown, and Freeman, by Heathcoat's knowledge and permission, about their machinery. Brown told Bailey that the bobbin in their machine had only one spring, and only three motions for twisting; also expressed wonder how Heathcoat could make such fine net from such coarse guages. This was in October, 1810, when Nunn also went over to Loughborough, and through Chapman, a draper, got an interview with Bailey, who was taken by him to Nottingham in a chaise, arriving there at midnight. On the way, Nunn showed Bailey a bobbin, which he at once recognized, and told him it was made at Mr. Heathcoat's factory. This Nunn denied. He pressed Bailey to enter his employ and make a machine; this Bailey declined, while in the service of Heathcoat and Lacy. Nunn alleged that

Lacy had defrauded him lately of £500 or £600, and trembled for any fortune connected with Lacy. Bailey pointed out to Nunn that the machinery shewn to him by Nunn, being intended to use only warp, could not produce traversed or sound net. This the drawings and specifications of Heathcoat, then in Nunn's hand, shewed his did. Upon which Nunn said that he feared the men were deceiving him. After an interview by Nunn with Brown and Freeman in another room, he told Bailey he had engaged with them to construct for him thirty machines to make bobbin net, ten of which were to be ready by Christmas. Nunn left for Bailey £2 in Chapman's hands to pay the expense of the journey.

James Hooley, hosier for forty-three years (1813) in Nottingham, had dealt in Morris's patent lace and every other braid made in Nottingham, and had frequent calls by inventors with improvements. He had never heard of machine bobbin net till he saw Heathcoat's, and was at once struck with its excellence. About two years after Heathcoat's patent, Nunn called on him and showed some new lace; he at once saw that it was an infringement and told him so. Nunn replied, he could make it from a different machine to Heathcoat's.

Blackner, writing in 1816, just after the question was settled, says—

"The merit of the invention by John Brown was in applying circulating planetary instruments and movements, enabling the warp threads to traverse diagonally in breadths with perfect selvages. Had he confined his claim to this, he would have gained the profit as well as credit of his ingenuity. The great obstacle of traversing from side to side had been overcome by Heathcoat already, to whom was principally owing the manufacture of bobbin net by machinery."

It is now time to describe the traverse warp machine, and the suits which followed thereon:

The patent, No. 3434, taken out April, 1811, in the name of John Brown, of New Radford, near Nottingham, lace net manufacturer, is entitled "A machine or machines for the manufacture of bobbin lace or twist net, similar to and resembling the Buckinghamshire lace net and French lace net, as made by the hand with bobbins on pillows."

From the peculiarity in its construction, by which

it was contradistinguished from that of Heathcoat, taken out and specified about twenty months before, it became known as the "*traverse warp*" machine. A description of the points of similarity to, and divergence from, Heathcoat's patented invention given in a former page, will suffice to enable the competent machinist to enter with ease into the following analysis of John Brown's specification, and the special questions raised by the long and expensive course of litigation to which these patents gave rise. The rights of invention claimed by each will necessarily, after such a number of clever heads had been at work upon their investigation as we have enumerated, bring forward and decide the question of an origin common to them both. It will be enough to say here, that while Heathcoat by his clear apprehension of the thing to be accomplished and judicious choice of the instruments whereby it was effected, shewed the highest inventive skill, his opponent in the points and mode of divergence from his forerunner, exhibited an amount of constructive genius, upon which Mr. Heathcoat long afterwards bestowed the warmest praise. John Brown, by his specification, describes every part of his machine, renouncing nothing as having been used before. Whether Heathcoat were an original inventor or not, yet, up to the points of divergence, he had clear priority over John Brown. By the latter claiming all, he lost what he would otherwise have been justly entitled to—a patent for the method of construction, so far as it was new, in any part of his machines, *i.e.* for traversing the warp threads instead of the bobbin, and producing perfect selvaged narrow breadths of lace.

Brown's machine has two beams, one on which the threads are wound, and the other to receive the lace. One half the threads employed are first wound on one beam and inserted into the other, the threads being parallel. The other half are contained in bobbins which are placed in carriages, and work in the circumference of a circle between the beams, the loose ends of these threads being inserted into the beam in which the others are inserted, and which is ultimately to receive the lace. The carriages are kept at equal distances by being placed between combs or teeth answering to Heathcoat's comb bar, and held fast during their motion by a bar pressing upon the carriages, called a 'locking bar', answering to Heathcoat's shifting bar. The crossing is performed by means of pins pushing one half the

diagonal threads to the right, and the other half to the left, forming two crosses, one of which is returned and used for the work. The other cross is done away by one half the diagonal threads moving to the right hand, and the other half to the left, changing the character of two bobbins every time they turn round the selvage. The crosses and twist are carried home to the edge of the plate by a swinging set of pins, and two sets of these act alternately.

Brown's beam on which the threads are wound is above, that containing the lace below; the bobbins, therefore, work in an inverted position between them. Brown works his lace carrying his cross and twist downwards. Heathcoat works just in the contrary order. The longitudinal threads in Brown's machine are those coming from the bobbins, those from the beam being diagonal threads.

These beam threads require that one half of them should traverse to the right, and the other half to the left, for the purpose of doing away one of the two crosses which is formed previously to twisting. This is effected by placing the beam in a frame like that which contains the roller of a castor in common table feet. The beam has thus two motions, one on its axis to wind up and let off the threads, and another upon an axis perpendicular to the other axis, by which the beam revolves in a plane parallel to its horizontal axis, the ends of the axis describing a circle of which it is the diameter. This beam is recommended by Brown to be of length equal to half the breadth of the lace to be formed. A little below this beam is a circular plate of brass fastened to the same frame which holds the beam, and turns with it upon the perpendicular axis on which the frame and beam turn together. The diameter of this plate is equal to the length of the beam. A circle near to the extreme edge of the plate is divided into a number of equal parts equal to half the number of threads, and then another circle immediately within this is divided into the same number, but so that each of the latter may be exactly between two divisions of the former. Small holes are perforated at all the divisions. These holes have to receive the threads from the beam above. The threads are wound on the beam in two layers, those in one layer passing through the holes in one half of the circumference of the plate, and those of the other layer through the other half. After the threads have descended a certain degree below the plates diverging as they proceed, they become of the intended width of the lace; at this distance the threads are received by a set of fixed points or pins, called 'dividers'; they serve to keep the threads at equal distances, and to prevent their diverging below this line.

Where the threads first pass through the plate they form a complete circle, the extreme threads in the right and left of the circle have simply a lateral divergence; those in the back and front at the greatest distance from the latter, will converge till they meet under the centre of the plate, while all the rest will take a compounded direction, meeting ultimately in a straight line determined by the face of the bar which contains the dividers.

The first threads which come from half of the circle will occupy the space between every other divider, while those in the back part of the circular plate will occupy the other vacant spaces. If the front half of the threads from the left hand were numbered 1, 3, 5, 7, &c. spaces of dividers; the back numbered in the same way would occupy 2, 4, 6, 8, &c. spaces of dividers.

It will be obvious that if the threads were detached from the dividers, and if free to move, the revolving motion of the circular plate would have the effect of causing one half of the threads to move to the right hand and the other to the left. This complicated apparatus is employed to do away the extra cross, instead of performing it by the lateral motion of the comb-bars. (It is much easier performed when the diagonal threads are contained in the bobbins, as Heathcoat's are, though there might be many contrivances to effect it without essentially altering the machine. A mere variation like this, in effecting this object, could by no means constitute an original machine, as endeavoured to be shewn by Brown's engineers, who spoke much of the planetary motion herein employed).

The diagonal threads being in one line, except while crossing, it is necessary to divide the threads into two rows before they can be moved in contrary directions. To effect this separation he employs two sets of pins forked at the ends to send out the threads from the dividers. One set of forks are longer and push out the threads which have to move to the right; the others are shorter, which have to push out those threads that move to the left. When two sets are thus formed one set is moved one division to the right, and another to the left, reciprocally changing the places of the threads. In this state they are allowed to fall into the dividers. The change will be effected of 1, 3, 5, &c., to occupy 2, 4, 6, &c., of divisions and *vice versâ*. Each pair of threads will now be crossed above and below each divider. Points are then raised to take down the lower cross. The upper cross has to be removed by the motion of the circular plate; each thread in the back half of the circle moving to the left, and those in the front half to the right, till the cross be removed.

Thus it will be seen that Brown's process of crossing does not differ materially from Heathcoat's. It has the same effect of forming two crosses, and has an extra motion in previous separation of threads.

The carriages are kept at equal distances by being placed in similar grooved bars; but where Heathcoat moves his bobbins in carriages along the grooves, Brown's combs move along with the bobbins. The pins employed in forcing up the cross act precisely alike in both. Heathcoat's crosses and takes up by two sets of pins. Brown also uses two sets for each.

It would perhaps be unlikely for any two other machines to be so different in appearance, yet so similar in construction and operation. A similarity of operation was admitted by Brown, but he denied similarity of construction. To this the following reply was made: "The bobbins in both move on pivots, and are held in place by springs. The carriages in each move in grooves or combs in the circumference of a circle by bars. The points act by lateral motion, forcing half the diagonal threads to the right, the other half to the left for crossing the threads in Heathcoat's, as do Brown's forks. Heathcoat's and Brown's points each

have a double motion to bring cross and twist to the work beam."

We now arrive at the case of Bovill *v.* Moore, in which the claim that was made to sustain the right of Brown and Freeman to the exclusive use of the machine they had constructed, was tried before Chief Justice Gibbs, on March 1st, 1816.

The Solicitor General for the plaintiffs rested his claim on this argument briefly stated:—"It is not necessary that every constituent part of a machine should be new, nor that any one part taken by itself should be new. It is sufficient if the combination be new, and applied for a purpose to which they had never been applied before. Almost all machines are composed of old parts; the beam, lever, roller, &c. are all old and well known; but if the combination be new and useful also, that will be sufficient: for the machine is composed of its different parts.

"In addition to 'point net' and 'warp net,' another machine (Heathcoat's) had been invented before this, with the view of making this sort of lace (traversed twist net), but Brown's machine was not similar to that in the combination of its parts, its productions, or the mode in which they are obtained. My case is not that this is a mere improvement on Heathcoat's machine, for if a man takes out a patent, and I, using that as a substratum only, invent a part, I should take out a patent only for the improvement I make. But however I may have had another machine before me, and though lace may have been produced by it, yet if my machine by a different combination of parts form together one new whole, then I do right to take my patent for a machine; for *qua* machine, it is a new one. I say this is a new machine; a new combination of parts producing a machine essentially different from any that has been produced before, though the effect of the former and the object of the present are the same; *i.e.* to produce lace on the same principle as a woman who works by hand producing lace. If the defendants can prove that mine is an imitation of their's that will avail them; but it is a new combination of parts effectually constituting a new machine." The Solicitor General also pointedly remarked: "It is most extraordinary that Heathcoat's patent was taken out in 1809 and John Brown's in 1811, that if the former deemed the latter an infringement he had never thought fit to bring any action in a Court of Justice on account of it."

With the reason for this reticence on the part of Heathcoat, the reader is already acquainted. At the time it was not known much beyond his advisers, legal and otherwise; nor was it politic or necessary to explain it upon this occasion.

Serjeant Copley, for defendants, thus stated, in brief, their case: "A new combination of old machinery may be the subject of a patent; but when one takes out such a patent he should call it 'a new combination of old machinery,' or 'an improvement of former machinery.'

High authority has decided that, the Act requiring the specification, when he specifies to what his patent goes, he must describe what is old and what is new. If he takes to himself every part by the terms of his specification, then there is no individual who could take any part of it, and the public has a right to know what he claims and what he does not. Now Brown describes all the simple parts of his machine and all its combinations, and thus appropriates to himself more than he is entitled to; this patent therefore cannot be sustained. The primary parts into which his machine may be ultimately resolved will be shewn to be old; and that the complete combination of it is old. There are parts of this machine which, if taken away, it would not work; and which parts are in themselves machines, and are now subjects of patents. These the plaintiff has incorporated in his patent without describing them as old, and as such he appropriates them to himself. The only point of originality in his patent consists in his making the beam threads traverse instead of making the bobbin threads traverse. In other respects it is similar to those used in Nottingham for a considerable time past."

The learned Serjeant had thoroughly studied both the machines, and made net on Heathcoat's, so that he was enabled to work the models on the table, explaining the various parts and precise nature of the invention with such clearness, as to astonish alike judge and counsel, jury and spectators. His masterly handling of the case was much and most favourably remarked upon at the time, and had, it was said, an important bearing on his subsequent professional career.

Chief Justice Gibbs concluded his summing up of the evidence thus: "If a conformation of those parts existed before, or if a combination of a certain number of those parts existed up to a given point before, and Brown's invention springs from that point and adds other combinations to it, then his specification stating the whole machine as his invention is bad. But if you think he has the merit of inventing the combination of all the parts from the beginning, I think his specification is good, and that he is entitled to your verdict."

The jury immediately pronounced a verdict for the defendants.

The Chief Justice: "Do you find the combination of the parts up to the crossing of the threads is not new?" The Foreman: "Yes, my lord." A Juryman: "The threads then taking a new direction; and certainly the most valuable part to the plaintiff is a new invention; but it is nothing more than an improvement."

A new trial being moved for before Lord Chief Justice Gibbs, Dallas, and Parke, (Abbott not present), it was unanimously refused on the ground that "a patent must not be more extensive than the invention. If the invention consisted of an addition or improvement only, a patent for the whole machine was void."

This conclusion of the conflict between the infringers themselves gave as its necessary consequence a legalized firm ground to sustain the original patentee in claiming his rights. Amongst those who submitted to them, were the plaintiffs and defendants in the late action.

It is interesting to know in what way Heathcoat viewed John Brown's traverse warp machine, and its position in regard to his own patented invention. His words are these:

"John Brown arranged his traverse warp and took out a patent for it *as for an entirely new invention;* not, as it really was, in the then state of knowledge as to the principle of my machine, a *great improvement*, enabling *very narrow breadths* to be made, though slowly, *of excellent texture*, indeed perhaps *superior to any other*. Soon after this Benjamin Moore constructed his traverse warp, and being sued as an infringer by Brown, two trials took place. Moore's reply in substance was, that Brown's machine was not new; and that if there were any infringement, it was by both Brown and Moore of my patent."

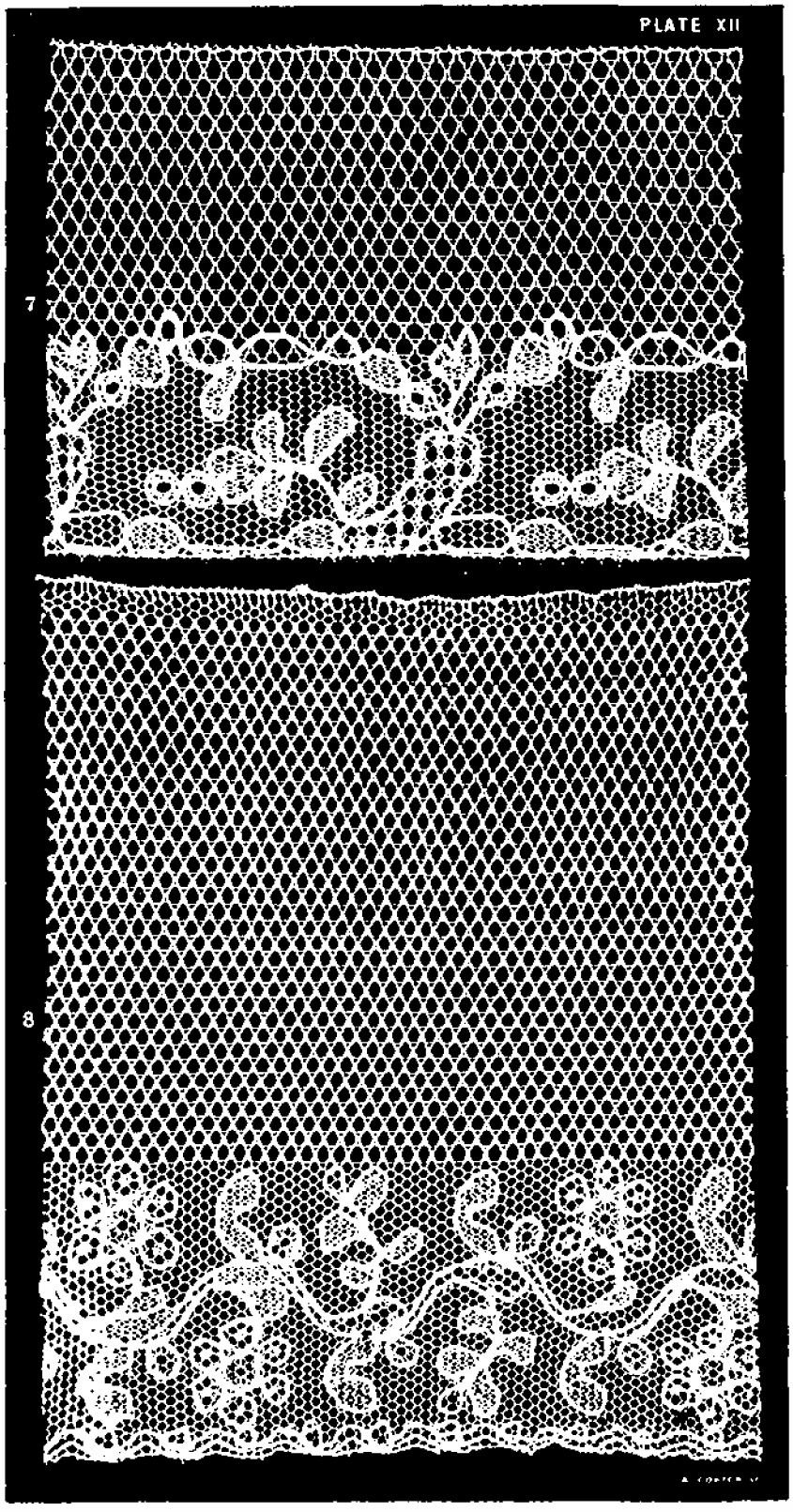
This statement of the matter is the correct one. As a machine for making plain net breadths, the traverse warp was unrivalled. When quillings went out of fashion, notwithstanding a simple and effective application of Jacquard apparatus to these frames, they have succumbed to the levers and have almost disappeared. We hope one of them may make its way to the Kensington Museum before the remainder are broken up. It is certainly a most interesting machine as a study. Thus Mr. Babbage designated it to the author after a two hours' close examination in 1833. It was a marvellous instance of constructive genius. Within two years of Heathcoat's specification reaching Nottingham, this surprising travesty of it made its appearance; and within two years more, from an independent quarter, a second machine having all its special character and attaining a similar end was brought out. There must have been an astonishing aptitude for overcoming mechanical difficulties at that epoch in the district whence these feats of skill emanated. Setting aside all considerations of plagiarism and infringement, this tribute of admiration is due to the talent which dared to attempt and actually succeeded in causing the warp to traverse instead of the bobbin. A plate (No. VIII.) is given to assist in perpetuating the knowledge of this machine.

The defendant Benjamin Moore's machine was constructed, in conjunction with Longmire and Noble, in 1812, at New Radford, under circumstances of difficulty that would have dismayed most men. Thus much there is no doubt of, for though carried on almost upon the same spot where Brown's was commenced, it does not seem that there was any intercommunication between the parties, and it is not certain that Moore's was a copy of Brown's. On the contrary Moore's family declare it was an independent construction. There is not one of Moore's remaining to test the fact: but no doubt both had seen Heathcoat's plan and worked from a common source to a like end. Unquestionably the trade desired ardently to be freed from patent rights, and to share in the profits derived from the manufacture. The expense of the course of litigation between these parties, occurring from October, 1816, to July, 1817, was enormous; £4200 on the defendant Moore alone, *i.e.* the winning side; of which he received from the losing plaintiffs for taxed costs £1345 or £1488, it is not certain which. How much it cost Brown we could never ascertain. "During this period Mr. Heathcoat visited Mr. B. Moore, from time to time, to talk the affairs of traverse warp frames with him." The result of the trial was received with great joy at Nottingham.

This class of machines furnished so few incidents of importance to the trade in after years that they may be most conveniently related here. Mr. Samuel Weston reduced the traverse warp motions by crossing and lifting up the point bars at the same time. Mr. Samuel Moore first put the whipping thread apparatus to the breadths. Before then they had been whipped together by hand before dressing. Nunn and his partners tried at first to get their machines worked at Warwick by tape weavers, but they required far more highly skilled workmen, and to such they had to entrust them, paying them for some time £7 to £10 a-week wages. Part of their machines were afterwards taken to Blackfriar's Road, London, and part to Whippingham in the Isle of Wight. A portion of these have remained there till now. About 1819, Mr. Brown died in London a rich man. Mr. Freeman resided for years at Tewksbury, having realised

considerable wealth, it is said, amounting to what is called 'a plum.' In 1825, Crowder combined the pusher with the traverse warp, but the result was a too delicate machine. In 1828 spotted net was made on the traverse warp frame; also Barnes and Deverill put it on to rotary power, but the warp threads got entangled in work, and it failed. In 1831, Barnes and Z. Bryant failed in a combination of the levers and traverse warp. In their machine the warp traversed by the action of the worms of two screws revolving on horizontal pivots and carrying the front warp threads to the right and the back to the left. This year, T. Alcock, of Worcester, put into the traverse warp an extra point bar, rising and falling in every traverse to carry up twist and keep threads from entangling; upon this he is said to have made six racks in an hour. Alcock constructed the same year a single tier traverse warp with rolling locker; the carriages, four and a quarter inches long, moved in circular combs; it is said to have produced ten racks in an hour, but that is very doubtful. This year, 1832, Freeman produced spotted net without clipping threads, and also honey comb net. In 1833, Mr. Nunn made at his factory in the Isle of Wight, a pattern in imitation of French white silk blonde, which he called 'Neige.' This was sold as real lace without detection during a whole season, it is said to the amount of £60,000, of which sum probably £40,000 was profit. Mr. Birkin and Mr. Vickers were both threatened with legal proceedings by Nunn, for producing the same pattern and article on other kinds of machines. But the pattern had been copied originally from a foreign lace, and the threat was disregarded.

PLATE XII



CHAPTER XVI.

LUDDISM.

THE war of 1803 brought yearly increase of taxation, and, being attended by bad harvests, the whole nation suffered, but especially the midland district. The times became troublesome and dangerous, issuing in the revival of Luddism. Frame breaking, as a mode of intimidating employers into compliance with the views and wishes of their workpeople, did not originate in the midland counties and in the present century, as is generally supposed, but was practised in London at least 150 years ago, when the disputes which had occurred for some years respecting the number of apprentices taken by master stocking-makers, came to a point, because one Nicholson had gotten very many of them. The unemployed and irritated journeymen proceeded to break about 100 frames thus worked by him and others, throwing them out of the windows, beating both the obnoxious masters and their apprentices. This occurred about the year 1710, and was confined to Old Street Square, Bunhill Row and the neighbourhood in St. Luke's, Shoreditch, and Cripplegate. The masters were deterred by these proceedings, and agreed to abide by the trade rules as to apprentices in future; while none of the rioters were punished, it is said not even apprehended. But one of the masters who had thus promised, named Fellows, decided to remove his frames to Nottingham, where he set at nought the rules, and, it is said, had at one time forty-nine apprentices, of whom many were bound by their parishes to him; the practice being to pay at least £5 each to the masters on thus getting rid of them.

This system of apprenticing by parishes to the weaving trades throughout the country, besides causing

much suffering and demoralization to the oppressed and friendless youths of both sexes who were its victims, gradually so overloaded the trade with wandering unemployed journeymen, as to cause serious riots in various manufacturing populations.

A committee of the House of Commons, after sitting to hear evidence on the subject, instead of stopping the malpractices of parish officers, passed an act in 1727 punishing with *death* those who destroyed the machinery used in making cloth or hosiery of woollen materials. Whether from the terrible penalty thus threatened, or the greater area over which frame-work-knitting was rapidly spreading in England, acts of violence to the persons or property of hosiery employers seem to have practically ceased for forty years. Though the trade was manifestly leaving London, there were still colonies of stocking-makers here and there; one of the latest of which was located in Spitalfields, where the frames chiefly made silk hose; and thus were nearly allied as to materials with the staple weaving trade of that district. The latter was much excited in 1770 on account of depression of wages, and which were sought to be raised by the terror arising from nightly destruction of the warps in those looms, the wages for weaving in which were paid for at an under price. These nefarious proceedings were largely aided by the neighbouring frame-work-knitters. Some of the silk weaving rioters were taken, convicted, and hanged in front of the doors of the houses where the offences were committed. The London stocking-makers were greatly deterred by this severity from such lawless proceedings in future. Besides the Spitalfields' act, another was passed empowering justices to regulate wages, and if needs be to raise them—a measure which was not repealed until 1824.

The riotous spirit was not laid at rest; it had only migrated into the midland district of England. Two bills having been rejected in 1778-9, which had for their object the regulation of apprenticeships and prevention of fraudulent work, chiefly upon the evidence of Mr. Need and some other hosiers, the country stockingers flocked into Nottingham, their frames were thrown

broken into the streets, and a house was burnt down between 10th and 19th June, 1779. Much other property belonging to obnoxious hosiers was destroyed. The riot act was read, and soldiers were called out. Such was the effect upon the minds of the authorities as well as the hosiers, that at the instance of the former, the latter, on 19th June, declared themselves unanimously determined as a body, "provided an immediate cessation of violence took place, to remove every oppression from their workmen, and to bring all the manufacturers up to a fair price, not the highest rate, but the best generally given." Upon this peace was restored. A man, Mephringham, was tried at the assizes for aiding in burning the house, but was acquitted: upon which this sad conflict was allowed to come to an end. On this occasion about 300 stocking-frames belonging to Need and others were broken, they having been mostly employed in making spurious and, as it was then and up to 1850 generally considered by the workpeople, fraudulent work.

In 1773, a newly invented stocking-machine was taken out of the Exchange at Leicester by a mob and destroyed, in spite of the entreaties of the mayor and others. Also Coltman and Gardiner, wool combers of Leicester, had a man in their employ in 1788, who invented the present mode of spinning animal wool by machinery into worsted yarn, applying the principle embodied in Arkwright's cotton spinning frames. To this man, named Brookhouse, the Leicester woollen hosiery trade is indebted for laying the foundation for much of its great extent and flourishing condition. His new plan was approved and taken up by Messrs. Coltman and Whetstone, two of the largest makers of worsted yarn in Leicester, and machinery was constructed to carry it into effect. But it was all destroyed by a mob of workpeople, together with the dwellings of Coltman and Whetstone. Before the riot could be quelled the military were brought into the affray, and blood was shed.

Thus the use of this important process was driven from Leicester at that time into Worcestershire, Yorkshire, and even to Aberdeen; from which parts for the next

forty years, Leicester hosiers had to obtain much of the materials they worked up. Meantime Mr. Brookhouse set up his machinery at Warwick, and worked upon his invention with such success as to gain a fortune, upon which he retired.

A list of prices, which had been agreed to in 1787 by both masters and men, had been in the main adhered to during the following twenty years, when from rapidly decreasing demand lessened prices for goods and consequent pressure upon the workmen ensued. In 1809 several hosiers, amongst whom were Haynes, Nelson, Brocksopp, and Eaton, agreed to reduce their wages 3*s.* per dozen if the workmen would not or could not obtain a reduction of frame rents, and the entire cessation of cut up spurious work. To these two things the workmen were very heartily opposed; but at a time when they could only get scanty labour if any, such as was within their reach, however ill remunerated, was not to be rejected. The time and circumstances on which the author is now entering, he himself passed through, and he has a most painful and vivid recollection of them. The fear of an entire cessation of demand in the markets of North America, the heavy burden of war taxation and the loans necessary for national purposes, left manufacturers everywhere only confined means, and lowered credit. In the hosiery districts the warehouses were full of goods. How many thousands of times was that cry repeated—"Give us work at any price; half a loaf is better than no bread!" It was a heavy cry uttered too often ever to be forgotten. The years 1811-12 were sorely distressful, and even dangerous in a high degree throughout the three midland counties. There was as little unity of opinion amongst the hosiers as to the causes of the difficulty under which all were labouring, as amongst the men. The higher class of employers paying best wages and making the best goods, eschewing altogether the manufacture of the spurious cut up goods, laid the larger part of the blame on their lower competitors giving less wages, making worse goods, underselling them, and destroying what little confidence buyers who still possessed means had in making purchases. The misery of the poor

dependants on wages which when at work were reduced to an average of about 7*s.* a-week, but often not now in their power to earn, rapidly drew towards the point that passes endurance, as the close of the year 1810 approached. So great and rapid was its progress during the next year, that the number of unemployed families relieved from the poor rates of the three parishes in Nottingham on the 30th January, 1812, was 4248, including 15,350 persons, or nearly one half of the then population. For twelve months past many working men had swept the streets in Nottingham, Leicester, and Derby, receiving a scanty eleemosynary pittance for their labour. Threats of vengeance had been loudly uttered against hosiers paying reduced wages. Early in March, 1811, many of these men came in from all parts of the county, and proceeded to carry their threats into execution. There was an assemblage in Nottingham market-place. The military appeared, so there were no acts of violence attempted in the town. But sixty-three frames, chiefly belonging to Messrs. Bolton, were destroyed at Arnold that night. Two hundred more were broken in the next three weeks. These things were done no doubt by persons led on by able, daring, and resolute workmen. How many there were thus banded (as it was no doubt justly stated on oath), was never known publicly. It was believed the number was small of those actually engaged in the work of destruction, and that most of them were young. If so, they compensated by an activity almost ubiquitous for their want of numerical force.

But this would partly account for their unexampled secrecy, and the fact, that for years scarcely any were brought to justice. Samuel Slater, a frame-smith, was said to be a principal leader, if not general Ned Ludd himself—so designated from the act of one Ludd or Ludlam, a Leicestershire lad, who, when desired by his father, a stocking-maker, "to square his needles," *i.e.* to place them in a perfectly straight line in the front of his machine, took his hammer and beat them into heaps. There were said to have been four companies or gangs, one each for the districts of Sutton Ashfield, Nottingham, Arnold, and Swanwick. Frames

were sometimes demolished the same night at places twelve miles apart. They made their attacks in parties of from six to fifty, and seem to have implicitly obeyed the command of their leaders. Those on guard were armed with swords, pistols, guns, and other weapons; the actual frame breakers carried sledge hammers, axes, &c. After the work of destruction was done, the captain called them over by numbers, to which they answered, and on his firing a pistol, the men uncovered their faces and dispersed.

An effective military force of about 800 horse and 1000 foot, was concentrated chiefly in and near Nottingham, under the direction of several experienced military officers who had orders to consult with the local magistrates and two London police magistrates, specially sent down by government, to assist in every way practicable. Money was secretly offered for information; and a royal proclamation was issued offering £50 reward for the apprehension of any offender. Notwithstanding all these measures, the devastation increased in extent and violence as the winter came on, and many country frames were brought into Nottingham for safety.

In November, 1811, one Hollingsworth's frames were broken at Bulwell, and all the furniture in his house destroyed. On this occasion resistance was offered by discharging loaded fire-arms at the assailants, whereby one of them, John Westby, of Arnold, was mortally wounded. There was great excitement at his funeral; the riot act was read; the high sheriff, magistrates and military being present. The enraged rioters destroyed next day a waggon-load of frames near Arnold, and a few days after thirty-seven frames at Sutton in Ashfield, belonging to one Betts, whose factory they sacked. Soon after he died deranged. Here the Yeomanry Cavalry caught four frame-breakers—Bradbury, Marshall, Green and Clarke—who were committed for trial. Stacks were burnt whose owners were active members of that force. In the following week thirty-six more frames were broken. The magistrates published a letter which states:—

"There is an outrageous spirit of tumult and riot, houses are broken into by armed men, many stocking-frames are destroyed, the lives of opposers are threatened, arms are seized, stacks are fired, and private property destroyed, contributions are levied under the name of charity, but under the real influence of terror."

It goes on to point out—

"That all this tends to insurrection, and that it is their duty to suppress these evils by civil and even military force, and to cause the due execution of laws which will affect the lives of offenders."

This address had no effect in checking the outrages. In the last week in November, forty-five frames, chiefly making cut-ups, were broken at Basford, and others at Nottingham, Chilwell, Cossall, Eastwood, Heanor and Arnold. Upon this, the public-houses were ordered to close at 10 P.M. and inhabitants warned not to be out after that hour. The hosiers and lace manufacturers now felt sufficiently alarmed to hold a general meeting, at which it was resolved, "that if peace were restored they would be prepared to receive and consider proposals from their workpeople and remove grievances if any were found to exist." Twenty more frames were destroyed the following week, and the minds of the people were evidently inflamed by the tenor of the Royal proclamation. Farmhouses were plundered of provisions and money by men who declared "they would not starve while there was plenty in the land." It was in this last week of November, 1811, that the writer of these lines, then a youth of scarcely seventeen, was required by his masters to get into the saddle and make a long round, to convey the information that if their frames, of which they employed about 3000, were spared from the destruction with which they were threatened, one shilling per dozen advance would be paid the following Saturday, and be continued whether others paid it or not. It was a dreary afternoon with heavy rain and winter sleet. He rode hard, and at Basford, Bulwell, Eastwood, Heanor, Ilkiston, Smalley, Sawley, Kegworth, Gotham and Ruddington, delivered to their head frame-work-knitters the joyful news of the offered advance. The wintry storm, though uncomfortable enough to the messenger, tended greatly to the success of his message. It prevented for that night the maraud-

ing parties employing themselves; these frames had been undoubtedly doomed, for an example, as belonging to one of the most influential houses in the trade. The promise made was faithfully performed; not one of their frames was injured, and no further fears were excited as to the safety of their property. The author served for a whole year (at this time of alarm) as a special constable, and though so young had others, at first civilians and afterwards foot soldiers, to lead every second or third night. In the latter case six men armed with muskets were told off, and at 5 P.M. having received the instructions and pass-word from the sitting magistrate, he did the duty of patrolling with them in the town until six the following morning. The responsibility was new and weighty, and not altogether unattended with danger, the Luddites being armed; and knowing they hazarded their own lives, they were not chary of the lives of others. Their daring and courage were shewn in the instance of one who entered a house alone in Rutland Street, Nottingham, one evening; proceeded up stairs and smashed the material parts of a frame in a minute or two; but that short time was sufficient to cause an alarm; constables were in front of the house, and the author happened to be on duty, in Park Street, behind it. The man at once perceived his danger, threw himself on the roof; passing along others he saw in the dim light that the earth had been lately turned up in a garden below, and leaped from the eaves of a three-story house upon it. The frame-breaker quietly passed through a kitchen where a family were at table, and escaped. In a few minutes the shouts of a sympathising crowd were heard at New Radford, half a-mile from the scene of the adventure. Nineteen warp frames worth £200 were broken at Linby, and fourteen stocking-frames at Ruddington, with twenty at Clifton, in the first fortnight of 1812; also fifteen frames were destroyed at New Radford, nine at Basford, nine at Hucknall, five in Nottingham, and three at Butwell—sixty-eight in all; and the Sunday night following, eight in Nottingham in eight minutes. Wheat was now £5. 8*s*. per quarter, employment scarce, and there was great suffering. The

town of Nottingham seemed as if in a state of siege. A large subscription was now entered into throughout the county, for the purpose of stimulating endeavours to suppress these outrages. It was headed by the names of the Dukes of Newcastle and Rutland, Earl Manvers and Lord Middleton, with others of £500 each; Messrs. Sherbrooke, Manners Sutton, and many others, £100 each, &c.

At the March assizes in 1812, judge Bailey sentenced four frame breakers to fourteen and three to seven years' transportation—leaving the commission of assize open, that if needful he might return and administer summary justice on any delinquents. At the July assizes, one was sentenced to fourteen years' transportation and another to three years' imprisonment for frame breaking.

In March an act was passed, extending the punishment of death to any one breaking a frame employed in manufacturing any kind of material. In April, Mr. Trentham, a Nottingham hosier, was shot by two men, but not mortally wounded, while standing at his own door. They were never discovered, although £600 was offered for their apprehension. In November this year, Luddism became again prevalent, chiefly on Sunday evenings. Several frames were broken at Sneinton; but a bold defence of some others, made by Mr. Black, caused the practice again to cease for a time.

When the government brought in the Bill which made breaking frames punishable with death, Lord Byron strongly opposed it in a debate which took place in the House of Lords, 27th February, 1812. In this, his maiden speech, he forcibly described the condition of things then existing around and in close proximity to his own dwelling, Newstead Abbey. His Lordship said—

"To enter into any detail of the riots would be superfluous, the House is already aware that every outrage short of actual bloodshed has been perpetrated, and that the proprietors of the frames obnoxious to the rioters, and all persons supposed to be connected with them, have been liable to insult and violence. During the short time I recently passed in Nottinghamshire, not twelve hours elapsed without some fresh act of violence; and on the day I left the county I was

informed that forty frames had been broken the preceding evening, as usual, without resistance and without detection.

"Such was then the state of that county, and such I believe it to be at this moment. But whilst these outrages must be admitted to exist to an alarming extent, it cannot be denied that they have arisen from circumstances of the most unparalleled distress. The perseverance of these miserable men in these proceedings tends to prove that nothing but absolute want could have driven a large and once honest and industrious body of the people into the commission of excesses so hazardous to themselves, their families, and the community. At the time to which I allude, the town and county were burdened with large detachments of the military, the police were in motion, the magistrates assembled, yet all the movements, civil and military, had led to nothing. Not a single instance had occurred of the apprehension of any real delinquent, actually taken in the fact, against whom there existed legal evidence sufficient for conviction."

During these excesses in Nottinghamshire, though few frames were broken in Leicestershire, yet the spirit of discontent was equally active there, but it shewed itself in a far more rational form. During the disturbances which prevailed, producing great alarm amongst the resident nobility and gentry, as well as all persons of property and others peaceably disposed, Mr. Gardiner relates, in his *Music and Friends*, vol. i. p. 476, that—

"Being at Wigston Hall, Lord St. John enquired of him their cause; to which he replied, 'a party was going about drawing out and taking away the jack wires from the frames of *those working under price*.' This act renders a frame useless for the time, but does not injure it; and when restored, the part may be replaced in the frame, by a competent person, in a few minutes time, so that it may be set to work again. Jack wires had been drawn and deposited in the churches at Arnold and elsewhere, before the more decisive step of destroying the frames was adopted."

During the same year, 1811, Gardiner, being in London to oppose as a hosier the proposed bill for legislatively giving powers to fix the fashion and price for making all kinds of frame-work knitted goods thereafter to be made, had an interview with the Archbishop of Canterbury, Dr. Manners Sutton, the representative of an ancient Nottinghamshire family, in the course of which his Grace said, "I am much alarmed at these Luddites, and fear they will produce a commotion if they are not speedily put down." A fear which pervaded for the time the whole kingdom. Gardiner replied:

"It is to be lamented that the operatives entertain very wrong notions about the improvements in machinery; and I am sorry to find well educated persons join them in saying they are injurious to their interests. Genius is not to be stopped in this savage manner. If invention is not allowed to work here, it will be carried abroad and ultimately destroy our trade."

Upon this subject an old and experienced Leicestershire stocking-maker remarked, "Frames were broken in 1811-15, not on account of disputes about wages, but of cut-up work, which lowered the demand for fully wrought goods, and so tended to reduce prices generally."

In October, 1814, the house of Mr. Thomas Garton, at Basford, was attacked. This person had caused the apprehension of a sworn Luddite, James Towle (afterwards hanged at Leicester) and being in expectation of this visit, he had obtained the assistance of several constables who were then with him. Several shots being fired, they fired in return, when Samuel Bamford, one of the assailants, fell. The rest in retreating shot a neighbour, Mr. Kilby, dead at his own door, which he had opened on hearing the report of firearms. Some wide frames making cut-up work were broken in and near Sutton in Ashfield about this time.

A long cessation of Luddism ensued, until, in the night of the 18th of June, 1816, nineteen lace machines were broken in the shops of William Wright and Thomas Mullen. Two men were tried for this offence, and saved by their counsel, Mr. Denman, successfully pleading an alibi. If they had been convicted the judge and jury were to have been shot by armed men, many such being in the court.

Whether the daring character, the extent of property destroyed, or the consequent dreadful results to the culprits, be considered, the attack on the factory of Messrs. Heathcoat, Lacy, and Boden, at Loughborough, which took place in the night of the 28th of June, 1816, was one of the most deplorable of these memorable affairs. Fifty-five frames were destroyed of the value of £8000 or £10,000, and the lace upon them was burnt. But the most serious and fatal part of these proceedings to the prisoners ultimately tried, was the "firing a pistol at John Asher, one of the workmen in the place, with intent to kill him." James Towle, who had been pre-

viously tried for frame breaking and acquitted, was found guilty of this attempted murder at the Leicester Assizes in August, 1816. He was executed in presence of an immense multitude, shewing undaunted self-possession, repeating and singing a hymn with seeming fervour.

Daniel Diggle was convicted at Nottingham, in 1817, of shooting George Kerrey, at Radford, in December, 1816, and wounding with intent to kill. He had pleaded guilty, and deplored on the scaffold his association with Luddites, thereby disobeying the commands of his parents.

The same year, at Leicester, eight men, Savidge, Withers, Amos, Watson, Mitchell, Caldwell, Crowder, and Clarke, were arraigned for the attempt on the life of Asher at Heathcoat's factory. John Clarke was tried alone, on account of the challenges exhausting the jury list. On this occasion there was the additional evidence, such as it was, of Blackburn and Burton, two accomplices, given avowedly to save their own lives. It seems from the statement of the first of these, and who appears to have been an active man amongst the managers of the frame breaking conspiracy, that £18 was given Withers, (who probably led the party and was one of the prisoners), with which to buy tools and fire-arms for the rest; £40 more was promised to be paid when the frames were broken, and £60 more to be collected and distributed among the men actually engaged. Savidge was active in the money part of the affair. "The Radford job had not yet been paid for, though promised; and none but *old* Neds" (men who had been thus employed before) "would do for this expedition," which was felt to be one of hazard, requiring the utmost boldness and experience. Seventeen names were enumerated as forming this picked party. The jury found Clarke guilty; as did another jury the next day the seven others. A woman, whose husband was a workman in the factory, gave evidence, that hearing the noise of frame breaking, she went into the street, and being laid hold of by Savidge, one of the prisoners, asked him why they broke the frames? He answered, because Heathcoat's men were working under price. On which

she replied, the men were satisfied, and they had no business to break the frames. She swore to the identity of seven of the men charged.

Being found guilty, six were hanged and two were transported for life. The former shewed great firmness, addressing the spectators, and all joined in singing a hymn, one repeating it for that purpose. Fifteen thousand spectators witnessed the execution. After this scene Luddism seemed to have become extinct; no frames being broken in these parts for several years. About one thousand stocking-frames and eighty lace machines were destroyed during this outburst of popular frenzy.

The practice extended into the northern counties, it was professed on account of the increase of machines directly calculated to supersede manual labour. In regard to the object had in view by the Nottinghamshire frame breakers, opinions at the time and since have much varied. Probably there were various hopes entertained by the multitudes around, who sympathised undoubtedly with the movement, though they stood aloof from personal efforts to promote it. The broad substratum of the whole of this wretched heap of wrong-doing was undoubtedly the hunger and misery into which the large portion of the fifty thousand frame-work-knitters and their families were fallen, and from which they never fully emerged for the following forty years. During that long interval, the average of the frame-work-knitters clear earnings by long hours of labour did not exceed six shillings a-week.

It was upon the occasion of the condemnation of the eight men at Leicester, that G. Henson and William Robinson took up to London a numerously signed petition for mercy, but before it could be presented, Henson was arrested, examined before the council, and confined seven months in Coldbath fields as a state prisoner, on suspicion of high treason.

Amongst the papers on trade subjects which Grovenor Henson left behind him, is one, which if true—and there seems no reason to doubt it, as to the main facts related—throws considerable light on the question how this bobbin net frame breaking originated and was carried into effect. The paragraph is as follows:

"The patent machines were worked by hand; in a few years wheels were put in to work the carriages by machinery, which improvements doubled the speed, and these machines were called 'Loughborough improved.' But even then, the patentees were pressed by the warp Mechlin nets, and had to reduce wages one-third. Upon this the (Nottingham) warp committee confederated with Lacy's Loughborough hands and the turn-outs; and the resolution was taken, though it was then in the midst of summer, to destroy his machines. This was effected. Heathcoat was obliged to build entirely new machines."

Lacy's hands referred to, were probably point net or warp lace workmen. When Heathcoat's patent traverse net factory was established, the newly sprung up manufacture of warp lace was making rapid strides towards taking the place of the decaying trade in point net, and absorbing the hands, gave a very high rate of wages, therefore these workmen could well afford funds; and to destroy so formidable a rival as the twist net patentee, they would be very likely to find the money. About £120 in all was promised for this business, and another recently performed was yet owing for, shewing that in both trades, hosiery and lace, when it was a question of breaking frames, the work was done for hire. No doubt the committee would select the 'old Neds' most suited for the purpose. The members of these trade societies were at that time and for twenty years after, bound together by secret oaths, and their leaders acted with most despotic power. It is not too much to say, that there was no trade combination in the three midland counties during the first forty years of this century with which—though he might not, and in this instance doubtless did not, take a part—Henson was not acquainted, both as to their leaders and designs, and in due time their operations. Thus, before the first frames were broken in March, 1811, at Arnold, at a conference with Brocksopp and other hosiers, it had been agreed "to give the men *un*abated wages, provided they would join in bringing up the under paying masters to the same standard and to put down cut-up work." Henson expresses, in his manuscript account, great indignation because the men in this instance would not carry out the plan—which if he did not devise, he strongly approved—but went and broke Brocksopp's frames amongst the first batch at Arnold.

In various conversations twenty to thirty years after, he recounted at some length the fears and hunger and thirst of four of the men amongst the seventeen who made the attack on Heathcoat's factory; who lay concealed, he said, the whole of the following day in the long grass then covering Loughborough meadows, not daring to stir from under the burning sun till night, and then not venturing to cross the bridge over the Soar, or through the toll bar at Cotes, for fear of detection, taking bye-paths along the river by Zouch Mills, there crossing it, and so pursuing their course over Red hill, crossing by the Trent ferry at Barton they took their way along the bank, till they reached Nottingham and their homes. The names of three of these he mentioned, whom he described as having been deeply implicated in most of those acts of violence since 1811; but who on effecting this escape, and the equal danger of being denounced by approvers on the trials of their comrades, separated themselves from all lawless courses ever after, becoming wiser and sadder men. One of them lived until a few years ago, employed as care taker of valuable stock in a warehouse, and was a faithful and trusty servant. He wrote, it is believed, a full account of what he knew of Luddism, to be read after his death. But the paper, if it exists, has not been accessible to the author, through the sudden and lamented decease of the late Alderman John Bradley, of Nottingham.

The name of the fourth frame breaker who escaped, Henson would never reveal, but promised to leave behind him "an historical account of Luddism," of which, if he should die first, the present author might avail himself. Such a document has not been found, which is much to be regretted, as its contents would have been both curious and valuable. So much was gathered from Mr. Henson, notwithstanding the decided repugnance he usually shewed to enter into details on this subject, as to make it quite evident that the executions, which took place in 1816-17, were, in his opinion, the efficient cause of the disappearance of Luddism from the midland counties.

The proprietors of the machinery which had been

destroyed at Loughborough, sued the county for the damage, which on an enquiry ordered by the King's Bench, it was decided must be paid to the amount of £10,000. The magistrates required that the sum when handed over should be expended locally. To this Mr. Heathcoat gave a decided refusal, and the amount was never received. He said that "his life had been threatened; and he would go as far off as possible from such desperate men as these frame breakers were." He agreed with Mr. Lacy that their future course as to the erection of new machines should be distinct; and in conjunction with Mr. John Boden, of Loughborough, who had become a partner and the director of the sale of their lace goods in London, a purchase was made of a large mill at Tiverton in Devonshire, where machinery could be driven by the powerful stream of the Exe. This building was restored and enlarged, and the construction of rotary *power* machines was *at once* commenced and vigorously carried on until in the end three hundred were at work there. This decision, directly consequent upon the unlawful and deadly violence of a combination of workmen, has already deprived the midland district of the employment and profit derived from six or seven hundred machines, during the fifty years which have since intervened. Comment on such a fact is unnecessary.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CHAPTER XVII.

MR. JOHN HEATHCOAT.—1816 TO 1860.

THE events which had just transpired at Loughborough proved in their results to be the turning-point in the life of the bobbin net inventor, by fixing him in a new sphere, employing improved machinery worked by new and inexpensive motive power, and in the midst of cheap labour freely employed. He set himself vigorously to work for the improvement of these advantages. The description of several modifications of his machinery, made by others since that of the traverse warp, has been postponed, with a view not to interrupt the relation of Mr. Heathcoat's course. The like plan will be pursued as to the other more important inventors, whether in hosiery or lace.

The next machine patented by Mr. Heathcoat was in 1816, No. 4037. He describes himself as late of Loughborough, now of Tiverton, lace manufacturer. His accurate knowledge of the construction of Lee's stocking-frame is not only demonstrated by the way in which he deals with its various parts in this ingenious modification of it, but he boldly subjected it to the processes necessary to produce the mechanical narrowing of the web, in place of performing it as hitherto by hand; and, in addition, added rotary motion to it. This attempt, forestalling by thirty years the course of adaptations and improvements, which have been successfully carried out for the like purposes only since 1845, was meditated and executed just at the time when his bobbin net machinery was destroyed, and when he would be deeply engaged in replacing it by other frames on improved models. In this specification of a modified stocking-frame, after giving a clear and succinct descrip-

tion of the working of Lee's machines the following new arrangements are set forth:

The placing two or more sets of needles in a frame over each other, so that one set of jack sinkers and one set of lead sinkers will form loops on each row at the same time. Also dividing the sinkers into two distinct parts, the one part applied in front of the needles, and the other he calls hooks. There is a further combination of parts described as thread layers, used so as to lay threads for the supply of several tiers or sets of needles, and of passing the threads between the needles so as to narrow the web on each edge, thereby enabling the machine to produce two or more webs at once in different heights or tiers by one set of jacks, and narrowed where desired. Also, finally, by a suitable arrangement, causing the machine to work entirely by the revolution of one pulley or drum.

In the same year 1816, No. 4078 was taken out; and before proceeding to state in it the further improvements he had made, Heathcoat described the modified operations up to that time of his bobbin net machines—

As seen in the fetchers and shifting bars, in the action of the feet; in the method of moving the brasses between the beam threads; and describes five movements to pass the back division of brasses between the beam threads from front to back; and seven more to pass the front division to the back, then five to return the back division to the front, and eight to cause the front to follow them. Also machinery for shogging guide bars; and for acting on the points in crossing and taking up meshes; and for better producing the turn again and selvage.

The improvements claimed in this patent are: a new application of added parts or guides to supply gimp threads to ornament the lace as it is worked. Applying machinery to give such motions to these additional guides as will direct and interweave the gimp according to the desired pattern, laying it along the sides of the meshes, not twisting the mesh threads round the gimp, but passing it longitudinally, diagonally, or horizontally. Also machinery for interweaving cloth work, either every course or discontinuing it to suit the pattern.

In constructing the new machinery necessary to fill the Tiverton mill, Mr. Heathcoat arranged it so as to be actuated by the inanimate rotary power supplied by water and steam. This relieved the workmen from any labour but that of controlling and supplying them with materials. In thus making way for the general introduction of the factory system into this manufacture, he was followed immediately by Lindley, Morley, Sewell, Jackson, and Henson of Worcester.

The infringers upon the patentees had been rapidly increasing, and the effect upon prices of their added

production to that of Heathcoat, had become such in 1816, as before the destruction of his machines, to require him to reduce his high rate of wages. Each of his foremen were permitted to have two or more machines of their own worked in his factory, the produce of which he took, paying them the prices at which his own goods were calculated before finishing. They paid their journeymen such wages as were received by the rest of the hands. The reduction of wages brought the latter to two-thirds of the amount they once received. This, together with the difference of their position to that of the overlookers, caused dissatisfaction, and a turn-out of some. Mr. Boden, however, brought down finished goods bought in London with the invoices charged at such prices as convinced those hands who were out, that the infringers who had supplied them were greatly underselling the Loughborough production. They returned therefore to their work. Mr. Heathcoat was at the time in Devonshire, where he accidentally saw the mill, afterwards so unexpectedly purchased by him. This partial expression of dissatisfaction gave an opportunity for the trade interference from Nottingham. Mr. Boden was on the point of leaving for London, and had just quitted the mill with Mr. Hallam, when at midnight they heard a shot fired, and two of their men came to tell them that the machines were being broken, and that Asher was shot.

Although for a time the Loughborough hands were thus entirely thrown out of work, the best of them were retained and transferred to Tiverton. There the greater part of them remained till old age or death, in the employment of Mr. Heathcoat, to whom they were greatly attached. Mr. Ferguson justly says, "Mr. Heathcoat was surrounded by a little world of workpeople, who loved him like a father." There were at the time of this exodus to the west of England of the patentee and his people, 156 infringers; viz. 116 lace and hosiery manufacturers, 31 frame-smiths, 2 watchmakers, 2 blacksmiths, 1 victualler, 2 butchers, 1 coal dealer, and 1 joiner.

The result of the trial above related, enabled the patentees to direct their attention to the important

question, how this body might be most satisfactorily dealt with. Their number having increased to upwards of 200 in 1819, the patentees commenced actions against about thirty of the principal ones, and filed declarations against about twelve. It was to hide from notice at this time, that seven old Loughborough frames were placed in a garret in Houndsgate, and lay forgotten until 1846, when they were thrown to the scrap heap, before we heard of them: none have been seen since.

Amongst the latter number of infringers were Grace, Berridge and Stanford, who were in partnership at Kegworth. With them Heathcoat determined to try the question, because their machines were constructed (with trifling deviations) upon the model of his own. Berridge having been one of his workmen at Loughborough, and for some unexplained reason left behind, at once entered into an engagement with Stanford, a gentleman of property at Kegworth, and Grace, whose father resided at Quorndon, and himself was a captain in the army. Besides these who were rapidly building machines, ten framesmiths were then ascertained to be under contracts for one year, and one for seven years, doing the like and displaying great skill. The disabled state of the patentees to supply bobbin net, which was from time to time in great demand, gave an irresistible impulse to making machines. The trial against Grace and Co., took place in Easter term, 1817, in the Common Pleas. The damages were laid at £10,000. A verdict was given for Heathcoat, subject to a reference to Mr. D. Pollock. The plaintiff, however, wishing only to secure his rights, declined to press for damages.

This trial established in a direct and positive manner the validity of Heathcoat's second, or 'old Loughborough' patent. It was then ruled—

"That inasmuch as it required a division of threads into two systems, it was of no matter which was made to traverse, whether the warp or the bobbin. And further, as to John Brown's machine and any other, Heathcoat claims against all infringers that his is an engine whether of parts used before or those new and peculiar to his machine, that it is a perfectly new conformation of parts, entitling him to a patent according to Chief Justice Gibbs, in Bovill *v.* Moore; Brown should have renounced the old parts and claimed only those he

had invented. But taking a part of Heathcoat's conformation into his engine and claiming for all, his specification is bad, it being only an improvement of another's invention, which tried by this test is a perfectly new conformation."

The expectation of this trial caused great excitement and some consternation in the trade, which increased after the verdict and pending the award. The action had been defended by the assistance of a trade committee backed by a large subscription, and represented in London by deputies in the conduct of the defence. An infamous handbill printed in the country was distributed in the avenues to the court on the days of the trial. Mr. Heathcoat had received overtures from many infringing parties, who were desirous of obtaining licences, and had agreed to grant them. He staid the actions against others, wishing to save expence to all parties, and to calm the apprehensions of further litigation. When the award was made Lord Chief Justice Dallas said—

"I know the system of terror that reigns at Nottingham, and that it is necessary to shew those who conceive that they can set the laws at defiance, not only that the laws will reach them, but that when it is proper there are those that will enforce them. Now that the cause is at an end, it is my duty to say that I have received this moment a paper, of which I have only had time to read enough to see that it is a most criminal attempt to interfere with the administration of justice by representing persons who by the exercise of their ingenuity have entitled themselves to patents, as monopolists endeavouring by their conduct to oppress the poor. Into so wide a subject as the operation and effect of machinery, I am not about to enter; but this I will say, that after the temporary inconvenience which is felt from what I would call the shifting of the scenes, whatever tends to abridge labour is in its result greatly beneficial to the public; and patents of this nature would never be granted unless they were of public utility. Having said this, I think it necessary to add that persons who have, at the door of this court, distributed a paper of this description, if discovered, ought to be prosecuted; and I recommend that an attempt to discover them be made, and if so, that a prosecution may be accordingly instituted."

No further proceedings were however taken, and the effervescence of feeling gradually calmed down.

The result of what had already taken place was to bring about a kind of general compromise, to which however there were a few exceptions amongst infringers. Licenses, containing permission to work the machines named in them, with other ordinary covenants, and

constituting the Deputy Recorder or his nominee the general and binding referee in cases of dispute, were granted for about six hundred and ninety-six machines, by March 21st, 1818, as stated by the patentees to Bovill; ninety of them being to himself, Brown, Freeman, and Aguttar. The licenses then produced about £10,000 a year, and so continued to do until the end of the term. Many of these licensed machines were in the hands of capitalists; but others were the property of persons who worked in them themselves, or who holding two or more had relatives as journeymen, but being without further available means must sell the lace net to the warehouses. The total quantity made was greater at times than the demand for it, and in consequence the article was much lowered in price. This seriously affected the interests of the patentees, who had difficulty in getting license money paid in, besides their production, as well as that of all others, being much reduced in value. A general meeting of patentees and licensees determined to enter into mutual arrangements in 1819, by a deed binding on the part of the patentees to grant no new licenses; and on the part of all the holders of licenses as well as themselves, to raise a fund to be subscribed *pro rata* according to the number of quarters worked by each. Under this deed a 'mart' was established, a secretary appointed, and the patentees, six other larger owners, and six representatives of the smaller licensees, were chosen and constituted its trustees and managers. It was calculated that a fund of £10,000 could be raised. The first year's contributions were under £3000.

The plan was, for the association to buy at prices to be fixed from time to time by the managers, any lace net made on their machines and brought to it for that purpose by any of the parties to the deed. The contribution to the fund was fixed at two pounds per quarter in width of each of their machines, which might be represented by notes of hand for the amount. Lacy bound himself not to go beyond his 127 machines, and Heathcoat his 147 machines. All parties were to use their efforts to prevent further machines being constructed. It was agreed also to pay on the requisition of the committee, a further sum of one pound per quarter of width, and finally threepence per quarter in width *weekly* while at work, during the continuance of the patents. The sums thus raised were to be used in buying up lace from the contributors, and in paying expences. The committee of which

the patentees were permanent members changed half yearly by three going out, their successors were elected by ballot; five to be a quorum and to them was given full power to transact all business, with the proviso that any goods sold on credit must be by permission in writing of the patentees and a majority of the committee: and that of all debts, credits, and assets, a faithful account should be kept in the books, in connection with the deed. At the expiration of the patents in 1823, the stock and debts of the 'mart' were to be forthwith realised by the committee, and the produce employed in paying the money subscribed. Any surplus to be divided amongst the workmen employed; if any deficiency, a rateable proportion to be charged on the contributions, but legal proceedings to recover to be restrained for twelve months thereafter. The committee were not to be liable for any losses except from wilful neglect, nor for each other, nor to be considered or constituted partners. The rules might be varied by a majority at a public meeting, provided the patentees and a majority of the committee agreed to them.

This document was signed by the two patentees, holding 274 machines and about 1918 quarters in width; eighty-two manufacturers with 1261 quarters; and eighty-two smaller owners with 557 quarters. The patentees machines were from five-quarter to eight-quarter, those in other hands from three-quarter to six-quarter in width.

The deed had not been signed by all who were become possessed of machines, and the few who were thus unlicensed infringers, gave no small trouble to those having heavy tribute to pay. The latter called on the patentees to protect them from this competition and secure to them their gains. More machinery also continued to be added, the produce of none of which would come into the 'mart,' but be sold at lower prices in the open market. A bill had been filed by the patentees before this association was formed, but still pending, for an injunction, in which an affidavit was made by Heathcoat that "by the use of his invention he supplied the market with large quantities of his lace at *reasonable prices*." Moreover other bills must now be filed for injunctions to prevent further making of these patent machines. But the objections made to these proceedings were weighty; and before long a question was raised as to the legality of the 'mart' association. For though the mart prices might not be unreasonable, yet no doubt they were higher than could be got from buyers under ordinary circumstances.

The intention of the association was carried out by keeping up prices beyond what the article would otherwise produce. Therefore it was objected, 'that it was illegal, the public having a right to buy at the fair market value, as regulated only by the necessities of the makers and the purchasers.'

Its legality was defended on the ground 'that its continuance was made to depend on the expiration of the patent: and that the association kept up the price of an article which the patentees could fix at any price they pleased during the patent.' The answer was made, 'the patentees are bound to serve the public at fair and reasonable prices; and as they have chosen for their own purposes to license so many competing machines, the article ought to be sold without the intervention of any association, or fixed at such prices as it will produce in the usual course of sale.'

Most parties seem to have admitted the illegality of such an association respecting any other than *machine wrought net, the subject of this patent;* but the opinions of some eminent men were said to vary on this point. The patent gives no rights beyond the particular kind of machine described in them. The article itself had been long made by hand on the pillow.

Therefore when the point arose, 'was the association an illegal combination?' the Solicitor General Copley, in consultation with Hart and Bell, replied, 'we are inclined to think the association founded on the deed and regulated by its provisions is *not* an illegal combination.' As to some other points, they were of opinion that 'the deed was not a breach of the proviso in the patent limiting the number of persons to be interested under it, nor did it prevent Heathcoat from applying a new moving power to his machines; nor would the deed affect his successful application for an injunction against infringement.'

In 1817 journeymen received 1*s.* per rack per quarter of a yard in width, and the net they made sold for 5*s.* per rack per quarter. In 1820 these prices had fallen to 4*d.*, and in 1823, 2*d.*, to the journeymen; and the net in 1820, 1*s.*, and 1823, 6*d.*, the rack per quarter to the masters. The number of machines had increased so much that the owners now preferred to be under license, provided more were not constructed. In 1820, one thousand and eight machines were licensed, and the licensees themselves proposed that the tribute should be made £5 per quarter in width of each machine for the year. Journeymen paid £50 for a year by £1 per week to be taught how to make bobbin net. When the demand fell off occasionally, the production was stinted for a time. The warp lace frames were in 1823 making such expensive goods as to use chiefly No. 190 cotton yarn at £2 per lb.; some consumed finer numbers, paying for them from ten to thirty guineas per lb.

Meantime Mr. Heathcoat continued—in the midst of all this excitement, and the necessary labours of his enlarging affairs, mechanical, commercial, and legal—to read and study as assiduously as ever. For some years he had been preparing, by the acquisition of a correct knowledge of the French language, to enable himself to carry out any business operations across the Channel. Such took place in 1818, when he established his machinery, *working by steam*, at Paris, and in which he is said to have embarked, first and last, at least £50,000. He was well acquainted with Italian, and it has been said he was versed in Latin. The latter is however incorrect. He began to lay a foundation in 1818 for a good collection of English and foreign works on the constructive sciences.

The machinery for making lace, just referred to, was transferred from Paris in 1826, to large and commodious premises at St. Quentin, where great additions were made to its numbers and power of production. There were at one time 150 to 170 machines, giving employment to a large body of workpeople. When this factory was visited in 1849 by the then President Louis Napoleon, he expressed his admiration at the intricacy of the machinery and the skill of its inventor, with his approval of the public spirit which actuated Mr. Heathcoat in that time of agitation and change, deciding him not to cease the regular employment of his numerous and effective, as well as peaceful artizans. The operations of this establishment were carried on until the death of its founder, since which, they have been almost entirely brought to a close.

One of the defendants, Mr. Grace, in the action of 1817, became soon after a partner with Messrs. Heathcoat and Boden, but in a short time quitted them. The partnership with Mr. Boden also was dissolved in 1826, when Messrs. Boden and Grace united their interests in machinery—a connection which was not of long duration. On their separation, Mr. Grace took his bobbin net frames to Rawleigh mill, Barnstaple, which, under the care of his partner Mr. Thomas Heathcoat, was worked until absorbed into the Tiverton business after the death of the latter. Mr. Boden having disposed

of his share of the machinery to Mr. John Miller, settled at Derby; and, being well versed in business, from his long experience and possessing both talent and capital, he proceeded to lay, in conjunction with Mr. William Morley, who joined him in partnership there, the foundation of an extensive manufacture of bobbin net, where for many years about 170 machines have been at work. These were built under the able instructions of Mr. Morley, of first-class widths, amount, and quality of production. Of this mechanician more will be said in a separate form. Mr. Boden's family connections alone carry on the business of this important establishment, which has always been employed in the fabrication of plain cotton nets. The Messrs. Bodens purchased from Mr. Morley his share of it, for, it was stated, about £70,000.

The expiration of the bobbin net patent, was precisely the period of national excitement in trade, as well as local activity in manufacture. At Nottingham, and throughout the whole district round, one of the great objects of every one's life, seemed to consist in seeking to become proprietors of machinery. Singularly enough, Mr. Heathcoat was at this exciting epoch as much engaged in devising inventions and improvements in other departments of manufactures, as in that of lace, hitherto almost engrossing his attention. Patents on some of each class followed each other in rapid succession.

Among the diversified mechanisms which were thought by Mr. Heathcoat susceptible of improvement, was the machine for platting various materials, such as silk, cotton, and other threads. After giving special attention to the processes in use, he patented in 1823, No. 4867, the following new arrangements of a platting machine:—

1st. The distribution of the system of barrels in one line, whereby a number of these systems may be put side by side, forming a compact series of any required number, all actuated at once, or any portion may continue in action, while the others stop.

2nd. Making all the axes of each set point to one centre, whereby the threads from the bobbins are of the same length, and do not alter their tension by changing their places; and the required angle at which the plait folds over the margin, is determined by the segment of the circle in which the bobbins travel from one end to the other.

3rd. Simplifying or reducing the number of tumblers, by the under and over lapping of the barrel rims which carry round the spindles and bobbins.

4th. By the flat arrangements of each series the breaking of any thread immediately stops that set by its action on the bar, throwing the wheel out of gear.

In the second of these modifications, the simple and important principle introduced into his lace machine, of working on a segment of a circle to give out materials equally in relation to a common centre from a number of sources, is reproduced in making articles of a widely different texture and character.

The manufacture of salt had engaged Mr. Heathcoat's attention for some time. He caused extensive enquiries and many experiments to be made at considerable expense in time and money. These issued in a patent taken out in 1823 by Mr. Josiah Parkes.

The invention consisted in a combination of a boiler with a vessel placed under it, and below the action of the fire, so as that the salt may be deposited within the vessel as it is produced, and withdrawn therefrom without interruption to evaporation, or opening the boiler if a covered one. Also for cooling the salt collected, by using cold brine.

His first invention in 1824, No. 4896, was for ornamenting goods manufactured from silk and other materials; but did not proceed to specification. Then he patented No. 4917, a method of forming and finishing carriages used in the bobbin net machine, by stamping them out in dies instead of filing them out to size and shape, as previously practised. This plan was soon universally adopted in the trade.

No. 4918, in 1824, was a patent taken out by him for improvements in rotatory bobbin net machinery, and in manufacturing certain parts of these machines. 1st. An apparatus for giving off warp and taking up the lace so equally as to give invariable form and size to the meshes throughout the piece. 2nd. For machinery for cutting out the combs used in bobbin net frames.

Of the same date is another patent, No. 4919, which caused much remark at the time, and though never carried into effect, is in more than one respect worthy of notice in the biography of the inventor.

He described it as an improved and economic mode of combining lace or other machinery worked by power

in spinning and weaving. It was upon what has been known as the 'Panopticon' plan; but only as to the power of general survey over the whole or nearly the whole of the machinery from one spot in the interior of the building. It was designed to diminish the cost of erecting factories; and to improve the warming, ventilating, and lighting of such places, and to give greater steadiness to the machines themselves when at work.

The machines were to be so placed and combined or connected, as that one tier or circle on the ground floor might support a second series; the second a third; the third a fourth, &c.; and this without pillars, arches, beams, joists, or floors of any kind, as a basis on which to place the several radiating superincumbent tiers of machines. The whole body of machinery was to be tied together so as to form one firm connected fabric or structure, without any dependence on the walls of the building surrounding it. The machinery was to be worked by an upright central shaft, operating by horizontal shafts upon the individual machines comprised in each tier. The overlooking was intended to be central also.

Again, in 1824, Mr. Heathcoat devised and patented No. 4926, an invention of a core or conical form of paper, cork, &c., on which in spinning cotton, wool, or silk, the roving or yarn may be wound into a cop. Also an eccentric pulley, drawing the carriage in at a variable speed.

And finally, in this year, he took out No. 4966, for improvements in the method of preparing and manufacturing silk for weaving into cloth or net. These consisted in a machine for combining into one continued operation, the processes of drawing off the silks from cocoons, and of twisting it into a thread without the intervening hanking and winding operations.

The ends of cocoons being united into one thread, this is carried to a spindle and flyer by which it is twisted; it is then wound upon a bobbin. By this mode 'singles' are made. The two or more threads for 'trame' may be in like manner separately drawn from the cocoons and twisted, care being taken that the separate threads converge equally to the guide forming the point of junction.

A further improvement was effected in 1825, patented No. 5200, in this machinery for throwing silk. The plan was not found to answer in regard to more than one important point, when tried in France and Italy. The twisted threads going on the bobbins wet from the

basins, required to be immediately re-wound into hank to prevent its caking together in drying, and so being difficult if not impossible to be separated. The loss of time in putting on the twist was so great as to lessen the gain obtained by getting rid of the intermediate processes. It never became general in Europe. Many thick sewing silks were thus made in the United States; and the machine is figured and described in several of their publications on silk growing nearly thirty years ago. It was shewn, with the original diagrams from the above patents, by the author, in lectures delivered by him at the Athæneum and Mechanics' Institute in Manchester at that time. Yet Mr. Dickens, about 1854, on behalf of Mr. Chadwick brought out the plan as a new and important invention, calculated to revolutionize the silk manufacture.

In 1825, No. 5080 was added to Mr. Heathcoat's list of patents, being for improvements effected in the circular bolt double tier power bobbin net machinery, by the combination of two additional locking-bars and the cams necessary to move them with the locking and driving-bars in common use in these machines.

The next patent in this year was No. 5093, for improving the reeling of silk and its quality.

By drawing off the silk filaments from the cocoons in larger numbers, but divided into separate smaller sets in the basin and up to the first guide wire, where the filaments of each smaller set are united. From these first guide wires as many of the smaller sets as will be necessary to compose when united, the size of silk thread desired for ultimate use, are taken through a second guide wire further on towards the reel, in front of which are placed the third guide wires to conduct the thread upon the reel and form the skein of raw silk. Before this takes place, however, a second thread similarly composed is brought from cocoons at the other end of the basin; and to incorporate fully the numerous filaments in each, by pressure of the warm and softened gum with which each is covered, these two ultimate thicker threads are passed round each other, and then separated before passing singly upon the reel. The surplus gum is forced out according to the number of twists given; and the thread may be wound off the skein with much greater rapidity than when reeled of the old fine sizes, and with much less waste. The expence of winding and then doubling fine silk threads is also saved.

This plan is to wind the cocoons in small numbers, as 4, 5, or 6, to each thread, but instead of taking it to the reel in this size, to reunite 2, 3, 4, or any number

of these smaller threads into one, before they arrive at the second guide wire. The woman at the basin has to keep up only the smaller number correctly, and can thus make the ultimate thick thread as even as the finest ones.

By this very simple arrangement, most important results were obtained. Previously, to obtain an even thread of 15, 20, or 30 cocoons in size, raw silk of 5 cocoons was reeled; the skeins were then wound on bobbins, and the threads from 3, 4, or 6 of these united in one; and after all the quality of perfect evenness was not so well secured, as by this patented method, while the serious expenses of the two last windings, with all the attendant waste, are by the new process saved.

The idea of this obvious improvement occurred to the mind of the author (who had spent the previous year abroad on Mr. Heathcoat's account in practical enquiries about silk reeling) while conversing with him on their way to Paris, upon the importance of getting heavy raw silks evenly reeled; and he proposed it for further consideration at the end of their journey, as he could not but suppose a method so easy and safe must have been thought of and practised before. But Mr. Heathcoat at once saw and sketched out how it could be done, and the next week the specification, written by himself with a drawing, were deposited at the French patent office. The author then again visited the Cevennes; and introduced the plan to M. Tessier, of Vallarogue; who, by his own freedom from prejudice, overcame the intense disgust at first felt by the silk reelers at the innovation, and reeled that season, 1825, about £5000 worth of 3-strand 5-cocoon silk, which gave a beautiful thread of 15-cocoon silk suitable for and worked up into bobbin net lace, partly in Paris and partly at Tiverton. No time was lost in taking out patents for Italy; and the same season the author was enabled to get the plan put into operation by one of the most extensive silk reelers and merchants of Milan, M. Dominique Staurengo, at his Cernusco filature. Mr. Heathcoat made arrangements for a constant supply from filatures of his own in the Milanese and elsewhere—

a plan pursued in his business down to the present time. The author obtained 35,000 lbs. of cocoons, in 1825, from Florence, took a young Englishwoman to Tiverton, who had been instructed in France to teach others how to reel, and these cocoons were reeled there on the patent plan into 3,500 lbs. of fifteen-cocoon raw silk by this the only English filature ever set up, and which was made into excellent lace at Tiverton. Though there is no absolute difficulty in reeling good silk in England, it is not likely that, from the adverse climate, it can ever be grown here to commercial profit. The use of this size of raw silk for making lace was confined during twenty years to Mr. Heathcoat. At last Mr. Wild, at the instance of Mr. Dunnicliffe, ventured on a *part* of a bale. Since then a very large yearly consumption has taken place in Nottingham. Its use led Mr. Heathcoat to make chemical experiments in dressing silk net, which have resulted in his finishing it to equal perfection with the French.

The next patents taken out by Heathcoat in 1825 were Nos. 5103 and 5144, both being for divers methods devised for ornamenting or figuring lace, by applying 'pearl' in various ways upon its lace so as to form bouquets, flowers, &c.—intended as an approach to the 'applique' work upon hand made lace. A purpose which it answered in some measure until further improvements took place.

In 1831, No. 6173 was taken out for improvements consisting of appendages to ordinary bobbin net machinery, so as to produce a combination of various fabrics hitherto produced by the warp frame.

This is a very curious introduction of the stocking loop by the use of the warp needles and guides placed in connection and working with the twist lace frame. The method by which the two classes of instruments for twisting and looping are made to co-operate, would require the aid of the entire specifications and drawings to explain. The invention is one of great ingenuity. Probably the combined result of the two principles was to complicate the machine, increase its cost, and render it more delicate in work, without producing a result equal to these drawbacks.

No. 6222 was taken out in 1832, for further methods

for working devices ornamenting lace net. These plans were all valuable as aids to the consumption of lace fancy goods, pending their more exact and elaborate production on the machines. By a modification he patented in 1833, No. 6471, the sewing or connecting threads in breadths are inserted so as to lay hold of two bobbin threads. He also describes the mode for inserting threads on lace by taking hold of two bobbin threads at the top of the meshes and passing across the warp threads, forming a kind of cloth work filling or ornament.

Perhaps one of the most original and clever adaptations of the bobbin net machine is that patented by Heathcoat in 1835, No. 6967, for weaving tapes, ribbons, edgings, &c. in less space and with greater despatch than on the old weaving loom.

This is done by weaving in a transverse direction, *i.e* at right angles to the ends from the back and front of the machine. The ribbons, &c. stand edgewise side by side, face parallel to each other, and to the ends of the machine. The shuttles and bobbins furnished with weft threads governed by springs pass from back to front and *vice versâ*. There is a set of warp threads for each ribbon passing through headles; slaies clear the way for them. The ribbons as woven pass flat, side by side on the work roller. The warp gives off as the work beam thickens under regulation. Ornamented or fancy fabrics may be made by using separate warp rollers, and so different thicknesses of fabrics and tightness of warp threads may be provided for.

In 1831 Mr. Heathcoat became acquainted with the late John Handley, Esq., M.P., well known as devoted to the strenuous endeavours for improvements in agriculture.

The result of their united investigations into the important and difficult question of cultivating land by the application of steam power, was the construction by Mr. Heathcoat of a 'steam plough,' which he patented in 1832, No. 6267, under the description of "certain new or improved methods of draining and cultivating land, and new and improved machinery and apparatus applicable thereto, and which may be applied to divers other useful purposes." This machinery to be worked by inanimate motive power, (which, it was Mr. Heathcoat's conviction, would one day do most of the drudgery of life), he deemed to be a useful and profitable substitute

for animal power in many cases where ploughing, draining, &c. by traction, from the nature and form of the surface is difficult or even impossible.

The machinery consisted of a carriage with steam engine placed on it, and an auxiliary apparatus capable of supporting an extended rope chain or band at a distance from the carriage. The latter received progressive and retrograde motion from the engine, which also drew the ploughs and other implements to and fro between the principal and auxiliary carriages at right angles, or any other convenient angle to the line of progress of the principal carriage.

The wheels of this carriage conduct a broad, endless, flexible floor railroad or way, upon which the carriage travels, and will thus pass great weights over soft, swampy, and unstable ground. But on solid ground the carriage may be placed on rollers or drums instead of the endless floor. Other wheels are substituted for the carriage, proper for travelling on land or soil, firm and compact; so simplifying the machinery and apparatus.

Auxiliary carriages are placed on each side of the principal carriage, by means of which, through bands from thence passing round the pulley or barrel of the auxiliary carriage, ploughs and other implements are dragged to and fro between them at convenient angles, and so a wide extent of land is brought under the operations of the machinery and apparatus. Flexible floors or ways are also placed under the wheels of the auxiliary apparatus, varying according to the nature of the soil. The boiler and engine on the platform of the principal carriage gives it locomotion in a longitudinal direction, as well as drives the drums or barrels which work the track ropes of the ploughs, &c. to and fro.

This steam plough, though since superseded by those of Fowler and others, was considered the best that had up to that time been invented. Mr. Heathcoat was led principally to incur the labour and expence attending this invention, by his desire to contribute to the agricultural improvement of Ireland—an object he had in various ways sought to promote during the previous ten years. This steam machinery he considered to be specially adapted to the marshy unreclaimed land of the sister island.

The attention of many had been directed by political discussions to the social, and, as a necessary consequence, to the agricultural condition of Ireland. Mr. Heathcoat deeply sympathised with the sufferings of the peasantry of that unhappy country; and was led to join in the formation, in 1825, of the Irish Land Improvement Association, in the hope that it might effect important ameliorations there, beneficial both to

the farmer and labourer. His thoughts were turned to the question, whether the mulberry could be grown and silk produced there, and he sent 100,000 plants and a large quantity of mulberry seed to be sown, as a contribution at his own expence, and for an experiment. He had however stipulated in the projected laws of the company, that the shares should under no pretext be made the subject of sale and purchase upon the Stock Exchange; therefore, on finding that important rule set aside in the speculations of 1825, he at once withdrew, publicly assigning his reason for it, and the crash of 1826 amply justified his determination. Forty subsequent years of observation on the course of Stock Exchange proceedings, compel one to dread that it may become at last the most ruinous as it is the greatest gambling-house in Europe.

In 1837 a patent, No. 7359, was for a mode of ornamenting gauze, muslin, or net, cloths, stuffs, or any woven textures, and for tools and apparatus used in producing such ornamented work.

This was a mode of adding figures to the surface of the tissue to be composed of edgings, &c., by adhesion from using size, pressing the net and flowered work through rollers, and thus causing the super-imposed ornaments to adhere. Articles thus flowered had a sale for some time; but the method has not continued in extensive operation.

John Heathcoat and Ambrose Brewin his son-in-law and partner, patented in 1843, No. 9646, a new method of intercepting warp threads, so making the application of the Jacquard apparatus more easy and secure. It included also a method of producing longitudinal stripes in nets of various widths of cloth work, almost non-elastic, by using extra guide bars, and causing the point bars to take up more frequently. And finally, for ornamental printing on nets, which had been thickened by laying in extra threads. After this epoch, Mr. Heathcoat retired from the more pressing pursuits of business in his manufactory, and from endeavours after further discoveries in machinery.

This comparative leisure, when at Tiverton, led

Mr. Heathcoat to consider how he might assist in improving the education of the population there. As the result, a noble and well-arranged building was erected in a convenient situation at Tiverton for British schools. The edifice is of stone from a neighbouring quarry, shewn by this experiment to be capable of superior finish. The ornamental parts are of Bath stone. The iron work was cast in his adjacent foundry. One of the lofty and spacious wings is for boys, the other for girls; the central apartment is for the infant-school. These were opened publicly on the first of January, 1843, in the presence of the mayor and other principal friends of education in the borough.

In his remarks made upon this occasion, Mr. Heathcoat explained the motives by which he had been actuated, and the objects he had in view in establishing these schools. The observations then made, bring into view some of the characteristics of the speaker; especially exemplifying his firm, yet conciliatory manner in handling subjects, difficult in principle or practice. An abridgement of them will therefore be interesting to those who desire to form a correct estimate of the man. The subject was introduced by his saying, that:

"Happily there is now no justification necessary for such educational institutions. That question is set at rest. But doubts are entertained, as to the step I have taken in opening these schools, on the liberal principle of seeking to educate the children of parents of *all* denominations of Christians. I would cast no reflection upon those who differ from me in opinion; but claim the credit of good intentions, while exercising the right of acting upon my own.

"Similar schools have been carried on for the past half century, without injury or inconvenience; on the contrary with most satisfactory results. Allowing children thus to mingle together irrespective of religious distinctions tends to prevent those distinctions from rising up as barriers in after life, and encourage abiding kindliness of feeling. These being my honest and sincere opinions I desire to act upon them. I have not previously assembled you for consultation, because I did not wish you to put your hands in your pockets. I believed you would have confidence in my intentions: these I will honestly and impartially carry out.

"Great importance is justly attached to the selection of teachers. I have not thought it right in applying to the British and Foreign training schools to stipulate for more than that they should supply us with good and pious Christians; such as shall be well fitted for the duties they undertake. As in that establishment I found churchmen and dissenters living together in harmony and good will and with

no instance of a teacher being drawn over to other religious views; there is security for us, that the same results will take place here; and that the teachers will feel it their duty to instruct in the fundamental principles in which all agree, and leave alone those minute and difficult points of distinction, of which were we ourselves to think less it would be better. We too often look with microscopic eye for these points of difference, rather than for those on which we can agree, and having found them, magnify them into importance, and allow them to produce feelings most undesirable amongst Christians. I should be sorry if my friends of the church (of England) should think this a dissenting school; or erected in opposition to one belonging to them. Could the whole have been united in one large establishment, there would have been peculiar advantages, and I should have been much more gratified. I hope that because I have thought it my duty to provide this school for those who could not be benefitted by the other, no jealousy will arise between them; and that all concerned in this will cherish the kindliest feelings towards the national school and all others.

"The instruction to be given here must of necessity be elementary; but that sound and good of its kind, such as may be carried on if opportunity offers, with advantage by the individuals themselves in after life. Amongst the things to be taught, the principles of religion are of the first importance. It is essential that these should be inculcated even from infancy. For instruction in distinctive creeds, Sunday Schools offer the fittest opportunity; and we make it a condition that children admitted here must belong to some Sunday School.

"Another important part of education attended to here, is the formation of good habits—habits of cleanliness, order, subordination, industry and proper behaviour to equals and superiors; not by lessons or precepts only, but by training the children to practise them. Though for the present I and Mr. Brewin, purpose retaining the responsibility, we shall listen to any friendly suggestions with deference, and endeavour to act upon them. If however superior advantages were sought by any one on behalf of his particular party, we should not be prepared to meet his views.

"To those parents who may be desirous of sending their children to these schools, I may be permitted to address a few words as to what will be expected from them. We shall require that the children be fit to associate with other children. If from having had bad examples as to language and general habits, they would expose the children of others to danger and mischief, we shall be obliged to say to the parents of such, 'we fear the harm your children will do to others will be greater than the good we can do to yours, and we cannot admit them.' We do therefore expect and require from parents that they will take care by good example and as to health, morals and general condition, that their children shall not be rejected for the faults of their parents.

"I would say to the young persons who undertake the conduct of these schools, that the responsibility devolves upon them, whether the children are benefitted to the degree they ought or not. I rely upon them for the fulfilment of their duties in an exemplary manner; and to act with a wise caution amongst strangers and in meeting inevitable

embarrassments, as well as in forming new associations. Their active pursuit of duty will render them independent of companions and of the idle gossip resorted to by some to kill time. Being amongst strangers and without acquaintances, I wish them to consider they have one resource; and that is, any advice they may deem it proper to ask will be given most cheerfully by me. Towards the children they have already learnt their duty, and are more capable of teaching me than I them. Let them earnestly aim at combining kindness of manner with great firmness, though justly to unite the two is a difficult acquirement, and they will succeed. From all Christians here I am sure they will receive kind attention; from ourselves, every comfort and assistance."

These schools were not confined to the children of persons connected with the factory, but open to all; and have been continued in successful operation on this principle ever since.

When the lace machinery was brought to Tiverton in 1816, the ancient woollen manufacture was so wretchedly depressed, that the labouring population was little employed and worse paid. The town had become the residence of military and naval officers on half-pay since the peace of 1815, who no doubt chose it because of its mild climate and cheap provisions, perhaps also for the advantage of an ancient endowed school. The advent of such an addition to the population as that employed by this factory, gradually raised the prices of everything to the annoyance of some; but the compensative result to retail trade was very remarkable. An officer came there to reside, and remarked in the hearing of an old and experienced collector of King's taxes, that "the coming thither of lace machinery had ruined Tiverton." On which the other rejoined, "I can shew by my books, that in 1816 there were not three shop-keepers in High street," (the principal street), "who could pay their taxes regularly, and that now (1826) there are not three that owe any." Its old importance as a borough returned with the arrival of Heathcoat, and has remained ever since.

In the factory at Tiverton there were employed in 1836 about 1200 hands, in 1860 about 2000. On the occasion of an excursion to Teignmouth, in 1836, given to the hands and their families by the firm, 2300 persons formed the party. The operations carried on by these workpeople are yarn doubling, silk spinning,

making net lace, bleaching, dyeing, preparing it for the market, smithing, and frame constructing; together with those of an iron foundry and the manufacture of plough shares, coulters, horseshoes, and other farmer's implements, forming a useful establishment to which the neighbouring occupiers of land can have recourse. The gas for lighting the town has been from the first supplied from these works. Since 1828 the factory gates have been regularly opened and closed so as to secure ten and a half hours' daily labour, and give one and a half hours for meals. In 1860 the number of machines had been reduced to 150, but increased to 122 inches in width and of great speed. They were entirely employed in making silk net. As Mr. Heathcoat always finished the larger part and latterly the whole of his production, he had no motive to destroy his narrow machines until they were fairly worn out. Therefore he only begun to replace his old 8, 10, and 12-quarter by wider machines within the last few years, while at Nottingham the cost of new 16-quarter and 20-quarter machines had been of an enormous amount.

Mr. Heathcoat felt deep interest in the lace trade of Nottingham; and when it has suffered reverses, they have never failed to call forth strong expressions of his sympathy. The large amount received collectively for tribute up to the expiration of the patent, was naturally unpalatable, and left a feeling of displacency on the minds of some long after that time. In justice to him it must *now* be stated, that during the whole of the period that intervened between 1826 and his death, the writer of this work (for the larger part of the time the representative of his private business in the Nottingham trade) was entrusted by him to act unreservedly on his behalf in the public discussion and management of its affairs; and was empowered to pledge his co-operation to whatever the owners of the majority of machines should decide to be done, in pursuance of the general prosperity of any and every department of it, whether employers or employed. Such resolutions were without exception or hesitation carried into full effect, both in his own factory at Tiverton, and by his brother, Mr. Thomas Heathcoat at the Rawleigh Mills, at Barnstaple.

Thus when the trade reduced the working hours for twelve months from twenty to twelve, he holding at the time large orders and small stock, at once reduced his time to twelve hours; but when at the end of that year the Nottingham trade returned to twenty, he continued ever afterwards to work only the twelve natural hours of a day's labour.

The inhabitants of Tiverton, in 1843, determined to mark their sense of the liberal and benevolent conduct of their enlightened member, Mr. Heathcoat, by presenting his picture to the corporation of the town. The subscription for the purpose was more than sufficient, and a gold snuff-box was purchased with the overplus, which was presented to the honourable member at a public dinner, Lord Palmerston being amongst the guests. The likeness is an admirable one. In replying to the address of the presiding clergyman, Mr. Heathcoat made the following remarks:

"My friend, the president, has stated various reasons which have induced you to shew me this act of kindness, and I may say affection; but there is only one ground on which I can presume to accept this token of regard. It is not on the ground of merit of any degree on my part, but of kindness on yours. The reverend president has reminded you of the period when, I think twenty-seven years since, I first came amongst you. It will be in the recollection of many whom I see here that I came almost like a shipwrecked mariner cast away upon your shores. From that day to the present I have only experienced one series of kindnesses from you and of happiness among you. I am not aware that I have ever done any thing to merit this kind compliment. To contribute to the comfort of the town one lives in, is but securing one's own, and to attribute merit to a man for so doing would be almost as inconsistent as to be surprised at his endeavouring to make his own house comfortable. Our happiness depends as much on the comfort of our neighbour as on our own. No individual can be happy unless his neighbour be happy with him. There is one word that I am desirous of addressing to you, which I hope may be of service to others when I myself may be no longer useful to you. It is well known to you all that I entered life in that state which is not generally looked upon with envy, as an artizan who had to earn my own livelihood. Under these circumstances I had to encounter many difficulties. These have been overcome; and notwithstanding the situation in which I commenced life, I have had the gratification of receiving this testimony of respect, which I esteem more than everything else I have acquired. This will be an encouragement to others not to allow difficulties however formidable to cause them to despair. With industry and care, with perseverance, and above all with a strict regard to their duty to God and their neighbour, they never ought to despair."

Young men setting out in life always engaged his sympathy and advice, and he gave them encouragement derived from his own success. If necessary assistance, pecuniary and otherwise, was added, sometimes to an important extent. From his naturally cheerful and buoyant disposition, he took a bright view of the characteristics and talents as well as conduct of those around him, and in whom he took an interest. He was liable to be disappointed, and indeed was so occasionally; but this did not embitter his feelings or disturb his equanimity. He took a broad estimate of the importance of the things that make up the business of life; and the soundness of his judgment prompting to successful action in weighty trade matters, more than counterbalanced any mistakes in his estimate of individuals. Few men have won those by whom they have surrounded themselves more entirely to their interests and persons than himself; they repaid his confidence with a sincere and lasting attachment. About twenty years ago his managers, clerks, and agents presented to him a service of plate, as an expression of their grateful respect and esteem. The general body of his workpeople, to the number of between 1200 and 1300, presented to him in May, 1859, a silver inkstand and gold pen, on the occasion of his retiring from Parliamentary life. Without ostentation or display, and in the quietest way imaginable, Mr. Heathcoat overcame the local coolness with which he was met for a short time by some who disliked his eminent position as a great employer of labour, and feared his influence. This all gradually passed away, and was replaced by respectful esteem and confidence. It was no wonder therefore that upon the passing of the Reform Bill in 1832, when the ancient family influences in politics were disturbed by an increase of the popular element in the constituency, attention was at once turned towards him as a suitable representative for the borough. Such a public benefactor it was felt ought to sit in the supreme legislative body. He was accordingly chosen to be a member of that honourable house, just twenty years after he ceased to handle the hammer and the file, and continued to sit in it without interruption for twenty-eight years. During the principal part of that time, Lord Palmerston

was his colleague and his frequent guest. On several public occasions his lordship expressed his high regard for him; and when Mr. Heathcoat retired, from age and infirmities, took occasion upon his own re-election, to express his regret for the loss of so excellent a coadjutor, paying him an eloquent tribute of praise. Though Mr. Heathcoat seldom spoke in debate, he was indefatigable in attendance, and his aid in committees was much and deservedly prized. In politics he was not a theorist, but a thoroughly practical man. He would advance where it was safe and necessary, and would alter, expunge, or supplement where requisite; always, however, in accordance with the principles of the constitution. He made light of speculative theories in philosophy and science, and abhorred them in politics and social life; regarding them as alike delusive and dangerous. He was an every day and home reformer, and desired that each man who really cared for and governed his own family well, should have a voice in the government of his country. He knew by his own experience how vast a number might by virtuous self-denying efforts even now raise themselves into that position. Mr. Heathcoat's course in the House of Commons was equally patriotic and independent, free from faction and self-seeking; consistent and honourable, entitling him to that respect and confidence which he received from the best men of all parties in that assembly. It was his happiness to be joined in public life by similar self-raised men. At a dinner party in the house of a friend at Leicester, in 1834, there met Wynn Ellis, M.P. for that borough, Richard Potter, M.P. for Wigan, Joseph Brotherton, M.P. for Salford, William Biggs, M.P. for Newport, John Heathcoat, M.P. for Tiverton, and Richard Harris, future M.P. for Leicester. It was a re-union of remarkable men, placed in a position made possible for the first time; legislators drawn from a new class; who by the experience they had gained, the knowledge they would impart, and the influence they could exercise, must prove eminently useful in any deliberative body.

The business of the Tiverton lace manufactory is carried on by Mr. Heathcoat's only male descendant,

Mr. Heathcoat Amory, in partnership with others allied to the family.

Mr. Heathcoat was a magistrate and deputy lieutenant of the county of Devon. His unremitting attention to parliamentary duties, prevented his taking part except occasionally in the business of this borough and the district around. After two years of gradually declining strength, his useful and honourable life was brought to its close in January, 1861.

The following testimony was borne by a local Journal to his character in describing his public burial:

"The last earthly honours were paid on Thursday last to the remains of that kind and benevolent gentleman who has just gone from among us. A man who had rendered himself so truly illustrious by his philanthropy and virtue, by the disinterestedness and uprightness of his conduct, by his love of truth, and by his ardent attachment to the great interests of mankind, very naturally endeared himself to those amongst whom he lived; and produced an unanimous demonstration of respect, when his body was conveyed to the family vault in the churchyard of St. Peter at Tiverton, from Bolham House, his late residence. It was preceded by the Masters of the Ancient Blundell's Public School, and the Baptist, Independent and Wesleyan Ministers; also by the Borough Magistrates, the Mayor and the Town Council; and followed by a body of Clergymen of the Church of England, relatives, friends, his late fellow member Mr. Denman, the neighbouring gentry, the clerks, foremen and artizans of his factory; the long procession being closed by a large number of Tiverton tradesmen. All business was suspended and the shops of the town were closed.

"After an impressive service, the grave closed over one well known through a long life for his steady devotion to the cause of truth and patriotism; and for public and private virtues, commending him to the respect of all parties. Tenderly alive to the duties that wealth imposed, the poor and needy he never sent empty away; while he humanely relieved the distresses and embarrassments of his neighbours. He maintained a high sense of moral obligation as proved by the discharge of duties laid upon him with impartiality and uprightness. His sober and rational equability of temper and conduct, shewn through life, is an example worthy of being held up to all, especially to such as are called upon to tread a path so perilous as his, in the commencement of life. His name will continue to be revered, wherever philanthropy, patriotism, and virtue, are held in estimation."

What Mr. Heathcoat *was not* may be studied and imitated by every artizan with great advantage, when contrasted with several of the biographical notices in these pages of other men of great mechanical genius, and engaged in the same arduous pursuit after success and fame. The testimony of all who knew him, whether

in early or later years, is very significant. There was no misspent time nor indulgence in youthful follies. He was not found amongst men of unsound character and principles, the bane of the working man's home, and of his prospects, independence, and usefulness in after life. From all such he kept aloof; yet ever shewed the most sincere regard for the well-being of the humblest working man and his household.

Much that Mr. Heathcoat *was*, will have been gathered from what he *did*, and the position he so early attained and so well filled. The high estimate of his character in Tiverton, and the value of his services to it, have been recorded in the eulogium pronounced as it were over his grave. His services to Nottingham may be stated in one sentence. His invention gave to it a trade, which within fifty years has mainly assisted to quadruple its population, giving employment year by year at fair wages to probably 150,000 workpeople, and for the past thirty years made an average annual addition of £4,000,000 sterling to the trade of the country. His great natural gifts, sound understanding, quick perception, and inventive genius, were plainly manifested in the work of his life. He stored his mind well by a diligent study of the thoughts of others, as recorded in the best literature of the past and present age; and there were few subjects of importance in natural or moral science on which he had not formed well considered opinions. His studies and memory were aided through life by a faculty, whether intuitive or acquired, it is hard to say, of dismissing from his thoughts and memory matters of a trifling and passing nature, leaving a proportionally clear remembrance of facts, arguments, and the grounds of judgment upon important subjects, of whatever nature they might be. His conversation was instructive and agreeable, though from indisposition to assume marked prominence, and a determination never to utter thoughts or opinions hastily formed, he was slow to engage in discussion, except in the familiar intercourse of friendship. He knew when to speak and how to be silent, without any tincture of pride or semblance of cold indifference. Great wealth and a higher station had little influence

on the manners and habits of Mr. Heathcoat. His tastes and enjoyments through life continued to be of the simplest kind. He was of so calm and equable a temperament, that through a long series of much personal intercourse, the author never saw him really angry, though there were times and circumstances under which such an expression of feeling would have been quite justifiable. His address, like his countenance, was remarkable for smiling amenity and gentlemanly courtesy. Thus it was to all. One of his workmen said to us long ago, "He has always a kind word for everybody." Miss Mitford writing to a friend thirty years ago said—"Mr. Heathcoat has just been here. How charming and simple a person—how perfect a gentleman! But a man of high inventive genius must be so." Integrity and uprightness of conduct and character were allied in him, to that delight in excellence which ever seems to be an attribute of real greatness and goodness. He was true to his friends, and determined if possible not to have any enemies; therefore was silent and placable under injuries. He freely assisted the afflicted, the weak, and the necessitous; and was most admired and beloved by those who knew him best. They cherish his memory, and revere him for those qualities of head and heart, which render his character so worthy of study and imitation.

CHAPTER XVIII.

THE SINGLE TIER LEVERS' BOBBIN NET MACHINE.

In the year 1813 another modification of the patent or 'Old Loughborough' machine was effected, realizing the idea Mr. Heathcoat originally entertained of placing all the carriages and bobbins in *one tier*. This of course required them to be made of only one half the thickness, and the combs in which they worked to correspond. The general construction of the machine had to be so ordered as to secure the necessary solidity and firmness of the frame-work in order to avoid vibration. Steadiness in its movements had to be combined with perfect accuracy in the finish of all its multitudinous parts. Such are, indeed, requisites in every kind of complicated machinery, especially lace frames, most of all a 'Levers' frame, as will be plain when its present construction and powers come to be described.

This new conformation of the bobbin net frame was due to Mr. John Levers, originally a frame smith and setter up, of Sutton-in-Ashfield. He removed to Nottingham, and extended his operations to the construction of point net and warp lace machinery. The specification of Heathcoat's machine having, as we have seen, become well known to the artizans of Nottingham, and the success of John Brown's traverse warp giving a great stimulus to similar efforts, hopes were indulged that they might be carried on without incurring the penalties of legal contravention. To this object Levers devoted (it is said, but without any evidence, conjointly with one Turton) his mechanical genius and skill. These proved to be very great, as was shewn by the extraordinary results. His labours were carried on in a garret at the top of a building situated in a yard on the northern side of the Derby Road; and so quietly

and secretly as not to be seen by any one, even of his own family. The carriages and bobbins, things which had presented so much difficulty to Mr. Heathcoat, with some of the other inside parts, had been made as thin as was requisite by a relative, Benjamin Thompson, an extraordinarily clever workman in metals, who will be afterwards further spoken of. He never was permitted to see the machine in progress, but was the first, except the constructor, to witness its completion. Levers had no son; but two brothers, and a nephew John. All worked afterwards with him, and the nephew always stated they saw the frame for the first time when it was ready to work. They found it to be eighteen inches in width, waiting for materials and prepared to start: which it did without difficulty. The entire isolation of the inventor during this process was a remarkable fact. Levers had expended his available means in the lengthened experiments and necessary expenditure incurred during the years 1812-13. The house of John Stevenson and Skipwith, carrying on a lace business in Nottingham, was induced to furnish the funds required for producing more machines; upon what terms is not now known. There were built by him for them another 18-inch, a 27-inch, a 36-inch, a 45-inch, and two 54-inch machines, Levers retaining the first 18-inch for experimenting upon. These were worked in a shop on their owner's premises in St. James's street. It is probable that the then existing patent rights on the one hand, and the profits daily realized by Levers and his patrons on the other, were the reasons why no patent was obtained to secure what was new in his method. For it seems to have been a prevailing notion amongst the mechanicians of the time, that a patent must be taken out for *all* the machine, and not (as this might have been) for any parts or combinations only which were really new. This single tier at first became known under the name of "Stevenson's frame;" but has been long and universally called the "*Levers*' single tier" machine. John Levers, the nephew, worked in the 45-inch. The well-known John Farmer worked about 1814 with another hand in one of the 54-inch, each taking five-hour shifts, the machine working twenty hours a day. The production

was four pieces of ten racks each weekly. The wages were 5*s.* a rack for some time, *i.e.* £10, or £5 each workman a week. There is no difficulty in understanding the origin of night-work in the lace manufacture, when such wages as these could be earned, and no doubt well afforded by the price of the article. After some time the workmen were reduced to 4*s.* 6*d.* a rack; but on an attempted reduction to 4*s.* they all turned out. This was a serious affair for the employers, as from the complexity of the hand movements required by the machine in its then comparatively crude state, none but highly skilled workmen could make net. Moreover, four of them, Levers, John Farmer, Dann, and Young, united to build a machine from memory, and completed one, which they jointly worked on their own account; but certainly not to advantage as compared with the amount of wages they had left behind them.

Some of the bobbins and all the carriages in these six machines were stamped out by B. Thompson. Heathcoat describes in his specification the process he adopted to get the sides of his bobbins perfectly flat and true. B. Thompson employed one very similar to it. Two half circles of very thin brass were placed within each bobbin fitting exactly the inside; they were put on an arbour passing through the centres, and were screwed together very tight, and heated until the arbour shewed a bluish tint; from which, on gradually cooling, the inside half circle plates were removed. The bobbins came out perfectly flat, and capable of turning without friction or accident in the carriages. This, in Levers' machines, where often thirty carriages and bobbins must safely work together edgewise within the space of an inch in width, is evidently a matter of first importance. B. Thompson, who was a frequent companion of J. Levers, and quite able to perform any such kind of work satisfactorily, no doubt supplied the springs also, in the tempering of which he was very adroit, as also the guides. His uncertain habits however seem to have rendered further aid necessary. Mr. Anthony Shepperley, then a watchmaker in Chapel Bar, and having workshops in Woodland Place, was employed

by Stevenson and Co. to make a part of the bobbins, turn the verges, put in the springs, and finish the carriages. The pieces being so short, John Farmer recollects a new set of larger bobbins and carriages were obtained from Shepperley, but they got from these only eleven instead of ten racks in the piece.

Having invented this new and admirable plan of constructing a lace machine, and succeeded in placing it and himself under the wing of those whose interest would be sure to promote its use, and which at that time they could do to an almost indefinite extent, this was Levers' great opportunity—prosperity and wealth lay before him, but he missed them. For what reasons, or under what circumstances the connection between Stevenson and Co. and Levers was dissolved, is not certainly known. After it ceased, he worked in an upper shop in the higher part of St. James's street. It was there, that in 1817, he altered his machines from the horizontal to an upright position, and built many of them yearly. As nothing is heard of pecuniary supplies from any external source, it is fair to conclude, that the means he employed were derived from profits resulting out of his late connection. The horizontal position of his first machines, along with some other peculiarities of construction, had no doubt been adopted in order that they might assume as unlike an appearance to the patent ones as possible. Those he now made upright were probably sold at once. If he worked any on his own account, those who knew him well, say, the produce would necessarily be sold as it came off the machines.

He is described by one who saw him almost daily for years about this time, and his testimony is confirmed by others who knew his habits and character, as having been a friendly, kind-hearted man, and a great politician; fond of company and music and song, being himself band-master of the local militia, in which also one of his brothers was a member. His domestic relations did not conduce to his comfort; his wife was not a helpmate, and unhappily for his progress and fame, he was himself a free-liver and irregular in his application to business. He sometimes worked day and

night if a mechanical idea or contrivance struck him, and would then quit all labour for days of enjoyment with chosen boon companions. He was then living in Elliott street, New Radford, next his shop, from whence, on some improvement in his fortunes, he migrated to a better house opposite. At this period, he was frequently heard to say, that the machine he had constructed was only in its infancy, because of the great facilities it afforded for alterations and improvements. The success consequent upon the exercise of his talents shewn in his machines actually at work, (which from his known want of steady application through self-indulgence had surprised many), shewed there was no reason now to doubt his capacity to mature and perfect his great discovery. He seems, however, to have attempted but little in that direction. He knew that by his skill he had helped to extend widely the manufacture of twist lace, and this appears to have satisfied him. By his invention, he was in reality greatly assisting to lay the foundation of the machine lace trade, the annual English transactions in which have at times amounted to £5,000,000, and of which the share arising from the adaptations of Levers' beautiful machine, has not been less than £3,000,000 a-year. By the exercise of self-command, energy, and even a moderate amount of ambition, Levers' advance to eminence and fortune was inevitably secure. But stimulants at the work-bench by day, and each evening the acknowledged supremacy amongst his brother mechanicians and politicians, stole away his incomings and energies together; so that he was not unfrequently without a sixpence, and had to borrow the money wherewith to purchase the next morning's supply of food for his family.

Levers entered after a time into an engagement with Messrs. James Fisher and Co., the particulars and duration of which are not known to us. He went to France in 1821. Mr. Ferguson, jun., says, but certainly without any real foundation in the facts of the case, "driven thither by Heathcoat's monopoly of the bobbin and carriage; Levers and his son and nephew (his brothers) being peaceful men, and more musicians

than lawyers. They went to Rouen, where they set up their machines, by the aid and on account of the late M. Le Forte." He seems to have taken up his abode finally in that city; paying only occasional visits to Nottingham. It is confidently stated by his relatives that he died there (and not in Nottingham, as stated by G. Henson), in what year or in what circumstances we cannot ascertain. The almost entire forgetfulness in which his memory is now enveloped, is suggestive of mournful reflections in regard to the last days of one so highly endowed with talents, and so deficient in the self-government, necessary to a wise and profitable improvement of them.

Levers seems to have trained his brothers to the construction, setting up, and management of lace machinery. They remained in France, and it is believed in Nottingham that they died there.

John Levers, his nephew, was the son of Joseph, a machine-smith, at one time in Fisher's service. The father brought up his son to his own business, and having, as before stated, worked in one of his uncle's newly-invented machines, he proceeded to make them too. This business, particularly after his uncle went to live in France, he seems to have pursued with considerable success; as at one time he believed himself to have gained £7000. Perhaps this might be an extreme estimate, founded on the supposed value of his interest in machinery—a very fatal mistake, nowhere more common than in the hosiery and lace trades, from the great prices paid for it when new. However, in 1821, when thirty-three years old, he remarked, upon finishing a new house, "I am worth just about thirty-three hundred pounds." "This sum," he is stated to have "embarked as his share of capital in a partnership, under the firm of Fisher and Levers. Trade soon after declining, stock and machinery lessened in value, so that in a few years his capital vanished, and his interest in that business ceased, by an unexpected dissolution in 1832, and he never really looked up after." While a partner there, he took a patent out, No. 5622, in 1828, to give machines on *circular comb* principle a rotary power action; and in the same year, No. 5741, to put Levers'

machines on with the like rotary power. Also in 1830, No. 5940, for a rolling locker to the Levers' machine. These three were the first of the long list of patents, in which Mr. Fisher had an original or acquired interest in connection with the lace trade.

Levers, jun., took out with Pedder in 1835, No. 6778, a patent for improvements on the *pusher* machine. He died at Nottingham in 1837, in poor and dependant circumstances. His brother Robert was a foreman for several years at Messrs. Fisher's factory till 1847. Since then, the name of Levers has disappeared from the English trade.

It seems that one of the family, who went to reside in France, and is called John Levers, jun., constructed a rotary self-acting Levers' machine, having two extra catch bars with hook pushers to divide the carriages and a plate bar with nicks cut in it by which the divided carriages were kept steady by the pushers. Bailey's plan let them slip. Louis Paul Le Forte obtained a patent for this plan in England in 1823, No. 6423.

The Levers' machine is by far the most delicate, its inner parts working in the smallest space, and requiring the most careful adjustment and finish of any amongst those bobbin net frames which are principally used. It is therefore, when prepared for fancy work, the most expensive in its construction. This will readily be understood by the following description of one offered for sale while we are writing: Besides the parts necessary to make the net, this machine, 153 inches wide 10-point, has 80 top bars, 400 bottom bars, 54 threading beams, and a Manchester Jacquard to enable it to produce silk ornamented laces. Thus constructed, it admits of such alterations of meshes, fine work, thick threading, and every kind of breadth patterns, particularly narrow ones, (all being of late years regulated and controlled by the Jacquard apparatus) that this class of machines cannot be too highly regarded for its usefulness.

Being now worked by power, Levers' machinery, though it has become very wide and ponderous, does not require proportionate physical labour. But it necessitates great skill and attention; and has, in consequence, ultimately given employment to the larger part of the most efficient workmen in the trade. The wages they

can earn are such as will maintain them in comfort, and enable them to bring up their families respectably; giving them a fair education, and preparing them for taking their part in the battle of life.

In constructing his machine Levers availed himself of all the essential parts of Heathcoat's machine. The bobbins and carriages are in shape nearly resembling those of the patent, though of half the thickness only and considerably larger in size. They perform the same functions; are held by catch bars, entering into the nebs of the carriages which are pushed through the warps by stump bars and fetchers. In the act of traversing, one half the carriages were placed in the front bar, and the other in the back bar; they were then shifted sideways (shogged) one gait, and were then all brought into *one line* (tier) *again*. This arrangement is the chief ground of difference between the patent and Levers' machines. But from it there results much difference in construction and consequent adaptation for producing different kinds of lace. These will appear from the special uses to which this great class of machines has been put, and the efforts to improve and add to its powers which have to be noticed with as much brevity as is consistent with justice to so important a branch of the trade.

Levers' machines are made as coarse as five-point and as fine as fifteen-point. A ten-point guage requires twenty warp threads to the inch to produce traversed net, *i.e.* when a full warp is wanted. In this there will be twenty bobbins and carriages in the inch single tier on the central comb bar. Besides these, in making fancy goods there will be thick threads moved greater or less distances sideways, according to the weight on each thick thread beam. Of these thick threads there may be forty or more in an inch. Where there is no net in the ground there will be no warp. The lace is produced in that case simply by the gaiting (shogging) movements from side to side of the thick threads, and the twisting movements of the bobbins and carriages to and fro as they pass through and around the thick threads. The machine will make eighty or a hundred of these backward and forward motions in a minute with their complement of relative movements, or about one inch in length of closely woven lace, the whole breadth of the machine, however wide, each minute. The guide bars are placed in the lower part of the body of the machine, and occupy in comparison with their number a very limited space; the warp and thick threads are passed through orifices pierced on their polished surfaces, and there may be fifty or five hundred of these bars, each guiding exactly to the right or left its complement of threads as governed by the cards of the Jacquard at the end of the frame. The bobbins and carriages are driven at the speed described through this maze of tight and, for the most part, very fine cotton twisted threads, or even still finer untwisted silk filaments in the spaces of one-tenth to one-twentieth of an inch, according to the guage, working side by side clear of each other and of the threads through which they pass; and which threads have all between each movement of the carriages been themselves moved one-tenth to one-twentieth of an inch, so as to vary the particular intervals through which

the carriages pass. Were that side movement in the least irregular, the threads would be cut down, and possibly the machine itself seriously injured.

The above description shews the necessity for perfect solidity of frame-work, steadiness of movements, precision in form, finish and adjustment of the wheels that give motion to these thousands each of combs, points, guides, pierced guide bars, carriages, and bobbins—including their very springs and nibs. These springs are seemingly trifling things, but are of major importance, and must be of proper temper, setting, and operation for the making of good lace. All these parts have to work in perfect harmony with and obedience to the Jacquard, which controls all the movements in the course of the pattern. These are too quick to be followed by an unpractised eye, and the quantity produced may be thus judged of. The machine, from the working of which the above description was taken, was 144 inches wide; and was making 144 one-inch black guipuire silk edgings. It had produced 2000 dozen yards in the week, selling at 2*s.* 9*d.* a dozen, or £275, which, if continued through a year, and allowing for discounts, stoppages, and holidays, would result in an annual return of £13,000 from one machine. The chief points in management of such machines in a factory are—seeing to the drafting patterns, perforating Jacquard cards, applying them to the requisite bars in the machines, and then superintending the production of the required quality and quantity of work. If to this be added the efficient control of workmen qualified to deal with such costly and delicate machinery, it will be seen that the responsibility devolved on these superior workmen is a serious one. The proprietor has to decide the prior question of what the pattern shall be, and afterwards the quantities of any one pattern which such rapid machines may be permitted to produce. To these last two points more and more importance must be attributed, in proportion as competition and fashion are developed in lace.

Many had failed in attempts to make breadths on the Levers' machine; at length, in 1823, John Bertie and Richard Biddle succeeded in doing this,—

By breaking out three combs and cutting out one half the comb in each side, having a whole comb and two half combs coming over them, in the act of traversing these combs and half combs were made to shog back, and thus left the piece divided. They were joined again by bringing up extra warp threads to interlap in the carriages in the instrument called a 'turn again.' This method, since improved, was used extensively.

In 1824 breadths were made by Jacob Woodhouse on the three carriage plan.

In 1827, Roe of Radford, Robinson and Widdowson of Basford, and Bertie, were still engaged in these Levers 'turn again' breadth improvements. This year a rotary Levers' traverse warp machine was constructed by William Barnes.

In 1829 a rotary motion Levers' frame was constructed by Bailey of Leicester, in which the carriages instead of being pushed to division in traversing are drawn back by hooks. This was first essayed by Bryant in making Brussels lace.

In February, 1831, William Sumner, of Hose in Leicestershire, took out a patent, No. 6070, for producing bullet hole open work on Levers' principle.

By which extra 'turn again' bars, pusher, comb, and point bars are made to shog and to perform the various movements of a non-traversing machine. The spring of the right-hand traverse carriage was made tight, the left-hand carriage opening slack.

This method once employed six hundred machines. A list of them was sent to Mr. James Fisher, who declined at first to pay the inventor an agreed sum for the assignment of the patent, but afterwards paid it. Sumner then required interest. During the delay, traverse laces were superseded by straight down Levers' goods, and the method is almost forgotten.

In 1834, Bertie and Gibbons patented, No. 6621, an apparatus applied to the Levers' frame for looping each alternate warp thread at the close of the hole to the bobbin thread making four distinct twisted pillars and two looped instead of traversed closings of the mesh.

This was effected by adding stumps fixed on levers, revolving in a comb bar and slaie, which levers, operated on by the pins of an organ barrel cylinder, and by pushing the warp threads sideways, prevented them from looping, leaving large holes, which could be made larger at pleasure by the alteration of the cylinder.

This looped net has been extensively made; and when controlled by the Jacquard cards, an elegant but inferior article is produced.

Another article, first made for Messrs. Frost, Nottingham, and called 'fender' net, from its being a mesh simply twisted like fenders or wire fire-guards, was made on Levers' frames, in 1829, by G. Fox, of Radford, and lay dormant for twenty years. Having but two sides twisted and four sides each formed of a single thread, it looks exceedingly light and airy, and when of silk stiffened, very brilliant. It will not bear washing. It has been brought into very extensive use during the last twenty years, under the name of Mechlin, both in cotton and silk net. In making the latter kind there are about three hundred machines at work. A twenty-quarter wide frame will produce so much of this silk net, as, when stretched and stiffened ready for sale, would cover two thousand square yards weekly, or twenty acres of ground annually. It is now chiefly made on the circular rotary machines.

In 1832, John Langham, of Leicester, obtained a patent, No. 6348, for a rotary arrangement of the Levers' point bars having common pushers. Bryant and Harvey produced straight down square net from 5-point Levers' frame for curtains, garden nets, &c. It is said to have been the first machine on which this class of lace goods was made.

In February, 1835, T. Allcock, of Worcester, took out a patent, No. 6764, for a new kind of Levers'—

> In which, catch bars and other parts for moving carriages are put on a camel or general carriage moving on trucks on a circular frame. On these trucks the catch bars ride on axles, and rise and fall on an inclined plane; the catch bars slipping, and not dropping, into the nebs of the carriages. The whole propelled by a fan segment.

S. Sansom, in 1836, made square net on Harvey's plan, but without any point bars. A similar method has been used at Calais, invented by M. Saillè, having extra laps at the close of the hole.

Blomer made Levers' Grecian net by extra bars and extra beams, which was superseded by blonde. This plan cost Mr. Thornton a large sum in perfecting it.

In 1837, R. White, of Bobber's Mill, took out under

Mr. Foote's auspices, No. 7473, for Levers' open work, by inserting thick stumps between warp threads to let two carriages pass between the warp threads instead of one. It was superseded by straight down nets.

In 1841, William Shepherd made Levers' tattings by shooting in thick threads in devices. There were double the number of points in each point bar, and the twist was taken up at each time of going through the threads; laying a foundation for making many excellent fancy articles. He went to Lisle.

Davis, of Nottingham, made tape edgings, spots, weavings, and other devices.

By breaking out main guides, and substituting extra guides soldered on iron plates, so that a number of bars might pass the guides, shogging each time the carriages went through the warps.

About 1840 many experiments were being made upon the Levers' machines. A square net was made by simply interlacing the bobbin and warp threads, as also an octagon hole blonde. Saillè, of Calais, thus made it, and Sansom readily imitated it. On the Jacquard being introduced, laces of any pattern were thus made by operating on the warp threads. A new era seemed to have begun. The pusher bars used in Levers' machines were taken off; the carriages were kept always in the same combs not traversing; the interlapping of threads being done by the warp alone. This mode became nearly universal in Levers' frames; but the work is inferior except for laces that do not require washing. Wire grounds are however made by another method in which warp and bobbin are so interlapped and twisted as to hold out in width and against any ordinary friction.

From this time also Levers' machines began to be worked by rotary power. Harvey, Bryant, Sansom, Preston, Langham, and others, were amongst those who took part in this great onward movement of the fancy trade. The improvement of the entire machine in speed and safety of working, followed putting it on to power. The carriages were secured from slipping off the angular hook pushers, thus avoiding smashes of carriages and combs.

Hitherto also power machines had the carriages, one propelling and drawing the others; about 1840, Samuel

Barton, of Sherwood, built a machine having carriages moving on circular combs in a single line and traversing by a double locker, saving the time of a long motion of two sets of carriages.

Amongst what may be termed the 'composite' machines, in which have been attempted a combination of two or more of the principal methods, one was patented by William Henson, of Chard, in 1832, No. 6354.

In this an upper set of carriages in single tier was propelled by rolling lockers. The lower set of double tier carriages traversed and worked in bolts, and were separated in the act of traversing by an edged plate coming up perpendicularly, acting as an under locker. The net was twisted and traversed by bent pins put in front and back, but were withdrawn and entered again at every third or traverse motion, the bent pins acting as guides. This machine was driven by rotary power. Henson proposed to make ten racks of 240 meshes each in length, in an hour. He made forty meshes in a minute, but never made a whole piece at that rate.

In 1839, Mr. Oliver, of Basford, constructed an apparatus for making figured open and linen work on a Levers' machine.

This was said to be effected by substituting two tiers of very large bobbins and carriages for the warp main beam, leaving each thread at liberty as to its tension, each large carriage and bobbin acting as a separate beam. These warp bobbin threads were said to be acted upon by stumps, which were moved by the Jacquard.

This was an attempt at a mechanical pillow for making patterned lace.

Heathcoat from the beginning had made every part of his machinery on his own premises. Not so any of the infringers in their first essays, though several of the most important soon did so. The success of the patent machinery at Loughborough, causing the increasing construction of bobbin net machines at Nottingham on Heathcoat's principles, was the signal for originating the twin handicrafts of the bobbin and carriage makers. For though at first they were carried on in conjunction, they soon became and still continue to a great extent separate occupations. Those who first undertook these manufactures as an independent business were generally watchmakers. Such was Mr. Anthony Shepperley, one of the first who added this to his regular business. His articles were of first class workmanship, and gained him a corresponding reputation and demand.

It has been already stated, that in none of the component parts of the twist lace machine are excellency of materials and a perfect finish of more importance than in these, which compose the circulating system of the machine. Therefore the fine touch, trained sight, and habit of exact manipulation possessed by watchmakers were the best qualifications for and passports to employment in these departments. Anthony Shepperley is here specially singled out, because from the recollections of his family several interesting facts have been obtained.

After finishing the Levers' bobbins and carriages for Stevenson and Co. as already mentioned, Shepperley preferred to engage in making those for the *straight bolt* machines first constructed by Mr. William Morley. But notwithstanding an improvement introduced by Mr. Shepperley, tending to counteract the great defect in the working of straight bolts, by the application of a lever to the carriages, regulating constantly the amount of thread given off the bobbins in that class of machines, the circular comb quickly superseded them. He then began to make that description of bobbins and carriages for Morley and many others. The *dishing* of bobbins for circulars, was first done in the Nottingham district, at the instance and under the instructions of Mr. Morley. This reduced them in thickness and weight, while less labour was involved in making and finishing them. Amongst his numerous hands, Shepperley employed several Germans. All, and amongst them his own son Mr. George Shepperley, Long Row, found the employment more profitable than that to which they had been brought up. For instance, Mr. George Tritchler, a German, one of these journeymen, left this shop with £4000 savings, on which his widow still subsists. Another overlooker, still living, an Englishman, left this occupation with a considerable sum, having to receive £60 or £80 at each settlement beyond the wages he had drawn. All were very highly paid, and many of the men were equally provident. But the greater part were not so. They dissipated the earnings of three or four days in riotous idleness and indulgence through the rest of the week. Songs, in celebration

as it were of this sort of saturnalia were composed, set to music, played by the band of the local militia in marching to and from parade, to which these jolly journeymen added their voices in a choral refrain—

"For we'll all go a bobbin and carriaging,
Oh yes! we will go—yes! we will *all* go,
We'll go *all together*, a bobbin and carriaging,
Hip, hip, hip, hip, hurrah!"

The more their employers were pressed for their work, the less work would many of the men do while the fever lasted. All were very highly paid, and the profits of the masters were great in proportion. During several years the demand was so great, that it could not be supplied; the news of such wonderful wages, independence, and jollity, spread like wild-fire; so that speedily, machine-smiths, lock-smiths, and black-smiths, together with every watch-maker who had a wandering or adventurous spirit within fifty or eighty miles, came together in the garret workshops, extemporised in every quarter of Nottingham. In the case of many of the machines then contracted for at fabulous prices, cash was paid down in whole or in part for them, and yet they never could be made to work, or only after more still was spent upon them than they were worth when done. So in regard to bobbins and carriages, orders were given for unnumbered sets, and thirty or fifty pounds paid in advance, without any guarantee or even enquiry as to whether the recipients of the money understood, or *had ever seen a bobbin net machine at work in their lives.* There were well authenticated instances, in which such consummate assurance on the one hand, and infatuation on the other, were found to be literally true. No wonder then, that such inferior articles were made by inexperienced pretenders to the art, that if the other parts of machines constructed after the expiration of Heathcoat's patent in 1823, were made so as to do their duty, the sets of bobbins and carriages were often unworkable. So much was this the case, that to get an order taken by the really competent and honest maker, bank notes would be laid with the order on the desk, as an inducement to execute it. All the good makers reaped a

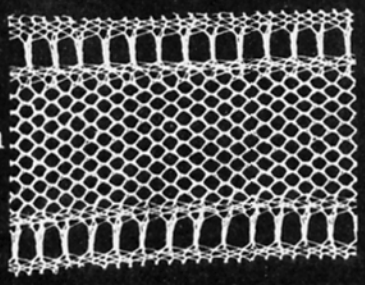
great harvest in those three or four years of excitement. Since then the business has settled down into a moderate rate of wages and ordinary profits. Messrs. Thornton and Aulton became large and excellent makers of Levers' bobbins and carriages, deriving like Mr. Shepperley and his successor, considerable and well-earned gains from the all-important fact that their articles might be relied on.

The following estimate was drawn up in 1836 from the information then and previously collected, as to the numbers employed in the various collateral branches of business in constructing machinery in the Nottingham trades in 1825 and 1835 respectively:—

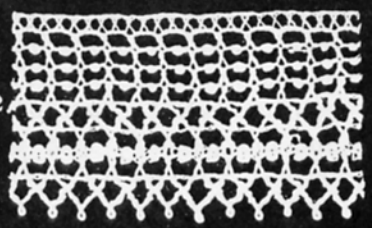
	1825	1835
Master smiths . . .	80	30
Journeymen	400	150
Master bobbin and carriage makers	50	15
Journeymen	250	140
Smiths privately employed . .	300	100
Guide, pusher, bolt, comb, point, hook, and slaie makers	150	30
Needle makers, turners, casters, wood-work makers, setters up, &c.	270	55
Totals	1500	520

Each of Heathcoat's first bobbins (or wheels) containing the threads working diagonally, was pressed upon by a small tongue of steel placed on each side of the carriage, and acting as a spring to regulate the amount of thread given off in crossing and in twisting round the warp threads, Plate IX. fig. 2,—thus making the sides of the mesh and crossing, and consequently the shape and size of the entire meshes as regular as possible. Upon the attainment of this, in a great measure, the whole face of the article, as to its beauty and use, must depend. To equalize the force with which these springs act on the bobbins throughout their whole range, and along the length of each thread as it unwound itself, were great points to be attained; and even with these first inconveniently placed springs they were in good measure realized (Plate XIV., No. 15). But the process was difficult and tedious. The shape of the carriages was soon improved in all kinds of bobbin net machines; allowing a spring to be attached to the upper part of each (Plate IX. fig. 3), at the unattached end of which was

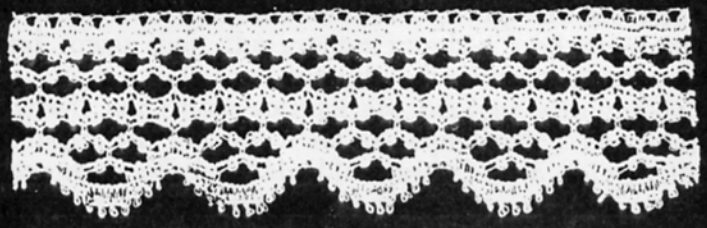
PLATE XIV.



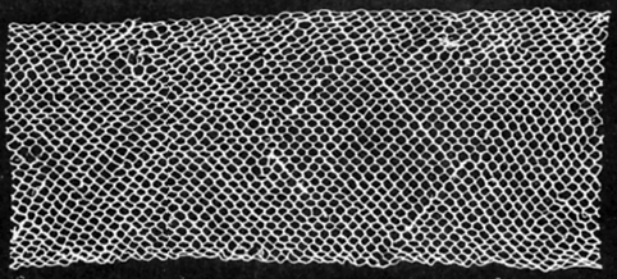
11



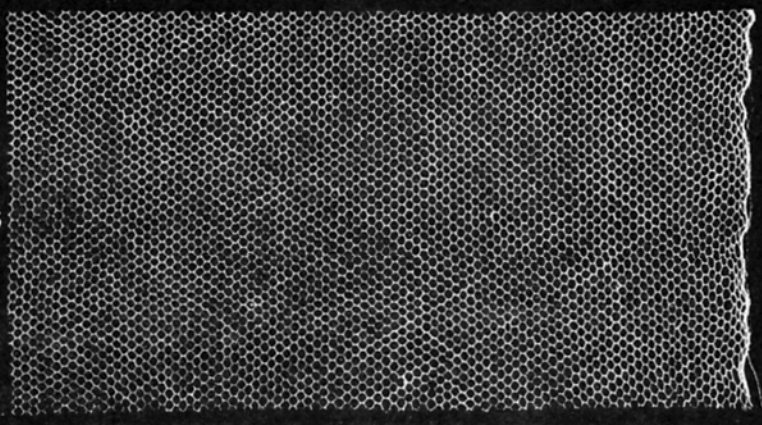
12



13



14



15

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a pointed nib, which just enters between the sides of the bobbins at their outer edges; and while it keeps them steady, regulates by its pressure on the periphery of the bobbin, the giving off of the thread. These springs are adjusted to each other by an easy process, but one requiring care. When filled with thread and placed in their carriages, these threads are taken into one hand, and the carriages and bobbins lifted up and slightly shaken. As the weight of thread in each is equal, those carriages in which the springs are too weak descend lower than the greater number, and those too strong do not fall low enough. Each are separately eliminated, and their springs are bent or straightened accordingly, till the whole set are equalized. To whom the invention of this valuable spring, now universally used, is due, is doubtful. It is said in a communication inserted some years since in one of the Nottingham newspapers—

"We believe the idea of fixing the spring on the edge of the bobbin was suggested by John Irving, but he could not execute it. After experimenting for twelve months at considerable expense, William Skelton, of Brick Lane, Nottingham, succeeded in perfecting the small nibs which enter between the sides of the bobbins, and thus enables them to hold double the quantity of thread, being made double the thickness, but occupying the same room. Such was the importance of this discovery that, to use the words of Mr. Heathcoat, now M.P. for Tiverton, 'the man that perfected and made that spring was the founder of the bobbin net trade, and not me,' as without it the pieces could not have been made of sufficient length to have established the manufacture."

As Henson makes this statement verbatim in his MS., and from internal evidence, there can be no doubt he wrote the article. G. Henson felt some prejudice against the patentee—on what account can only be surmised. He speaks of the 'Old Loughborough,' the patented machine "as merely an ill constructed, intricate combination of other men's inventions, too difficult and slow ever to work to profit, and nearly disused." The facts are all against this highly coloured statement, and as is in evidence by inspection of the sample of his net sworn to in 1813, given in Plate XIV., No. 15, it will be seen that more perfectly regular net cannot be made by any machinery now, than that which was made by

Heathcoat while using his first spring. Therefore the trade is not founded on the discovery of the new spring, though that is in many respects a great improvement. It is merely incredible that Heathcoat should ever have thus expressed himself in this matter. The article concludes by asserting "that had not Skelton produced the spring, there would have been no bobbin net produced." The writer knew or ought to have known that it had been produced years before, and of excellent quality.

William Skelton was originally a shoemaker, but early turned his attention to making the smaller implements used in hosiery and lace manufactures, and which required great care and precision in their finish. He appears to have understood and could explain well the intertwining of threads and formation of meshes in foreign laces; therefore was consulted as to the way to get out in machinery these difficult reticulations. Benjamin Thompson often stated however, in Skelton's hearing, that the spring and its nib were his (Thompson's) invention; as also that the mode of tempering it was his discovery; and Skelton on such occasions acquiesced in the claim. Thompson, it is asserted by his son, gave Skelton the plan, who being a clever workman, made them so well as to take and maintain the lead for their sale for a long time, during which it was his principal means of existence. The case may have been thus: Irving devised the spring only; Thompson tempered and gave it the nib, and, as they were companions, handed it to Skelton, whose position seems to have been a precarious one at that time. He was the first to apply the spring with two opposite nibs to the *pusher* carriages, and gained largely by them, others for a long while being unable to compete with him. He nevertheless died a few years ago in humble circumstances at Nottingham.

The name of Benjamin Thompson has occurred several times in previous pages, and we cannot pass on without giving some account of so singular a person; one, who during the first quarter of this century was universally known to the mechanical world in Nottingham, and not much less so to the men of

scientific note then resident in this district. He was born at Groby, in Leicestershire, and apprenticed to a chemist in London by a rich maternal uncle, who liberally supplied him with the needful resources. When out of his time he became acquainted with the elder Dolland, then in humble circumstances, afterwards the celebrated optician. From this intercourse he was enabled to make some considerable progress in the practical application of more than one of the natural sciences. He left London from some unexplained cause, thereby displeasing his uncle, and was cast off by him. He found his way to Nottingham, no doubt drawn thither by the then well-known skill of the machine-smiths and other artificers, who found good employment in the two staple trades of the place. He married the niece of Mr. John Levers, whose machine has been just described. Thompson's skill in handling tools, as well as making them, soon became noised abroad. We find him styled in various documents of those times, a brass turner, an optician, a maker of prismatic division lathes, and of various curious and useful instruments. From Dolland he acquired the knowledge how to make telescopes and microscopes. One of the latter of his make is now in use. Several of his turning-lathes are still doing their work perfectly, though made fifty years ago. It is stated, on good authority, that he could smelt, fuse, and purify his metals; turn in wood, iron, brass, and ivory; grind the object glasses, make the slides, put the parts together, and finish an optical instrument. He constructed a machine for slicing wood and plants for microscopic observations, dividing off some thousands of sections in an inch. A flute was required by the Prince Regent for presentation to another royal personage. The musical instrument maker to whom the order for it was given, confided its execution to Thompson, who went to London and completed it to his satisfaction.

With such an amount of useful knowledge and extraordinary handicraft skill, what might not Thompson have attained in such a time of mechanical effort and unlimited demand for the very class of objects he could best produce. He claimed to have made the *first* bobbin

and carriage for Whittaker. He certainly did so for Levers. Here was an opening to fortune, too plain to be mistaken. He could help his acquaintances (and they included every maker and setter-up of machinery of all kinds, large and small) to devise and construct it; but disdained to benefit himself, or to bargain with them.

He was employed successively on point net warp and bobbin net machinery, yet derived only a scanty income from them all, while others with less genius, stept on by paths open to everybody, to fortune and influence. Thompson was versatile, unstable, and self-indulgent; too independent of the ordinary laws that govern a really useful and happy life; too desultory in labour to be depended upon for its punctual performance however important; he solved the difficult problems which were daily cropping up at that time requiring apt skill and a sharp eye very cleverly, when he could be induced to undertake them, gaining the credit for them while others took the reward. He had great but misdirected talents, and his careless habits were manifestly inconsistent with the comforts of home and well-being of his family. He died poor at Nottingham, in the year 1825.

From the recent interference of the legislature in the employment of women and children in lace factories, the following explanation is necessary to shew what they do as to these bobbins and carriages, which have been likened to the shuttles in weaving looms, inasmuch as they supply weft to the bobbin net warp. The machines by their own operations gradually empty the bobbins of thread. The bobbins are charged with threads drawn from drums, on which the materials have been wound by boys from the wooden bobbins, which have been just before filled with the yarn from the hank by girls.

When these carriage bobbins, circular, flat, thin, and deeply grooved, are to be filled, the woman takes up as many as there are threads on the drum, and passes them by means of a quare hole in the centre upon a revolving spoke or cylinder; stretching the threads over the bobbins, she slips each thread into

its corresponding groove. A few turns of a revolving machine going at great speed, fill the bobbins with a sufficient quantity of materials. The inferior qualities or errors in the size of cotton yarn or silk thread, shew themselves by the under or over filling of any of the bobbins. The bobbins when full enough are taken off the spoke, to be replaced by empty ones, over which the threads from the full ones are severally passed, and are then snipped asunder between the full and empty ones; the full ones are laid aside and the new set filled as before.

These full bobbins are next to be inserted, each into its thin steel-framed carriage, in order to its being carried with its thread to and fro, from back to front and contrariwise by the machine. This is performed by sharp-eyed young lads, with such rapidity and neatness of manipulation as looks very like legerdemain; the bobbin fixed, the carriage spring adjusted, and the thread passed outside through a minute hole in the carriage top. When the springs are evenly bent, as elsewhere described, the carriages with their contents are ready for the machine.

These young people, male and female, are now employed very properly only within factory ages and hours, instead of at hours in any part of the night, which was formerly the demoralising practice. As the sets of bobbins are necessarily emptied at uncertain times by the operation of making pieces, either there must be a double set of bobbins and carriages to each machine, or the workman must take his turn in obtaining a full one. This is a small cost at which to secure the great benefit now enjoyed.

CHAPTER XIX.

THE PUSHER BOBBIN NET MACHINE.

THE PUSHER machine was constructed first in 1812, by Samuel Clark and James Mart, assisted it is said by Joshua Roper, all of Nottingham. As contrasted with the patent machine of Heathcoat—

> The carriages containing the bobbins were pushed by long instruments through the warp threads; which bobbin threads were drawn off downwards and the net thus formed below was carried to a work beam also in the reversed position. The carriages were only held on short combs by the tension of the bobbin threads. An important difference exists between the double tier circular machine and the pusher. In the circular, *pairs* of bobbin threads with their carriages must necessarily act together; they cannot be parted in operation and effect. Whereas in the pusher, every bobbin and carriage being each operated upon by an independent pusher just as wanted, can be obliged to proceed in any direction desired, or remain at rest. Thus cloth work can be made more uniform and clear.

While this machine possesses some special advantages, it is costly and a delicate one in work. The pieces made on this plan are short, the bobbins not holding much thread. This was nevertheless a clever modification of the original machine.

Pusher cotton and silk nets with excellent fining clothwork are finished by needle embroidery passing thick threads around and through the finings and open work; so that cushion-made fancy goods, such as shawls, veils, berthas, &c., are closely imitated by articles obtained from this machine. In making the ground, fining, and open works on the machine for one such article, five thousand cards may be required. Mr. Vickers and Mr. Reckless have been and still continue eminent in Nottingham for their successful use of pusher grounds, as also for the superiority and execution of their designs. The pusher imitation of Chantilly lace

nearly approaches the real article. A *flat* appearance is all that serves to distinguish its mechanical origin.

In 1814, Clark and Leonard Elliott made breadths by extra pusher bars to let the carriages rest on the traverse motion, with extra beams to sew the threads. This net sold for double the price of wide plain net for several years.

In 1820, an improvement was made to the pusher by Joshua Crowder, John Day, and Richard Seymour, of Nottingham, and Francis Moore, of Radford—

> By adding a tie-bar to pusher-bars and making them act together. Thus instead of the pushers driving half of the carriages into the back combs and coming again for the other half thus making a blank motion, the half tier was taken to the back and returned and the other half taken and returned in like manner, which being thrice repeated reduced the motions from twenty-four to fourteen.

These persons sold their method to the trade, and received for it *promissory notes*, which were ordered by an injunction *not* to be circulated. After several years' litigation they obtained a verdict, but their attorney dying, they never received the value of their notes.

In 1821, Kirkland and Cooper moved point bars by wheels instead of treddles.

In 1823, a pusher circular machine was brought out by John Day, of Nottingham, and John Lindley, of Tottenham. Also Henry Mayfield introduced another mode of working it.

In 1825, Mart and Day constructed a circular pusher, in which the carriages were grooved and rode on short bolts to prevent their falling off. The plan did not succeed.

In 1828, the improved pusher machine was taken to Lisle by Clark, to Paris by Bonington, and to Calais by Rayner.

In 1829, John Synyer, Sneinton, by extra wheels and pusher bars, and letting the carriages rest at traverses, when single formed by it a *bullet hole;* when changed in the next hole, it formed *Grecian* net.

In 1830, Skevington, of Loughborough, by turning a spindle on cams, got increased speed and safety on the old patent Loughborough machine, and intended the plan to be applied to the pusher machine also.

James Pedder, of Radford, contrived, in 1832, an apparatus by which two sets of eccentric wheels moving at different speeds produced ornamented lace. In this method a thick gimping thread was placed by using long extra guides; spotting, by stumps pushing warps to prevent a traverse; linen cloth work, by breaking out certain main guides and inserting extra guides; net or other plain work, by cutting wheels suitable for each.

John Bell, Nottingham, made open works in required patterns on pusher machines in 1838. These might be different in each breadth if desired. He used an apparatus to answer to the draw-boy in the weaving loom. Also, in the same year, Day and Forgie applied the Jacquard and draw-boy to this frame. Forgie was a cloth weaver by trade.

He applied a long lever pusher to each carriage; but when open work was to be made, it was raised and missed the required carriage leaving a hole in the web; which once repeated and changed to the next carriage made Grecian net; if further repeated it produced a still larger mesh or open work; cloth work could not be made and the plan failed.

In 1839, James Wright, of Radford, applied cylinder Jacquard cards to pushers, adding them to Forgie's process in order to make cloth work ornaments. The carriages were traversed at every motion. This plan caused a large demand for black silk laces, since partly superseded by goods made upon Levers' Jacquard machines.

John Lindley, jun., resided in the first part of his business life at Loughborough, where he made point net lace. After assisting to improve that class of machines, he spent much of his time, from about the year 1798, in endeavours to produce twisted and traversed bobbin net. This he did at first, it is probable, alone; and is described as fastening his pocket comb in the slit of a table top, and using the teeth as points, from which to hang a series of cotton balls; and by his fingers twisted the threads, after the manner of the pillow workers. He thus made a small piece of irregular shaped net, two or three inches in width. This on being shewn to his uncle, C. Lacy, the latter declined to patronise it. If, as has been asserted, he knew and

had intercourse with Whittaker, who had not yet gone to Loughborough, it was most likely some years after this period. Blackner says, his next step was made in 1799, by the construction of a small set of bobbins worked on a singularly rude machine, on which was made a small portion of something like the present bobbin net; and at length this was followed in 1811-12 by another machine also entirely constructed by himself. This was upon the single tier arrangement which had been adopted and laid aside by Heathcoat, but successfully carried out eventually by John Levers, and known by his name. It made traversed net of twelve inches wide. There was one dividing bar (cut by T. Kerry) and guides (made by Rudd). Mr. James Fisher and Mr. Charles Lacy saw it, and they said they expected great results from it. The former took all the work made upon it in its rough state, giving £1 per lineal yard as its price.

Lindley's son, then a youth, wound the thread upon the bobbins in his play hours, and thus earned his first watch. Why the frame was thrown aside is not stated by his son, who furnished some of the foregoing particulars. The model of it was in Lindley's possession in 1828. Guides and carriages used in it were placed in the Nottingham Exhibition in 1840, but unfortunately the opinion of Mr. Sewell, who examined them, cannot now be obtained. The author did not see and therefore is unable to describe them. The invention by Levers and its extensive adoption, was probably the reason of this machine not having been continued in use. The circumstance of Lindley's endeavour to make lace before Heathcoat's patent, and his subsequent use of a bobbin and carriage, does not throw any light on the claim put forth for Lindley as the *inventor* of these important and ingeniously combined instruments; nor on Whittaker and Hood's proceedings; nor does it affect Heathcoat's claim to originality. They were all at work close to each other; but how far Lindley had then progressed is not now known. G. Henson gives 1809 as the date of the invention of this machine; on what ground does not appear. It is certain that the son, who states 1811-12, must have the best knowledge of the year,

for he says "the construction took place in the chamber in which I usually slept, but often could not, by reason of the inharmonious jangling of my father's operations."

John Lindley, afterwards being in connection with Charles Lacy (partner in Heathcoat's patent), took out a joint patent, September, 1816, No. 4063, for a machine in which were combined the peculiar systems of the Levers' and traverse warp machines, and to be worked by a *rotary power movement.* It was unhappily an unprofitable effort, and resulted in ruinous consequences to its projectors in regard to the business they were carrying on at Tottenham in Middlesex. The separate machines sought by them to be made of combined use, were found by the trade each to have its special adaptation and value. The expence of constructing the machines on this new plan was enormous at that time and at that distance from Nottingham, and it failed by this and the delicacy of its organisation to secure adequate results. Nevertheless it contained the bold idea of working the lace frame by rotary power action; and which, through some mechanical arrangement or other, has gradually been introduced into every department of bobbin net, warp, and even hosiery machinery. The direct result of this invention of Lindley's was disastrous to him; its indirect influence was highly beneficial to the lace trade.

In this machine the carriages were very long, and the bobbins were placed at one end of them, while the entire series of meshes across the machine was completed by six movements only. To describe, in a popular manner, the thousands of instruments employed, and the peculiarly diversified operations whereby they are made to co-operate, seems impossible. The plate given in the specification, shewing a front elevation of this machine, is a great curiosity. It may be called an outline portrait of mechanical genius; which, contrasted with the picture of Lindley making his first effort at *meshing* lace, by using his pocket comb and cotton balls, cannot fail to astonish these who doubt what a self-taught mind can accomplish; and will cause deep regret, that in this, as in so many other instances, such a severe course of mental labour, directed by

practical, though in this instance misdirected skill, should not have met with its commensurate reward.

Mr. Lacy embarked in this invention with the patent and machinery, the very large sum which he had realised under Heathcoat and Lacy's patent, and spoke of applying for an *Act of Parliament* to authorize secrecy of the methods employed under the patent, and so secure the expected benefits entirely to themselves. The idea was characteristic of the man. He was loud in his lamentation over the change which supervened in the position of their affairs; Lindley, a clever and of course greatly disappointed mechanician, knew how to carry his misfortunes with modesty into an unrepining retirement. An examination of the specification and drawings, describing how the more intricate parts of machines so widely different in construction, are made to work together in subjection to inanimate rotary power, will furnish ample evidence that Lindley very nearly attained a position in the first rank of our local inventors.

The art of *meshing* has been spoken of above as one in which Tarratt, Heathcoat, and Lindley engaged in connection with their efforts at mechanical lace construction. This is a science of no small importance, which has been investigated, and in some considerable degree acquired, by every one who has made any important advances in the manufacture of lace, whether in the construction of machinery, or its application and use in the production of almost endless varieties of ground-works and designs. It has been the study of lace patentees, from Morris in 1780, down to the present time. In the case of several of these, curious instances of its value and of their facility in its use, are on record.

It consists in a careful examination and study of the different classes of *pillow* lace; ascertaining the number of threads used, and their several courses, in the formation of every kind of mesh; the number and order of twists, plats, weavings, and crosses, which are formed with each pair of threads; the fine-works, open-works, thick threads, points, and pearls, which go to make up the texture of each class—Mechlin, Brussels, Alençon, Valenciennes, Lisle, Bucks, or Honiton.

This information is necessary to be gained, in order to be fully aware what is to be done by the machine, so that imitations, more or less perfect of any of these, may be obtained from it. And this, always taking into account that the mechanical progress of the work is not by dealing with merely single pairs of threads as on the pillow, but by forming thousands of twists, plats, or crosses at once, and, that there can be no actual retrogression, every movement is one in advance. A thread cannot return at all, though some may for the moment be held stationary; but each and all must proceed *onwards, if at all,* with the continued action of the machine; and the effect of this upon mesh and pattern must be calculated upon, and subordinated accordingly.

Persons who have applied themselves to this kind of investigation, so as to become familiar with its details, will follow out and master the intricate courses of these threads with surprising ease and accuracy. They get into the mind a full and clear idea of what they wish to accomplish, and thus can proceed to invent, adapt, or add to, a machine; having, by a peculiar mental process, carried on almost involuntarily, often in the dark, and not unfrequently in bed, seen their way to contrivances, modes of construction, and operations that lead, often it is true, by a round about way, to the desired result. It is thus that the *mesher* obtains an accurate knowledge of the thing to be produced; is enabled to devise means requisite for its production, and how he must apply them to the machine, so as to make them effective.

This habit of analysing the component parts of things to be produced, and the means best adapted for effecting them; of mechanical powers and their action, of separating and casting aside the superfluous, and securing the aid and effect of that alone which is necessary, has distinguished the crowd of acute, self-taught mechanics, who have within the last century, applied their talents to the staple trades of the three midland counties. Its incessant application has issued in the wonderful inventions and scarcely less surprising improvements now witnessed in its machinery. In the

search after speed, exactness of imitation of real lace, and variety of designs, they relieved themselves from obstructions unknowingly laid in their way, by the want of foresight or of mathematical skill on the part of the original inventors, or of those who from time to time have introduced changes in these mechanical operations.

There were no inherent advantages to be gained, by uniting the lever and traverse warp plans in one machine. They are each composed of very delicate instruments, working in most confined spaces, and in very different ways. In this attempt, Lindley therefore made a serious mistake. But in carrying it out, he much simplified the functions of each of these plans; so that motions of Heathcoat's original machine to which they owe their common origin were at length reduced in Lindley's machine to six. The reduction of working parts must have been equally great, for every motion requires a mechanical agent to effect it; take away the necessity for the motion, and the part requisite to its performance disappears.

The steam power, which Lindley was the first to apply, has been found to be a vital necessity; and in the processes of separately adapting the two kinds of machines above-named to rotary motion, they have been found capable of still further improvements. So long as these efforts were confined to the production of plain, *i.e.* unornamented nets, though of meshes of very different constructions, the skill of the mechanician was directed to dealing alike with the course of the threads composing the meshes forming the entire set from side to side of the machine, and was carried into effect by varying or simplifying its *ordinary* movements. It was by the practice of clearing needless parts away, which has been described, that room was made in which to place the additional instruments for making the almost perfect imitations of real lace, which the exigencies of the trade brought into use, as will be further indicated while describing the progress of the manufacture.

CHAPTER XX.

THE GASSING, BLEACHING, AND FINISHING OF LACE. MR. SAMUEL HALL.

THE rapid developement of the hosiery and lace manufactures of the midland district had a corresponding effect upon the collateral operations of bleaching, dyeing, and finishing yarn and wrought goods. By the application of practical chemistry considerable advances were made, whereby fast bright dyes were imparted, and nearer approach secured towards French colours and finish. Thus the houses of Keely and Windley laid the basis for their well-earned success and property realized in that department. By the like spirit of research in the sister arts of bleaching and finishing, great improvements were effected; amongst others by the house of Robert Hall and Son—a name which has thus become identified in an especial manner with the staple manufactures of Nottingham.

Mr. Robert Hall, the father of Mr. Samuel Hall, lived at Basford, near Nottingham. In the early part of his life, passed during the latter portion of the last century, one of his businesses was that of spinning cotton yarn for hosiery purposes. Afterwards he spun a mixture of cotton and animal wool, into what is called angola yarn, a useful article extensively consumed for stockings, possessing a medium warmth between cotton and worsted hose. He was a scientific man, who if he did not discover, was one of the very first to use chloride of lime in bleaching, which was another department of his affairs. The benefit resulting from this improvement has necessarily been very great in the hosiery and lace manufactures, where cotton goods to the amount of several millions sterling per annum have been for the last forty years submitted to this

process; by it goods which would under the old plan have required to be retained a month in process, can now be well and soundly bleached in two days. This Mr. Robert Hall was an estimable man and a good citizen. His ideas on several subjects were peculiar and somewhat ahead of his age. By his love of scientific researches and experiments, he gave an impulse to the minds of two eminently gifted sons, Samuel and Marshall Hall. These received a liberal though not a profoundly learned education; and each, following out the natural bias of his mind, copying also their father's example of free and ardent enquiry, entered upon a diverse but remarkably useful career in life.

The younger son, Marshall, was born at Basford. Entering on the medical profession, he received a sound training in the general hospital at Nottingham, then practised for a time at that town, but soon transferred the exercise of his professional talents to London. There he became the celebrated Dr. Marshall Hall, to whose profound physiological researches are owing discoveries, especially that of the duplicate nervous systems, highly appreciated by medical authorities, and which have conferred lasting benefits on mankind.

The second son, Samuel, was also born at Basford. He was engaged from his youth with his father in the spinning and bleaching businesses, and also was early initiated into his chemical and mechanical investigations. There was a patent taken out by the father (it was his only one) in 1813, No. 3675, for machinery to be employed in dressing and finishing frame-work-knitted goods. Samuel Hall, when once embarked in these scientific discoveries, pursued them with unwearied diligence. Success never satisfied him, and disappointment never cooled his ardour; with a mind always on the utmost stretch of activity he gave up the pursuit after improvements only with his life.

His first effort was an eminently successful one, and also of an entirely practical character. All woven fabrics composed of threads of animal wool, cotton, or silk, however carefully spun, have on their surface more or less of rough hairs, floss, or fibre which are unsightly when lying on the surface of printed cloths or other

stuffs; but in gauzes, nets, or other fabrics intended to be semi-transparent, they are positively detrimental to their use. Mr. Samuel Hall must have often noticed this in the course of his business of spinner and bleacher, especially in the case of warp point net, and at length in twist cotton lace; to seek for a remedy would be therefore very likely on the part of so inquisitive a mind.

The floss on the surface of cotton cloths is usually singed off by passing the pieces with an uniform velocity over red hot cylinders of iron which burn off the loose fibres, the cloth proceeding too rapidly over them to permit of injury to it.

To remove this disqualification from cotton yarn and lace, so materially affecting their value, and consequently their use and the extension of their manufacture by machinery—the subject of this memoir devised and took out two patents, both of them under date November 3rd, 1817, Nos. 4177 and 4178, securing the use of a very ingenious apparatus and process, whereby in the former the fibre of thread, and by the latter of cloth or gauze, or lace, may be singed off by being caused to pass through delicate blue flames of carburetted hydrogen coal gas, drawn to the height of half an inch or so up to or through the web intended to be cleared, by means of a vacuum above. The processes by which cotton thread and woven tissues are gassed are substantially the same.

At Plate IX., fig. 8—

A represents gas flame issuing from a pipe through numerous orifices. *B* a row of threads or web of cloth or net drawn uniformly along with the requisite velocity to prevent its catching fire while passing through the flame. *C* the section of a kind of chimney, cap, or vessel, running the whole length of the horizontal tube, and terminating in the tube *D*; through the connection of which with an air pump of great power worked during the whole process, a brisk current of air is kept passing over the inflamed gas. The consequence is that the web to be cleared (gassed) from fibre presses rather forcibly against the bottom of *C* and the flame is cut off without passing through the web of cloth, but singes off the fibre only on the side exposed to it; if of lace or yarn the flame passes all round the threads and through the meshes, destroying the fibres on the surface, but without injury to the substance.

There is a second tube placed about a foot from the former in which are similar openings for gas to be emitted; through which also when lighted, the threads or web are to be passed by means of rollers,

and thus the process is completed. Stop cocks and valves are so placed as to regulate the emission of hydrogen gas, and the exhaustion of the covering above it.

This difficulty of cloudy, rough surfaces on nets and yarns, once thought insuperable, has thus been removed effectually by a very simple process, resulting from *a priori* reasoning on the principles of pneumatical chemistry applied to the special requirements of the case on hand.

In 1823, No. 4779, a further patent was taken out by Samuel Hall for improvements in the gassing frames. And its present adaptation is so accurate and complete, that though mainly entrusted to the hands of women and children, and in the case of thread, the yarn operated upon is to form exclusively warps for the finest and most delicate fabrics, which, if too much singed, would be made tender and worthless, yet the result is generally perfectly sound and satisfactory.

Up to this point in Mr. Hall's course of invention, he had the practical skill of Mr. Benjamin Thompson, (elsewhere more fully spoken of) at his command, to assist in carrying into the most perfect operation the novel suggestions of his own fertile brain. Hall devised the plan of gassing without doubt; it is equally certain that Thompson's knowledge and skill were employed on executive details.

Hall took an extraordinary method of making his invention known, by very widely exhibiting its actual results. He made an arrangement with a lace house in the Strand, and advertised under their name of G. F. Urling and Co., the patent *gassed* thread and lace, causing specimens of these articles themselves to be placed beneath the advertisement in each copy of several of the then popular magazines. Thus he was one of the first to introduce the system of advertising on a large scale, since so generally and successfully followed in regard to business matters. These notices served to spread more widely the knowledge of patent bobbin net and to increase its consumption.

When this patent was obtained in 1817 there were about 700 bobbin net machines at work; in 1820 there were 1008; the average of the first five years to 1822

was about 1000, of probably six-quarters in width, and making 200 racks weekly, taking three racks to the lineal yard. The charge for gassing lace was three farthings per square yard for some years. As nearly all the trade had their nets gassed, *i.e.* about 5,000,000 square yards a year, the amount of Mr. Hall's income from this source might then probably be from £10,000 to £15,000 a-year. The inducement to infringe became very great. Cyrus Boot, and others, did so under colour of patent rights for *singeing* by other processes, but they proved illegal and fell to the ground, after putting Mr. Hall to serious expense and otherwise causing injury to his interests.

As was to be expected, Mr. Heathcoat being the bobbin net patentee, held himself and by his connections machinery producing nearly half the total amount made; and as they gassed all they produced, had paid Mr. Hall during the first four years several thousands annually. On their part and on his own, the patentee offered to enter into an arrangement to pay £5000 a-year to Hall during the remaining term of his gassing patent, or for so long as he maintained the then price for gassing and kept down infringement, in compensation for the right to gas all the nets produced from their machinery then constructed. This was immediately declined. Mr. Heathcoat was sensible that he had been benefitted by the publicity Hall had given to bobbin net; though without the bobbin net invention Hall's would have had much less chance of success. Believing, therefore, that he was making a proposition calculated to be profitable to both parties, he declined to receive a refusal from Mr. Hall without the latter taking due time for consideration. The following morning Mr. Hall gave a final negative, on receiving which Mr. Heathcoat adopted the alternative of selling all his production without gassing the nets. This he continued to do for several years, and thereby no doubt reduced the quantity of nets sent by the rest of the trade to be gassed. Probably Mr. Hall never dreamt of such a resolution, or if he had would not deem it possible to be really carried out. By this mistake, arising from his over confidence and characteristic impetuosity, he sustained a very serious

diminution in the profits he would otherwise have realized by this patent. As it was, it could not be justly affirmed that he was an unrequited inventor. To this charge lately made it was no doubt truly replied that Mr. Hall gained at least £50,000 to £60,000 clear profit by this gassing patent. The increase of the trade and its machinery was so rapid that in 1826 there were 2469 bobbin net machines, and 4,500 at the expiration of Hall's patent in 1831. The superior character of lace and other fine fabrics when gassed was more and more recognized. Mr. Hall also gave numerous licenses to use his patent in Lancashire, Scotland, France, and elsewhere; so that altogether he realized a considerable income to its close. By this patent he established his position as a successful man of science in its application to manufactures. He had conferred a most important and lasting benefit upon the lace, muslin, and gauze departments of business.

In 1821 he took out a patent, No. 4559, for another successful discovery, also beneficial to local and some other important trades, and useful in domestic life. This was the bleaching of starch employing a chloride in its preparation, by which its quality and colour were so improved, as to give the substance thus treated precedence at that time and long after over any other starch used in the finishing of many kinds of goods for sale, and in getting up of linen and cotton articles in the laundry. In consequence, however, of the patentee engaging himself largely at that time, and, indeed, through all the rest of his protracted life in experiments and improvements (of the utility and value of which he never had the least doubt) on land and marine steam-engines, generation of a new motive power, and the consumption of fuel and smoke—he, with extraordinary indifference to ordinary prudential considerations, gave this lucrative patent into the hands, and to be used for the advantage of his third brother, Mr. Lawrence Hall, then lately returned from abroad; to whom it became the foundation of a large fortune. Ever since, and up to the present day, the public sees advertised "Lawrence Hall's Patent Starch." The name of the scientific inventor and munificent donor was thus ignored even while

he lived; and we are not enabled to record that when affluence vanished, and declining years supervened, any adequate return was made for so generous a gift. Mr. Samuel Hall seemed constrained by the very constitution of his being, to invent or perfect inventions without interruption, and at whatever cost. Except to supply means for the prosecution of these incessant self-imposed laborious experiments, he did not know the value of money. He could neither husband present resources, nor provide for the future. But of this, the too frequent defect of men of genius, he appeared to be unconscious. Thus his latter years were overshadowed by a sense of wrong shewn to himself. Mr. Hall was naturally of an ardent, sanguine, enterprising temperament; indefatigable, undaunted by failures, and undismayed by difficulties. He was kind, hospitable, and cheerful amongst his friends, shewing no hesitation in communicating all he thought or knew or felt to those, and they were many, who enjoyed his society. After forty years of personal intercourse and correspondence, we gladly pay our tribute of respect and admiration for talents and services of which Nottingham may well be proud. Mr. Hall died lately in London at an advanced age.

The following patents, combining an amount of ingenuity and usefulness seldom exhibited by any one individual, being foreign to the special subjects of this history, are enumerated without further details, simply as an act of justice to the memory of this prolific inventor and remarkable man:

In 1824 Mr. S. Hall took his first patent, No. 4985, for an inprovement on the steam engine. No. 5659, in 1828, was for an apparatus for generating steam and various other gases. No. 6204, in 1831, was for a steam piston and valve, lubrication of valves, condensing of steam, and supplying water to boilers. No. 6359, in 1833, for lubricating pistons, rods and valves; condensing steam by a vacuum and a mode of condensing for other purposes. No. 6556, in 1834, for a super-heating steam engine which if of twelve-horse power stands in only fifteen feet of cubic space. In this engine he augments oxydation by burning gas, and connects with it an apparatus for decomposing water; and proposes by this engine with no increase of cost in fuel to get nearly treble results in power. No. 7135, in 1836, steam engine for propelling vessels. No. 7754, in 1838, method of heating or evaporating fluids in generating steam. No. 8233, in 1839, method of propelling vessels. No. 8792, in 1841, and No. 9345, in 1842, were for improving consumption

of fuel and smoke. No. 10531, in 1845, improvements in boilers, furnaces, and flues of steam engines; in consumption of fuel and preventing smoke also in mode of propelling vessels. No. 12527, in 1849, apparatus for regulating combustion of fuel and burning the smoke; and prevention of explosion of steam boilers; by constantly passing fuel into the furnace on an endless revolving chain platform as it may be needed. No. 13444, in 1851, for manufacturing starch and gums. No. 14125, in 1852, for the improved construction of cocks, taps and valves.

Cotton lace, after going through the processes of the machine, has acquired a colour much darker than that natural to the wool: but bleaching restores the article to a perfect whiteness, by scouring and the use of bleaching liquid, &c. A piece is often returned soundly bleached within twenty-four hours after delivery; is forthwith dressed, finished, and received in London or Liverpool the next morning. Messrs. Manlove and Allcott, bleachers of Nottingham, patented a drying machine, by which, instead of being wrung or pressed and hung up in a hot room to dry, as is the usual mode, the article being wrapped round in a kind of coil between two copper cylinders, the outer one of which is perforated with holes, the apparatus is made to rotate perhaps a thousand times in a minute, so that by the centrifugal force thus obtained the water is quickly driven out from the damp article inclosed, through the holes of the cylinder, and left nearly dry. This valuable invention is already applied with very important results in manufactures greatly diversified the one from the other.

The dressing of lace, so as to fully extend the meshes to their proper shape, and by stiffening the fabric prevent its collapse, is a most important operation, and of course requires care and experience on the part of the class termed dressers, of whom there are about thirty-three having extensive premises in or near Nottingham.

It is performed, first, by passing the bleached or dyed and purified lace pieces through a hot mixture of gum and starch with other materials, and then submitting the lace to the action of revolving cylinders which squeeze out the surplus stiffening fluid: this is the work of a man and a boy usually. Second, the piece in a wet and heavy mass is taken to the stretching room which extends from forty to one hundred and

twenty yards in length, and is wide enough usually to allow of two frames being placed at a sufficient distance to be worked side by side. On the sides of the rooms as many large windows as possible are placed, chiefly for ventilation. The heat required is great, seldom under eighty degrees, it is often much more. These frames run nearly the length of the room. Upright rows of pins are placed along the edges, the selvages of the piece are run on by girls on each side and at the ends. The sides of the frame are made to recede from each other by the operation of a winch, and the lace is gradually extended to its full width; the utmost care being taken not to disturb the mesh either in length or width. On this point will absolutely depend the quality and saleable value of the article. Strict attention has also to be paid to the amount of dress in regard to stiffness and weight, if for single, double, treble, or even quadruple stiffness; and as to colour, clearness, crispness, and elasticity, on which particulars, together with the peculiar ingredients used, have depended the preference which was so long given to French over English dressing of plain silk nets. Third, to secure freedom from small blotches of stiffening and impurities clinging to the meshes, the pieces are lightly and carefully rubbed with flannels to equalize the stiffening and then beaten by switches or rods as they are distending; and to promote rapid drying and the consequent clean face and elasticity in hand of the dressed article, the piece when fully stretched is fanned with broad spade-like implements, which being properly waved about produce powerful currents of air. Fourth, while one piece is drying on one frame, another will be in process of putting on and stretching out on another. When finished each is carefully rolled up as it is stripped from the pins and folded preparatory to its being sent to the finishing warehouse; where, the selvages having been placed exactly even in rolling off the dressing frame, it will, if a wide plain piece, be cut up without unrolling, into suitable widths for sale.

The length of the daily employment of young women in these dressing rooms and its effect on their health, has lately been the subject of enquiry by a Government

Commissioner. The labour and heat are no doubt trying to those engaged; they are also usually careless of their own health and the means of preserving it when exposed to cold and wet in going to and from their work in our variable climate, having had but little domestic care or training bestowed upon them. It is possible, and much to be desired, that in the progress of chemical and mechanical inquiry and experiment, means and agents may be discovered which shall render the drying process in dressing innocuous, and the atmosphere in which it is carried on cool and healthy.

The business in chemicals and dye stuffs for bleachers and dyers, in starch, gum, and other materials used for dressing, has necessarily become very large. A piece of cotton net, weighing in the unbleached state 15 lbs., will increase in proportion to the dress required, so that if 'Paris' dressed it will become 60 lbs. weight, and the edges will cut through the skin like a saw. All nets for foundations of bonnets and similar purposes are thus weighted and stiffened. Such articles have been enormously used in this way, but are subject to the fluctuations of fashion, or the rise of the materials used, and consequent advances in price which may lessen or destroy their consumption. The mere disuse of 'curtains' to bonnets, lowered the returns of one finishing lace house some tens of thousands of pounds in one year.

CHAPTER XXI.

IMPROVEMENTS IN DOUBLE TIER LACE MACHINERY.

BEFORE proceeding to notice several other modifications of importance, it may be premised that there were many references to Mr. James Sneath in the discussions upon the traverse warp trial. It was asserted, Brown and Freeman finding they could not complete their design, sought his aid, and perfected it by his skill. On this account further particulars as to himself and his connection with Brown and Freeman have been sought out.

James Sneath was a frame-smith and setter-up, living in Mansfield Road, Nottingham. His employment at first was chiefly amongst point net frames, but as they declined, the use of warp machinery increased, and he entered upon its construction. His acquaintance with the principal makers was the origin of his association with Brown and Freeman in 1811, and thus becoming practically acquainted with the construction of the lately invented twist lace frame by Mr. Heathcoat, through its specification which was early in their hands. No doubt the smithing for their travestied imitation was done in James Sneath's shop in Coalpit lane, which will account for Brown and Freeman's disappearance from Radford. In addition to the constructive skill Sneath himself possessed, the next neighbour to this shop was James Tarratt, a good mechanician, who was at this time a frequent visitor. It is not improbable he also might aid in getting the difficult problem solved. The surprising character of the traverse warp machine, and the comparatively short time occupied in its inception and completion, however it may have been brought about, must still appear a mechanical marvel; but the

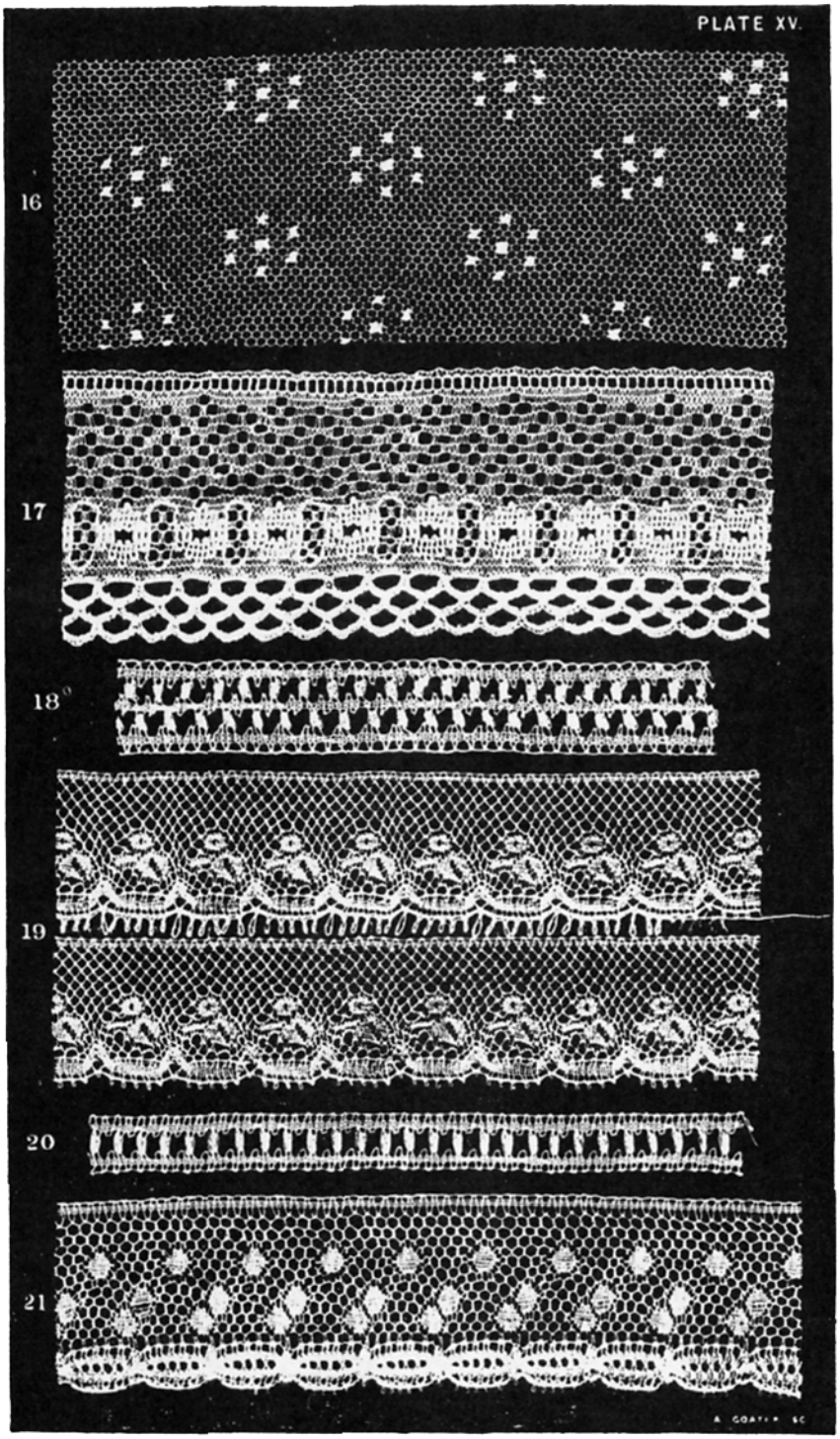
PLATE XV.
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surprise is lessened, if it were the result of the combined skill derived from these three sources operating on the materials furnished by the patented machine, with the assistance of one at least of the Loughborough workmen at their deliberations. During the time the construction of this imitation of Heathcoat's frame was going on, Sneath told Timothy Richards, that he thought he should master its being made different to Heathcoat's frame.

Upon the completion of the traverse warp machine, and a number being made, Sneath went with them to Warwick on Mr. Nunn's account, was there in 1813, and remained there some years in the management of them. From thence he removed to Croydon, where he assisted William Sneath in an unsuccessful attempt to make a platted net machine.

It had a set of warp threads on a beam; and a set of bobbin threads on a bar operating in some way like the carriages in the present twist machine getting a twist by two motions. Further than this the movements are now not known; the particular result and cause of failure however was, that while one half the work was of a regular twist and plat, the other half of the breadth shewed a rough surface as if made of single yarn, the reverse movement of the bobbin and carriage bar having untwisted the threads.

From Croydon, James Sneath went to a small factory at Bleak Hills, Mansfield, where he placed and worked bobbin net machinery. He died there a few years ago much respected.

Having risen by his steady industry, combined with mechanical skill and general intelligence, to a respectable position in society, he brought up his family comfortably, and gave them a good education, fitting them for the discharge of the duties of life—an example that might and ought to be more generally followed by artizans of every class.

Mr. William Sneath, above referred to, was born at Linby in Nottinghamshire, about 1800. He was taught by his father to work in the warp lace frame. When two and four course net, with blonde and Mechlin from warp frames, had nearly gone out of use, Sneath, sen., John Kendall, Henry Leavers, and Cockayne, with James Sneath, jun., often met to talk about machinery. It was thus William Sneath got into the

twist net trade; for Kendall and the others were early connected with it. Soon after Heathcoat left Loughborough, William Sneath went there to overlook Linthwite's machines. They were 'old Loughborough's,' and he made an improvement which helped to continue their use for some time. Returning to Nottingham, he purchased a circular bolt machine, and in 1831, invented the plan which had never before this been effected on any machine, of producing spots, 'Points d'Esprit,' on the circular comb system.

He selected spotting carriages to lap for the spot, letting the main body of carriages remain stationary, retained by pickers, while the spotting carriages were propelled backwards and forwards by driving bars, having three extra point and hook bars to take up the spot.

Mr. John Hind at first took a share of the responsibility in bringing out a patent, No. 6208, for this invention of great and permanent importance. Spots of wattled basket work add to the value of many cushion laces; they are too beautiful and useful ever to go out of fashion. On J. Hind relinquishing his share of interest in the patent to Mr. Fisher, with William Sneath's consent, it was agreed "that each should build twelve spotting machines in succession; and that after these twenty-four, for which neither was to pay tribute, all constructed beyond during the patent should be built by or pay tribute to Mr. Fisher." Thus, William Sneath's interest in his invention, was that derived within the patent-right from the profit of working twelve machines. The profit resulting to Fisher was very considerable indeed. One Mr. Pearson took the plan to Calais, and also gained, it is said, a large sum by it.

After the above transactions, William Sneath continued for some time in the manufacture of lace, but eventually took up his abode and died in the house of his son, Mr. George Sneath, a magistrate of Midhurst County, in West Canada.

John Litchfield devised an arrangement for spotting on the Levers' machine. It was patented and disposed of to Mr. Fisher, who received tribute for its use; but upon a contest with Mr. R. Birken (who produced spot

on Levers' in 1833), backed by many machine holders in the trade, the patent was rendered partially inoperative. Freeman, of Tewksbury, made a spot on traverse warp also about the same time.

Mr. William Morley was an ingenious fitter and setter-up of stocking and point net lace frames in Nottingham. He began early in life to endeavour to improve the machinery in which he was employed, and which led him to introduce the use of a 5-bar tackle, or apparatus on the point net frame. Before the year (1811) closed, a simplification and consequent improvement upon his plan took place, whereby 3-bars were made to operate with equal effect; and their operation, singularly enough, was performed by *six* different methods, hit upon by as many mechanics. The Mr. Kendall mentioned in connection with Mr. William Sneath, being already engaged in making bobbin net, was joined by Mr. Morley, who in 1812, constructed a machine known as the 'straight bolt,' from its differing from Heathcoat's, in which the carriages went backwards and forwards in combs forming a segment of a circle, and therefore called the 'circular comb.' Kendall and Morley's machine was an infringement of Heathcoat's. Though not an improvement as to the shape of the bolt or comb, it was so by the simplification of several other parts, by putting in spur selvage wheels, and in the mode of changing the carriages on reaching the selvages, which resulted in greater rapidity of movement. In consequence it was much used during a few years.

Soon, however, Mr. Morley saw that the defective irregular net, resulting from the unequal length of thread drawn off upon his straight bolt plan, was irremediable, and he returned to the circular comb, from which it is singular that so clever a mechanician should ever have deviated, except for the purpose of dissimilarity to that extent from the patent.

In doing this, a great improvement was made, by reducing the bolts from four shorter combs as in Heathcoat's frame to two longer segments of circles as at present in use. He used pusher bars below the circular combs instead of above them to carry along the carriages; and nothing could be more smooth and regular than the movements

under the impulse of double bladed lockers of the carriages and the amount of thread given off from the bobbins they contained. He put his machines thus improved upon rotary action and worked them by steam power.

No modification of any importance in the manufacture of plain nets, for which these machines are specially adapted, and to which they are generally applied, has since been made, nor is likely to be. The superfluous parts of the insides of the machines were taken away, and the speed was at once increased from three to at least four racks of 240 meshes each an hour. For these practical improvements the trade has been eminently indebted to Mr. Sewell and Mr. Morley. While meditating and perfecting his double locker rotary machine, the latter was observed to be unusually thoughtful and absorbed. He was never talkative, but now for a time he displayed unusual reticence. Notice was given for a patent in March, 1824, No. 492, but it was never specified. At length the plan became known, and was highly appreciated, as the one on which plain net must chiefly be made. He had quietly constructed a large body of this machinery which brought to his house great profits forthwith, and his judicious and scientific management of hands and machinery, placed the firm at the head of the plain net manufacturers for the Nottingham market up to the present time. The mechanical skill possessed by Morley was amply vindicated by this machine, and his technical skill is seen in the excellent description of it furnished by him, and inserted by Ure under the article "Lace" in his works. This writer's prejudice against Heathcoat, no doubt arising from Mr. Morley's early chagrin on account of an injunction granted for infringement of the patent, is to be gathered from his withholding the merit of invention from the patentee, while it is given to several on account of their modifications of the machine.

The question of whether Heathcoat is entitled to the honour of being the inventor of the bobbin net machine or not, has been already discussed in these pages; our present duty is to do justice to one whose talent lay emphatically, not so much in invention as in simplification—a science which is, however, only

second to that of the inventor himself. As was the case in every other instance of success in management of bobbin net machinery, Mr. Morley had the perfect confidence of his workmen. He understood the machine as well as the most experienced of his hands, knowing what could and what ought to be done, and the best way to do it. The men willingly obey such a leader, and only such; and it has resulted, that amongst these machine hands there has arisen a body of skilled artizans, equal to any and superior to most, in the whole range of manufactures.

Mr. Morley was a man of excellent common sense, plain in his manners and habits of life; his great success did not unduly exalt him above those who started in a similar career with him, nor induce any perceptible departure from the simplicity and economy of his early days. He retired from his connection of thirty years continuance with Messrs. Boden's, of Derby, (by whose partners the business is still carried on) in 1853; at his death, which took place in 1855, at the age of 70, he was possessed of large property.

Mr. Thomas Robert Sewell was almost an entirely self-taught artizan, having received only the rudimentary education given by respectable parents in humble life. He was born (about 1788) in or near Nottingham, and he improved every opportunity that place afforded him of obtaining general and more especially scientific knowledge, assiduously and successfully. He soon became known and esteemed for his talents and the use he made of them. In process of time he acquired considerable skill in mathematical, chemical, and some other branches of science. But the chief bent of his mind was toward mechanics, which at that time opened up a field for study and enterprise of vast extent. He early acquired a knowledge of the construction of the stocking-frame and the point net loom. The net produced on the latter when compared with that obtained from its new rival, the bobbin net machine, he deemed so inferior in quality and beauty as to decide him to give attention to the manufacture of bobbin net, notwithstanding the secrecy maintained in regard to everything connected with it. Examination

of the net led him to think he could accomplish the task of constructing a machine to make it. He saw a bobbin net machine for the first time in 1818; and at first it by no means pleased him, not agreeing with the notion he had entertained of what a frame intended for such a purpose ought to be. He was erroneously given to understand that it was of the description then used by Mr. John Heathcoat, who had justly acquired great reputation as an inventor, and therefore purchased one capable of making net a yard in width in ten-point guage. A few only produced net more than 45 inches in width. For making this 36 inches net he paid the workmen 3*s.* per rack. He soon became dissatisfied with the machine in its then state. The movements were numerous and intricate, there being eight handles and two treddles necessary to effect them. When out of order and a stoppage took place, the workmen would forget the next proper movement and mistakes were made, time was lost and the net wrought seriously damaged. The wages though apparently high, did not always give satisfactory weekly earnings. Having seen two straight bolts in process of construction upon an ingenious modification devised by Mr. William Morley, of Nottingham, he considered the plan a great improvement, and purchased them. One was a 54-inch and the other a 72-inch, the greatest width made up to that time. But this class of frames, even in the hands of Allen, Kendall, and Morley, at first passed the bobbins and carriages through the warp threads eight times or sixteen motions, when Sewell saw that six passes or twelve motions would suffice. He added the further improvement of shortening the 'take up' by the points. The machine though still requiring dexterity in the workman was reduced to four handles and two treddles, the speed was increased one-third, the wear and tear diminished, and the net improved.

'Quillings' *i.e.* net in narrow widths, were now produced on these machines, but they had 'saw' edges. The extra warp threads used in wattling these breadths together pulled the bobbin threads which passed round them so much as when withdrawn, to leave a series of unequal and unsightly loops on the edges. These depreciated the value of the article greatly. A remedy was therefore sought for; and after much study Mr. Sewell found that the 'turn

again' used at the edges of the wide frame might be made to operate at any point or points in the width of the double-tier machines. By this process the two tiers were left complete, and the breadth selvage warp threads were laced together; and being perfectly tight, when the lacing thread was withdrawn, the edges were without any loop or irregularity at all. This 'turn again' at pleasure was effected by introducing a compound driving bar instead of the plain one; and it was so slit as to allow the lacing bobbins to fall out wherever that was necessary, and thus prevent them traversing with the rest.

For secrecy this principle was first applied, in 1820, to a forty-five inch frame at the house of Mr. Kendall. Being successful, all their machines were put on with it. The plan has since been brought into extensive use, as by it double-tier machines can be made to produce elegant open works, the large holes therein having selvages formed perfectly on their inner sides.

Mr. Sewell's next efforts were directed to still further simplify the machines and increase their speed. In endeavouring to do this, he was led to entirely invert all the parts of the double-tier, placing the warp beam above and the work beam below, the bobbins and carriages being moved under the arched combs, whose inner circles faced downwards, instead of over them as before. To this inverted arrangement was added an improved form of the carriages, enabling the two tiers to be passed through the warp threads at one sweep instead of two, and that by using only one locker to drive them instead of two, and by this one operation doing this part of the work so as to more than double the speed. This machine was capable of producing four to five racks an hour; the straight bolt, as he had before improved it, made only two racks an hour. By adding a simple crank motion he put this 'upside down' machine on with steam power.

Upon seeing these important changes, Mr. Kendall, whose partnership with Allen and Morley had ceased, proposed to Mr. Sewell to become his partner, which was agreed upon, and further machines of the newer kind were constructed. Mr. Morley had also proceeded to build 'upside down' frames, but without Sewell's simplified arrangement of parts. This accounted for the defective quality of the net made from them. But both these eminent mechanics agreed that the in-

verted machine required too much care on the part of the workman in regard to securing equal tension of the bobbin threads. This was a matter of vital importance, which might be secured without the sacrifice of much speed, by a still more simple arrangement of the *non*-inverted double tier machine. Each of them set about it in his own way, and about 1825-6 both had accomplished it, by retaining the method of passing the two tiers of carriages through the warp threads at one sweep. The 'upside down' machine had certain properties which, but for the Levers' frame absorbing the greater part of the fancy manufacture, would have most likely kept it in use for the like purposes.

Upon a dissolution of partnership with Kendall in 1831, Sewell erected a factory and constructed excellent circular power machinery at Carrington, upon which he made for many years three twist or 'Brussels' ground net from fine yarns, suitable for the application of pillow wrought sprigs and flowers. Here also he arranged this class of machines so as to secure increased speed without depreciating quality.

In his 'rolling locker' machine driving bars were dispensed with, and only a front and back locker bar used, which being moved by rack work and carrying both tiers of carriage tails, (fluted to correspond with the rollers), to and fro at one sweep, passed them through the warp threads with safety and great velocity. Some years after he patented, No. 6936, an improved 'turn again' including extra bobbins for embroidery in this class of machines. On the whole it may be doubted whether the wear and tear by weight, vibration and friction, of the rolling locker when pushed to the enormous speed of which it is capable, may not prove a counterbalance to its profitable use.

In 1841, by applying a straight bolt to each guide, and putting all under the control of the Jacquard, he produced patterns in wide nets in outline cloth works, ticking them on the edges, and throwing in beautiful open works so as to give light and shade, and produce a rich effect. He drew all his own patterns, many of which were in excellent taste embodying ideas derived from his careful study of the enrichments in Greek architecture. This modified machine was exhibited by him in 1851, and being purchased by the Prussian government, was put to work by him in the public school at Elberfeld in 1852.

Mr. Sewell made on his thirteen-point machine a beautiful net, in which four sides of the mesh were twisted and two platted. Using No. 300 yarn, and working it twenty-four holes to the inch, it was equal to the best pillow plain net, but found to be too expensive for general use; made half guage and of heavier yarn, this article has a graceful effect in window curtains.

It has been already mentioned that Mr. Sewell was practically conversant with chemistry. Our account of him would not be as complete as his knowledge and efforts to make himself useful deserve, were not his several patents in this department enumerated. We are not competent to judge of their merits.

In 1837 he took out No. 7280, for a mode of combining oxygen with lead by combustion of charcoal so as to produce protoxide of lead; and a further mode of preserving the carbonic acid gas generated for the purpose of carbonating protoxide of lead and producing ceruse of white lead; also the apparatus for doing it. In 1838, No. 7736, for a method of manufacturing oxide of lead to be turned into oxides of litharge and massical. Also a superior quality of white lead composed of more metallic lead and less carbonic acid than are commonly used, the carbonic acid being in better state, also to purify or wash white lead more perfectly. In 1840, No. 8765, for obtaining carbonic acid pure and at a small expence from minerals containing carbonate of magnesia. In 1848, No. 12030, for improvements in making flour so as to admit its being kept for several weeks and subsequently being made into bread without using yeast. This he proposed to accomplish by a superior method of combining hydrochloric acid in which were one equivalent of hydrogen and one of chlorine, with bi-carbonate of soda in which were one equivalent of oxygen and one of sodium, these applied in the way described in his specification to the fecula or starch in flour, the hydrochloric acid is immediately absorbed and remains inactive till the flour is wanted to be made into dough by the process specified. Mr. Sewell also devised a new method of making artificial manure.

Mr. Sewell, it has been well said, is a representative man, of whose abilities the class of mechanicians may be proud; while the suavity of his manners and high integrity of his character made him the object of affectionate regard to friends and fellow-citizens, who regretted that in the evening of life he should seek an Australian home. The writer of these pages may be permitted, after thirty years' intercourse, to record the esteem he has ever felt for the subject of this short memoir.

CHAPTER XXII.

MR. JAMES FISHER AND MR. WILLIAM CROFTS.

Mr. Fisher was identified with the bobbin net trade from its commencement in several important respects. He was born in Cumberland about the year 1775. His father occupied a farm in that county, but by a singular and painful accident which occurred to one of his sons, the three other brothers successively decided to quit their home and occupation, and seek their fortunes in trade. Of these, James the second son, was the first to proceed in search of employment, which, it is said, he found in the shop of a London haberdasher. Shortly after he had attained manhood, he was noticed as an active and intelligent traveller for the disposal of Buckinghamshire lace goods, principally in the northern and midland districts of England. No doubt he early acquired in this difficult school that knowledge of men, and insight into the principles of trade, which lay at the foundation of his future success. He was distinguished for his acquaintance with the best sources from which the goods he dealt in might be drawn, and with their quality and value. He combined a just taste in their selection, with an unswerving resolution to make them bring a profit. His first purchases in Nottingham lace were made from C. Lacy, afterwards his brother-in-law, who was in the point net trade. At that time, 1800, this connection was valuable to Fisher.

Upon entering into the business of a wholesale London dealer in lace on his own account, he determined to build up a concern that should be both extensive and profitable. He sought and obtained for his customers in London and the provinces first-class traders. Punctual himself, he required punctuality on their part,

if distrust were excited, explanation was sought, which if not satisfactory, closed the account. The town and country connexion of this house from 1812, was cultivated with such vigour, as seemed to render want of success impossible.

While making steady advances in a business, which extended at length to most of the principal towns in the kingdom, as well as in all his subsequent management of it, he required on the part of those he employed, the same promptitude as from customers. Although dissatisfaction with his travellers, sometimes not on the most material points, might probably be the signal for their dismission, there was one extraordinary exception to these sudden determinations. Like most men of great administrative talent, Mr. Fisher gathered round him very active clever people to carry on his operations. Several such have since become well-known. One of them became a partner in his London house, and represented it for some years on the west of England commercial circuit. This person used to boast, that his allowance for travelling expenses was £1000 a-year. He astonished even old commercial travellers and helped to ruin younger ones, by daily excessive indulgence at the dinner table, and by nightly dissipation. His talents when engaged in business were confessedly unsurpassed. In whatever way the preceding evening had been spent, at nine in the morning he was prepared for his customers, whose accounts being first paid, sales of surprising amounts were frequently effected. His Sunday dinner bills were sometimes enormous. On one occasion, including broken table, pier, and window glass, the charge amounted to upwards of £40. Such insane profusion rendered it at length impossible for the head of the house to retain him. Thus was lost one of the best partnerships in the metropolis, with the certainty of an affluent position for life. After a few years spent, partly in America and on the continent, this unhappy man returned to London, broken in constitution, and almost without resources. Mr. Fisher, hearing of his state, sent a physician to alleviate his sufferings, and a friend with means to administer to his necessities. He refused

both, and soon after died. As a contrast to the example of Mr. Fisher, who had passed unharmed through the seductive influences of the commercial room and the road, and attained a station of such eminence, the history of the lace trade would have been incomplete, without some record of the talents and end of John Hughes, its most noted salesman in the west.

Some time after Mr. Fisher's commencement of business on his own account, being at the warehouse of Mr. Lacy, he was shewn a sample of the bobbin net then just produced, approved of it, and bought the first parcel of this article ever sold. From this time he entertained a high opinion of Mr. Heathcoat's ability, and showed a growing interest in his machinery. His purchases of bobbin net became very large as his business increased. In 1847, nearly forty years after the first expression of his favourable judgment of the invention, Mr. Fisher presented a likeness of Mr. Heathcoat, painted by Pickersgill, to the Nottingham Mechanics' Institution, saying, "that the portrait of one of the foremost mechanicians of the present day would be suitably placed in the locality where the first triumph of his genius was achieved."

After the expiration of Mr. Heathcoat's patent in 1823, Mr. Fisher began to embark capital in buildings and bobbin net machinery at New Radford, near Nottingham. This was increased rapidly, until the outlay became very large. His attention was early and strongly directed to the possibility and importance of making such alterations and adaptations of the various kinds of machines, as would produce plain nets more rapidly and cheaply; afterwards slight then closer imitations of pillow lace grounds were got off the frames. This opened up the way more clearly to the steps necessary to secure the mechanical skill which might place further inventions in his own hands.

In narrating John Levers the younger's connection with the lace trade, the three first patents taken out for Mr. James Fisher are mentioned, Nos. 5622, 5741, and 5940, and the dissolution of their partnership. In 1831, Mr. William Crofts had constructed a machine for making a net, called, from its being made round like

a sack, "sack bag net," and from the formation of its meshes "fender" or "pantry-window net."

The machine was a rolling locker single tier; it had three distinct comb bars and two warps coming from two separate beams at the back and front of the middle comb-bar. The carriages passing through both warps made two pieces of this net traversing round at the selvage.

This machine excited considerable attention at the time, but as there was and could be no traverse, and consequently no solidity in wear, it soon fell into disuse. A similar article, made in a different manner, has been again for a long time largely made.

Crofts was already known as one of the quickest and cleverest hands working in a Levers' frame. The machine just described, shewed that he perfectly understood the principles upon which it is constructed. He rapidly acquired an accurate knowledge of every other kind of bobbin net machinery.

Upon the exit therefore of Mr. John Levers, jun., from Mr. Fisher's manufactory, Crofts took his position as principal mechanician of the establishment, and in his name the eighteen patents, including thirty distinct constructions, about to be referred to, were taken out on his principal's account. These he specified for, and must at least have understood and assisted in drawing out specifications for, whoever the inventor might be. But from the nature and extent of the alterations and adjustments of the original machinery, required to produce the varied results obtained under these patents, it is very certain none but a man of very clear mechanical mind could have successfully fulfilled the responsible duties which Crofts undertook. The trade is no doubt indebted to him for devising important improvements of his own, as well as bringing into successful operation those of others.

The following is a brief and as intelligible an account of these patents, and of the many matters for which they were taken out, as the nature of this work will allow:

The first patent obtained by Crofts on behalf of Fisher, was for Bagley's lever honeycomb invention in 1832, No. 6229, as mentioned

elsewhere. The next was, No. 6349, for making breadths on a rolling locker machine, also in 1832.

In this year also Crofts made spots on a double locker frame by breaking out the main guides and replacing them by active guides.

Again, in 1833, No. 6382, a rolling locker circular machine for making breadths, but it would not work safely.

And on the same day, No. 6383, for bobbin net machinery which was combined and actuated in a new manner.

Another, in 1833, No. 6447, is a double locker breadth machine in which the locker is cut in nicks to let carriages remain untraversed and using pickers to hold them back, and having pins to fill up interstices acting from extra bars.

In 1834, No. 6618 was for making pusher net by carriages working upside down, and which were acted on by pushers like jacks, moved by an organ barrel. To lay in weaving threads, a large wheel is placed on the side of the machine. It had in the whole three organ barrels. This machine was very complicated and but little used.

Again, in 1834, No. 6717, for ornamenting lace on a treble bolt and comb bar machine, having front and back bolt bars, double tier; and middle comb bar, single tier. Between the three bars come up two warps. The carriages are turned upside down and the tails are worked by hook pushers operated upon by an organ barrel to draw the carriages; the Jacquard not being yet applied.

And, in 1834, No. 6739, also for ornamenting lace on a Levers' machine having six extra guide bars and two extra cotton beams. In making the net there are nine motions to the hole; to avoid hogging the twist, the points take from the carriage heads.

In 1835, Crofts took out what is called his monster patent, No. 6854, from its enormous length of specification, (filling 149 pages, and requiring forty-nine sheets of drawings, many of them of no little intricacy), as well as from the significant fact that it claimed and described nine professed inventions or improvements in the manufacture of spotted goods and cloth works—four on pusher, three on circular, and two on Levers' machines. The cost to Mr. Fisher of taking out the patent for these machines, was said to have been from £4000 to £5000, and must have been very great; the cost to the Patent Office of their 250 published copies has been £250. The reason for this outlay by Mr. Fisher was not at first sight very apparent. It is probable, however, that the success consequent on the use of the first spotting patent bought from Sneath, and the advantage attending a perfect control over the production of every article, into which a *spot* was introduced, even to the narrowest fancy edging or insertion wrought upon these classes

of bobbin net machinery, was seen to be of such magnitude and importance, as to convince so keen a man of business as Mr. Fisher that any outlay, however large, for such a purpose, would almost certainly more than repay itself. Moreover, a series of patent rights would render excellent service under the competition to which his country trade was now subjected, by securing priority of novelties and leading articles in meshes, ornamentation, and style; enabling him to keep the precedence, which, by his talent and energy, he had for a quarter of a century maintained in the supply of machine-wrought lace. The plan so far succeeded that the trade in wide spotted nets has ever since remained for the most part in his hands, his machinery being continually engaged in its manufacture.

Croft's patent inventions, in this prolific year, 1835, may be briefly stated as follows: (1) A method of weaving on pusher machines by using five cotton beams, seven extra pusher bars, three extra guide bars and two weaving guides which operated between pusher and comb bars, two worms conducted the point bars. (2) A method of making spots on pusher machines by two extra cotton beams without stopping the machine. (3) Another method of making pusher spots. (4) An improvement on his former patent, No. 6618, in 1834, by applying a particular kind of combs instead of bolts for guides to hooked pushers. (5) A circular comb frame in which the spotting threads were slackened by a drawing bar and carriages which make the spots when moved by pushers. (6) A machine for making spots on rolling locker and on double locker frames by throwing the main wheels out of gear and moving the spotting carriages only. Champollier, of Calais, and Machien, of Lisle, have gained a suit in the French courts, which has decided that this is not an infringement of Sneath's method. (7) For spotting on double locker frames. There are nicks made in the locker bars which hold back the carriages while the spots are made. Slide plates fill up the interstices when the plain net is making. The front points are of two lengths, the long ones take up the spot and lodge the cast thread of the spot upon the back points. This frame has five cotton beams and six guide bars. (8) A method of making blonde or straight down net, the carriages and warp only traversing a mesh or two. The spotting is effected by the use of extra guide bars on the circular bolt machine by throwing the main wheels out of gear while spotting. (9) A method of making spots on a circular machine with extra guide bars and extra cotton beams, not stopping or throwing the main wheels out of gear while spotting, the spots being made by extra warp threads. (10) Making spots on *rolling* locker machine, by using extra guides and extra beams, and throwing the beam wheels out of gear while spotting. (11) A method of performing the same spotting process on a *double* locker as that last described.

(12) A method of making Levers' spots, by breaking out the main guides where the spot is required and substituting extra guides. The main body of the carriages is at rest while the spot is made. This plan not used. (13) A method of spotting blonde or straight down net, by shooting in two extra threads and working without pusher bars, thereby reducing the labour considerably. (14) A plan for making honeycomb net from circular bolt machines by breaking out the main guides where the honeycomb is required and filling up the space by two taping and four filling up guides. There are eight guide bars and four thread beams in this frame. The point bar is worked by an eccentric wheel. (15) A plan for making honeycomb on *rolling* locker frames. And (16) one for making honeycomb on *double* locking frames. In 1836, Mr. Fisher, by Crofts, patented a plan, No. 7190, for an application of the Jacquard to the bobbin net machine. And, in 1836, No. 7345, methods for figuring and ornamenting bobbin net twist lace and other fabrics. No. 7638, was the patent taken out in Crofts' name for Bagley's double warp platted lace described in the account given of the latter inventor; but it also included making spotted and honeycomb nets.

In 1839, Crofts took out, No. 8038, a patent for making ornamented lace and net of various kinds.

In 1840, No. 8430, for twisted looped or woven fabrics by the application of Jacquard caids, using Levers' jacks acting on stumps which entering the warp threads when the stumps were pressed forwards, the levers removing the warp threads over more gaits than one, thus made linen work or large holes when required. Again, in 1840, No. 8690 was taken out for a straight down spotting Jacquard machine. And finally, so far as Crofts' patents on behalf of Mr. Fisher are in question, in 1842, No. 9467 was obtained for an improved method of manufacturing figured lace.

It will have been noticed that these patents were not only for the fabrication of certain diverse woven objects on the three great classes of bobbin net machines—pusher, circular, and lever; but also for different mechanical modes *in each* of accomplishing these results, as by double or rolling lockers, stumps, or Jacquards; and thus a series of shackles were put on the free use of machinery by a great capitalist, who on the one hand was a very large producer of machine-wrought lace, and on the other, had risen to be for many years one of the largest purchasers of every class of finished goods in the market. These facts combined to produce on the minds of many mechanicians great disinclination to seek for useful adaptations of bobbin net machinery, under fear of litigation and penalties for infringement. At length meetings of machine owners were held upon a subject felt to be of the greatest importance to the trade, and which had, in 1835, drawn the earnest

attention of a large part of the owners of lace machines to the serious position of the trade.

A short abstract of the address of this body, and their plan of association for the encouragement, protection, and throwing open for general use, inventions and improvements of machinery employed in the hosiery warp and bobbin net trades, is as follows:

"These machines are capable of very great modifications, calculated when effected to much increase their value, and use and open up new sources of employment and profit. Skilful persons often suppress such inventions (some of which have afterwards proved of much value) because unable to bring them out, so as to secure any profit resulting from them. Some have been ruined by costly experiments, which others have beneficially appropriated. English inventors, being generally in humble life and not able to encounter the expense and uncertainty of our patent laws, carry them abroad, where, as in France, an inventor can secure the fruits of his skill at little expense in time and money. If they could command security for the profit of their inventions, they would apply to them all their skill and ingenuity; in the exercise of which, is to be found all our advantage in competing with foreigners, and ought therefore to be fostered with the utmost solicitude and care." The plan was—"To raise by instalments a fund of £10,000, to be invested in the names of trustees then appointed; and by subscriptions of machine owners and traders, mechanics, workpeople and others, to pay current outlays, premiums and expences. This fund to be under the control of a board, deciding on all measures finally, and reporting annually. One sub-committee to be composed of members competent to understand and decide upon the value of improvements and inventions offered for purchase or remuneration, and to report thereon to the board. Another sub-committee to watch proceedings under the patent laws and manage the legal department, reporting upon them to the general board. The association to be so constituted as not to form a combination to limit trade; or interfere with the lawful exclusive right to the use of machinery and inventions; or by seeking any profit to the members as such, to form a partnership, or render liable to any claims beyond the amount of their several subscriptions. But it is intended to be so constituted as to prevent fraudulent assumptions of patent rights and their undue accumulation, through fear of expensive legal processes, and thus restraining the assertion of individual or trade rights to the use of inventions; and chiefly to stimulate skill and ingenuity by the prospect of a fair reward, and, as far as possible, securing it to them."

Scarcely any inventions or modifications of machines were brought under the notice of this board, no doubt from the idea cherished by each constructor of possible gain by patent rights from any new combination. But the fact that it numbered amongst its members the holders of three-fourths at least of all the machinery in

the lace trade, and was supported by the sympathy of the hosiery trade, was too significant to be slighted. And although, from 1835 up to 1838, Mr. Fisher sent out repeated notices to every maker and dealer in lace, that neither, at first spots, nor afterward plats, might be safely bought from any other than his authorised agents, the feelings of masters, workmen, and buyers were loudly—sometimes, by small makers and men, intemperately—expressed in opposition. This culminated in a resolution to try the validity of the spotting patents taken out by Fisher; and in April, 1838, at a meeting, held in the Exchange Hall, of sixty highly influential owners of hosiery, lace, and yarn doubling machinery, presided over by J. C. Wright, Esq., banker, nearly £2000 was subscribed, and the following address was issued:

"It having been unanimously admitted at this meeting as an undoubted and incontrovertible fact, that most serious injury is accruing to the trade from the extent to which ingenious mechanics are carrying their inventions to the continent, and the causes of this most alarming and increasing evil being also unanimously declared; it was agreed that the proposed society was the best and most legitimate mode of securing the just rights of ingenious artizans, and of retaining and fostering native talent in our own country."

The committee appointed consisted of fifteen members, of whom five were magistrates, and Mr. Wright was treasurer.

The object in view and the manner of pursuing it, were mainly those described in the address of 1835; but had even more special reference to mutual protection against actions for infringements. To prove the extent of intrusion upon the free action of the bobbin net trade, it was shewn that Crofts had then fifteen patents running; besides which there were forty unexpired taken out by other parties, some of which were also in Fisher's hands. Gradually less was heard of infractions of patent rights; till, in October, 1847, an action, which had long been pending between Fisher and Crofts, and Oliver and Atkin, to try the validity of the patent for Bagley's plat nets, and to which the defendants (backed by the trade) had put in one hundred and ten objections, the expences having been already large, both parties tired, and the issue doubtful, a compromise was ar-

ranged; each party paid their own costs; the plat claim was allowed to Fisher and Crofts, while Oliver and Atkin were to have a right to make the eighteen patterns (being only double warps in certain parts) alleged to have been infringements,—leaving as an open question whether wicker fine work made with a double warp, and broken into meshes, was or was not an infringement of the plat patent.

From this time hostile interference on the part of Mr. Fisher with the trade practically declined, and at length ceased altogether. The factory and machinery for making bobbin net is still carried on at Radford, by Mr. James Fisher, of Scotholme house, his eldest son. This gentleman is a highly educated and talented graduate of Cambridge University. The purchase of goods in Nottingham for finishing, largely carried on for years by this house, has since the death of Mr. Fisher been given up. His London business reached its highest point probably about twenty years ago; since which it has somewhat declined, and is not now in the hands of the family.

Mr. Fisher was a personification of method in carrying out sound principles of business determinately to their appropriate end. In their steady development there was neither intermission nor change; and every one who knew him, saw in that fact the ground of well-earned prosperity. He willed success, and he won it; becoming the master of an excellent business and large property. He only ceased to manage personally his weighty affairs, when attacked by the disease which rapidly brought him to the grave. Mr. Fisher died at his house at Dulwich in 1849, aged seventy-four. His opinion and judgment in matters of general commerce and national manufactures were highly appreciated at the Board of Trade, and well thought of by first-class men in the city.

After quitting Mr. Fisher's manufactory, Crofts in connection with Gibbons, in 1844, took out No. 10,370, a patent for making velvet patterns on circular Levers' bobbin net, by the Jacquard operating on stumps which acted upon the warp threads, producing various textures. The same year, in concert with Dunnicliff and Bagley, a patent, No. 10,390, was obtained by him for lace and other weavings. And

finally, in 1846, No. 11,344 was taken out by himself alone, for a similar class of productions obtained by means of pattern surfaces acting on independent instruments, so as to slacken bobbin threads at will, in single tier rotaries.

A method of producing pattern originally devised by William Herbert and perfected by Crofts was intermediate between the use of the chain wheel which was cumbrous and expensive and the Jacquard. It may be described as a pin pattern surface plate machine. If 112 pins in 4 rows of 28 in. each be placed lengthwise to each guide bar, the plate recedes and advances to and from the machine and at 28 removals; the bolts shog from one line of pins on to the other, and have the same powers in action as an eccentric cut wheel having 113 rises and falls. The pins are of unequal lengths, and by merely taking one out and replacing it by another in the progressing plate, the pattern may be changed nearly as quickly as printing type is set.

Mr. Crofts in the decline of life is not in the enjoyment of those pecuniary results which his mechanical talents have undoubtedly deserved. For more than thirty years his great abilities were devoted successfully to the mechanical subordination of the separate threads of which lace is composed, so as that exact imitations of various kinds of pillow lace might be obtained. In the retirement of age it will be pleasant to him to know, that in the judgment of many others he has attained a high position in practical mechanics.

CHAPTER XXIII.

THE BOBBIN NET LACE TRADE.—1823 TO 1836.

WATER or steam power had been applied several years to bobbin net machinery in the larger establishments, but between 1820 and 1822 it was much more so, and was the means of drawing machines into factories on all hands. Every thing combined to lead the people in Nottingham and its neighbourhood, to expect golden times when the patent shackles were removed. In consequence, through the years 1823 to 1825, a time of unparalleled prosperity, capital flowed into the business abundantly from bankers, lawyers, physicians, clergymen, landowners, farmers, and retail dealers, in order to construct new lace machinery. That which was already at work could be sold for three times its cost. Every available smith and mechanic on the spot was hired, and the wonderful wages offered, speedily attracted smiths and mechanics from far off towns. Day labourers came from the plough and strikers from the forge, for some of the latter got £5 to £10 a-week. Birmingham, Manchester, and Sheffield engineers and tool-makers met on one common ground; but houses were too few to lodge them; bricks doubled in price, and building land sold for £4000 an acre. Thousands of pounds were wasted in paying enormous weekly wages to people pretending to construct machinery, the movements of which they could not comprehend; and tens of thousands of pounds were drawn from speculators for machines, which, even if well constructed, could not possibly repay *them* their outlay. The inflation of the public mind was universal and became a sort of local epidemic—a mania, acquiring the name in after years of the 'twist net fever.' The whole community was athirst for gain, and became intoxicated. Nothing like it had ever been seen before in that trade

or probably in any other. Those who actually wrought in the machines had an opportunity to realise large sums of money. The provident generally, as was natural, put their gains in a part or the whole of a machine, paying for it by weekly instalments; thus becoming partly or wholly their own masters. The self-indulgent spent their time and money in a constant round of alternate work and pleasure. They would ride on horseback to and from labour, and having taken their shift at their machines, refresh themselves with a pint of port or claret on their return. Not a few of these spendthrifts were receiving parish pay or aid from public benevolence within the following ten years. The minds of many of the more ardent smiths and other mechanics became bewildered and overpowered, in the endeavour to overcome the difficulties presented by this intricate class of machinery, and they fell into insanity. When the speculative national frenzy of 1825, which had countenanced this more limited mania, collapsed in 1826, the effect in Nottingham and the district around was fearful. Visions of wealth and cherished schemes for grasping fortunes suddenly, were dissipated almost in a day. Many not in the trade, as well as some who were, lost all their means and fell into hopeless poverty; some died from despair; others went into self-imposed exile; a few destroyed themselves.

The patentee and licensees had in the time of prosperity put into operation the most improved and speedy machinery devised up to that epoch, and of course reaped the larger part of the profits that accrued. The demand for this lace net continued for some time to increase, until it became very large indeed; but the supply invariably went beyond it, and prices fell constantly. The prejudicial results of the unnatural and excessive increase of machinery, between 1820 and 1826, were very manifest in the experience of the trade during the following ten years. Meantime the immigration had been so great that the Nottingham of that day suddenly burst its bounds, not being able to contain the people, and has continued to overflow ever since—the population, which was 47,300 in 1810, when the twist trade begun, having become, in 1830, 79,000, and about 150,000 in

1866. The returns of this new branch of the lace manufacture were such as, when added to the extraordinary amount of wages paid for machinery, greatly to increase the circulation of money through the wholesale and retail trades of the town. Although Mr. Heathcoat disposed of the greater part of his Tiverton production through his London house, and Mr. Nunn also sent that of his Isle of Wight factory to be disposed of in the London market, Nottingham became from this time the emporium for the English machine-wrought lace, to which the goods have ever since been sent for sale, and where buyers resort to make their purchases for home and foreign trade.

Trade committees, both of masters and their workmen, had been watching the course of events in the bobbin net trade, through the last years of Heathcoat's patent, and their deliberations were deemed to be of still greater importance in the eventful time which it had been foreseen must inevitably supervene upon its close.

The masters' committee found in 1826 the machines thus located: In Nottingham, 650; Radford, 315; Hyson Green, 110; Beeston, 69; Basford, 62; Sneinton, 80; and elsewhere in Nottinghamshire, 150—total 1436. In Loughborough and neighbourhood, 240; and at Leicester and vicinity, 38; in Derbyshire, 78; at Tewksbury, 37; Shipton Mallett, 53; Chard, 49; Exwick, 40; Taunton, 100; Barnstaple, 34; Isle of Wight, 99; Tiverton, 204; Tottenham, 23; sundry other places, 38—altogether 2469 machines, to which number they had arisen from 970 in 1818.

The masters' committee ascertained also that during the speculations in machinery, prevailing from 1823 to 1826, Levers' eight-qr. machines sold for £700, circulars for £650, pushers and traverse warps for £480 to £550; during the first six months of 1826, though the working hours had been restricted to ten per day, the prices of Levers' sunk to £150, of circulars to £130, of pushers to £120, and of traverse warps to £80. An 'old Loughborough,' was purchased in 1822 for £1100, and was sold in 1823, just before the mart ceased its operations, for £700. A 'Greenwood' machine was bought for £250. Each was sold for £2, the day the mart was dissolved. This was before the 'fever.' A Derby workman told Dr. Ure that he had bought a machine for £230, by working which he had gained for a time £1. 10*s.* a-day,

and had sold it for £2 as old iron. During the 'fever,' £75 to £120 a-year was paid for the rent only of a six-qr. machine. Such a machine cost the builder £600; and £50 to £60 was often paid for being taught to work one. It was found that having no confidence in the continuance of high prices either of machinery or nets, many sagacious persons had realized their interest by selling both, so that of the then owners of machines, only one-third were originally lace manufacturers; and that of these not a few had fallen into difficulty, and some into deep distress.

The knowledge how to build this class of machinery had been in great measure confined, during the continuance of the patent, to the smiths' shops of the patentees and their principal licensees; but it had now been made a separate business also, employing independent skill and capital to a large amount, in order to meet a demand unprecedented in its character and extent. The subsequent fluctuations in demand for bobbin net machinery have been great; but the necessity felt by those who had thus embarked their means to keep their men employed, did then, and has ever since operated to, keep the supply of machinery up to an amount beyond the home demand for it, as well as that for France and elsewhere. The influence which surplus machinery must ever have upon any trade is very great. It forces production at whatever cost upon those who hold those machines and they cannot employ them, except at the risk of an unnatural pressure on prices and profits. The like pressure will come in due time on workmen's wages also—a result eventually of the greatest importance to them, as well as to their employers. That the business of building machines is different in its operation to that of producing consumable articles, is a truth never yet estimated at its real value in our practical trade economy.

The inevitable result of so great and sudden an addition to the machinery in the twist net trade was an equally rapid reduction in prices of nets and diminution in the confidence of buyers as to their ultimate value. Though very low in 1826, prices of nets had somewhat advanced in 1827: but so great had the panic in the lace market become in 1828, that the trade committee

called a general meeting of machine owners, at which it was resolved to institute a 'trade mart' for the purchase and sale of nets, partly on the principle of that of 1819, and partly on that of the Leeds cloth halls. This company was to raise a fund by 200 shares of £30 each, to be held exclusively by owners of machines, and the business directed by twelve such owners whose machines were working by power and twelve by hand labour. They were to regulate the working hours of the machinery. This scheme, however, it was found impossible to realize. A subscribed fund wherewith to purchase the goods as they were made, was found to be out of the question. It was thought that if many further machines were not built, and the working time of those already constructed could be sufficiently limited, the risk of loss to subscribers consequent on the mart plan would not be incurred, and the immediate interests of all would be consulted by the reduction of stocks and of supply, which such restriction must effect. At a large meeting, held on December 11th, 1828, including most of the principal owners or their representatives from all parts of England, it was unanimously resolved to limit the working hours from eighteen and twenty then customary, to twelve daily, for one month. On January 7th, 1829, another public meeting was held. The restriction had been adhered to almost universally, and it was resolved the twelve hours should be continued in operation. In March, the unanimity on the part of the owners of machines was such as to induce the committee to draw up, and offer for signature, the following draft of an—

"AGREEMENT FOR THE EXECUTION OF RESTRICTION OF HOURS' DEED."—

"A committee shall be appointed for better management of the bobbin net trade in England.

"That each person owning ten machines which are in work, or one person belonging to a firm owning ten machines at work, or his or their known agent, in the absence of the principal, shall whilst owning and working or causing the same to be worked, be one of such committee.

"That the owners of every two hundred working machines (independent of the above) may choose one representative who shall form one of the said committee; such last committee men to be chosen annually, and appointed by a written authority from such owners.

"That each committee man or known agent may appoint a proxy; such proxy being a member of the committee. It shall meet on the first Tuesday in every month, and at other times when needful, if called together by the president of the last meeting, and may adjourn from time to time. A president shall be chosen, who shall have a casting-vote when the business is to be decided by a majority. A majority of votes shall carry all questions except as after mentioned. In case of death, refusal or incapacity of one of the representative committee, the remainder of the representative committee may choose another until the next annual choice of the committee. Three-fourths of the whole committee to have power, after giving not less than ten days' notice by advertisement, to limit the hours of working and to control the same (including stoppage) in such way as they may think right, the assent of such three-fourths to be signified by their respective signatures. Machines are not to be sold or parted with, but so as to be subject to the present restrictions. In case of machines being worked contrary to the orders of the committee, a penalty to be incurred of twenty shillings for each machine for each day of offending. The committee to pay all necessary expences, and may reimburse themselves, costs and expences, from the money to be received from the penalties as far as the same will extend, and from the money to be raised as after mentioned. Funds shall be raised for such purpose by a subscription of threepence, or any less sum if directed by the committee for every quarter of a machine, the same to be collected quarterly from the date of the deed; payments to be due at the commencement of the quarter. The committee every Christmas to certify in writing signed by the president, the number of working machines in the trade, which certificate is to be conclusive for the following year. It is agreed that there are now four thousand machines in the trade at work. The deed shall from time to time be in force when executed by the owners of seven-eighths of the working machines; and may be put an end to by the signatures of the owners (parties thereto) of seven-eighths of the working machines. The present renters of machines signing the deed, shall stand in the place of the owners as to penalties and payments. No owner shall hereafter let a machine except to a person who shall sign a separate deed, binding himself to the above restrictions and to the above penalties and payments; and whilst such person rents the machine, the owner not to be answerable for the penalties and payments."

"*We the undersigned do mutually agree with each other to execute a deed upon the above terms and conditions, as soon as the same shall be prepared and made ready for signature. As witness our hands this 30th of March*, 1829.

(*Signed*) JOHN HEATHCOAT AND CO."

Working 206 machines and by 1252 other machine holders. The aggregate of machines represented held by these signataries and controlled by the committee was 3307; of these, ten held respectively 83, 71, 67, 60, 40, 39, 32, 28, 27 and 24; two held 23 each; three held 21, 20, 19 respectively; two held 16; and two 14 each; three, 13; six, 12; three, 11; and ten 10 each; these 43 houses having 1037 frames, had a right to sit and vote in the committee. Besides these, four persons held 9; eight, 8; eight, 7; eighteen, 6; twenty-five, 5;

sixty-seven, 4; one hundred and seventeen, 3; two hundred and fifty-two, 2; seven hundred and four held only 1 each; and eight had one-half share each in a machine. These 1211 machine holders had a right to send eleven delegates into the committee to represent their 2220 frames.

The total number of the frames in the trade was ascertained to be 3842 in 1829; so that signatures for fifty-five more machines would have made the deed operative. If desired these could have been at once obtained. But this was not deemed advisable, and the document was placed in the hands of the chairman, the writer of this work: where, with all the other papers connected with this laborious affair, it has since remained. This deed was not approved by a minority of the owners of about one-eighth of the machinery of the trade. One very large owner, who had supported the committee, withdrew in May; another, equally important, had signified his dissent by working his machines twenty-four hours in the day (which practice he maintained as a rule long afterwards), and much ill will was thus engendered, followed by some slight acts of violence. Stocks had been reduced by the end of June, so that there was only in the hands of producers less than three weeks supply. But though prices of the unfinished plain goods in widths of 12 qr., which had been forced down by a special competition, were raised 33 per cent., yet sales of other kinds were as difficult as before the restriction; and the confidence of the buyers of finished goods was lessened rather than increased by what they justly deemed to be the factitious interference of this committee with the freedom of manufacturing operations. The fact of two factories, one of 95, the other of 105 machines being worked unrestricted hours, added to the serious oversight that *the deed contained no restriction against an unlimited construction of new machinery*, was sufficient to break up the committee. On the 13th October, 1829, the resolution of the committee to give up their charge was made known at a very large meeting of the trade; and contrary to the wish then strongly expressed, and of the memorial sent by 1808 Nottingham bobbin net journeymen signed between 10 A.M. and 6 P.M. of that day, the committee

resigned; the deed was given up, and of course the restriction came to an end.

The whole transaction was, with the exception of one member of the committee, undertaken and carried on in good faith. The number of machines building was twenty-one in May throughout the trade, and in June seventy-one. But the latter did not include forty-four of 12 qr. width, which, by the time the deed was set aside, Samuel Hall (*not* Mr. S. Hall the gasser)—one of the most active promoters of, and workers in the committee of the restriction—unknown to the rest of the members, had put in rapid course of construction. The subsequent history of these machines is curious and instructive. The trade had become over loaded with plain net rotary machinery before these were ten years' old. They were excellently constructed and in working order, yet, though they had cost about £14,000, the lot was unsuccessfully offered by auction for £600 in 1838. In truth, as will be seen by the census of machines in 1831 and 1833 respectively, the mania for building lace machinery seemed incurable, however depressed and unprofitable the trade might be. There still existed amongst the Nottingham machine owners much jealousy of those in the west of England. Yet the bobbin net machine owners at Tiverton, Barnstaple, Taunton, and Exeter working together about 500, chiefly 8 qr. machines, entered into this restriction, not only without stock, but with large orders for France on hand at relatively high prices. This is explained by the fact, that the twist machines then at work on plain nets in France were 8 qr. The 12 qr. nets therefore, if smuggled in, would have been detected by their width, so the contraband trade was confined to 8 qr., which enhanced their relative price in Nottingham. The makers of them, however, gave their authority to their agents without hesitation, to bind them to the restricted hours, and they were duly adhered to. It is worth notice, that so great had been the demoralization amongst some of the families of the workpeople by the relay or shift system, and continual nightwork, that several machine owners in the west resolved, when this temporary restriction ceased, that though the long hours

were resumed in the midland district, they would not return to them again.

The amount of capital engaged in the machinery thus restricted, was about one million sterling; returning when at work in finished goods, three millions sterling a year, and employing with more or less constancy about 150,000 workpeople. The committee sat weekly, and held six large public meetings, at a total expence of £390. This is believed to be a solitary instance of such an almost unanimous delegation of authority and power on the part of the proprietors of so large an amount of machinery and capital, wielded so long, and relinquished with such a prompt and decided resolution. It is interesting to remark also, that all those who signed, except seven, were originally working artizans; as were all those in the trade who did not sign, except one, Mr. Fisher. Some, but not many frames, were hired from those that remained of the outside owners who crowded into the business in 1823-4-5. Where did the rest obtain the one million of money wherewith to become possessed of 3300 frames, and the additional credit and capital necessary for materials to work them? The whole was the result of individual labour, skill, economy, and foresight, exercised for the most part during ten or twelve years. While too many, pressed by the after exigencies of the trade, have returned to their original position of workers in machines, which they for a time owned, the remainder with their successors have built up the goodly trade edifice that we now behold.

During about nine months of the year 1829, fortnightly meetings were held of the agents for the sale of power plain nets, at which lists of prices for them were agreed upon. So long as they could be obtained, these lists regulated sales, but as trade declined by accessions to the machinery employed and return for the most part to long hours, the impossibility of controlling prices by any such compact was manifest, and the meetings ceased. Since that time, though often proposed in periods of difficulty, the plan has only once been actually resorted to. This was in 1835, and as it immediately preceded a sudden increase in demand, its

operation was highly beneficial. There has, on the part of some of the principal machine owners, ever since prevailed practical disunion in relation to fixed rates of prices.

The author's connection with the public operations of the bobbin net trade in 1828-9, gave him facilities for drawing up with considerable accuracy an account of its then extent; he therefore published such a document in 1831. Some of the more important facts will serve as a basis of comparison with future similar enumerations.

The Manchester and Nottingham spinners and doublers' capital, employed in 35 factories containing 682,000 spindles and in stocks of wool and yarn, was calculated to amount to £935,000. The bobbin net trade had in 22 factories 1000 power machines; also 3500 hand machines, stocks unwrought, wrought and in embroiderers and finishers' hands, valued at £1,375,000. At this time the number of people employed was about as follows: Manchester spinning and Nottingham doubling, 13,000; power net making, 3000; in hand machines, 5000; 4000 winders; 6000 menders; 30,000 pearlers, drawers, and finishers; and embroiderers wholly or partly employed in addition to domestic work, about 150,000. This surprising number was spread round Nottingham for fifty miles and in London, Devon, Somerset, Norfolk, Scotland and Ireland. The work being given out at centres near their homes by persons competent for that purpose, embroiderers' wages and profits thereon were this year about £1,525,000. The diminution in the amount of embroidery, required a few years later, caused corresponding distress. At this time the larger part of the produce of the machinery, consisting of 1350 hand levers; 100 hand rotaries; 1300 hand circulars; 750 hand traverse warp and pushers; and 1000 power machines; 4500 in all;—was disposed of in Nottingham by fifteen agents for factories, and about 200 persons who carried their employers goods daily from one finishing warehouse to another for sale. The first cost of cotton wool, almost the only raw material used, was £120,000; the ultimate returns amounted to £3,417,700; passing through the hands of about 70 plain and 70 embroidering houses. An excessive and most rapid reduction had taken place in wages, for the amount had fallen 6*s*. a-week in the last two years; and men did not get now more than 18*s*. and youths 10*s*. a-week, working the difficult and ponderous twist net machine by hand. Winders, 2*s*. to 5*s*.; menders, 4*s*. to 8*s*.; embroiderers working long hours, children 1*s*. to 3*s*.; women, best hands, 5*s*. to 8*s*.—reduced in 1833 to 1*s*. to 1*s*. 6*d*. and 3*s*. to 4*s*. 6*d*. respectively.

If the reader carefully notices the fact that the 4500 machines could not have cost the handicraft owners less than £300 to £500 each, many of them much more, the following list is a most interesting one, as creditable as it is, at least to the author's mind, melancholy, from the after position to which the small owners have been reduced: seven hundred owned 1 machine each; two hundred and twenty-six,

2; one hundred and eighty-one, 3; ninety-six, 4; forty, 5; twenty-one, 6; seventeen, 7; nineteen, 8; seventeen, 9; twelve, 10; eight, 11; six, 12; five, 13; five, 14; four, 16; and twenty-five owned respectively 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 35, 36, 37, 50, 60, 68, 70, 75, 95, 105 and 206. The total number of owners was 1382. It will afterwards be seen how rapidly the small owners were absorbed into the ranks of the journeymen, or disappeared from the trade. The principal cause was their falling into the error of putting too much of their acquired capital into machinery, to their distress and ruin as manufacturers, when the overload of stocks on all sides forbade prudent finishing houses to buy, and the payments for wages and materials compelled sales not only of goods, but eventually of the machines themselves at whatever loss.

The movements in the machinery of the trade, from 1824 to 1833, were thus important and significant.

In 1828, machines had begun again to be constructed; continued to increase in 1829; more so in 1830; chiefly of 8 qr. rotary; in 1831 many 10 qr. rotary; and again in 1832; and still more in 1833, and of increased widths. So that, notwithstanding the great number that had been sold as old iron, the total number which had become 4500 in 1831, had swelled out to 5000 machines in 1833. These consisted of—

Hand Levers, 5 and 6 qr., 500; 7 qr., 200; 8 qr., 300; 10 qr., 300; 12 qr., 50; 16 qr., 30; 20 qr., 20; . . .	1400
Hand rotary, 10 qr., 100; 12 qr., 300; . . .	400
Hand circular, 5 and 6 qr., 100; 7 qr., 300; 8 qr., 400; 9 qr., 100; 10 qr., 300; 12 qr., 150;	1350
Hand traverse, pusher, and straight bolt averaging 5 qr.;	750
Hand machines	3900
Power, 5, 6 and 7 qr., 90; 8 qr., 350; 10 qr., 280; 12 qr., 350; 16 qr., 30;	1100
Total machines	5000

The embroidery was reduced two-thirds and the hands one-third. The total returns of the English bobbin net trade were lessened since 1831 at least one million sterling.

There had been publicly offered for sale from 1824 to 1832, 1843 machines, being 740 Levers, 418 circulars, 173 rotary, 512 pushers, &c., during which time certainly one-third at least of all the machinery in the trade changed hands. Machines of greater widths were constantly sought after in the midland district; while in the west of England the makers of bobbin net were wisely contented with 8 qr. to 12 qr. widths. Levers 6 qr. now sold for £30; 8 qr. £50; circulars the same; 8, 8 qr., 11 points which cost £5000 in 1825, sold for £300, and five other 8 qr. sold for £20 altogether; 6 qr. pushers which cost in 1825 £350, sold for £30, and traverse warps for £3 a machine. Rotary 8 qr. sold for £100; 12 qr. £180. The despair in 1834 of ever again making narrow and slow machines valuable, led to the breaking up in that year of between 5 and 600. Many were thrown piecemeal from the windows of the upper rooms in which they had been employed into the street below, not being thought

worth the trouble of carrying down stairs, though they had cost several hundreds of pounds each. A list is in the author's hands of machines thus broken up, which cost £2,000,000 but a few years before, and many of which were still in fair working condition. One of the Nottingham street cries then was "Old rags, bones, and twist (bobbin net) machines to sell;" and numbers thus found their way to the scrap heap. By 1835 however, constructors had found uses for many such despised frames, adapting them to produce very valuable articles, so that they had risen tenfold in value; not a few Levers and traverse warps, previously producing articles selling at 4*d.* a rack, were by a trifling outlay, made to produce at a slight advance in cost, articles which sold currently for several years at 3*s.* to 4*s.* a rack. Machines worth prior to alteration £10 each, after £50 had been expended in alterations to adapt them to make some new imitation of a pillow lace pattern or ground, have repaid the outlay the first month, and put £1000 a year profit into the pocket of the owner. For a time therefore but few more frames were broken up. Nevertheless the body of machinery was found in 1836, when an exact account was again taken of it by the author, to be much lessened in numbers, though partially compensated in production by their greater width. They had fallen from 5000 to 3800. But the most striking change was in the number and classes of owners as indicated by the machines each owner held. In 1831 there were 1382 owners, in 1836, only 837. Of these three hundred and two now owned 1 machine each, in 1831, 700; now two hundred and three owned 2; one hundred and two, 3; sixty-two, 4; forty-eight, 5; twenty-one, 6; fifteen, 7; thirteen, 8; fourteen, 9; six, 10; seven, 11; six, 12; ten, 12 to 20; nine, 20 to 30; six, 30 to 40; five, 40 to 50; two, 60; one each 70, 80, 100, 120, 170, and one, 200 machines. Thus more than five hundred owners of 1, 2, and 3 machines each, had disappeared; principally owners of the 400 narrow pushers, traverse warps, and Levers', and 800 narrow circulars, that had been withdrawn from the trade since 1833.

The change in the kinds of goods produced in these two eventful transition years was from plain almost entirely; 200 frames in 1833 only making fancies out of 5000; but in 1836, 1000 out of 3800. This is an important fact, shewing the tendency of the scientific skill at work to be now rapidly taking its only safe direction; and which before another twenty-five years had elapsed put an entirely new face upon this manufacture, by the general use of the Jacquard and other consequent improvements, in making fancy goods.

There were in 1836 at work,

	152 traverse warp,	165 pushers,	317
1293 rotaries making plain,	247 quillings,	47 fancies	1587
116 circulars making plain,	114 quillings,	188 fancies	418
16 Levers' making plain,	761 quillings,	448 fancies	1225
1425	1122	683	3547

And about 253 standing or not enumerated. Total at work 3547. Gross total, 3800.

In 1836 there were in Nottingham and its vicinity 372 machines making plain net, 1006 quillings, and 784 fancies, altogether 2162; in Leicestershire and Derbyshire 399 plain, 86 quillings, and 113 fancies; altogether 598; in the west of England and Isle of Wight, 654 plain, 30 quillings, and 103 fancies, altogether 787. There were therefore then 1425 making plain net, 1122 quillings, and 1000 fancies machines. The widest and quickest frames now made 30,000 meshes a minute. In 1835-6 it was stated in the report, on good grounds "that by the change in the employment of machines to make fancy work, in consequence of the pressure on the prices of plain goods and the application of Jacquard and other apparatus acting similarly on machinery, 1000 machines were raised in those years from the price of old iron (£2 to £10 each) to the value of £50 to £100 each, and 1500 to 2000 of the best hands were employed on them at an advance of 50 to 100 per cent. in their wages; adding also to the returns of these machines alone £300,000 per annum. Altogether a fresh and marked impulse was given to ingenuity and effort throughout every department of the manufacture. The raw materials consumed in 1836, cost £210,000; the final returns were computed to be about £2,212,000. Of this sum only about £350,000 was paid for English embroidery. The changes then beginning in the kinds and locality of employment, ensuing on the putting in pattern by the machine instead of by the hands of the lace runners, and which has never since ceased its operation, rendered it impossible to give any near approach to the numbers actually employed on either the new kinds of work or the old. The revolution has been almost complete throughout the whole process. Of the entire production of this trade, about one-half was exported in 1836, instead of three-fourths as in 1832. The number of persons employed in selling the rough production to finishers has much lessened. The finishing houses, 114 in number, now passed about half their goods through London to their ultimate destination.

Several incidents occurred from time to time publicly indicative of the fluctuations of the bobbin net trade. The desire broke out into action repeatedly for some years upon each access of trade stagnation, for the regulation by committees of the working hours of the trade, or of some branch specially affected. Thus, in 1831, a stint to eight hours daily labour was nominally agreed upon, but after a fortnight's trial ceased; the journeymen declined for a time to return to more than twelve hours' labour, and resolved to form a Lace-maker's Union. In 1832, a short stint was carried into effect by the conjoint efforts of masters and workmen. The government was also memorialised by the committee with an expression of earnest desire for *reciprocal* free trade with France. The injurious effects of many and conflicting patent rights was also

a topic now beginning to engage considerable attention in the trade. Another stint was attempted ineffectually of the Nottingham bobbin net frames, though persevered in at Loughborough for some weeks. The journeymen put forth a 'regulated' list of wages, amounting to 100 per cent. advance. This being refused, some windows were broken at Carrington.

It was thought that the interests of the local staple and other trades might be advanced by opening a hosiery, lace, and yarn exchange, in connection with a corn exchange, and the establishment of a chamber of commerce. These ideas have been in succession carried into effect. Another memorial, signed by 2500 persons, was presented to government, stating their increasing desire for the admission of English lace into France, and that of France into England, on a reciprocal basis or entire mutual freedom. To which the minister replied, "the government desired reciprocity, but could not force it." Dr. Bowring was then negociating on this subject, and expressed his belief that the free import into France of our lace would be ceded in twelve months from that time. The trade was so depressed as seriously to distress the workmen, many of whom did not earn through 1834 more than 8*s*. a-week. They earnestly pressed upon Sir John Hobhouse, M.P. for Nottingham, a bill "for regulating wages by the decisions of a Board composed of selected masters and men, and making a scale thus agreed upon, binding on the trade upon its receiving the signature of a magistrate." This plan he declined to sanction. These proposals for legislation in respect to the consideration and adjustment of questions as to wages and trade matters, led the author to make a translated *Analysis of the Laws and Constitution of the French Conseils des Prud' hommes*, which was published in 1834. How far and in what manner courts of arbitration, whether constituted legally or on a purely voluntary basis, can be made to work efficiently and satisfactorily for both parties, in adverse as well as prosperous states of trade, is still one of the great questions, social and commercial, of the day; the solution of which would almost seem more distant than ever. Measured by the grave differences between em-

ployers and employed, its magnitude and importance cannot be too highly estimated, and in proportion we hail with pleasure the amount of success attendant upon the operation of the hosiery board of conciliation of which we shall give an account in a future chapter.

In the distress of 1834 the owners of the 1100 quilling machines stinted their time, raised a fund of £2000, and maintained their prices. The like was attempted amongst the plain net owners, but without success. The reason for not assenting given by one great maker, was that "small makers lowered prices by their necessities, and ought to be driven out." Next year, however, 1835, a stint of hours took place, including the machines of the house just referred to, and the regulation of prices was carried out for two months; 1300 plain net frames worked only eight hours a-day, when a sudden revival of demand set all fully to work again.

The chamber of commerce, lately established, memorialised the Board of Trade upon the occasion of great distress amongst English lace embroiderers, which it was averred arose from the facility with which foreign embroidered goods were imported by smuggling into England. Ample proof was offered, shewing that the charge by smugglers into England was 5 to 7 per cent. only; while, by the superior vigilance and activity of the French officers of customs, the charge on their frontier was 50 per cent. for similar goods. The question was a very unpalatable one to Mr. J. D. Hume, Secretary at the Board. He spoke to the members of Parliament who introduced the deputation, of "this dab of Nottingham lace standing in the way of more important interests;" which drew from Mr. Heathcoat the remark "that it employed a capital of two millions, and gave work to probably 150,000 hands, making a return of three millions annually, therefore was not to be altogether frowned upon"—a statement more than confirmed by Mr. James Fisher then present, and rendered effective by Mr. J. E. Denison declaring "if the matter were not taken in hand by the customs authorities, he should feel it his duty to mention it in the House." Mr. Dean, chairman of the custom board, was surprised at the facts—placed beyond doubt by the

invoiced charges being produced—and he took steps to set the business in a more satisfactory position for a time. In 1837, the general money panic and pressure bore with especial weight upon the hosiery and lace business of Leicester, Derby, and Nottingham. At the latter place a subscription of £5000 was raised to assist the poor; parochial assessments were made, varying from 7*s.* 6*d.* to 12*s.* 6*d.* in the pound, and two thousand houses were untenanted; private benevolence was also exercised in a most effective manner. In October, only one-fourth of the machinery in either staple trade was employed, and that only working half time. The quilling machines were entirely stopped. Many heavy failures took place, and the chamber of commerce was broken up. An endeavour to get a general cessation of working of the machinery of the trades was not responded to; it being evident that even occasional employment of limited amount was of importance, when every fifth family was pauperised. Any orders that could be obtained must be executed without delay. At the "relief" meetings held in this disastrous year, the question was much discussed, "whether, as reciprocity in our trading with foreign nations appeared to be unattainable, the interests of employers and employed would not be best secured by a return to high protective duties and the adoption of a scale of remuneration for labour more adequately compensative to the artizans when in employment." The opinions of the workpeople were strongly in favour of this view of the matter. Amongst employers there was greater diversity.

The author, considering it the more practical way of meeting it, and endeavouring to forecast the future, took that occasion to propose—as means of securing in due time results highly beneficial to the trades of Nottingham and its sister towns—the establishment of schools of design; collections of models, patterns, and drawings; an alternate annual exhibition of the productions of the three counties; the adoption of measures for securing inventors' and trades' rights respectively, together with other measures, whereby the taste of fancy designers and the fabrics from our looms might be

improved; and then—while making machine-wrought hosiery and lace more and more worthy of approval by the leaders of fashion—taking well considered steps to bring them with effect under their notice, and that of the general mass of consumers.

Articles advocating these views—and especially pointing out the impossibility of safely depending for the employment of the vast body of lace machinery, upon the continued demand for plain net; and asserting that its real ground of permanency was in the production of close imitations of pillow lace—were inserted from his pen, at short intervals, for some years in the local press.

With reference to mechanical improvements since 1820 in the manufacture of lace, the following additional modifications of the double-tier circular machines have been made:

Jackson and Henson, of Worcester, in 1824, introduced the fluted rolling lockers moving carriages, having corresponding teeth. The lockers turned both ways by a segment. The movements are exceedingly swift in this frame.

In 1825, William Harvey improved the working of the machine by making the combs work more steadily. Other modifications of this excellent working mechanician will be noticed as they occurred. No one understood bobbin net machinery better than Harvey, and his personal qualities caused him to be highly respected. He died at Carrington a few years ago in humble, but comfortable circumstances.

William Shepherd, in 1831, constructed a single locker circular comb machine for making breadths, using a back plate riding on back combs and cut in long nicks. The plate pressing sideways on breadth carriages, prevented their advancing in the traverse motion and thus divided the net. At the time, this plan was a step in advance.

In 1832, Allcock, of Worcester, patented No. 6343, a rolling locker frame having two outward rollers, acting by a double segment, and made to move more slowly than the inner rollers, avoiding overshooting the carriages.

Joseph Litchfield, of Nottingham, produced spotting on a circular comb frame, by letting the carriages remain on both bolts and making spots by drawing spotting carriages by extra back and front pushers, and having only the usual point bars. By the action Fisher *v.* Dewick, this was decided to be an infringement on Sneath's spotting patent.

The pearl on the edge of machine-made laces had been stitched on by the needle with great care and expense, until about 1827 or 1828, when Marmaduke Miller, of New Basford, produced a good imitation of cushion-made pearl upon narrow edgings. This was

the first instance of success in regard to this important and difficult, though at first sight, seemingly minor part of a breadth of narrow lace. This was effected by him on the pusher machine, and having a bullet-hole on the edge of it, required the finish of a thick thread with the needle. Its introduction to the trade required some time and effort, but was brought about by Mr. W. B. Carter, and the demand soon became general. Levers' and circulars were soon put on to add a pearl, which, though not so lacy in structure, was of a more perfect loop-head. This improvement led the way to greater widths and much superior patterns. The inner sides of lace open works are now pearled on the machine.

In 1832, Mr. Miller arranged the pusher so as to work thick threads in various devices by using extra guides, operated upon by eccentric wheels; thus pusher tattings were produced.

This clever mechanician has not confined his abilities to lace machinery. He and his family, though brought up amongst the noisy machinery of these trades, have been thoroughly musical for at least three generations.

About 1836, one Davis, a workman, aided by others, arranged a machine—

By breaking out a part of the main guides and attaching others to a separate bar so as to take their place working it by a wheel, and thus interwove threads making cloth work taping on the edges of quilling nets.

This assisted to open the way to further ornamenting lace, by using the chain wheel in various ways.

A patent, No. 6412, was taken out in 1833, by J. and F. Smith, of Nottingham, for making quillings from circular machines.

In this the carriages had upper nebs moved by catch bars and under nebs acted upon by double lockers, using pickers to select dividing carriages. This plan was long worked at Chesterfield.

In 1836, No. 7219, and in 1845, No. 8362, patents for chains operating on bars, were taken out by the same parties.

About this time, Cook, of Loughborough, put together a machine, the carriages in which were propelled by two fluted rollers. It could not make breadths. Nothing more seems to be known of it than that from its speed, actual or proposed, it was called "the high-flyer."

Though some expected this plan would supersede all others, on Mr. Paget quitting the lace business it was laid aside finally.

Harvey made on circular bolt, in 1837, wire-ground having arched shaped meshes using four guide bars. And in 1839 he invented—

An apparatus for making silk figured laces, by putting in threads which could be withdrawn, thus leaving large holes which were afterwards filled up by the needle with thread imitations of fish-nets.

The plan, on which he employed four machines (his wife doing the needlework) was used for a time, but died with Harvey.

Thomas Alcock, of Claines, near Worcester, took out a patent in 1836, No. 7032, so multifarious in its objects and plans as to fill one hundred and eighty-three closely printed pages with the specification, and to require thirty-one sheets of drawings, mostly of the largest size, filled as closely as possible with illustrations. Sheets, No. 27 and 28, containing the front and back views of this "improved Levers' spotting machine," are commended to the examination of any one curious as to intricate inventions; being another surprising example of what self-taught mechanicians have constructed thirty years ago, in this wonderful department of genius and skill.

This patent, Alcock states to be partly for improvements on inventions patented by him in 1832 and 1835; applicable to traverse warp machines; to making spots on traverse warp fluted rollers rotaries; to producing spots on Levers straight down net, called Mechlin spotted net; also an improvement of Henson and Jackson's fluted roller circulars by using 14-point comb, and 7-point guides and points; and in single-tier fashion, producing spots &c.; also making spots on double-tier machines making straight down net. He further specifies an imitation of Valenciennes hand made lace, being a four-sided twisted mesh of two threads not traversed and ornamented with spots made on a Levers' machine, also the same mesh and spotting made on a fluted roller frame working single-tier; also the same working double-tier. He goes on to specify spots made on circular bolt traverse net in such manner that 'figure of eight' weavings of pairs of warp threads should form the spots, and the like manner of forming spots on the single-tier Levers' machine; this specially by the use of bullet hole apparatus, particularly that kind of 'turn again' combs patented by and known as Sumner's patent machinery. Finally he describes fluted roller machinery to be worked with single-tier combs

and bobbin carriages by two fluted rollers and comb-bars so disposed as to produce other fabrics than bobbin net, in the nature of weavings, tapes, or ribands of cloth work texture.

This specification includes a description of eleven distinct modifications of bobbin net machinery, in each of the three principal classes or combinations of them all.

In 1835, there were about 1100 machines employed in making cotton bobbin net in breadths. These were called 'quillings' or 'plaitings,' because used quilled or plaited about the head and shoulders. The demand for them was very much reduced for some years by a device adopted at this period of difficulty in the lace trade with a view to lessened cost and underselling, on the part of one or two engaged in this branch, whose cupidity jeopardised for a long time the character and consumption of the article. The process adopted was simple enough. The size of the mesh can be made nearly regular throughout the whole of the piece by adjustment from time to time of certain wheels in the machine. Without this, the increasing size of the work roller will cause the size of the holes to increase, till at the last end the piece will be more open in quality to a marked degree. Breadths are put up for sale in cards heavily pressed and banded; to undo which, before arriving at the retail counter, would spoil the sale. They are therefore bought on the faith placed in the seller. At that time these exceptional parties caused the goods to be made in this irregular way, and unjustly put them up with fine faces at top and bottom of the cards, the insides being of coarser qualities.

An attempt to introduce the like plan was made, in regard to plain wide cotton nets: but was effectually put down by the trade as soon as known. The fact and its results on the cotton quilling demand, are given here as a noteworthy example of the power of wrong doing on the part of even a single individual in the first instance, to influence demand and injure a trade. Under the sometimes excessive competition in business, too much care and determination cannot be exercised in any trade to keep up the soundness and real quality of the articles forming the staple of its productions.

An account of the proceedings taken by the lace manufacturers of Nottingham for the purpose of rendering effective the laws against the export of their machinery, will close this chapter; bringing our narrative of events transpiring in the trade, down to 1835-6—the period of its greatest depression previous to the close of the year 1866.

The large increase known to have taken place in the introduction of English bobbin net machinery into France, and its rapid transfer after the breaking down of the restriction of working hours, in 1829, led to the appointment of a committee in 1832, and the holding several public meetings of the trade with a view to take measures to prevent the continuance of the export of machines, and consequent increase in foreign competition. Long existing Acts of Parliament had prohibited the export of machinery of various kinds; as that of William III., 1695, which fined exporters of knitting machines in a penalty of £200, and punished them with twelve months' imprisonment; and its extension in 1718 to all other kinds of machinery used in silk, cotton, and linen manufactures, adding a penalty of £500 on persons seducing artificers to leave the kingdom. These acts were, during the following sixty-six years, confirmed; and in 1785 they were extended to include engines, tools, and utensils used in constructing machinery.

After the conclusion of the long and expensive war in 1815, the heavy burthens of which were mainly sustained by the profits realized by the employment of greatly improved labour-saving machines, there was gradually manifested a disposition to relax in the vigilant and strict execution of these laws. Licenses to export machinery were granted on exceptional pleas without enquiry; and artizans transferred themselves with their skilled training to foreign countries: that part of the law which forbade their emigration, after a parliamentary enquiry, being repealed in 1825. The committee sat again next year, and recommended the repeal of the rest of the statute, which the House of Commons at that time declined to do. The practice of licensing became more common, and countenanced the decreasing

vigilance of the custom officers in regard to this (to them) difficult and obnoxious duty, while it gradually made way for the practical carrying out of the cherished theory, that there is no difference in principle, and ought to be none in practice, between free trade in goods, and freedom to export our machinery and the tool making machines also. The bold and unscrupulous way in which this contraband trade was carried on after the cessation of the bobbin net patent monopoly, at length caused public opinion and feeling in the midland counties to take a more decided form. The meetings above spoken of appointed two permanent committees: a secret committee, to ascertain the removal of machines with their intended destinations, and to take measures for their seizure if going abroad, the members of which committee should be guaranteed from legal consequences: and a financial committee to receive, manage, and pay funds subscribed for this purpose. Within a month every principal house in the trade signified their adhesion, as did the body of journeymen also. It was at this time, that Gravener Henson drew up a memorial to the Lords of the Treasury, signed by the owners of more than 3000 machines and 4000 workmen on this important and difficult subject; which for fair statement of argument, skill in handling, diligent research, and nervous diction, would bear fair comparison with any document presented to the minister of the day. A solicitor of eminence was appointed. Mr. Heathcoat, Sir John Hobhouse, Sir Ronald Ferguson, Mr. John E. Denison, and other members of Parliament, gave their aid in applications to government, by whom these deputations were civilly but very coldly received. Besides the machinery, for the export of which treasury licenses were obtained, to nearly every shipping port round the island, parts of machines were sent; if seized, they were sold at the price of materials, because useless there for anything else; but when got abroad, were rejoined to the other parts, so making complete machines. A general notice was given at these ports, of the illegal nature of these shipments, and government was pressed to carry out the law against them by its own officers;

it was evident that local bodies had neither means nor power equal to the task. Nevertheless, the committee sought to strengthen their influence upon the authorities by a union with the manufacturers of Birmingham, Manchester, Leeds, Leicester, &c., which was but faintly accorded.

In the summer of 1832, Mr. William Morley, a partner with Mr. John Boden in the large bobbin net manufactory at Derby, being upon a tour in France and Belgium, obtained the best insight in his power into the amount of similar machinery at work in those parts. He stated the results of his enquiries thus: Calais 700, Cambray 400, Lisle 170, Douay 200, St. Quentin 150, and 380 in other places; making a total of 2000 machines. This summary was sufficiently important to further direct the attention of the trade to machine exportation. A machine was seized in 1834, but given up to the intending exporter by the Crown. Several others which were seized, were in like manner given up at the out ports, "proof of intention to export" being laid upon the informer and those who made the seizures. The Board of Trade declined to sanction any seizure five miles from a port. Upon which an application was made for a bill, to more effectually stop the export of machinery. The funds of the committee were now exhausted; they retired from further active opposition, but continued to watch events. Exportation of machines to France, Germany, and Russia, immediately recommenced on a large scale, £5000 worth lay at one time at a single wharf in London, and the execution of an order for £2000 more waited for models and drawings of every process then in course of preparation.

In January, 1835, an action was instituted by a Mr. Faber against G. Henson, for the illegal seizure of a machine in 1833, which the Crown had restored to Faber on submitting to his acquittal. The plaintiff was probably supported in prosecuting Henson by a body of persons interested abroad, either in machinery or in its transit by fraud. The attorney general was retained by him. Henson had adhered strictly to his instructions; it had been seized by the excise; he had

afterwards identified it. The few members of the secret committee, his employers, shrunk from the responsibility both individually (for the committee had expended its funds) and as representing the trade. The trial was put off by the plaintiff on frivolous grounds three times; we, though not of the five, furnished Henson with funds, that his cause might not be lost for lack of means, and so "the town gaol be his lot." At length, on June 23rd, 1835, "having fought a hundred trade battles at home and elsewhere," he determined to conduct his defence himself, and without any friend present, he took his seat in court, with books and papers, "to do that for others, which," he says, in a letter addressed to us the day before, "I am afraid few men would do for me, namely, protect them from the consequences of their own acts." This he must have the credit of doing, and in a most skilful and determined manner. The real object of the plaintiff was, to get hold of the undertaking given by the secret committee to hold him harmless in his proceedings carried on by their directions. This he resisted, supported by the sympathy of the bar; and after long and powerful argument, Lord Abinger said "he would be no party to bringing fresh suits" (*i.e.* against the members of the secret committee, who were men worth shooting at); "indeed, if they got the instructions, they would have to prove malicious intention. They had better take a non-suit"—a suggestion which was acquiesced in to the satisfaction apparently of most present. This result relieved the secret committee from their disagreeable position. But with the meed of admiration for this self-denying act, then and always expressed by the author, Henson had to rest content. It was his only repayment; except the fund of enjoyment derived from his triumph over the chief law officer of the Crown. Some may read these lines, who will feel that he did not deserve *all* the disparagement that has been cast upon his name.

A committee of the House of Commons sat in 1841, upon an enquiry into the exportation of machinery. At the request of a public meeting held in Nottingham, three gentlemen went up to give evidence against it.

In the next session the laws forbidding it were entirely repealed.

In 1836, there were 1863 machines for making twist lace in Nottingham and its suburbs. By 1840, 80 of these had been exported, besides 143 new insides; 485 had also been broken up, and 50 new machines had been built meanwhile at Nottingham.

CHAPTER XXIV.

THE JACQUARD FANCY LACE MANUFACTURE.

A NEW developement of the bobbin net lace trade has taken place since 1835, by the general application of pierced bars and the use of the Jacquard apparatus on the principle of individual selection of threads in fancy machines. The era of ornamenting lace in the process of making upon the frame has now been fully ushered in. The results are new, striking, and of the utmost importance. All articles from the narrow lace edging to the two yard wide store curtain requiring many thousands of cards to complete the design, are now as familiarized to our draughtsmen, mechanicians, and workpeople, as they were unanticipated by them forty years ago, or as to taste, workmanship, and beauty by the purchasers of lace goods only twenty years since.

The local School of Art and Design has been far more effective in promoting knowledge of the principles which govern taste in the choice of drawings, with a view to their successful application in the peculiar tissues of lace, than was once thought possible. It is but comparatively a few years since the idea was first broached in the press of Nottingham, that such an institution was absolutely necessary to secure the interests of the lace trade and of the town. The artizans of the district are not now, in respect of appreciation of the beauty of a pattern, like the same class of men they then were. Considering the difficulties inherent in a tissue composed of interstices large and small, of fine and heavy cloth work often uniting to produce effect by thick threads surrounding or veining a pattern, many of the floral and arabic styles now familiar to the designers in the larger establishments (in several of which an expence of £1000 a-year is incurred), will bear comparison as to light, shade,

contour, and effect with the elaborate works of the oldest schools in manufacturing art. In this respect the trade is placed on a surer basis than it was before.

It has been seen that *plain* bobbin net is made by the to and fro movements of the carriages and their bobbin threads, together with the lateral motions of the various sets of threads, whether warp or bobbin. Figured or fancy net is produced by the like movements; only instead of being of the whole of each set, and constantly similar in their operation, in making fancy nets, some are stationary, some pass between the warp threads, some are shifted laterally to the extent of one mesh, some to the distance of two, three, or more meshes; some to the right, some to the left; the warp threads too, instead of being separated into two divisions only, are separated into many, each of which is susceptible of the lateral movement independently of the others. It is by modifications of these lateral movements that all the numerous varieties of machine made lace are produced; such as cloth work or fining, open mesh work or bullet hole, thick threads surrounding or veining flowers or leaves, besides the great number of different meshes, blonde, Mechlin, Brussels, Valenciennes and others. A great portion of the present complexity of the machine, as contradistinguished from its previously simplified condition for making plain net merely, is due to the mechanism by which these lateral movements are produced. If the warp threads be placed in several divisions, each moving to the right or left independently of the other, and if the bobbin threads are similarly classed in several divisions, each moving without reference to the others; it follows that an almost infinite variety of movements may be brought about, and it is not difficult to see that these movements must govern the manner in which the bobbin threads twist round the warp threads, as well as how the different systems and sizes of warp threads are made to enter into the outline and body of the pattern required.

When the movements of the systems, into which the warp and bobbin threads are divided, are intended to be regular and constant, and of the whole of each set, then they are produced by the eccentric surfaces

of wheels operating directly on the bars controlling each class or set. But when the movements are to be irregular and arbitrary, as in fancy and ornamented lace, then it is by means of bars attached to springs or levers placed at the ends of the machine, that the various sets of warp threads, whether those sets be fifty or five hundred, are made to move laterally; each bar being of steel and as long as the machine is wide; and each pierced with holes answering exactly to the particular threads in the pattern, which are, by being passed through these holes, to be guided by the bars to take the place assigned to them in the formation of the pattern. The levers or springs which pull or push the bars to or from the end of the machine, were themselves selected formerly by nobs on wheels or cylinders with irregular surfaces, but are now almost universally by a Jacquard apparatus. This may consist of a four, five, or six-sided roller; each side being perforated with as many holes as there are moveable pins or levers placed in a frame above the rolling cylinder. A number of oblong pieces of cardboard, from fifty to five hundred it may be, are connected together in an endless chain, and so arranged as to size, that when one of the cards is laid on one side of the cylinder, and the latter is made to revolve, the whole series will be brought successively in contact with the cylinder, each one lying temporarily on the flat upper side. Every card is pierced with holes varying in number and position, according to the pattern of the lace to be produced, but never more in number than the pins or levers above; and these holes are so cut as to coincide exactly with those of the cylinder. The cylinder has an up-and-down motion given to it on the presentation of the face of each fresh card, bringing it in contact with the pins, so that wherever a hole occurs in the card, it permits the pin opposite to it to penetrate into the cylinder; but where a blank occurs, by the card not being perforated opposite to a particular pin, the pin cannot enter the cylinder, but is driven upwards. As the pins or levers act on the bars that move the threads in the machine, when any of the pins are driven upwards, some bars of the thread apparatus are moved laterally; the disposition of the holes in the

cards determining the order and number of shiftings of the threads. The number of cards employed depends on the number of successive movements requisite to form one complete pattern. In a store curtain, ten or twelve thousand cards may be required. The arbitrary selection of bobbin threads is brought about by acting upon the angular or raised parts on the surface of carriages by instruments called, from the duty they perform—pushers, stumps, selectors, &c., and so moving some carriages while others rest; or causing them to remain inactive, while the others are in motion. By these operations, brought about from below or above the combs, the power of the machine to diversify the course of the threads is evidently greatly increased. This kind of selection may be brought about by various mechanical arrangements; often a second Jacquard apparatus from the back of the machine is employed. Notwithstanding the great width of the machine—its complexity and intricacy, as well as the diversity and delicacy of the work to be performed—the construction and adjustment is so solid and exact, as to render the ordinary operation safe. So long as the machinery works steadily and correctly, the workman may be a mere spectator; but he must be a vigilant one. His eye must ever and anon pass from side to side of his machine, noticing the thousands of threads, bobbins, carriages, points, and guides, passing in rapid motion before him. Soft, ill twisted, lumpy cotton yarns spoil his work while they stop his progress. An ill tied knot in winding may cut down threads, which if unseen may lead to damage that may cost the man days, and the employer pounds, to repair. An irregular warp of mingled fine and coarse silk, and which if unevenly reeled is almost certain to be foul also, will sometimes take three months to work off, requiring intense labour and care, instead of running smoothly to a finish in as many weeks. In the case of the silk net generally made, but especially in very light or irregular weights, the eyesight is much and prejudicially affected. In factories of modern construction, warmth, ventilation, and an atmosphere free from dust have been secured. The health of the workpeople employed in machine lace

making is on the whole satisfactory; and if the practice of working by shifts in the night were discontinued, it would be superior to that in most other trades. In the manufacture of plain nets, the employment of the people is regular, except in some occasional times of difficulty, when the trade has accumulated very heavy stocks. Under such circumstances, a general reduction has taken place for a time in the number of hours the machinery has been worked. But latterly the owners of factories cease working or stint the whole or any of their machines without consulting any one. This is entirely the case in the fancy business, and is frequently adopted as to a single machine. The workmen also lose time on a change of pattern; which, in the case of those engaged in the Levers and warp lace branches, frequently causes a lengthened, and to the masters as well as man, an expensive delay.

Amongst the earliest and most ingenious, though not most successful pioneers of this great advance, Mr. Draper was as energetic and sanguine as any. Two patents, having together a most important bearing in this respect on the interests and progress of the manufacture of imitations of real lace on bobbin net machines, were taken out by "Samuel Draper, of Whitemoor, Nottingham," in his own name only, though assisted with capital by Mr. John Hind, in the years 1834, No. 6683, and 1835, No. 6907.

In the first patent he adopted a plan of traversing the bobbin threads every time they were passed through the warp threads, and thus made a handsome linen fabric. In this machine he used extra bars for the selecting of threads, and operated upon them by means of an organ barrel.

Next year he patented the other machine, in which there were two sets of bobbins, arranged one over the other; the upper set being in *single-tier* steeple top carriages, the lower set being in *double-tier*, also steeple top carriages; the bottom set traversed having three comb-bars, the back comb-bars being divided into two bars. He traversed with the bottom set, and at first selected by using an organ barrel: but, it is said, seeing a Jacquard in the Lowther Arcade, London, he adapted it to the lace machine. The bottom tier of carriages were governed by drivers placed between the bolts, which selected any required carriage. By letting these bottom carriages remain stationary, or traversing them every motion, he made net, large open works, or cloth work. Between the two sets of carriages was placed a point bar, riding between the front bolts, having two

lengths of points in front operated upon by the cards of the Jacquard cylinder; when the holes in the latter are not covered by the card, the pins enter and the carriages remain at rest; but when the holes are covered, the carriages are taken backwards, and are either traversed or are passed through the combs. The points enter the back line of threads, and then shog to the front line; when the points are all entered, it then shogs to make the net. It is withdrawn and entered each time the carriages pass, the upper carriages making the net as in the straight bolt and in organ barrel machines.

Many excellent patterns were made on this machine, but it did not work safely, and was very expensive in its construction. Although Mr. Heathcoat made a special visit to inspect it at Whitemoor, and so far took an interest in it as to purchase some right in the patent, and also had Draper at Tiverton for a considerable time, conducting some mechanical improvements there, yet the plan was finally abandoned. The outlay by Mr. Hind was many thousands of pounds. Mr. Heathcoat gained nothing by it.

It has been stated above, that the accidental sight of a Jacquard led to its substitution by Draper for the organ barrel, as the means of selecting threads. Mr. Andrew Wilkie, a table linen manufacturer, came from Dunfermline, in Scotland, and settling in Nottingham, quitted his former business, and entering into that of making bobbin net, became possessed of four or five bobbin net machines. He ultimately co-operated in the experiments of Draper; and conjointly with Hind, it is said, supplied money for taking out the patents. Having been accustomed to the use of the Jacquard in his former manufacture, on the failure of the organ barrel, (he always asserted) it was at *his* suggestion, that a Jacquard apparatus was tried and eventually answered. His son therefore claims this honour on his father's behalf; who (he says) expended £650, a sum which came to him through his wife, and the whole of his machinery. Wilkie died soon after in humble circumstances.

Draper's second patent was for the application of perforated substances to lace machinery. In taking out this patent, he said "he had in view the government or control of the individual threads across the machine, and this also on each of the several principles of the bobbin net machine." The plans for this purpose he

laid before Mr. Carpmael. The working out the patent on each of the classes of the machines would have been so expensive, and the time so long to have put them on, that it was considered one would be enough to secure to the patentee the exclusive use of the principle for the whole. Draper, having to consult the views and arrangements of others, was delayed and thwarted in getting the machinery to work, by circumstances beyond his own control. The plans became known. It was nevertheless understood that tribute was to be paid him by those who used machinery constructed on the principle of his patent. He did not deny the merit (if the idea were not surreptitiously derived from his own) of Mr. Deverill's mode of application to and control of the guide bars; or of any other that had been devised having that effect, by the operation of the Jacquard apparatus. He claimed the merit of shewing, that the application of Jacquard pierced cards, or of the use of nogs or raised points or surfaces acting on bars, was practicable.

The first scarf made by Draper on the Jacquarded bobbin net machine, is in the collection at South Kensington museum. The fellow to it, in the state it came from the machine, was retained by himself.

Draper took out a patent in 1837, No. 7491, for using the Jacquard cards on warp machinery—

Including the plan of using a double number of threads, either for the purpose of increasing the firmness of the tissue produced by carrying the threads over the adjoining needles, and then returning them to the original needles—one of the two threads being carried at the same moment to the right hand, the other to the left—thus making a crossing and then back again. No traverse was obtained by this method, beyond carrying threads five needles to produce open work. It was the first step, however, towards obtaining one. Champollier worked this plan in France, but without success. In 1840 Draper patented, No. 8635, a further modification of his Jacquard application.

This great problem of how most simply, easily, inexpensively, and perfectly, an entire control might be obtained over every thread at work in a machine—so as that without going backwards (which it is evident those threads which are mechanically operated upon cannot do) they should be as completely under command as those in the fingers of a pillow workwoman—

was thus grappled with by Draper. He had not solved it when faith and money on the part of others failed him. The expence incurred had been very great, the means had been advanced very liberally; but unhappily for the ingenious constructor, he could not perfect his results in time to prevent their exhaustion. Nevertheless, these elaborate and diversified combinations of machinery—having for their object what, the moment his attempts were seen, appeared to be certain of ultimate accomplishment—were the true germs of that which has since been done by his successors, with great profit to themselves, and to both the bobbin net and warp trades.

It has been the opinion of some, who from their experience in machinery were quite able to form a sound one, that had Draper persevered in using the straight bolt in 1831 (whereon he made lace all pattern with no meshes, traversing every time the carriages passed through the longitudinal threads) he would have produced an article in quality equal to pillow lace. On the straight bolt the carriages will remain at rest while the open work is made. In the circular, which he then adopted, he had to overcome the difficulty of the carriages gravitating to the centre.

In 1838, Draper devised a very curious plan, a description of which has been reserved for this place, as it contained a method of producing an imitation of real Alençon blonde laces, partly by machinery and partly by hand:—

> A silk net wholly untraversed was made on a Levers' frame, from which net the warp threads could be drawn out at pleasure. On another Levers' machine was made a solid web of quillings, about ten holes wide. A warp and extra beam was used for draw threads. The carriages were divided, and while in front and back catch bar, a warp thread was shot in the full breadth, thus making a solid fabric. These two fabrics were used thus: The linen tissue was inserted on the lace, and was drawn by the needle in any required form, as it was capable of being lessened in width by drawing the warp threads together. The net threads were then extracted, and the cloth work shewed as if woven in, giving the appearance of the Normandy blonde cushion lace.

But the needle-work made the cost higher than the real article. After three years expence upon it,

Mr. Hind, Draper's partner in these experiments, declined to make further outlay, and it was given up.

The last modification made by Draper may be described as one by which warp threads were passed through beads holding them in a row of points; the card being raised lifted the beads on which the warp threads fell into another set of points, which were moved by an eccentric wheel, different from that operating on the main guide bar points.

This ingenious mechanician was living at Nottingham in 1856, we regret to say in deep poverty.

Six years after Draper's second patent, *i.e.* in 1841, Hooton Deverill took out a patent, No. 8955, which was alleged to be the first really successful application of the Jacquard apparatus to bars from the end of the bobbin net machine. This raised at once, and in a serious form threatening much litigation, the question of what in this respect were the rights acquired under Draper's patent just described. The staple trades, to the history of which these pages are devoted, have been the arena of more patents and discussions consequent upon them, than perhaps any other in the whole range of British manufactures. The one now before the reader is, even amongst them, remarkable for the points raised, diverse opinions given upon them, and the results ultimately arrived at. Some further details may therefore throw light on the operation of patents generally, when added to the other facts spread over these accounts of mechanical inventions. These will be best given by citing the questions put and the answers to them by Mr. Carpmael in November, 1841, and by Mr. Newton in June, 1842. To avoid tedious repetitions, it must be understood, that where not otherwise stated, the reference is always to bobbin net machinery. To Mr. Carpmael—

"*Question.* *A* and *B* have invented a mode of working *guide bars* by Jacquard cards. Is it new to work these guide bars by Jacquard cards; and if new, can the patentees claim generally to work guide bars and by Jacquard cards, or must they confine their claim to the mode they have invented?

"*Answer.* I have read specification of Draper's patent, 1835; of Crofts, 1836; White's, 1837; Crofts, March, 1840; Draper, 1840; and of Crofts, November, 1840, which I think are the only patents in which it is proposed to employ Jacquard cards in working bobbin net machinery; and am of opinion that if *A* and *B* are the first to invent means of applying Jacquard cards to working these guide

bars, they may safely claim the application of Jacquard cards to work these guide bars, and not confine themselves to the exact details by which that application is made. This mode of claiming invention was fully supported in Winter *v.* Wells; Morgan *v.* Seaward; Elliott *v.* Ashton, and in some other cases. On the other hand, if *A* and *B* have been anticipated by others in using Jacquard cards to work these guide bars, then they must only claim the peculiar mode by which they have applied them; and it appears to me, that *A* and *B* will be obliged to confine their claim of invention to their novel mode of application, and must not claim the application, generally, of Jacquard cards to work these guide bars. For in the specification of Crofts, 1840, there is fully described the application of Jacquard cards to work these guide bars.

"*Question.* There having before been several patents which relate to the use of Jacquard cards regulating the working of the *threads* in twist lace machinery, would guide bars worked by Jacquard cards be an infringement of any of those patents? if so, which of them? In what position do these various patents legally stand in relation to each other? *A* and *B*, wishing fully to understand their own position in respect to others, and the position of the trade in respect of their patent; and, generally, in the use of Jacquard machinery in combination with that of twist lace.

"*Answer.* Draper, in specification of patent, 1835, claims to be the first to combine the properties of the Jacquard loom with twist lace machinery, and describes a mode by which it is carried into effect, such mode being so arranged as to act on the bobbin threads. But the patentee states he does not confine himself thereto; as any or every of the threads may be governed by Jacquard cards. And he concludes his specification by claiming the *combining* Jacquard machinery with twist lace machinery, thereby producing a compound machine having the capacity or combined character of the two machines. Under this specification, I can have no doubt that the using of Jacquard cards and machinery to work the guide bars of twist lace machines, would be an infringement of Draper's patent. And this opinion is based on cases already cited, besides Fisher *v.* Dewick, and Russell *v.* Cowley, (in the last case the defendants were working according to a patent obtained by them) and many others; particularly the first lace case ever tried, Bovill *v.* Moore, wherein it was held that traverse warp bobbin net machines were an infringement of Heathcoat's patent; and in fact, till Heathcoat's patent expired, every twist lace machine, if used without license, would have been held an infringement of that patent. The court considered that Heathcoat, having been the first who caused one system of threads to traverse and twist round another system of threads by machinery producing bobbin net, his patent was not to be judged of by the details by which that end was accomplished. At the same time, the traverse warp patent would have been good in law, had the patentee confined his claim of invention to traversing warp, thereby obtaining breadths of lace and other results, which were then very valuable. But the patentee could not have used the traverse warp machinery, without license from Heathcoat so long as his patent was unexpired.

"I am also of opinion that Crofts' mode, described in patent of 1836, of selecting bobbin threads by Jacquard cards and machinery,

if used without license would be an infringement of Draper's patent. Also White's mode, patented 1837, of working warp threads by separate intercepting instruments; worked by Jacquard cards and machinery. Also Crofts' mode of governing working threads, patented September, 1840, would each be infringements of Draper's patent. Also, that if Draper's mode, described in patent of 1840, of working warp threads by Jacquard card machinery be practised by any other person without a license, it would be an infringement. Also, that if the mode of using Jacquard cards to work warp threads described in Crofts' patent, November, 1840, be put to work without license under Draper's patent of 1835, that patent would be infringed.

"I give no opinion of the position of *A* and *B's* patent in respect of this patent without knowing the particulars of *A* and *B's* invention. In conclusion, I am of opinion that as Crofts, White, and *A* and *B* have obtained patents for peculiar modes of applying Jacquard machinery, and cards to the working threads of twist lace machinery, Draper could not use without license under their patents, their respective *modes* for the application of Jacquard cards and machinery.

"W. CARPMAEL, Lincoln's Inn, 1841."

The following opinion on the validity of the patent granted to Draper in 1835, was given by Mr. Newton, 1842:—

"In the specification of Draper's patent, in 1835, for 'improvements in producing plain or ornamental weavings,' the patentee describes a mode of adapting a Jacquard to work certain Levers' drivers for selecting certain of the bobbin carriages applicable for producing patterns in lace; and he states at the end of this specification that he claims 'combining the properties of Jacquard looms with bobbin net machinery, whereby the cards or other perforated substances are caused to select any and every of the threads of the latter machinery, and cause some to be laid or woven into plain or ornamental weavings; and whereby a machine so constructed will partake of the capabilities of both these descriptions of machinery, and enable the workmen to produce a greater variety of weavings, plain or ornamental, than can be produced from either uncombined.' There seem to be several important legal objections to the validity of this patent, taking its title and specification together. But without entering into these, the main feature of enquiry is: Can the patentee maintain the exclusive use of the properties of the Jacquard applied to lace machinery, however modified, supposing all other parts of the patents sound? My opinion is that he *cannot;* and that, for the following reasons: 1st. The properties of the Jacquard are in the *Dawson's wheels,* long known and applied to lace machinery. Also in the *chime barrel,* the adaptation of which, to a lace machine, is the subject of his previous patent of 1834. 2nd. Plain and ornamental weavings have been produced before by various kinds of mechanism in lace machinery, and in ordinary weaving looms by the Jacquard. Therefore the novelty or improvement, if any, must be in the means of applying that old contrivance, the Jacquard, to a lace machine. For even supposing the product or quality of work produced 'plain or ornamental weavings' to be new, which is not the fact; still the

invention is not the 'weavings,' but the means of producing them. This must involve the '*modus operandi*' by which such production is obtained, not the thing produced. This is certainly by combining the properties of Jacquard looms with bobbin net machinery, whereby 'certain improvements are produced, and certain results take place.' But how is this to be done? Does the simple direction, that the properties of two old things are to be combined, give to the uninitiated sufficient information to enable him to effect the production sought? Certainly not. Therefore the patentee has very properly shewn the construction of apparatus whereby the object may be effected; and this apparatus I take to be the matter of invention, for which alone the patent could be granted. The claim of combining the properties of Jacquard looms with bobbin net machinery is absurd, without a specific means of enabling the combination to work so as to produce the fabric required. The patentee has set out one mode, and that is, his invention; all other modes of making the combination available, must be the subjects of distinct inventions; for any other mechanical contrivance is not obvious from the specification. The patentee not having pointed out any leading feature, or general mechanical agent, whereby the Jacquard can be adapted to the various constructions of lace making machines. If it could be shewn that the essential matter of Draper's invention are the levers *B*, acting upon certain of the bobbin carriages with their projecting arms *A*, operated upon by the Jacquard (which, I think, cannot be made to appear from the words of the patentee's claim); then it would follow, according to my views of the patent laws, and the practice of the courts, that all other modes, forms, and combinations of mechanism for connecting the principles of a Jacquard with a bobbin net lace machine, are open to the inventive world to modify and adapt as they please.

"Draper has a subsequent patent 'for certain improvements for producing ornamental lace or weavings,' November, 1837, which is the adaptation of the Jacquard to warp machinery, and much in the same way as before adapted to bobbin net machinery; and I think his general claim in this case may be answered by the same argument as before.

"If it were necessary to say more on the main point above considered, I would cite the opinions of several judges on this question: 'If a specification be such, that men of common understanding can comprehend it to make the thing by it, it is sufficient; but it must be such that they may be able to make the thing by the specification, and not by any new inventions or additions of their own.' 'A specification is insufficient if a man of ingenuity be required to supply its defects. If sensible men who know something of the business and mechanics in general cannot by the specification make the thing invented, it is not so described as to support the patent.' Query. Does the statement made in Draper's specification shew the mode or furnish the means of adapting the Jacquard properties to a Levers, a pusher, or any other differently constructed bobbon net machine? I think not. It only shews a mode of holding back and locking certain of the bobbins in a Morley's rotary. It does not appear to contemplate any movements of the bars as in Deverill's or Boot and King's. I will again quote one of the Judges: 'Articles of specification which denote intention only, and do not state the thing to

which it is to be applied, will not entitle a patentee to maintain an action for a breach of those articles; for he cannot anticipate the protection before he is entitled to it by practical accomplishment.'

"In conclusion I would add, that I think Draper must have felt this was the proper interpretation of the law as to inventions. For in September, 1840, he obtained another patent for 'improvements in the manufacture of ornamental twist lace and looped fabrics' by the adaptation of the Jacquard to work warp threads in a particular way; although in his patent of 1837 he has the wholesale claim of 'the application of the system of selection by Jacquard cards to warp machinery or warp lace machinery for the purpose of governing and controlling the order in which threads are lapped on needles or worked in looped lace or looped woven fabrics.'

"(*Signed*) W. NEWTON."

It is probable that these widely differing opinions were given in answer to questions arising from the very important modifications of Hooton Deverill, when they were transferred to Messrs. Biddle and Birkin. In the face of the diversity and doubt thus opened up, these gentlemen practically and with praiseworthy public spirit, relinquished their patent rights, and by emancipating the trade, conferred the greatest benefit upon it at a period of unequalled depression in the plain branch, and when its freedom of action in the fancy department was most ardently desired.

Mr. Richard Birkin was born at Belper in 1805. He was the son of poor parents. His father was a calico weaver, and his first ideas of mechanism and labour were connected with the shuttle and loom. He had but a limited opportunity of gaining knowledge at school, having been employed early in life in Messrs. Strutt's mill, where he laboured until he was seventeen years of age. During these years, his evenings were spent at home in reading, drawing, or contriving objects of utility, which were sources of improvement and pleasure to himself, and not unfrequently of profit to his family. In 1822, he removed to New Basford, a suburban village to Nottingham, then containing thirty houses or so. A relative named Blatherwick, hitherto a framesmith at Nottingham, was just entering into the manufacture of lace in this village, and under his instructions, R. Birkin learned to work one class of bobbin net machines; losing no time and endeavouring to become practically master of the several other kinds

PLATE XVI

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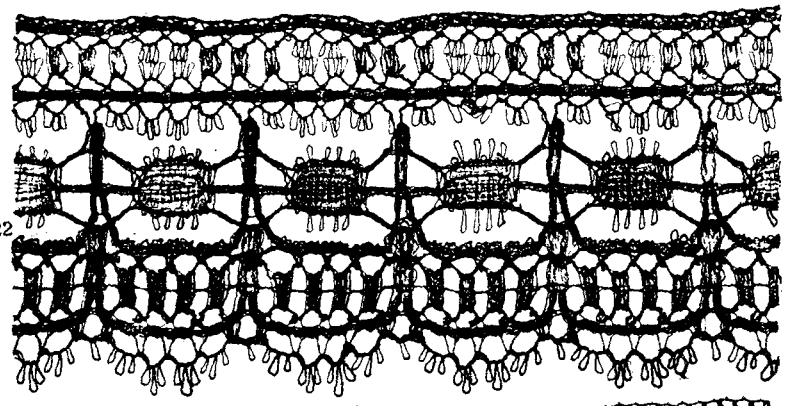

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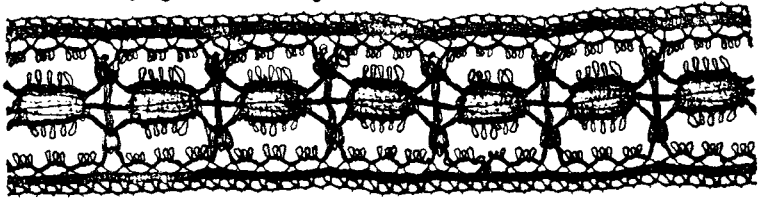

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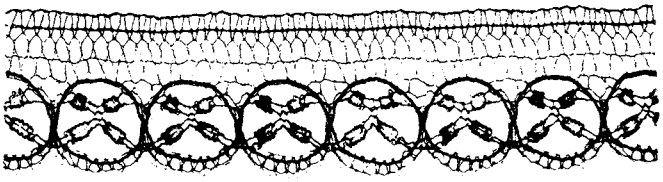

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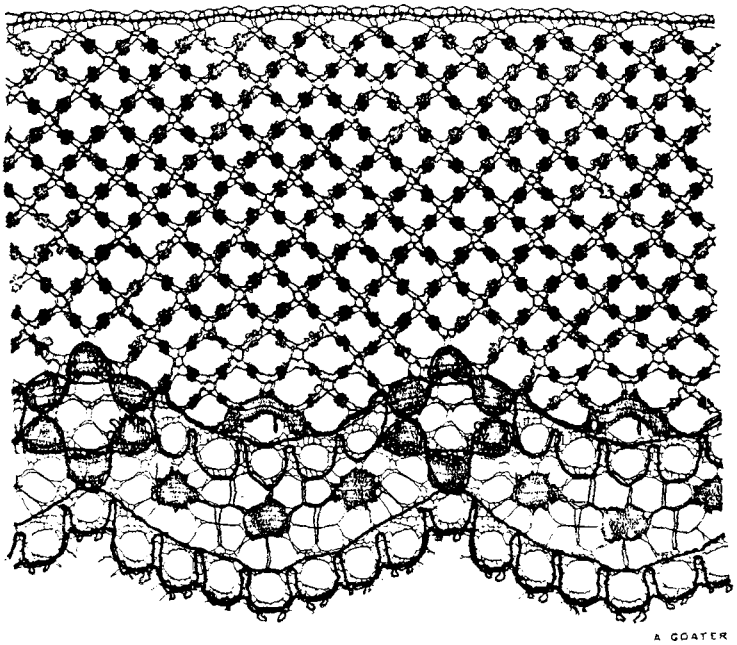

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of construction. These machines were all of them originally very costly, complicated, slow, and difficult to work, as has been already seen. Yet they were each realizing £20 to £30 weekly to not a few of the owners, and wages of from £5 to £10 a week to diligent and clever workmen. Birkin husbanded both time and money; seizing the opportunity afforded by this epoch of frenzied excitement, when the wondrous rush of capital flowed into the trade, he took it at the flood; and the tide, dexterously managed, led him on very rapidly to fortune. During the next few years, his aid and advice on mechanical matters were sought by most of the machine owners in that neighbourhood. In 1826, his employer Mr. Biddle offered him an advantageous partnership. It was accepted, and the connexion continued twenty-one years. At the end of that time his partner retired with an ample fortune, leaving Mr. Birkin the buildings and machinery necessary to the carrying on of the now large concern. By this time New Basford had become a town of 3000 inhabitants or more. It was a new place, a new people, and with a new occupation. In it were now many persons who had risen from humble occupations to be wealthy employers; and some even corporators and magistrates. The principal of these, Mr. Birkin, has shewn no ordinary skill, shrewdness, and intelligence, combined with great perseverance and energy, in the pursuit of the manufacturing and commercial success with which his efforts have been crowned. Having always been distinguished for his good taste and sound judgment in qualities and designs of lace goods, he was appointed juror on behalf of Nottingham for those articles in the International Exhibitions of 1851 and 1862. His comprehensive reports on those occasions will be made use of in our subsequent pages. He has left private business in the hands of one of his sons, and for some years devoted himself with much assiduity to municipal and magisterial duties, those of chief magistrate especially, to which has been recently added, that of a seat at the board of the Midland Railway directory.

Amongst those who have been engaged with the