THE

THEORY AND PRACTICE

OF

THE ART OF WEAVING,

BY HAND AND POWER,

WITH

CALCULATIONS AND TABLES,

FOR THE USE OF THOSE CONNECTED WITH THE TRADE.

BY

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ILLUSTRATED WITH DRAWINGS AND DIAGRAMS.

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PREFACE.

To acquire a competent knowledge of any Art, it must be learned either by reading, verbal teaching, observation and reflection, or actual practice; and as it is of the utmost importance to the apprentice in any branch of business to be told the theory of it, and shown how to use the tools connected with that particular branch, it must be of use to the apprentice or young beginner in the Weaving Trade also. Believing this, I have written this volume on the theory and practice of Weaving, and have through its pages given instructions how any one with ordinary capacity and perseverance may learn the theory of the Art. The Writer, when a beginner in the trade, had often felt the want of such a book, and considering that others would be similarly situated, was induced to undertake to write this work; for at the time he began his apprenticeship in the Power-Loom Trade, it was more the rule to keep the apprentice in ignorance, than teach him the theory of the Art; however, that narrow-minded selfishness is, happily, now the exception. This volume is written more especially for Power-Loom Weaving, but it may prove of equal use to the Hand-Loom manufacturer, as the principles in both are the same.

PREFACE TO SECOND EDITION.

In preparing for the Second Edition of the "Art of Weaving," we have spared no time in making it complete, and have added a Chapter on the Weaving of Woollen Goods, as this department of Weaving is now a very important branch of our trade, and one that is now being done to a large extent in the Power-Loom. We have also given all the improvements, but not all the alterations (for a number of them are no improvements), that have been made in machinery connected with Weaving.

PREFACE TO THIRD EDITION.

In preparing this Edition, the Author has not omitted improvements that have been introduced into the trade, since the last Edition was issued. The Contents show that the volume is still designed to be of practical use to readers. We have treated upon every thing about Weaving, and Power-Loom Factories.

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INTRODUCTORY REMARKS

ON

The Art of Weaving.

To discover the origin of Weaving would be rather a difficult task, and one that does not form part of our plan in this work; our purpose being more to show its present state, and give a description of the latest improvements that have been made in the power-loom, than to go into a long history of its origin, although we believe that it would be both interesting and amusing if such a history had been kept, there being scarcely anything of more importance to the human family than the records of the arts of the preceding generations. However, we will give some of the remarks that can be found. But before doing so, we will give some statements about the origin of the power-loom.

About the year 1809, in a factory at Pollokshaws (a place about three miles from Glasgow), a considerable number of the original power-looms were started, and were still working in their primitive state in the year 1818, and for many years afterwards, without any alteration having been made upon them worth mentioning. But power-looms were working in another place before they were put up at Pollokshaws, which will be seen from the following remarks:—

Mr Bullough, one of the inventors of the motion for stoping the loom when the weft fails (that is the motion with the fork, now almost universal, the other plans being now superseded), was in Glasgow in the year 1845, and called upon me, when I was manager in Gilmour and Kerr's, about some business in connection with his patents. He had brought with him from England an old man who had been long acquainted with power-looms, and as some of us in the trade felt interested in the old man, we resolved to give him some entertainment, such as a supper, which was done, along with a purse of sovereigns. The following is a copy of the circular we sent through the trade at the time:—

"*To the Power-Loom Masters, Managers, Tenters, and Dressers of Glasgow:*

"GENTLEMEN,

"Perhaps it may not be generally known to you, that Andrew Kinloch, the first power-loom weaver in the world, is at present on a visit to Glasgow, after a residence of forty-five years in England, to see two of his first apprentices in the power-loom trade, viz., Mr. Barclay, of James Finlay & Co.'s

Catrine Works, and Mr. Walter M'Hutchison, manager of Wellington Factory. Andrew is now 85 years of age, having been born in Port-Glasgow in the year 1760. After leaving his native town, he, in 1793, with the assistance of an operative joiner and clockmaker, in Gallowgate Street, of our ain guid town, set up the first power-loom, with which—the propelling power being his own hand—he managed, after an outlay of one hundred guineas, to produce about 90 yards of cloth. This sum, we may explain, was jointly subscribed for the experiment by four members of the Glasgow Chamber of Commerce. Shortly afterwards, Andrew got the loom conveyed to Milton Printfield, at Dumbuck, where 40 looms on the same principle were erected under his special direction. These machines, with the exception of a few slight improvements, remain as they were, and at the present day may be seen working at Pollokshaws and Paisley. Andrew's further history it will be unnecessary for us to relate; suffice it, that he left for England in the year 1800, and was employed in setting up similar looms in different towns in Lancashire. The first looms set up by him in England were at Staleybridge, near Manchester. Fifteen of these in a short time were removed from that place to West Houghton, where they remained till the year 1812, when the hand-loom weavers of the neighbourhood, jealous of their interests being affected by the new invention, attacked the factory and burned it to the ground, along with 170 looms and the other materials on the premises. Andrew, in detailing this circumstance, adds, that he believes the weavers would have burned himself had they got a hold of him. He has made other escapes besides this, having frequently been in danger of his life in different parts of England and Scotland. In this respect he may, therefore, to a certain extent, be esteemed a sufferer for the establishment of our trade—a trade which, at the present time, embraces the staple manufacture of our country, and from whence has been derived the princely fortunes of our richest merchants.

"Andrew, considering his years, is in the best of health; but, like most other men who have introduced improvements for the benefit of mankind, he is by no means wealthy. He is contented and happy, however, and quaintly remarks, that perhaps if he had had £1000 a year to live upon, he would not have lived so long. Be this as it may, Andrew, in our opinion—for his many good qualities as an ingenious mechanic, as the first power-loom weaver in the world, and on account of his age and moral worth—is deserving of a token of respect from the masters, managers, tenters, and dressers of Glasgow; and, we, the undersigned, having taken the matter into consideration at a meeting held for the purpose, consider it our duty not to allow the opportunity to pass without appealing to you as to the propriety of evidencing our regard for the power-loom veteran, by entertaining him to a public supper, and, if possible, presenting him with a substantial mark of our esteem.—We are, gentlemen, your most obedient servants, John M'Bride, manager of Nursery Mill, Chairman; David Brown, manager of Cogan's Mill; Daniel M'Nab, manager of Hill Street Factory; John Watson, manager of Kerr & Gilmour's Factory; William Sim, manager of Smith's Factory, St. Rollox; James Gibson, manager of Kelvinhaugh; Walter M'Hutchison, Wellington Factory; John Black, tenter, Clyde Bank; James Livingston, tenter, Smith's Work, Townhead; John Foulds, tenter, Cook Street Factory; Robert Whitson, tenter, Corbett & Alexander's Factory; William Muir, tenter, Nursery Mill; John Rae, dresser, Smith's Work, St. Rollox; Hugh Kirkland, dresser, Cogan's Factory, Graham Square; James Brown, dresser, Burnbank Factory; James Aitken, manager, Cook Street Factory, treasurer; Thos. Richmond, 12 Stirling Square, secretary.

"P.S.—As it is intended that the supper will be held on Wednesday, the 29th current, it is requested that persons having charge of subscription sheets will hand in the same on Saturday, the 25th current, from 6 to 9 evening, at Stenhouse's Tavern, 8 Charlotte Street, so that the committee may make the necessary arrangements.

"GLASGOW, 20th October, 1845."

I have given the foregoing circular, because it contains nearly all I know, that can be depended upon, about the first power-looms.

It will be seen that the art of weaving is very ancient from the following passages taken from the sacred volume: Exodus xxxv. 25, "And all the women that were wise-hearted did spin with their hands, and brought that which they did spin, both of blue, and of purple, and of scarlet, and of fine linen." 35, "Them hath he filled with wisdom of heart, to work all manner of work, of the engraver, and of the cunning workman, and of the embroiderer, in blue, and in purple, in scarlet, and in fine linen, and of the weaver, even of them that do any work, and of those that devise cunning work." 1 Chronicles xi. 23, "And he slew an Egyptian, a man of great stature, five cubits high; and in the Egyptian's hand was a spear like a weaver's beam, and he went down to him with a staff, and plucked the spear out of the Egyptian's hand, and slew him with his own spear." Job vii. 6, "My days are swifter than a weaver's shuttle, and are spent without hope." Many more passages from the sacred volume might be taken to show that the ancients were very well up to the art of weaving, although we do not understand the mode they had of doing it. It is evident they were able to make a great many kinds of figured work. It is frequently stated by writers, that weaving is one of the arts which furnishes one of the main distinctions between savage and civilized life. One says—"For, though we find finery and external adornment common to every people, yet comfortable clothing is almost exclusively confined to the inhabitants of those portions of the globe which are far advanced in civilization."

The Hindoos and Egyptians have been acquainted with weaving for thousands of years, and it is well-known, that the fabrics made in India were much valued, and yet they have made little or no improvement in their looms, although it appears that looms were originally invented in the East. One writer says, when speaking of the common forms of the loom, "that, simple as they are, they can yet be favourably contrasted with the rude contrivances still pursued in India, where the wretched weaver performs his labours in the open air, choosing his station under trees whose shade may protect him from the scorching rays of the sun. Here extending the threads which compose the warp of his intended cloth lengthways, between two bamboo rollers, which are fastened to the turf by wooden pins, he digs a hole in the earth large enough to contain his legs when in a sitting posture, then, suspending to a branch of a tree the cords which are intended to cause the reciprocal raising and depressing of the alternate threads of the warp, he fixes underneath and connected with the cords two loops, into which, inserting the great toe of either foot, he is ready to commence his operations. The shuttle with which he causes the cross-threads or woof to interlace the warp is in form like the netting needle, and being somewhat longer than the breadth of the warp, is made to perform the office of a baton, by striking the threads of the woof close up to each other."

With this rude apparatus the patient Hindoo succeeds in weaving fabrics which, for delicacy of texture, cannot be surpassed, and can scarcely be rivalled by the European weaver, even when his labours are aided by the most elaborate machinery. But it is only in climates where the absolute natural wants of men are few, and under systems of government, where the oppressions of the dominant caste deprive the unhappy bulk of the people of all means for obtaining more than suffices for the barest supply of those wants, that such labour can be performed.

There is no very reliable authority to tell us of the different kinds of implements (mountings) used by the ancients in weaving the different kinds of figured cloth, the only description being that of the Indian loom ; and we shall now proceed to show the progress it has made in our own country.

When weaving was first introduced into Great Britain the exact date is not known, but it appears, from what we can gather from history, that there was a considerable number of weavers in London in the year 1351. Twelve years previous to the above date, in the city of Bristol, which is 118 miles west of London, we find looms started for weaving woollen cloth; very likely these looms were put up by foreigners, as England was frequently invaded previous to this period.

It will be seen from early history, that the inhabitants, who had settled near the sea-coast, possessed some property, and were therefore more easily intimidated than those tribes that were dispersed through the forest. None of them cultivated the ground; they all lived by raising cattle and hunting. Their dress consisted of skins; their habitations were huts made of wicker-work and coarse rushes; their priests, the Druids, together with the sacred women, exercised a kind of authority over them.

We find the following letter, which was written by one of the kings about the year 1030, from which will be seen that many foreigners must have been in England. In it mention is made of rich mantles and garments being given as presents.

Part of this letter is given, not for anything it contains concerning weaving, but to show the strong probability that this country was first indebted to foreigners for this art, as we see from the letter, that the king himself was on friendly terms with them.

"Canute, King of all Denmark, England, and Norway, and part of Sweden, to Egelnoth, the Metropolitan, to Archbishop Alfric, to all the Bishops and Chiefs, and to all the nation of the English, both Nobles and Commoners, greeting: I write to inform you that I have lately been at Rome, to pray for the remission of my sins, and for the safety of my kingdoms, and of the nations that are subject to my sceptre. It is long since I bound myself by vow to make this pilgrimage, but I have been hitherto prevented by affairs of State and other impediments. Now, however, I return humble thanks to the Almighty God, that He has allowed me to visit the tombs of the blessed Apostles, Peter and Paul, and every holy place within and without the city of Rome, and to honour and venerate them in person. And this I have done, because I had learned from my teachers that the Apostle St. Peter received from the Lord the great power of binding and loosing, with the keys of the kingdom of heaven; on this account I thought it highly useful to solicit his patronage with God.

"Be it moreover known to you, that there was at the festival of Easter a great assemblage of noble personages, with the Pope John and the Emperor Conrad, namely, all the chiefs of the nations, from Mount Gargano to the nearest sea, who all received me honourably and made me valuable presents; but particularly the emperor, who gave me many gold and silver vases, with rich mantles and garments. I therefore took the opportunity to treat with the pope, the emperor, and the prince, on the grievances of my people, both English and Danes, that they might enjoy more equal law, and more secure safeguard in their way to Rome, nor be detained at so many barriers, nor harassed both by the Emperor and by King Rodulf, to whom the greater part of the barriers belongs, and it was enacted by all the princes, that my men, whether pilgrims or merchants, should, for the future, go to Rome and return in full security, without detention at the barriers, or the payment of unlawful tolls."

At the time the above letter was written, the inhabitants of Britain who wore woven clothing must have got it from the East, or the Continental nations; but when we pass on to the year 1376, we find woollen cloth made in Ireland, and a company of linen weavers established in London ten years afterwards. North-west from London 262 miles, stands Kendal, a borough town, which has long been celebrated for its woollen manufacture, and mention is made of its coarse cloth as far back as the year 1390, and from the spirit and industry of its inhabitants, they have continued to flourish ever since; they have now mills established for both spinning and weaving. We now pass on to Manchester, the great centre of the cotton manufacture, and we find in the year 1641, the merchants of that place buying linen yarn from the Irish in great quantities, and getting it woven into cloth, and then returning the cloth to Ireland to be sold.

In the year 1685, Louis XIV. revoked an edict which was issued by Henry IV., in the year 1598, the effect of which was that many foreign weavers came to Great Britain at this time, all adding to the industry of the country. Many other incidents might be taken notice of, but we will pass on to the factory period, and we preface our remarks with a quotation from Dr Ure:—

"How different is the spirit of modern philosophy since it was first directed into the path of utility by Galileo, Bacon, Pascal, and Newton. It places its chief delight and honour in investigating the relations of number, figure, and all material substances, in order to apply the resulting discoveries, to assuage the evils and to multiply the enjoyments of social life. In its modern familiarity with the sublimest of speculations, that of the equilibrium and movements of the celestial bodies, mechanical science does not, however, disdain to study the most humble machine of manufacturing industry, and, indeed, may hold many of them up to the admiration of the transcendentalist, as the happiest achievements of the human mind. Should any one ask where, let him enter a cotton factory and look around."

We enter the factory and look around, and we first make inquiries as to age, and obtain answers which satisfy us that the factory system is little more than eighty years old; then we observe the fine arrangement of the different machines connected with power-loom weaving, the mode of working them, the regularity of their management, &c., which things constitute the principal theme of this volume; we allow the mind to contemplate the great number of different tradesmen that are required, and the amount of labour that is spent before these machines can be made. It gives a kind of pleasure in making a contrast between our loom of the present day and that of the Hindoos, which has been explained. Before one of these factories, with a thousand looms, can be put into operation, it will have given employment to more than one thousand individuals for more than six months, at the rate of three shillings per day for each individual. The parties who receive this employment are coal, iron, lead, and copper miners; labourers, brickmakers, bricklayers, plasterers, slaters, sawyers, joiners, glaziers, glassmakers, nailers, millwrights, engineers, boilermakers, machine-makers, gasfitters, tinsmiths, and a whole host of others; indeed, it would be difficult to mention any kind of employment that does not get part of the money put out on the erection of a factory.

Before the power-loom was brought into operation, the weaving power of this country was a mere drop in the bucket compared to what it is at the present day; indeed, it is within the last forty years that power-loom weaving has been brought to that extent that it could be called a trade, and now it is one of the most important in the kingdom. What has brought the power-loom trade to its present extent, must be attributed to a number of circumstances; for the power-loom would have been of little use, had not the invention of the spinning jenny taken place, which was about 85 years ago; and neither the spinning nor the weaving machinery would have arrived at their present magnitude, had not the steam-engine been brought to their aid; while many other improvements in the other arts have contributed to advance the power-loom trade. It may also be stated, that had it not been for the industry of the people, and the security that capital has in this country, the power-loom trade could never have arrived at its present greatness. For unless capital is protected in such a manner that there is a fair chance of it being made profitable, by it being invested in business, it will not be employed where the chance does not exist; and the work-people should consider this subject more than they have done in many cases, before they make a turn out, leaving the whole machinery standing idle; for what is the interest of the employer, is also the interest of the employed. We have felt a degree of diffidence in making this statement, knowing well the opinion that once existed among some workmen; but when a good feeling exists between the employer and his workers, both parties are benefited by it. The reason is obvious without explanation.

The weaving of cotton goods being the most extensive in this country, a very good idea may be formed of the progress of the power-loom from the quantity of cotton consumed at different periods.

The time was when there was only a few bags of cotton consumed in Great Britain, but we will not go further back than the year 1822. The quantities will be given in bales, considering each bale to average 440 lbs., which is about the average weight at the present time, although the average weight was little more than the half of this in the year 1822; however, this is taken into consideration in our calculations; and it appears that in 1822, the number of bales (at an average of 440 lbs.) were 330,564. The next year we take is 1825, and the increase over 1822 is 48,256 bales, which gives for that year 378,820 bales. The year 1826 was a very bad year for the cotton workers, as a great many of them were out of employment, and consequently for that year the consumption is considerably less than the four years previous; but in 1827 trade revives, and the consumption increases. As prices may have had something to do with the increase we will give the extreme prices for the years 1825, 1826, and 1827, of the three principal kinds of cotton, namely:—Surat, Uplands, and New Orleans, which are as follows:—

Price of Surat	Cotton for 1825,	......	$5\frac{1}{4}$d.	to 16d.	per lb.
— Uplands	— —	......	6d.	— $19\frac{1}{2}$d.	—
— New Orleans	— —	......	8d.	— 22d.	—
— Surat	— for 1826,	......	$4\frac{1}{2}$d.	— 7d.	—
— Uplands	— —	......	$5\frac{1}{4}$d.	— $8\frac{3}{4}$d.	—
— New Orleans	— —	......	$5\frac{1}{4}$d.	— $11\frac{1}{2}$d.	—
— Surat	— for 1827,	......	$3\frac{7}{8}$d.	— $6\frac{1}{2}$d.	—
— Uplands	— —	......	$4\frac{7}{8}$d.	— $7\frac{3}{4}$d.	—
— New Orleans	— —	......	$5\frac{1}{2}$d.	— $9\frac{1}{2}$d.	—

It will be observed that the prices for 1825 are high and very irregular, and that in 1826 and 1827 the prices are lower and more regular. The increase of consumption in 1827 over 1825 is 80,652 bales, the whole number of bales consumed being 459,472 bales. In 1829 the consumption is 508,040 bales, and the prices are as follows:

Price of Surat	Cotton in 1829,	....	$2\frac{7}{8}$d.	to $5\frac{1}{2}$d.	per lb.
— Uplands	— —	....	$4\frac{5}{8}$d.	— 7d.	—
— New Orleans	— —	....	$4\frac{3}{4}$d.	— 9d.	—

We now pass on to 1832, and find the consumption to be 629,928 bales, which is nearly double the quantity that was required for the year 1822. The year 1833, the quantity consumed is rather less; but it comes up again in 1834. The following are the lowest prices for 1822 and 1832:—

Lowest Price of	Surat Cotton	in 1822,	....	5½d.	per lb.
— —	Uplands	— —	....	5¾d.	—
— —	New Orleans	—	....	6d.	—
— —	Surat	— in 1832,	....	3½d.	—
— —	Uplands	— —	....	5d.	—
— —	New Orleans	—	....	5½d.	—

The price of cotton is higher in the year 1835, yet the consumption is greater than any year previous, it being 715,520 bales. The following are the extreme prices for the year 1835 :—

Price of	Surat Cotton, for 1835,	......	6d.	to	9d. per lb.
—	Uplands — —	......	6⅞d.	—	13¼d. —
—	New Orleans — —	......	6¾d.	—	14½d. —

About this period many thought that cotton goods were being produced in too great quantities, and that ere long there must be a reaction; but instead of this, their production is still more and more. About ten years after this period we find the consumption of cotton, instead of 715,520 bales, to be about 1,664,000 bales per annum, showing the consumption to be more than double what it was in 1835, and it still goes on increasing, for we find at the present time, 1872, the consumption to be about 2,596,000 bales, about eight times more than what it was in 1822.

When the American crop of cotton alone is seen to be upwards of 4,000,000 bales, independent of all the other places that send us cotton, the quantity used in Great Britain at first sight does not seem very large, until we calculate the quantity of cloth the

2,596,000 bales of cotton will make, then it appears very different.

Suppose the yarn spun to average No. 40's, and the cloth to average 10^{00}, with 10 shots 36 inches wide, and allowing 20 per cent. for waste on the cotton, and 4 per cent. on the yarn, the cloth woven from the 2,596,000 bales of cotton would be 8,122,595,554 yards, or about 270 yards of cotton cloth per annum for each individual in Great Britain and Ireland, or about 10 yards for each person in the world. Although this quantity of yarn is spun in Great Britain, it is not to be understood that it is all made into cloth by the looms in this country, for rather more than one-sixth part of it is exported. But to counterbalance this exportation of cotton yarns, there are thousands of looms, both hand and power, that are employed weaving linen, woollen, silk, and jute yarns.

How long the weaving trade in this country will continue increasing as it has done, is a question no one can answer, as it is liable to be affected by so many unforeseen circumstances, that it is almost impossible to predict, with anything like certainty, what may be the condition of it a few years hence; but supposing there are no national struggles or commotions, and still heavier taxation, things which cannot be foreseen nor calculated upon, we do not think that there is anything in our condition, or in that of any of the manufacturing countries of the world, that should lead us to anticipate a reaction in the weaving trade for a long time. The natural capabilities possessed by this country for carrying on the business (all things considered) are decidedly superior to those of any other people. And the superiority to which we have already arrived is perhaps the greatest advantage in our favour, and so long as this superiority can be kept up to that degree as will enable this country to make goods cheaper than any other, the probability is, that in other ten years after this the consumption of cotton will be at least 800,000 bales more per annum than what it is at present, which will then make the consumption to be about 3,500,000 bales. However, we will state what has been written by another bearing on this subject.

At the time when our consumption of cotton was about 600,000 bales, the following remarks regarding the cotton trade were made by Dr. Ure. At this time there was a duty on cotton of 5-16ths of a penny per lb. We state this, so as the remarks will be better understood.

"The superior skill and dexterity of British operatives have been assumed as constituting one of our chief advantages. Their experience must no doubt be more extended, in proportion as the range and variety of British fabrics are greater than those of any other country; but in such goods as the foreigners carry into neutral markets, the superiority of the

British operatives is a point by no means decided. Manufacturers of the United States, and of some parts of the Continent, claim for those employed by them at least an equality within the sphere of their own productions, and to which their competition with the fabrics of Great Britain is necessarily limited. The late remarkable ingenuity of the American artisans, in their mechanical improvements, gives no countenance to the notion of their inferiority.

"The impolicy of the import tax on cotton wool is so glaring as hardly to require illustration. A tax on the raw materials of such manufactures as are principally consumed within the United Kingdom, would be comparatively harmless; but since two-thirds at least of British cotton goods are exported, a tax upon their raw material operates as a bounty upon the cotton manufactures of other nations. Where duties have been imposed on importation, as in the case of sugars, wines, spirits, &c., a corresponding drawback on their exportation has been always allowed; yet cotton, as if undeserving of fiscal justice, has been, ever since the year 1798, persecuted with a series of imposts, in twelve successive rates, all tending to turn the balance in favour of our foreign rivals in that trade. No government, except our own, possessing any pretensions to the title of enlightened, lays a tax upon the import of cotton wool, which is not countervailed by an equivalent drawback on exportation.

The peculiar pressure of the competition in America is upon those coarse yarns and heavy cloths, for the production of which it possesses the advantages of an indigenous raw material, unencumbered with taxation, and procured at the minimum cost of carriage. The spinning also of the Continent of Europe has been hitherto directed principally to the coarse numbers of yarns, which are worked up into heavy fabrics, and with the effect of depriving this country of almost all European customers whom she not long ago supplied.

"The very existence of this country depends on retaining an ascendancy in the cotton manufacture, as the principal means of enabling her to sustain the enormous burden of taxation accumulated by the war-funding system. Were Great Britain as free from taxes as the States of America or the Continent of Europe, she might surrender to them a share of her cotton trade without suffering any national misfortune; but she has nothing to spare without involving her people in distress, and her public credit in jeopardy."

Since Dr. Ure wrote the foregoing about British manufactures, many changes have taken place in the cotton trade, and the duty on cotton, and a number of other articles, has been abolished; and the Continental nations have been making strong efforts to compete with Britain in the manufacture of all textile fabrics. Indeed, many of our manufacturers think that we are losing ground for want of a proper system of education being given to our workpeople—more especially a *technical education*—and there is not the least doubt but that we are fast losing our position, for want of that system of training which France, Germany, and other nations have adopted.

There is a desire in all nations to be first in whatever they produce, that they may be able to hold a large share of the trade that is doing in the world. To be able to do so, there are many things which have to be taken into consideration; but the greatest thing of all is the labour of the workmen, for the workmen have it in their power to drive the trade entirely out of the country. And if our work-people were to take the advice of some men, it would not take a very long time to do it; but it is well for themselves, and the nation at large, that they do not. These are subjects which might be greatly enlarged upon, but it is not our intention to enter into them in the present work.

THE

THEORY AND PRACTICE

OF

The Art of Weaving.

CHAPTER I.

GRISTING YARN.

THIS chapter will be found to contain a number of calculations and observations that are necessary for Manufacturers and Managers in the Weaving Trade.

It may be remarked that almost every substance that can be made to answer for warp or weft is now woven for some purpose or other; and as cotton yarn is the most common material now used in this country, we will begin with it; and we may mention that the same principle that applies to the calculating of cotton yarns applies to all the others (that is a given number of yards of yarn in a given quantity of cloth), and how to find that we give the following remarks:—

To find the grist or fineness of yarn, it was necessary to have some rule or standard to go by; and for cotton yarn it has been adopted in Great Britain and other countries where it is bought and sold, to have 15,120 yards in the spyndle, the yard being 36 inches; and cotton spinners in this country all keep to the same measurement for the size of the reel, which is 54 inches in circumference, and eighty turns of the reel make one skein—this is the first shift made on the reel, and seven of these shifts make a number or hank. It is from the quantity of numbers contained in 1 lb. avoirdupois that the size of the yarn is determined; so that, when the yarn is said to be No. 50's, there are 50 numbers or hanks in 1 lb.; when No. 60's, there are 60 hanks; when 70's, 70 hanks, and so on. For every hank more in the lb., one number finer. The usual way for taking the size or grist of yarn, is to have a small reel for the purpose, and take seven copes, or bobbins, as the case may be, and give the reel eighty turns. This will make one hank at once. There is a wheel attached to the reel, with eighty teeth, to give an alarm when the reel has made eighty turns. When it is desirable to be very particular, eighteen hanks can be reeled, which will make one spyndle, and, for the finer yarns, if it is wished to be more particular still, wind as many hanks as there should be in 1 lb. However, this will be made plainer as we proceed.

The common way yarn is reeled is as follows:—

120 yards	1 skein.		
840 ,,	7 ,,	1 No. or hank.	
15,120 ,,	126 ,,	18 ,,	1 spyndle,

and put up in 10 or 5 lb. bundles to be sold. It will easily be seen then, by counting the No's in the bundle, whether the proper sizes of yarn are given or not, by multiplying the weight of the bundle by its numbers.

For example, a 10 lb. bundle of 36's should have 360 hanks or numbers, because

$$36 \times 10 = 360.$$

A 5 lb. bundle of 60's should have 300 No.'s, as

$$60 \times 5 = 300.$$

Cotton yarn is also sold in large quantities in cope, and on beams, and also in chains. The way to find the size of the yarn in copes, is to take 7 of them, and reel one skein off each, which will make 1 number, and weigh it, either on a quadrant, or small beam and scale for the purpose, and from this the size of the yarn will be found.

YARN ON BEAM.

To find the size of yarn when on beam, take off 80 ends, 54 inches long—this will make 1 skein; but it will be more exact to take 560 ends, 54 inches, and this will make 1 No., then weigh it to find the size; or, to make sure to find the size of the whole yarn that is on the beam, ascertain the weight of all the yarn that is on the beam or beams; and after they are dressed, ascertain the number of yards they have run, then calculate according to the directions given to find the size of yarn in a chain. This is the most correct method, because the yarn at the beginning of a beam may not be the same size throughout the beam or beams, as many of them have upwards of 7000 yards put on them.

YARN IN CHAIN.

To find the size of the yarn in a chain, take the whole chain and weigh it, ascertain the number of ends that are in the chain, also the length of it, and the hanks will be found from the length and number of ends; then divide the hanks by the lbs., and the answer will be the size of the yarn. Suppose a chain is 8 lbs., and has 846 ends, and is 284 yards long: then 846 × 284 is 240,264; divide by 840, and the answer is 286, the numbers in the chain: this divided by 8, the weight of the chain in lbs. is $35\frac{3}{4}$, being the size of the yarn.

EXAMPLE.

```
   846 Ends
   284
  -----
   3384
  6768
 1692
 ------
 240264
```

```
             8
840)240264(286·02
    1680   ------
    ----    35¾
    7226
    6720
    ----
     5064
     5040
     ----
       2400
       1680
       ----
        720
        ---
        840
```

It may be remarked here that the yarn bought in cope, chain, or beam, is in general from 3 to 6 per cent. coarser than the size ordered; this should not be, but still it is the case. Some spinners are more in the habit of spinning coarse than others, but it would be better to keep to the average size, and charge a little more per lb. for the yarn. It is well-known that it is almost impossible to keep the proper size in spinning, as there are so many things to contend with that alter the sizes; but suppose that 60's is the number wanted, it might range from 57's to 63's, and the average would be 60's; and to keep any of the yarn from being too soft spun, a twist pinion for 63's should be put on, for if the twist was for 60's, then the yarn that sized 63's would be too soft. When yarn is bought in bundle, the proper length is given, and no more than the weight in lbs.; this is managed by spinning average No.'s in the following manner:—

Suppose a spinner is selling 40's in bundle (as before observed), the proper length must be in every bundle, as the buyer will not pay for more than 10 lbs., and must have both the weight and the length. When the party who has the charge of the sizes sees only 38's, then he has to get as much spun of No. 42's, and mix the two sizes in equal quantities to make them average 40's. If this was attended to by the spinners, the weavers would have less difficulty in keeping the cloth to the proper weight, and the calculations for it would be more correct.

The same principle of calculations apply to all the other kinds of yarn; as before observed, the main thing to know is, the number of yards contained in a given weight, and how the particular kind of yarn is sized.

LINEN YARN.

This yarn is spun from flax, and should be reeled (according to an Act of Parliament) on a reel 90 inches in circumference, and 120 turns of the reel will make 1 cut, and 48 cuts 1 spyndle. As 90 inches is $2\frac{1}{2}$ yards, multiply the 120 by $2\frac{1}{2}$, and the product by 48, which will give the yards in a spyndle.

EXAMPLE.

$$
\begin{array}{r}
120 \times 2\frac{1}{2} \\
2\frac{1}{2} \\
\hline
240 \\
60 \\
\hline
300 \times 48 \\
48 \\
\hline
2400 \\
1200 \\
\hline
14400
\end{array}
$$

14400 yards in a spyndle.

But the spyndle is divided into other parts besides the above, as will be seen from the following table:—

Cut.	Heer.	Hesp.	Spyndle.	
1	0	0	0	300 yards.
2	1	0	0	600 ,,
24	12	1	0	7200 ,,
48	24	2	1	14400 ,,

	Cut.	Heer.	Hesp.	Spyndle.
or 300 yards,	1	0	0	0
600 "	2	1	0	0
7200 "	24	12	1	0
14400 "	48	24	2	1

The fineness of linen yarn should be found from the number of cuts in the lb. avoirdupois. If there be 25 cuts in 1 lb., that is No. 25's; if 50 cuts, No. 50's, and so on, for every cut more in the lb., one number finer; but the fineness is expressed in different places by different terms; however, it would be better to have one common scale, and the number of cuts in

1 lb. of 16 oz. is considered the best; and it will also be observed that No. 48 linen yarn is equal in weight to No. 18's cotton, because there are 48 cuts of No. 48's in 1 lb. of linen yarn, and 18 hanks in 1 lb. of No. 18's cotton yarn, and 1 spyndle in both: the cotton spyndle has 15,120 yards, and the linen has 14,400, making a difference of 720 yards; but as linen yarn has less elasticity than cotton, 1 spyndle of linen will make as many inches of cloth as 1 spyndle of cotton yarn, unless it be woven tighter than what is commonly the case in weaving cotton.

I wish it to be understood that these remarks about linen yarn having less elasticity than cotton, and that a given length of linen yarn will weave more cloth than the same length of cotton, that is, it is owing to the cotton shrinking more after it is woven, and that more especially in the weft. But it may be that the warp of a cotton web, in the weaving, may be stretched as much as to come out as long as linen, but the linen cannot be stretched to the same degree, because of it not being so elastic as cotton. The shrinkage in the warps will depend on the wefting.

WOOL YARN.

Wool yarn is spun from the short fibres of the fleece that is taken from the animal, and worsted yarn from the long staple. They are reeled on different sizes of reels; the wool is in general reeled on the 54 inch reel, and has 18 hanks to the spyndle, but is one-third heavier than cotton yarn :—For example, 1 lb. of 18's wool yarn has only 12 hanks, 840 yards long; and 1 lb. 18's cotton has 18 hanks.

Worsted yarn is sometimes reeled on the short reel, and sometimes on the long one, and is sold by the gross, a gross being 144 hanks.

THE REED.

The reed is a very important article in weaving, it divides the warp threads, and may also determine the fineness of the cloth, but a coarse web may be made in a fine reed, and a fine web may be made in a coarse reed, consequently, it is really the number of warp threads contained in a given space, that determines the fineness of the cloth or web. For example, a 6^{00} web can be made in a 12^{00} reed, by putting only 1 thread in the split; and a 24^{00} can be made in the same reed, by putting 4 threads in the split; or an 18^{00}, by putting 3 in the split. However, the common practice is to put 2 threads in the split, and when speaking about the fineness of a web, it is always understood that 2 threads are in the split; but in other localities there are different scales or rules by which they name the fineness of the web.

In Scotland, the reeds are almost all made on the 37 inch scale, which was frequently called the Scotch ell. What is meant by the 37 inch scale is, the number of splits contained in 37 inches; if there are 300 splits contained in 37 inches, that reed is called a three hundred (marked 3^{00}); if 600, it is called 6^{00}; or if 1200 are in the 37 inches, it is called a 12^{00}, and so on; for every 100 splits more, it is 1 set finer. By the common web glass used in Scotland, the fineness of the reed may be ascertained by counting the number of splits that are seen through the hole in it, when placed upon the reed; if 5 splits are seen, it is a 10^{00}; if 6 splits, a 1200, and so on; the measurement of the hole is contained 200 times in 37 inches, so by multiplying the number of splits seen through the glass by 200, the fineness of the reed will be found.

EXAMPLE.

Seven splits multiplied by 200 is a 1400 reed. But when the glass is placed upon cloth, and 7 threads of the warp are seen, it is a 7^{00}, or if 12 threads are seen, it is a 12^{00}, and so on, for every thread more, 100 finer. In England, the splits are called dents, and many of the reeds are rated by the number of splits contained in 1 inch, which is more simple than the Scotch scale for calculating warps, and their glasses are made with two spaces, of half, and quarter of an inch. If the half-inch glass is used, and 25 threads are seen, it is called a 50, or if 36 threads are seen, it is called a 72, and so on. In some places the fineness of the web is named by porters, as a 25 porter, a 30 porter, and so on; the meaning of this is, that 20 splits or 40 threads are called a porter (and some keep to this yet), so that a 25 porter is equal to a 5^{00}, because

25 × 40 = 1000 ends.
40
———
Threads in a Split 2)1000
500 Web.

A 30 porter is equal to a 6^{00}, and every 5 porters 100 finer on the 37 inch scale. It is hoped that enough has been said to make the principle understood, how the fineness of a web is to be found, as it would be too tedious to give all the rules used in the different localities where weaving is carried on; it would however be better, if one scale for the reed was adopted by all the manufacturers throughout the country, and as an inch is a measurement of very general use, it might be made the standard, and the inch scale would answer for all the variety likely to be required. The old reeds could be wrought out in course of time, without any extra expense to the manufacturer. If all new reeds required were made on the 1 inch scale, it would be no inconvenience to the trade in general; for reeds could be made within a very small fraction on the 1 inch scale to the other scales now in use. Take a 12^{00} Jaconet for example, it measures 33 inches of cloth, and has in it 2264 threads just now, and it fills $34\frac{9}{10}$ inches in the reed; if 2264 is divided by $34\frac{9}{10}$ it will give the number of threads in 1 inch, which is nearly 65; the difference is so small between a 12^{00} and a 65, that no merchant would complain of the alteration.

As most other trades are endeavouring to get a common measure established for the different articles they make, the weaving trade, which is of great importance, should have one common measure also. Some people may object to this, and think it against their interest, but what is to be a benefit for the country at large, is in general good for every individual, when taken in a proper view; this hint is merely made for others to consider, as it does not answer to discuss it here.

CALCULATION OF WARPS.

Having explained the principle of gristing yarn, and how to find its numbers, also the measure for the reed, it may now be shown how to calculate the warp of a web.

The first thing to be ascertained is, the number of ends, or runners, that will be required to make the proper breadth for the cloth wanted. The old method of calculation for warps, was to do it by ells, splits, porters, and spyndles, and that may have been the best at one time; but as all cloth is now sold by the yard, and as a warp is just so many threads, so many yards long, it has been thought better just to keep by the threads, yards, and hanks, this plan being more simple.

When the number of threads are found, it is a simple matter to get the porters or spyndles, if they are required.—For porters, divide the number of ends in the web by 40, and for spyndles, divide the hanks in the web by 18.

To find the number of ends in a web, ascertain the number of ends in an inch, multiply the number of ends in 1 inch by the given quantity of inches that are to be in the breadth of the web, and the answer is the number of ends required.

EXAMPLE.

Breadth of web 34 inches.
Threads in 1 inch 54

 136
170

1836 ends in the web.

In the Scotch scale of reeds there is always a fraction in every breadth, except 37, 74, and 111 inches;

but the general way to find the number of ends is by simple proportion, taking 37 for the first term, the number of ends in 37 inches of the given set for the second term, and inches required in the breadth of the web for the third.

EXAMPLE.*

Say a 12^{00} reed, 33 inches wide. If 37 inches give 2400 ends, what will 33 inches give?—

```
37   :   2400   : :   33
           33
         ----
         7200
        7200
        -----
        37)79200(2140 Ends for 33 inches.
           74
           --
            52
            37
            ---
            150
            148
            ---
              20
              --
              37
```

* Any one who wishes to save time in calculating for the Ends in a Web, should procure one of the Tables that are published, showing the number of Ends or Splits in any given number of inches. These Tables may be had from the Publisher of this Work.

WARP IN A WEB.

To find the quantity of Warp that is required for a web, say 265 yards long, with 2400 ends, multiply the ends by the yards, and divide them by 840 for the hanks.

EXAMPLE.

```
   2400 Ends.
    265 Yards.
  ------
  12000
 14400
 4800
 ------
840)636000(757 Hanks 1 Skein.
    5880
    ----
     4800
     4200
     ----
     6000
     5880
     ----
      120
```

The above example gives 757 hanks, 1 skein; and to find the weight of yarn that is in the web, divide the hanks by the size of the yarn. Suppose the warp to be No 50's, divide the $757\frac{1}{7}$ by 50 for lbs.

$$
\begin{array}{l}
50)757\tfrac{1}{7}(15{\cdot}2\tfrac{1}{4} \text{ ounce full.} \\
\quad 50 \\
\quad \overline{257} \\
\quad 250 \\
\quad \overline{\ \ 7\tfrac{1}{7}}
\end{array}
$$

If the spyndles are required to be known, divide the $757\frac{1}{7}$ by 18, and the answer is the spyndles.

EXAMPLE.

```
18)757 1/7(42 Sp. 1 Hk. 1 Sk.
   72
   ---
    37
    36
    ---
     1
     7
    ---
   7)8(1 Hank.
     7
    ---
     1 Skein.
```

In calculating warps, it has been a common rule to add 5 per cent. for waste and shrinking, but there can be no fixed standard for it; the manager or manufacturer must find this out by practice on the different fabrics they make, as it entirely depends on the kind of cloth and quality of the stuff that the web is made of. Therefore, all the examples given in this work are made out nett (except where stated), with the percentage added, that has been found in practice to be correct, and even in the examples given it will not be always the same, as a great deal depends on the quality of the yarn.

A short method to find the hanks in the warp of a web:—

Always take 80 yards for the length, and divide the number of ends or runners that is required to make the warp by 10, and the answer is the number of hanks, with an allowance of 5 per cent: and as 80 is a number very easily divided, it can be reduced, or added to, with very little trouble in calculation. If the manufacturer is wishing to rate his goods by 5, 10, 30, or 40 yards, instead of 80, then for

5	take a	$\frac{1}{16}$
10	,,	$\frac{1}{8}$
20	,,	$\frac{1}{4}$
40	,,	$\frac{1}{2}$

When the number of threads has been found that will make the warp of a web, for example, say 1920 ends.

EXAMPLE.

To divide by 10, throw off the figure to the right hand, and the remainder is the answer.

1920 Ends in the web, that is

192	Hanks for	80	Yards.
96	,,	40	,,
48	,,	20	,,
24	,,	10	,,
12	,,	5	,,

In the example given (page 45) the warp has 2400 ends, and is 265 yards long: these numbers are given to the warper with the number of pieces that are to be in the web: and suppose it is a plain white web, the warper has to know how many numbers are on each bobbin, and divide the hanks in the web by the hanks on the bobbin, and the answer is the number of bobbins that will be required for the web.

EXAMPLE.

Say 8 Numbers on each bobbin, then 8 in 757—

```
8)757(94 keeping out the fraction.
  72
 ----
   37
   32
  ----
   5/8
```

This shows that 95 bobbins will be required to make the warp of the web. It is generally left to the warper's own judgment how to arrange the bobbins in the bank. The process is explained under warping.

To find the quantity of cloth that a given quantity of yarn will make, find the number of hanks in the given quantity of yarn, which will be found from a rule already stated; then fix upon the number of ends that will make the breadth of the cloth wanted.

Suppose 220 hanks is the quantity of yarn, and the number of ends to make the breadth of the cloth to be 1800, multiply by 840, and divide by 1800, and the answer is the length of the web.

EXAMPLE.

```
          220 Hanks.
           840
          ----
          8800
         1760
1800)184800(102 2/3
         1800
         -----
          4800
          3600
          ----
          1200   2
          ---- = --
          1800   3
```

And suppose that 5 per cent. is the proper allowance for waste, &c., then the quantity of cloth would be 97 yards.

The following are a few different fabrics with the kind and quantity of yarn that was required to make them; and it will be seen from each, the shrinkage both in length and breadth, which may be of some advantage in rating fabrics of a similar nature:—

A 10^{00} 33 inch shirting, 11 shots, No. 18's warp, 20's weft, required 1876 runners, which is 35·07 inches in the reed; and to make 60 yards of cloth, it required 64 yards of yarn, which is nearly 7 per cent. for shrinkage in length, and about 6 per cent. for the breadth.

A 34 inch 10^{00} 11 shots Window Holland, No. 18's warp, and No. 18's weft, required 2024 runners, which gives in the reed 37·44, or nearly $37\frac{1}{2}$ inches; this web also required 64 yards of yarn to make 60 yards of cloth, but in the finishing, it gained about 3 yards.

A 54 inch 10^{00} 11 shots Window Holland, 18's warp, 18's weft, required 3168 ends, the breadth in the reed was 58·60, or nearly $58\frac{5}{8}$ inches, and 64 yards of yarn for 60 yards of cloth.

A 9^{00} $11\frac{1}{2}$ shots Cross-over, 24's warp, 12's white weft, and No. 14's blue weft, required 1848 ends, and 65 yards of yarn to make 60 yards of cloth.

A 38 inch 9^{00} $11\frac{1}{2}$ shots Cross-over, required 1904 ends. The white weft No. 12's, and the blue No. 14's, require 65 yards of yarn to give 60 yards of cloth.

A 33 inch 12^{00} 11 shots Jaconet, with 60's warp and 80's weft, required 2264 ends, which fills $34\frac{9}{10}$ inches in the reed; and to make 25 yards of cloth, it required 26 yards of yarn.

CALCULATION OF WEFTS.

To find the quantity of weft for a given piece of cloth, first find the quantity of shots in one yard, and multiply them by the number of yards in the given piece of cloth, and the product by the breadth of the web in inches; then divide by 36 for yards, and the product by 840 for hanks.

EXAMPLE.

25 yards, with 11 shots on the glass 35 inches wide. As there is 200 shots on the yard for every shot seen in the glass, a web with 11 shots will have 2200 shots on the yard; so multiply 2200 shots by 25, for the quantity in 25 yards, and by 35 for inches, and divide by 36 for yards.

```
   2200 × 25
     25
   ------
   11000
   4400
   ------
   55000
     35
  -------
  275000
 165000
 --------
36)1925000(53472 2/9 Yards.
   180
  -----
   125
   108
   ---
    170
    144
    ---
     260
     252
     ---
       80
       72
       --
        8   2
       -- = -
       36   9
```

$$
\begin{array}{l}
840)53472(63\tfrac{23}{35} \text{ or about } \tfrac{2}{3}. \\
\quad 5040 \\
\hline
\quad\ 3072 \\
\quad\ 2520 \\
\hline
\quad\ \dfrac{552}{840} = \dfrac{23}{35} \text{ or about } \tfrac{2}{3}
\end{array}
$$

There are shorter methods, however, than the one given, for finding the quantity of weft for a piece of cloth, but the preceding one shows the principle clearer than any other. The quantity of weft may be got from the quantity of warp that is in the web or piece of cloth, in the following manner :—

Suppose a 12^{00} 33 inch Jaconet, it will be seen that there is 2264 ends, and from the 25 yards of cloth, there is 70·07 hanks; if 12 gives 70 (keeping out the fraction), what will 11 give ?—$\frac{1}{12}$ less, or in proportion to whatever the shots may be.

EXAMPLE.

$$
\begin{array}{r}
12 : 70 :: 11 \\
11 \\
\hline
12)770 \\
\hline
\text{In proportion } 64\tfrac{1}{6}
\end{array}
$$

always taking the hanks found in the warp of the web for the second term, and the set of the reed for the first, or divisor; or in other words, multiply the hanks by shots, and divide by the set of the reed, thus:

$$\begin{array}{r} 70 \\ 11 \\ \hline 12)770 \\ \hline 64\frac{1}{6} \end{array}$$

The foregoing is sufficiently correct for any practical purpose, although not exactly correct; but the following short methods can be depended upon as correct:—

Another mode of finding the quantity of weft that is required: Make 50 yards the standard, or fixed number of yards to calculate by; multiply the breadth of the web in inches by the shots on the glass, and the product by 33, and the answer will be the number of hanks, after taking off the two figures at the right hand.

Suppose the web is 35 inches broad, and 11 shots to be on the glass: then $35 \times 11 = 385 \times 33 = 127{\cdot}05$.

$$\begin{array}{rl} 35 & \text{Inch.} \\ 11 & \text{Shots.} \\ \hline 385 & \\ 33 & \\ \hline 1155 & \\ 1155 & \\ \hline 127{\cdot}05 & = 127 \text{ Hanks of Weft.} \end{array}$$

If the foregoing length do not suit, it will be an easy matter to find a number to multiply by for any other length that the manufacturer or manager wishes to rate by. Another method which is perfectly correct, and which gives an allowance of five per cent. on the cotton standard (that is the spyndle with 15,120 yards). This rule is for 800 yards. Multiply the shots on one inch by the number of inches the warp yarn occupies in the reed, and the product is the number of hanks per 800 yards. Suppose you have 63 shots on the inch, and the web 32 inches wide, then multiply the 63 × 32.

EXAMPLE.

```
   63 on 1 inch.
   32 inches broad.
 ----
  126
 189
 ----
 2016 hanks for 800 yards.
```

And if you divide by 8, for 100 yards, you have 252 hanks, or 14 spyndles, with five per cent. of an allowance. It will be obvious that the quantity of weft can be found for any other number of yards by the same rule, and it is the most simple I know. But where there are many ratings to make out, much time will be saved in calculation, by using the Tables made out for that purpose.

CHAPTER II.

WEAVING.

WEAVING is the making of cloth from yarn or threads; this is the most simple explanation of the word. Like all other arts that are carried on to any extent, the division of labour is found to be advantageous in weaving also. The first process is winding, and it may be mentioned here, that the ancient mode of winding, warping, and weaving, was as follows:—Winding they had none, as they spun the yarn on a spool or bobbin or into balls; and when a web was to be made, only one bobbin was taken at a time. The whole warping and weaving apparatus that was required was two sticks, like walking canes, a little longer than the breadth of the intended piece of cloth: these sticks were placed in the ground at two or three yards apart, the length of the web; then taking the bobbin in hand, the person ran round the two sticks, making the warp of the web. After the proper quantity of yarn was fixed on the two sticks, the web was made, and the weft put in, much in the same manner as darning a hole in a stocking, so that the primitive weaver required neither heddles, treadles, reeds, nor shuttles. But now in our days, winding machines, warping machines, dressing machines, twisting frames, and weaving machinery, are all required to bring out the cloth at a cheap rate. The yarn as it comes from the spinning factories, is either in cope or hank, except when in some instances the spinners have both winding and warping, and sell their yarn warped on beams, ready to be put into the dressing machine; but when it is silk, worsted, or linen, it is generally got in hank. Then the power-loom weaver requires winding and warping machines, which will now be explained.

WINDING.

There are many varieties of Winding Machines, but they are all made to perform the same thing, although some do it better than others. The best winding machines for winding water-twist yarn, or the yarn from small bobbins on to larger ones, are those that have the following improvements applied to them: The small bobbins as they come from the throstle frames to the winder are full of yarn (the yarn being spun on them). The small bobbins are put on a verticle spindle, running in a step and collar, tapered like a cone. When the throstle bobbin is put on, the bobbin being on a tapered part of the spindle, its own weight is sufficient to keep it tight on the spindle, so that when the yarn is winding, the small spindle turns with the bobbin.

This is a great improvement over the old mode, when the throstle bobbins had to run on a rod of iron or wood, causing the bushes in the bobbin to be more worn in the winding than they were in the spinning; and those who are acquainted with throstle spinning, will know the bad effect that this produces. Another improvement is a thin plate of iron put along the machine with small slits in it, one for each thread, and the yarn, when in the process of winding, passing through this slit, it takes off all the loose pieces of cotton seed or what is called gins, or any other loose substance that may be sticking to the yarn. It also serves to catch bad piecings, when the winder ought to take them off and knot the ends anew. After this, the thread passes through a brush, or over a woollen cloth, put on the machine in order to keep the yarn clean. In many of the machines yet in use, there is just one rod of iron for the ends to run under for building or guiding the yarn on to the large bobbins, but it is better to have a small piece of wire for each thread or spindle, with the one end of it screwed, so as it can be set up or down when required, and this will save all the washers or pieces of leather or cloth that is put underneath the bobbins to make them build properly. But even with all these improvements, if the winder is not careful, bad piecing and lumps on the yarn will be passed.

Some time after the first edition of this work was published, an improvement was made on the thin plate of iron, with the slits that the yarn passes through, and it is thus:—By having the one slit, as formerly, it was easy for the winder to lift the thread out of the slit when stopped by a bad piecing, or any other obstruction, and allow it to pass. But by this improvement it is more trouble for the winder to take the thread out of the slit, than it is to knot it anew. The slit in the iron plate is made like an arrow, with a slit on each side of the main slit; so that if the winder attempts to lift the end up, it goes in either to the one or the other, and the winder is obliged to break the thread and knot it anew.

The winding of cope (or mule) yarn is done in the same kind of machine, with this exception, that the copes are put on to skewers, and winded from the cope standing upright. But if the cope does not run till it is finished, which frequently happens, the skewer is put in a horizontal position and allowed to run free in centres, and at the same time steady; this is accomplished by having the centres made movable, and held up to the end of the skewer with a small spring. It is an advantage to have three or four spindles in each winder's charge, to run about half the speed of the others, where the bottoms of the copes may be wound when the skewers are placed in a horizontal position. This can be managed by having larger warves on the spindles, and giving the winder a few extra skewers, so as to save the time of changing the bottoms from one skewer to another. In winding warp from the hank, swifts or whisks are used, and as it is more difficult to do, the winder is not able to keep so many spindles employed as with the former. Sometimes a different kind of machine is used for this kind of winding, as the hank yarn takes up more room than the cope or bobbin. This machine has no cylinder nor spindles, and of course requires no banding for driving the spindles. It has one shaft the whole length of the frame, with small drums on it, one for each bobbin. In some of the double winding machines, one drum is made for two bobbins. This is accomplished by having the drums about ten inches in diameter, and placed along the top of the machines in the centre, between the two sides; and the bobbins are driven, not on the exact top of the drums, but on each side, a little from the top. The drums are made to fit the size of the bobbin between its ends. These machines have the advantage over the spindle kind, as the yarn always runs at the same speed; whereas, in the spindle machine, the speed of the yarn increases as the bobbin fills.

The next machine we will notice is for winding weft, or what is called a pirn winding machine; but to describe all the different kinds that have been made during the last thirty years, would take up too much time. The best that have yet been made are those that have the mechanism or contrivance for accomplishing the following things:—A separate building apparatus for each spindle; also one to stop the spindle when the thread breaks; also the plan to prevent doubles (that is, two ends going on the pirn at the same time), and the mechanism to make the yarn run at the same speed at the thick part of the pirn as at the small. When the machine wants this apparatus, the quantity winded is much smaller than with it. Also the apparatus for stopping the spindle when the pirn has received its proper quantity of weft.—A machine made with all these appliances will make a pirn much superior to the pirns wound by the hand. The pirn winding machines most in use, for light yarns, are those with the cone and the horizontal spindles, with the spindles driven by a cylinder and bands. The cone does for building the pirn. But some object to the cone for winding certain kinds of coloured yarns, as it rubs off the lustre. There are different methods for stopping the spindle when the pirn is full. One method is to have a long fixed warve on the spindle, with a loose pulley at the end of it, and, as the pirn fills, the spindle is pushed back until the band goes on to the loose pulley, and the spindle stops. Another plan is to have a cross wire in the spindle, so that when the spindle is pushed back a given length, the wire catches upon a projection which stops the spindle. This is not a good plan, because the friction of the band still continues on the warve of the spindle. Some machines have a small lever that is acted upon, when the pirn has received its proper quantity of weft, which throws the spindle out of gear and stops it.

There has also been different plans for making the yarn run at a uniform speed, and some of them very good, but expensive. One of the plans is to have eccentric wheels for driving the cylinder at an increasing and decreasing speed to suit the bevel of the pirn. Another way to accomplish the same object, is by connection rods; and another way is to have one or two cones for driving the cylinder. When only one cone is used, a lever is required to keep the belt at the proper tention. There is another, and a very simple and cheap way of doing it, and that is, by having a rod of iron placed between the swifts and the pirns. All the ends pass over this rod of iron, and it is made to rise and fall with the traverse motion, to take up or give out the yarn at a uniform rate, according to the build of the pirn.

Some pirn winding machines are made where the spindles are driven with friction plates, and the shaft where the friction plates are keyed on, is made to oscillate in such a manner as gives the yarn a uniform motion.

The foregoing remarks will be understood, without giving drawings of the different apparatuses, by any machine maker who is in the habit of making pirn winding machines, and who understands the principle.

I will now state the objections made by some manufacturers to the machines at present in use. The driving the spindles with banding is one, because of the expense of their frequent renewal, and the friction put on the bushes where the spindles run in. Having the swift down below instead of above the spindles is another, because when the swifts are placed below, the winder has to stoop when looking for the proper end, and if the yarn is not very good, they are more apt to make waste than when standing upright, because their actions are better seen by the overlooker. Another objection to those that are driven with wheel and pinion, and without bands, is that the price is so high. I have no doubt but that a machine will be brought out soon to answer the purposes of the trade better than any in the market yet; for the weaving of cloth, where pirn winding is required, has been greatly on the increase in the power-looms of late years.

WARPING.

Having explained winding and the winding machine, the next process in the art of weaving is warping, and it is done both by hand and power.

Warping by hand requires a person with some knowledge of arithmetic, where complicated patterns are to be made in the warp, but this is treated on in another place. The common warping mills are constructed of different circumferences and heights, but those most in use are the five-ell mills; it is a reel with three rows of arms, and 20 arms in each row: on the arms are fixed 20 spokes, and these spokes are divided into 20 equal parts $11\frac{1}{4}$ inches, which is $\frac{1}{4}$ of an ell to each; so $20 \times 11\frac{1}{4} = 225$ inches $\div 5$, is equal to 5 ells. The arms are mortised into three centres, and these centres are put on a piece of wood, with iron pivots at each end for the mill to run upon; the mill is placed perpendicular, and the web is warped on to it from the bobbins in the bank in a spiral form. The length of the web is regulated by the number of turns the warper gives the mill before reversing its motion, and the breadth of the web is according to the quantity of bobbins in the bank, and the number of bouts the warper gives the mill. After the proper quantity of yarn is on the mill to form the web, it is taken off by the warper in links and put up into a chain; but before taking it off, a lease must be taken with the heck for the drawer or twister's guidance.

Warping by power is far more simple than by hand, and is done cheaper. In general, the fourth part of the web is warped at once, by putting into the bank a sufficient number of bobbins to make up the fourth part, and putting all the ends through two reeds, with one thread in the split, the reeds being of the proper set to keep the warp on the beam the same breadth as the intended web; the reed nearest the bank is made in the common way, but the other which is to conduct the yarn on to the beam, has every alternate split filled with solder, about an inch from its rim, for the purpose of taking the lease.

There are many different kinds of warping machines in use—the make most approved of is what is called the Cylinder Warping Machine, with its latest improvements, which are explained in another place, our object here being to show how the warping is done in these machines.

Suppose a 12^{00} with 1160 splits or 2320 ends, is to be warped, then the fourth of 2320 is 580 bobbins, which will require to be put into the bank, each space in the bank holding 20 bobbins, leaving 29 spaces to be filled up to make the number 580, or $14\frac{1}{2}$ spaces on each side of the bank. Care should always be taken to have an equal quantity on each side of the bank, so that there may be an equal quantity of yarn on each side of the beam, from its centre, otherwise the yarn will be badly warped. After all the bobbins are in the bank, and the yarn taken through the two reeds, a rod of wood is cut the exact length of the space of the reed which is filled with the yarn, and the cylinder is made up to the same length as the rod, then the beam is flanged to answer the cylinder; when this is done and the measuring apparatus set at its proper place, the warping commences. After a little yarn is on the beam, it is common to hang a weight at each end of it, so as to make the yarn build harder on the beam, but it will be obvious, that unless the beam be of equal weight at both ends, it will have what is called a slack side, which is very annoying to the dresser, and makes the yarn after it is dressed, break more when it is being woven in the loom. The machine, and all the other things being adjusted, the warper's duty is to watch when any of the threads break, stop the machine, and take the ends in (although some machines have an apparatus that, when a thread is broken, it stops itself.) With the old warping machines, a long practice was required before the worker was able to stop it properly, as they had no fly-wheels; but with the new machines, nothing more is required than to shift the belt from the fast pulley to the loose one, as the fly-wheel does the rest. The use of the fly-wheel on a warping machine is to allow the bobbins to stop gradually, for if the machine was stopped instantly, they would over-run, and break the threads. There is also a small roller, made of wood, used for this purpose, which floats upon the yarn, and if the beam is instantly stopped, the weight of the roller keeps the yarn from being slack, by it descending a little towards the floor.

Suppose the length that is wanted is 6000 yards, the warper must watch when that quantity is indicated on the measuring apparatus, and take out the full beam, and put in an empty one, then go on as before, till he has four beams filled, which makes the set for the web.

TO WARP STRIPED WORK.

If the pattern is to be 2 of blue (or any other colour), and 2 of white; or 4 of blue, and 4 of white; or 6 of blue, and 6 of white, or any other pattern that is half-and-half, up to 40 ends of the one, and 40 of the other, may be warped 2 beams of blue, and 2 beams of white, and the exact pattern is made by the twister when twisting the web; or if the pattern is $\frac{1}{4}$ of one colour, and $\frac{3}{4}$ of another, then warp three beams of the one and one beam of the other, and the drawer or twister makes the pattern. But if a pattern similar to the following is wanted:

24 of Brown,
4 „ White,
4 „ Red,
14 „ White,
2 „ Red,

which is 48 ends in all, in 1 repeat of the pattern, and say the pattern is repeated 42 times, then $48 \times 42 = 2016 \div 4$, is 504 ends on each beam, which may be warped as follows:—

2 beams with	6 Brown	and 2 beams	6 Brown.
	1 White,		1 White.
	1 Red,		1 Red.
	3 White,		4 White.
	1 Red.		
	12		12

Another example of this kind will show how the most difficult pattern can be warped on beams:—

60	ends of	Brown.
2	„	Red.
2	„	Orange.
2	„	Yellow.
8	„	Green.
2	„	Brown.
20	„	Slate.
2	„	Brown.
8	„	Green.
2	„	Yellow.
2	„	Orange.
2	„	Red.
10	„	White.
10	„	Brown.
10	„	White.
4	„	Red.
14	„	White.
14	„	Brown.
4	„	Green.
2	„	Orange.
20	„	Brown.
20	„	Slate.

9 times over.

2 Beams with 15 Brown,	and	2 Beams	15 Brown.
1 Red,			1 Orange.
1 Yellow,			2 Green.
2 Green,			1 Brown.
5 Slate,			5 Slate.
1 Brown,			2 Green.
2 Green,			1 Yellow.
1 Orange,			1 Red.
2 White,			3 White.
3 Brown,			2 Brown.
2 White,			3 White.
1 Red,			1 Red.
4 White,			3 White.
4 Brown,			3 Brown.
1 Green,			1 Green.
			1 Orange.
5 Brown,			5 Brown.
5 Slate,			5 Slate.

The following will show how the pattern should be on paper, and that paper is to be given to the warper, then the dresser, and after the web is dressed, the drawer gets it for his guidance :—

	2 Beams.	2 Beams.
60 Brown,	15	15
2 Red,	1	0
2 Orange,	0	1
2 Yellow,	1	0
8 Green,	2	2
2 Brown,	0	1
20 Slate,	5	5
2 Brown,	1	0
8 Green,	2	2
2 Yellow,	0	1
2 Orange,	1	0
2 Red,	0	1
10 White,	2	3
10 Brown,	3	2

10	White,	2	3
4	Red,	1	1
14	White,	4	3
14	Brown,	4	3
4	Green,	1	1
2	Orange,	0	1
20	Brown,	5	5
20	Slate,	5	5
220		55	55

9 times over.

Nine times over means that the pattern is repeated 9 times in the breadth of the web, which in this pattern makes 1980 ends, and say 8 threads for the selvage, gives 1988 in all, and this divided by 4, makes 497 ends for each beam.

To warp patterns with fine and coarse yarn, the best method is to put the coarse on one beam, and the fine on another, and make the pattern in the dressing machine, or, by the drawer, when drawing the web into the heddles, whatever way the pattern answers best; but if both the coarse and fine are put on one beam, it will then be necessary to bank for the pattern, and in taking the yarn through the warper's reed, it must be observed that splits will require to be left empty in proportion to the coarse yarn; for example, if the fine yarn is No. 60's, and the coarse No. 20's, then one thread of 20's must have the space of 3 splits to keep it from forming a larger diameter on the beam than the fine. Suppose the pattern to be 80 threads of No. 60's, and 10 threads of No. 20's, then the 10 threads of 20's would require to be drawn through the warper's reed, 1 split full, and two splits empty alternately, and the 60's will have 1 thread in each split as usual.

In power-loom warping it is a common practice for the warper to take out the bobbins before they are run nearly empty. Sometimes a considerable quantity of yarn is left on them, and to avoid this as much as possible, the barrel of the bobbin should be at least 1¼ inch in diameter, for if it be less, the bobbin will not run until it is empty, without the risk of the yarn breaking frequently. Another advantage is gained by having the barrel of the bobbin large, namely, that less yarn is allowed to go to waste, the bobbin is stronger, and less liable to be broken.

Some manufacturers have their bobbins painted different colours, a colour for each size; when this is done, the warper can see at once when the yarn is mixed. The apparatus for stopping the warping machine when any of the ends break, has not, as yet, come much into use. There are different ways of doing it, but the principle is, that each end or thread passes through a wire or mail, which is supported by the end in its position; and when the end breaks, it drops and comes in contact with a lever which is moving under the needles, and the belt is shifted to the loose pulley, and the machine stops.

The expanding cylinder is now applied to all new warping machines, which is an improvement over the old plan. And where very heavy yarns are used, the machine has two cylinder shafts, with two drums on one shaft, and one on the other; and the beam that the warp yarn is to be wound upon, lies on the top of the drums, and these drums are made to shift upon their shaft, so as to suit the breadth of the warper's beam. This kind of machine is by some considered the best for either coarse or fine yarns.

As it is very essential to have the yarn put on the beams, so as to have no slack pieces (more especially for linen yarns) a small cylinder about 9 or 10 inches in diameter, is employed for that purpose, by being placed between the two warper's reeds, and the yarn is made to go almost round this cylinder, and the cylinder being made parallel, if the beam is not taking up the yarn properly, the warper will at once observe a slack side, because the friction of the yarn on the cylinder is sufficient to turn the bobbins in the bank.

BEAMING.

After the process of warping next comes beaming (if the web is to be dressed in the loom), which is to put the warp on the weaver's beam in a proper manner. The first thing is to ascertain the number of half-gangs, and the breadth of the web, then pass two rods through the half-gang lease, which is made by the warper for the purpose of getting the web put into the ravel. After this is done, the ravel must be set to answer the breadth of the web, then fix the end of the chain to the beam, and commence winding it on. Ravels are now made to answer any set; the old kinds were made like reeds, and marked 5, 6, 7, or 8 score according to the fineness of the ravel.

The beamer must be particular to tie all the broken threads, and in doing so, not to cross them, or the weaver will have a deal of unnecessary trouble in making his web, by being obliged to stop frequently to take out the crossed yarn and put it in its proper place. Many of the beams yet used by the hand-loom weavers have no flanges on them to support the selvage of the web; and it is necessary to have the ravel coarser than the web, to form the headings in the process of beaming; this is done by holding the ravel oblique, as the beaming proceeds.

In beaming for the power-loom, the web or chain must be starched or sized before commencing to beam.

Generally the machine is driven by power. Sometimes a reed is used instead of a ravel, and two threads put into one split of the reed, with a rod between them, so that when the yarn is wound on the beam, every thread takes its own place. This sort of beaming does much better for power-loom weavers in general, than having the web beamed in half-gangs. When the chain or web is to be beamed in this manner, the warper of the chain will require to take a thread lease at both ends of the chain: it is obvious that the yarn will have less chance of being crossed on the beam when it is beamed in this way.

When the yarn is dyed in the chain, and is to be dressed in the dressing machine afterwards, the reed should be used instead of the ravel, as it is more convenient for the dresser, and for making patterns in the warp.

For large quantities of one pattern, a considerable saving is made by having the yarn dyed in the chain, and the white bleached, as it does not require to be reeled into hank first, and then winded after having been dyed. The same principle as stated under warping for making patterns will answer for making the pattern in the beaming machine. For example: the pattern to be made has in it white, green, blue, orange, and black. The pattern being drawn out on paper in the usual way, it can be ascertained how many ends of each colour will be required to make the web, then dye a chain for each colour, and indent them at the beaming machine according to pattern. When a number of chains are required for one web, the beamer must be very careful to have them all kept the same tightness, otherwise some parts of the yarn will be overstrained. The machines in use for beaming power-loom webs are made so as the speed of them can be changed from one speed to another as the beaming proceeds. Some have for this purpose only two speeds, but a better plan is to have two cones, and then the speed of the yarn can be regulated to any degree of nicety, which is a great advantage where different qualities of yarns are to be beamed. It is also more suitable for beginners, because it can be driven according to the capability of the workman.

SIZING AND DRESSING.

SIZING

Is to put the yarn that forms the warp of the web through a process whereby the fibres of the thread are all laid or glued together. There have been many different ways of accomplishing this.

The method used by the hand-loom weaver is to put the dressing on with two hand brushes, but before beginning to put the paste on, the lease rods will require to be taken back from their working place to the yarn beam, and that part of the yarn which is to be dressed should be cleared of all lumps, and the long ends of knots that would damage the cloth, or retard the progress of the weaving. When this is done, the dressing should be brushed on tenderly and regularly, so as not to have one part of the web with too much, and the other part with too little of the size. The weaver then separates the threads of the warp with the lease rod, by turning it on its edge: he then uses a fan for the purpose of drying the warp, at the same time using one of the brushes to keep the threads from sticking together. After the warp is dried, sometimes a little soap or tallow is brushed over it to make the web smoother. It is a very important part of the hand-loom weaver's work to be able to dress his web well; and it may be stated here, that when dressed yarn is allowed to stand (with the common dressing generally used) for any considerable time before being woven into cloth, the air has a tendency to make it hard and brittle, and the yarn then has little or no elasticity, which makes it very difficult for the weaver to work; besides, the cloth is not so smooth and even, and the drier the weather is, the effect will be the worse.

Another mode of sizing warps, although it cannot be called dressing, is to put the whole chain or chains, as the case may be, through a starching machine. This machine has the starch boiling in a large cistern, and the chain is conducted (in the shape of a rope) through this cistern by means of rollers working inside of it; and after it has traversed for a sufficient length of time in the starch, it moves out at the opposite side of the cistern from where it entered, and passes through between two rollers, which press the superfluous starch out of the chain; it then passes round a number of steam cans for the purpose of being dried. The number of cans in this machine are various—the more cans the greater the power of drying; and it is the drying power of the machine that regulates its speed.

After the chain has passed over all the cans, it is rolled up into a ball, and, if required, put through the machine again. (This is called double starching.) When a chain is put through the second time, the weaver does not require to dress his web. A great many chains now are done in this manner, as it requires less labour from the weaver, and consequently the cloth is woven cheaper. However, this will only do for certain kinds of work; where the yarn or reed is very fine, it still requires to be dressed in the loom or dressing machine.

To prevent the yarn of the chain being torn or cut in the process of starching (which frequently happens), the rollers should be kept very smooth, and the starch put through a sieve, to take out any impurities that may be mixed with the flour. The chains that are starched in this kind of machine should be allowed to lie in some damp place for at least twenty-four hours before being beamed, otherwise the yarn will be brittle; care must also be taken to put them in a place that is free from rats and mice.

DRESSING.

The old crank dressing machine is the best yet out for making good work when the yarn is fine. It is also well adapted for coloured yarns; but the drawback with it in common work is the small quantity that can be produced, although it may yet be improved in this respect.

For the crank dressing machine the yarn is first warped on four beams, and two beams put at each end of the machine. It is then drawn through the back reed—two threads in each split; from this reed it is drawn into the copper (or hole board), with one thread in each hole—this keeps every thread perfectly distinct—and from the copper into the fore-reed, with one in each split. The fore-reed is made so as a lease can be taken with it; but in putting the web at first into the machine, it is better to draw dressed yarn into the coppers and reeds, and then twist the beams to the yarn in them. This is in general done by the person who draws the webs for the looms.

To work the crank machine properly, the following observations will be found useful to the new beginner. The machine should stand perfectly level on the floor; this can be ascertained by putting a straight-edge along the machine, and applying a spirit-level on the straight-edge, and then putting it across the rolls.

When it is made level and fixed down to the floor, the yarn should be set and stretched in the machine so that it will be level also. Then pitch the machine for the brushing. This is done by taking the wheels out of gear that drive the wyper shafts, and placing the one shaft with the full part of its wypers exactly up, and the other with its wypers exactly the reverse. The crank shaft is then turned with its crank fair up or down, as the case may be, so as to make the brushes take hold of the yarn when they are in the act of moving from the copper. The wheels should all be put into gear again, when the three shafts are in the position above described, the machine will then be pitched. A piece of cloth or leather of an equal thickness, the size of the friction wheel, should be put in between it and the plate. Some oil and a little black lead should be used to make the friction work regularly. If the machine is new, it should be allowed to run for a short time without the yarn, for the purpose of seeing that all the working parts are correct. It is essential that all the dressing rolls be of the same diameter, otherwise the yarn will be strained in some parts more than it should be. The belts for the fans and brushes being on, and other little things in their places, the machine is ready for dressing; the workman must temper the dressing to answer the fabric of the cloth. This can only be known by experience, but the first web, after it is in the loom, will give an idea what is required. The yarn, after passing through between the dressing rolls, should continue in a moist state until it passes through the copper, but never allowed to go on to the weaver's beam before it is properly dried. Many a web has been spoiled by allowing the yarn to go on damp. The brushes must be kept clean by being washed regularly. Some workmen wash them every hour, some every two hours, and so on; but it altogether depends on the kind of work and the quality of the yarn, as foul yarn will require that they be oftener washed than clean yarn. When all things are nicely set about the machine, the workman has just to move about and watch that the yarn is properly dried, and be very expert to mend any broken thread before it is out of his reach, and then he will have no complaints about bad work.

There is an improvement made on the old crank machine which should be applied to all dressing machines, and that is an apparatus for regulating the speed of the machine according to the drying power. The most common way is to have two cones driving the whole machine, except the fans (which should be kept at the full speed), and the yarn can be made to run at a speed sufficiently slow, so as it will be properly dried before it is allowed to go on to the weaver's beam. And it is advisable to have change pinions, to regulate the speed of the brushes (in the crank machine) at pleasure, to suit the different kinds of yarn, as some yarn requires less brushing than others.

For driving the tape leg dressing machine, some use a small high-pressure steam engine, and make use of the steam, after it has driven the engine, to heat the cylinder that dries the yarn. The exhaust steam from the engine can be so regulated as to keep up the required pressure in the steam can.

CYLINDER MACHINE.

This is another machine for dressing warps, and does its work very well with coarse yarns, but it is not so well adapted for fine as the crank machine. The observations made for working the crank will also apply to the cylinder machine—the difference is, that it has no hole board. It has the back reed, the brush reed, the fore reed, and a set of heddles for taking the lease. It derives its name (cylinder) from the brushes, as they are made cylindrical, and brush the yarn as they revolve. To have the reed at the brush properly set is very important, and the proper way is to have it so as the brush may just touch the yarn with the points of the hair. This is regulated by thumb-screws, with their points resting on the side framing of the machine.

The dressing used in these machines is in general made from American sour flour, and is prepared in the following manner:—The flour is steeped in the proportion of five pounds of flour to three gallons of water for two or three days. It is then put into the boiler and boiled for about two hours. When it is sufficiently boiled, the dressing is drawn off and put into tubs, and allowed to stand for two or three days more before it is used, for, when it is used too new, the yarn is not well dressed.

TAPE LEG DRESSING MACHINE.

A machine has been in use for twelve or fifteen years, which is known by the name "Tape leg dressing machine." The yarn for this machine should be warped as wide on the beams as the machine will take in, so as to give it the greatest power of drying. The warper's beams are placed in such a manner as to allow the yarn on the beam next to the machine to unwind from the top, and the second from the bottom, the third from the top, the fourth from the bottom, and so on alternately from top and bottom. The yarn is then taken and tied to cords, or pieces of an old chain, previously placed in the machine, round the cylinder, and over and under the different rollers that the warp has to pass in the process of dressing. The steam should now be put on, and after the dressing is brought to the boiling point, the yarn is submerged into it, and the machine put on, till the dressed yarn reaches the weaver's beam. Then the yarn is put into the ravel, to answer the breadth of the intended web. The workman requires to calculate the number of threads that are to be put into each pin to bring out the proper width, and it is requisite, before stopping the machine (when it is to stand for more than five minutes), to take the yarn out of the boiling dressing. This is done by winding up the copper rolls that keep it submerged. If this is not attended to, the threads get all fixed one to another. To keep each thread distinct on the weaver's beam, a lease cord is put between each of the warper's beams, and run through the machine, until they come within a few inches of the ravel; and then round iron rods are put into the place where the lease cords are, and these rods remain in their place till all the yarn is dressed that is on the warper's beams. This machine should have the elastic ravel and the new improved keeling motion to make it complete. Manufacturers who make coloured work, and use the tape leg machine, have different boxes in the machine for holding the dressing; so that one colour can be put through one box, and thus prevent it from mixing with other colours which might destroy them. This arrangement is also useful for dressing bleached yarn, when it is desirable to dress it in a separate box; and, as the boiling of the yarn hurts some colours, that class of yarn can be dressed with cold dressing, while the others are being put through boiling dressing. It will be observed that this arrangement of different boxes will suit a variety of purposes.

DRAWING OR ENTERING.

When the web is beamed, either by a beaming machine or in the dressing machine, it is ready for the drawer. The beam is then hung up with two ropes or iron hoops about six feet from the floor, and a sufficient length of yarn turned off, so as to allow the end of it to come down to the drawer, who sits on a stool, with the heddles before him. Two rods are inserted into where the lease cords are; these lease cords are put into the web either at the warping mill or dressing machine. The ends of the rods are then fixed together, and the warp spread out to its proper breadth. The ingiver takes thread by thread and hands it to the drawer to take through the heddles with a hook, and the drawer takes the heddles in regular succession according to the draught of the web. When the web is drawn into the heddles, it next requires to be put into the reed, which is in general done by the same person, who has a sley hook for the purpose. He commences at the right hand side of the web, and takes out the number of threads from the heddles that are intended to go into one split.

This operation being done, the web is ready to be put into the loom, which is explained under weaving.

TWISTING.

As drawing and reeding a web is more expensive than twisting one, they are always twisted, except when new heddles are required. This operation is performed by boys.

The heddles and reed, as they come from the loom with the yarn in them, are hung up in the twisting frame opposite the web. The twister puts a piece of rope round the pulley, on the end of the beam, or round the beam itself, and hangs a weight to the end of it. He then takes a portion of the yarn, and fixes it between his knees, till once the rods are put into the lease of the web. After the rods are in, and the yarn all made straight, he begins to twist the ends of the web to the ends that are in the heddles. He picks out the yarn from the rods in the web with his right hand, and twists with his left.

The twisting frame should be made with its upright standard sufficiently high, so as to allow a web to be hung from them for the purpose of being drawn into the heddles, for, in general, the same person that twists the webs also draws them into the heddles. By this arrangement it saves the room that would be taken up by a separate place for drawing the web.

In drawing or twisting webs that have difficult draughts or patterns, the worker should get his instructions given him on a piece of paper, and this should be kept before him until he can do without it.

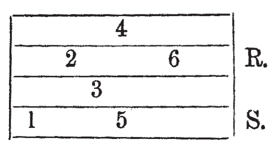
DRAUGHTS AND TREADING.

After the web is put into the heddles and reed, it is ready for the loom; but before beginning to explain the operation of making it into cloth, it has been deemed proper to give the draught and treading of a few different kinds of fabrics, and the description given here will answer for both the hand and power-loom. The explanations for mounting the different tweels will be given under another head.

PLAIN CLOTH

Is made by causing every thread of the warp and weft to cross each other at right angles, and tacked together alternately. This is done by drawing the web into two leaves of heddles, with equal quantities on each leaf. But a plain web is in general drawn on four leaves, to keep the heddles from being too crowded on their shafts, and the two fore-leaves are fixed together as one, and the two back ones as another, and mounted in the loom as if they were just two leaves. The figures, as shown at No. 1, are the draught of a plain web with four leaves.

No. 1.



The figures 1, 2, 3, 4, 5, and 6, show how the yarn is drawn through the heddles, and R S are the shafts. They are sunk and raised alternately, to form plain texture. The term plain cloth, as applied here, must be understood as the kind of weaving, as there are many fabrics made by plain weaving that are not commonly called plain cloth, such as the great variety of ginghams, fancy dresses, blue and white checks, &c., but only to distinguish it from that class of goods where the yarn is flushed, and it is this flushing that forms all the variety of tweels and figures that are made in the loom by the warp and weft, being produced by the order and succession in which the weft is interwoven with the warp.

TWEELING.

Tweeled cloth is made for many different purposes. But before proceeding further, it may be remarked, that, so far as its strength depends on the mode of weaving, it is rather diminished than increased, when compared with plain cloth, containing an equal quantity of warp and weft; for, in making plain cloth, as stated before, every thread is alternately interwoven, while in that of tweels they are only interwoven at intervals, according to the kind of tweel. Now, in the latter case, the threads can have no support from each other, except at the intervals where they are caught by the weft, and that part of them which is flushed, must depend on the strength of the individual threads, those of the warp being flushed upon one side, and those of the weft upon the other.

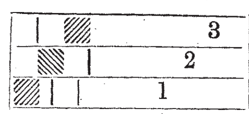
For illustration, take the following:—Let two webs be made of equal length, breadth, quantity, and fineness of yarn; let the one be plain and the other tweeled, and their strength, as far as material is concerned, ought to be the same. But if the strength is to be understood by the durability of its wear, the tweeled cloth will be worn out long before the plain cloth is much injured.

Tweeling is adopted for the purpose of getting a greater quantity of yarn put in the same space, which this mode of weaving affords, and the larger the tweel is the heavier the cloth can be made. This will be easily illustrated: When the shed of any web is opened every thread of warp, either above or below the thread of weft, will oppose a certain resistance to the operation of weaving. Now, in plain cloth, every thread is alternately interwoven, and therefore opposes its portion of resistance, whereas, in a six leaf tweel, every sixth thread is only intersected, and it will easily be seen that less resistance will be given to get the weft on. It may be remarked that tweeling is often applied to light fabrics for the appearance it gives the cloth, and it is sometimes also applied to give the cloth a soft feel. I will now give the draughts and treading of a number of tweels.

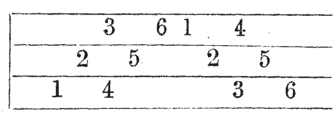
A THREE LEAF TWEEL.

Three leaves are the smallest quantity that can make a tweel, and its fabric comes nearest to the fabric of plain cloth. There are a great many different kinds of cloth made by the three leaf tweel, such as jane stripes for shirting, ticking for beds and pillows, furniture stripes, &c., &c. From Figure No. 2, it will be seen, that two-thirds of the warp is on one side of the cloth, and two-thirds of the weft upon the other; this is accomplished by sinking two leaves, and raising one every shot. The hand-loom weaver, when working a three leaf tweel, in general uses six treadles, although it can be woven with three; but in the power-loom never more than three are employed.

No. 2.



No. 3.



It will also be observed that the yarn is drawn through the heddles, as follows:—One thread on the first or front leaf, one thread on the second leaf, and one on the third or back leaf; and the first shed is to sink the first and second leaves and raise the third; the second shed is to sink the first and third leaves and raise the second; the third shed is to sink the second and third and raise the first, and repeat.

To make what is called a herring bone tweel, with three leaves, the same treading as above will do, but the draught will be as follows:—Suppose the cloth is for bed tick, and the pattern 12 of blue, and 12 of white, then the web will require to be drawn, as shown in No. 3, which is six threads of blue drawn through the heddles, beginning with the first leaf, and six threads, beginning with the third, and the white drawn in the same manner. It will be observed that the tweel turns upon two threads, which does not make the herring bone so neat; but if it be drawn, as shown in No. 4, with 10 threads of blue, and 10

No. 4.

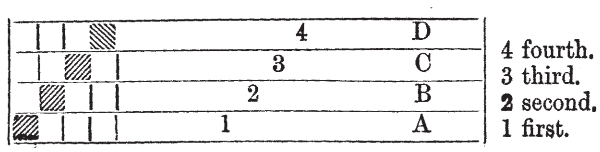
		3			6			9				13			16			19	
	2			5		7			10		12			15		17			20
1			4				8			11			14				18		

threads of white, then the tweel will turn on one thread, which is the proper way.

A FOUR LEAF TWEEL

Can either be drawn straight over, or a heddle on each leaf alternately; when it is drawn straight over, as shown in No. 5, the first shed is

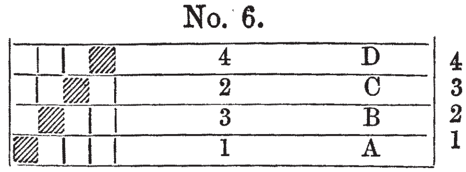
E No. 5.



the back leaf up and the other three down; the second is the third leaf up and the other three down; the third is the second up and the other three down; and the fourth shed is the first (or front) leaf up and the other three down. Let the beginner understand this figure No. 5 thoroughly, and there will be no difficulty with the other tweels that follow. That part of the figure at E, is a representation of design paper, or the cloth with a four leaf tweel, and the dark squares are the warp threads that are above the weft, and the white squares are those that are below it. The spaces that are marked A B C D, represent the leaves of the heddles, and A is the leaf next to the lay, or what is called the front leaf; the figures 1, 2, 3, 4, are the draught in the heddles once over.

If a four leaf tweel be drawn, as shown in No. 6, which is the common way for the power-loom, it being more convenient where both plain and tweel cloth are working in the same factory; because by this draught, plain cloth is made by fixing the two front leaves together as one, and the two back ones as another, and fewer spare thrums will be required, as they will do for either tweel or plain.

No. 6.



In this plan the treading will be different; the fourth leaf will be raised first; the second, second; the third, third; and the first fourth.

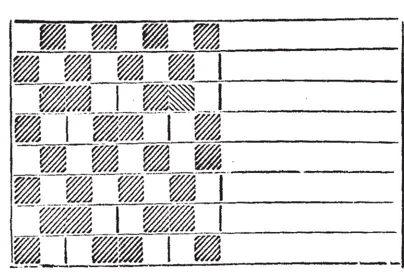
A very large quantity of cloth is made by a four leaf tweel, where the warp and weft are equal on both sides of the cloth, this is managed by sinking two leaves, and raising two alternately.

Take No. 6 for an example—

1st sink A and C
2nd " B " C
3rd " B " D
4th " A " D

This tweel answers better for sheeting and skirt lining than the common four leaf tweel. The appearance it has on the cloth is shown by figure No. 7, the shedding being repeated two times over.

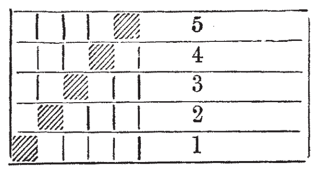
No. 7.



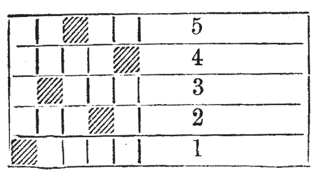
A FIVE LEAF TWEEL.

Figure 8 is a regular Five Leaf Tweel, and figure 9 is what is called a broken one. And in these two

No. 8.



No. 9.

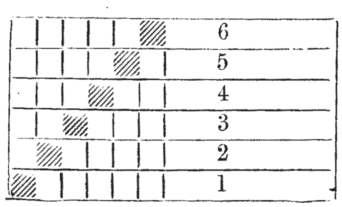


figures, as in the other plans that follow, the black squares are the leaves that are raised, and the white ones those that are sunk, and the numbers 1, 2, 3, 4, 5, are the draught.

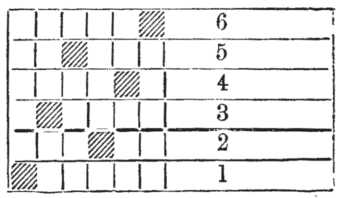
SIX LEAF TWEEL.

No. 10 is a Six Leaf Tweel, and No. 11 is the same broken.

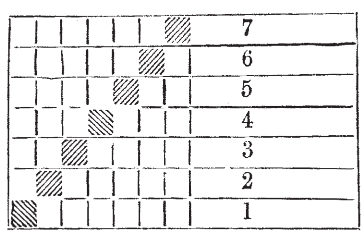
No. 10.



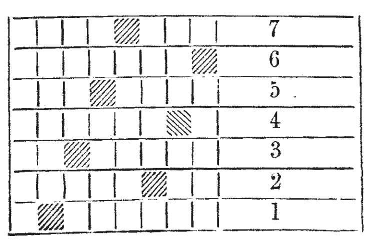
No. 11.



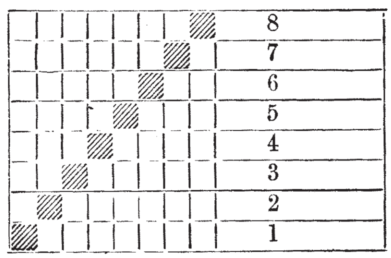
No. 12 IS A REGULAR SEVEN LEAF TWEEL.



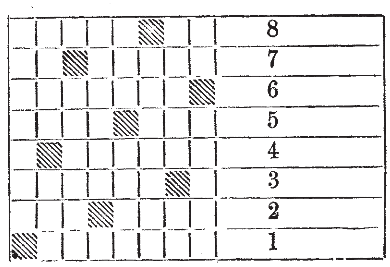
No. 13 Broken.



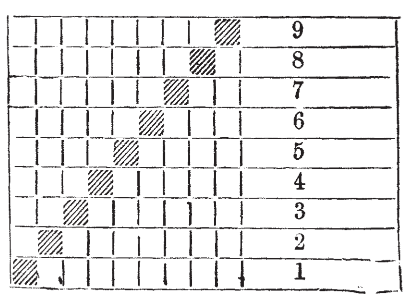
No. 14 IS A REGULAR EIGHT LEAF TWEEL.



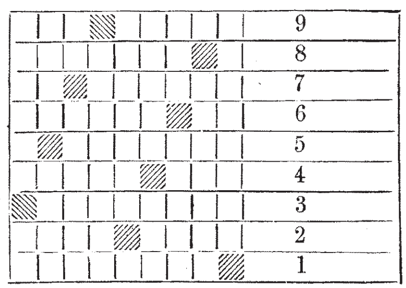
No. 15 Broken.



No. 16 IS A REGULAR NINE LEAF TWEEL.



No. 17 Broken.

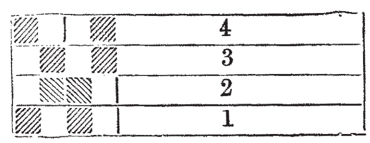


The examples given will be sufficient to show how regular tweeling is done. It is seldom that more than nine leaves are used for a regular tweel, for when the tweel is large and regular, the cloth has the appearance of small diagonal stripes, but when the draught or treading is changed, so as to raise the warp threads at intervals, of one, two, three or more from each other, the tweel will be broken, and the cloth will not have the corded appearance.

The following plans are all Broken or Fancy Tweels, and they may be varied according to taste. But when it is possible, the intervals should be regular, as it makes the tweel more perfect; and the tweel is said to be imperfect when the number of leaves will not admit of this.

It will be observed in the foregoing examples of tweels, that one leaf is raised, and the others sunk; but in what follows, they are sunk and raised in all varieties to make the pattern wanted. No. 18 is the tweel generally called the blanket tweel; it is also used for making sheeting, and a number of other fabrics.

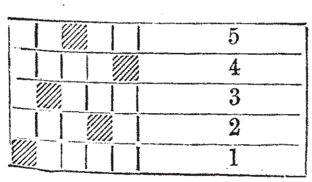
No. 18 BLANKET TWEEL.



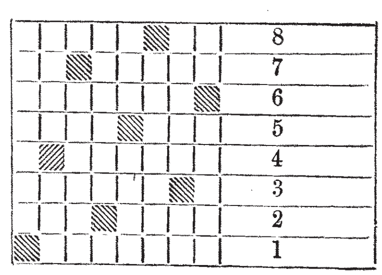
No. 19 is a Five Leaf Tweel, very much used for making table-cloths; and No. 20 is an Eight Leaf Damask Tweel, also much used in making table-linens. We will have more to write about this tweel under Damask Weaving.

No. 19 A FIVE LEAF TWEEL FOR TABLE-CLOTHS, AND No. 20 IS AN EIGHT LEAF DAMASK TWEEL.

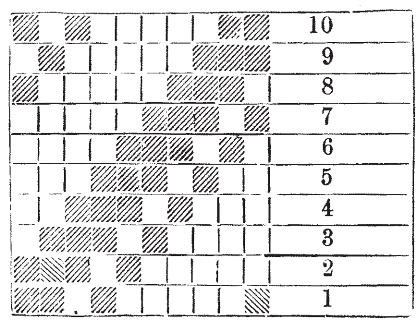
No. 19.



No. 20.

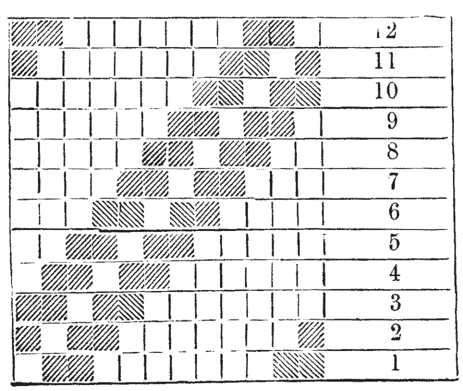


No. 21 A TEN LEAF FANCY TWEEL.

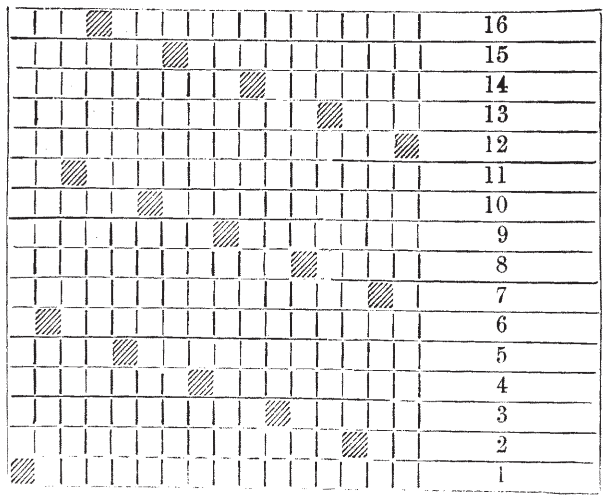


No. 22 A TWELVE LEAF FANCY TWEEL.

This is a very good tweel for some kinds of woollen goods, when the cloth is wanted to have a soft feel, such as scarfs for ladies and gentlemen.



No. 23 A SIXTEEN LEAF TWEEL, WHICH IS CALLED THE FULL SATIN TWEEL.



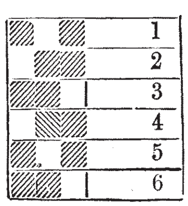
DIAPER.

Having given the draught and treading of a number of tweels, it is presumed that the examples given will be sufficient to make the principles of common tweeling understood; and if so, the method of drawing Diapers, and the treading of the same, will be readily comprehended. The few following patterns given here have not been published before, so far as known to the writer, except in the first edition of this work. They were brought out for dresses and other fancy goods, and at that time had a very good run, and I see that a number of them are still made and sold at the present time.

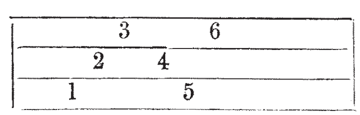
Diaper weaving was at one time chiefly confined to the manufacture of towelling and table-cloths, but it is now applied to a great many different kinds of goods. At the present day, hundreds of power-looms are making nothing else but Diaper cloth, which is sent to the Indian market, under the name of figured long cloths, figured shirtings, &c., &c. The Diaper is also used for pinafores, cloutings, neck-ties, ribbons, and dresses of all kinds, and they are all woven on the same principle, viz., reversing the tweel, and altering the draught. It will be obvious, that the more leaves that are used the greater will be the scope for making a large variety of patterns; the mounting of them in the loom will be explained under the head Diaper Weaving.

No. 24 A THREE LEAF DIAPER.
A IS THE DRAUGHT, & B IS THE TREADING.

No. 24 B.



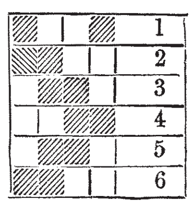
No. 24 A.



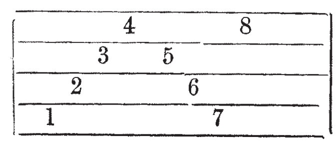
This Diaper is called the Irish eye, and is the best of all for nursery diapers, cloutings, and such like cloth.

No. 25 IS A FOUR LEAF DIAPER. A IS THE DRAUGHT, & B IS THE TREADING.

No. 25 B.



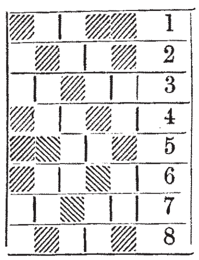
No. 25 A.



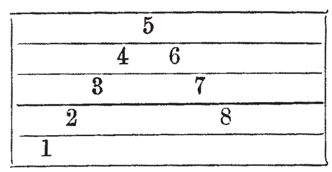
It will be seen on examination that the three leaf Diaper has two-thirds of the weft thrown to the one side of the cloth, and two-thirds of the warp to the other; but the four leaf Diaper has the warp and weft equal on both sides, which makes by far the best bird-eye Diaper, although the three leaved one looks much finer, if they are both woven in the same set of reeds, and both have the same quantity of shots on the glass. But suppose the warp of the three leaf tweel to be white, and the weft brown, or some other dark colour, then the one side of the cloth would be much darker than the other; this answers very well for some kinds of goods.

No. 26 A FIVE LEAF DIAPER WITH EIGHT TREADS.

No. 26.



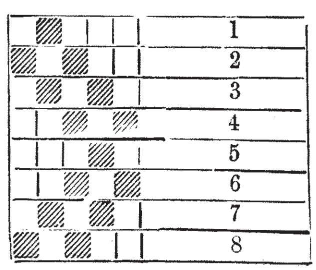
No. 27.



Drawn as shown at No. 27, which is called the diamond draught, and it has eight different treads to complete the pattern.

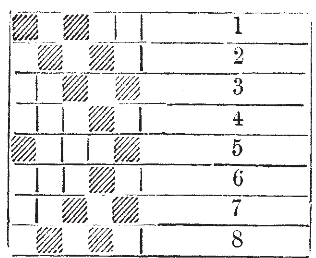
No. 28 is also a Five Leaf Diaper with Eight Treads, and the Nos. 1, 2, 3, 4, 5, 6, 7, 8, on the right hand side of the pattern show how the treading proceeds, and all other patterns are treaded on the same plan.

No. 28.



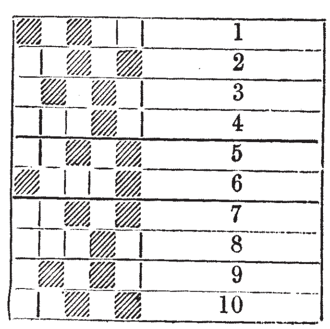
No. 29 is a Five Leaf Diaper. This pattern when woven, has the appearance of being striped, and makes a neat little pattern for a cravat or neck-tie, when made in silk or worsted.

No. 29.



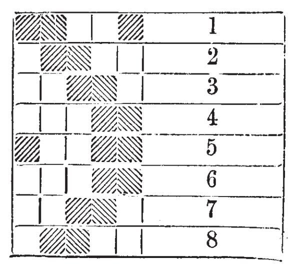
No. 30 is a Five Leaf Diaper, with Ten Treads, and answers for the same kind of cloth as No. 29; it has a bolder appearance when the warp and weft are different colours.

No. 30.



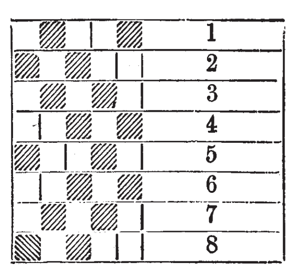
No. 31 is a Five Leaf Diaper, with Eight Treads; the figure in this one appears smaller than in Nos. 29 and 30.

No. 31.



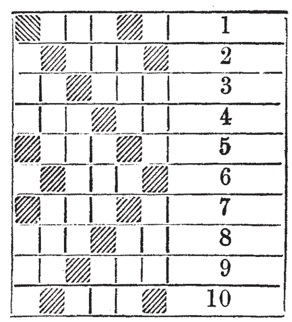
No. 32 is also a Five Leaf Diaper, and is the last one with five leaves that will be given in this place; the cloth of it is firmer than the preceding ones, and will be better adapted for bleached cloth than for coloured goods.—It has only Eight Treads too.

No. 32.



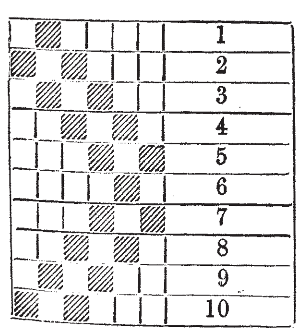
No. 33 is a Diaper with Six Leaves, and has Ten Treads to complete the pattern; and, although it has six leaves and ten treads, it makes as firm a piece of cloth as four leaves and six treads can do.

No. 33.

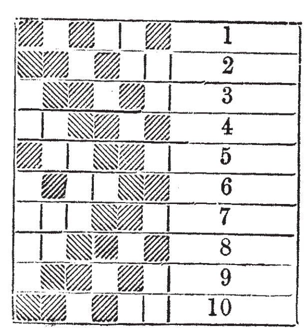


No. 34 is another Six Leaf Diaper with Ten Treads upon it; also No. 35.

No. 34.

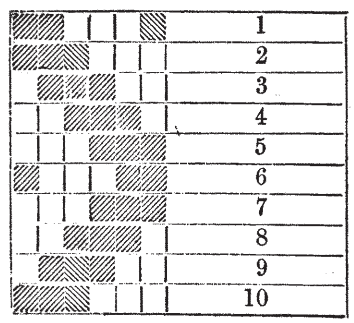


No. 35.



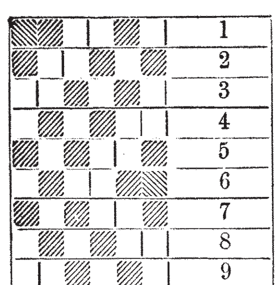
No. 36 is a Six Leaf Diaper with Ten Treads. It is very much flushed, and is a pattern that will answer well for a heavy piece of cloth.

No. 36.

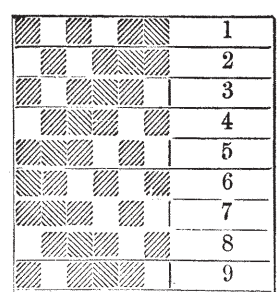


No. 37 and No. 38 are both Six Leaved Diapers with Ten Treads. They are good patterns for dresses, as the figure is well brought out, and a good fabric of cloth kept up.

No. 37.

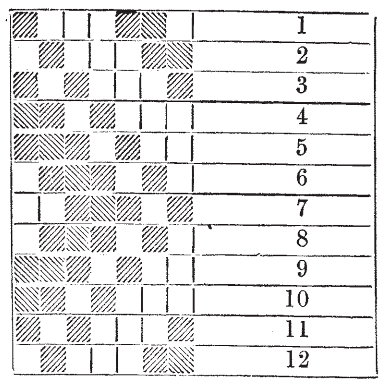


No. 38.



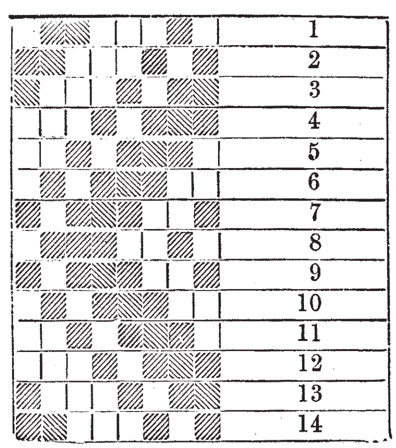
No. 39 is a Seven Leaf Diaper with Twelve Treads, which does very well for towelling in linen, when large diaper patterns are wanted for a fine class of goods. It also suits for figured long cloths and shirtings.

No. 39.



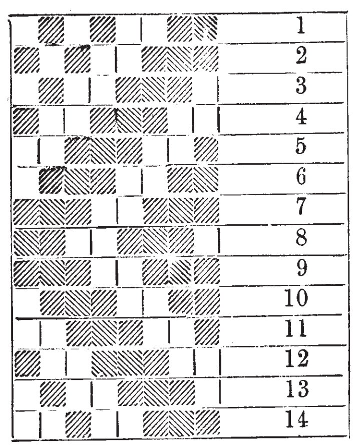
No. 40 is an Eight Leaf Diaper with 14 Treads, and has a fine bold appearance, and will answer for the same description of goods as No. 39.

No. 40.



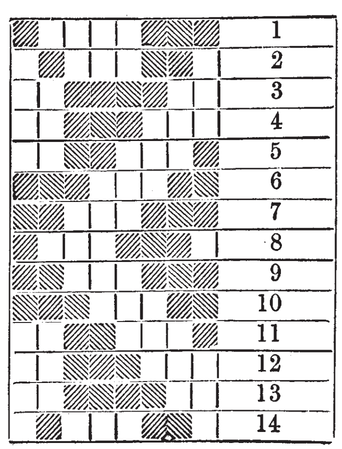
No. 41 is another Eight Leaf Diaper with 14 Treads. From the manner of its flushing, it is well adapted for making a heavy fabric, suitable for vest pieces, or any other kind of stout cloth.

No. 41.



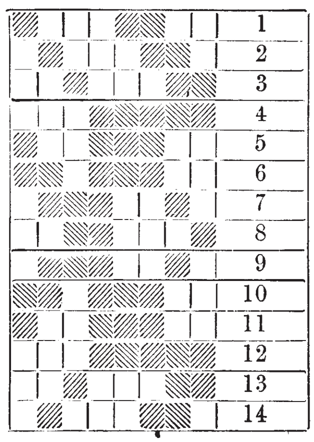
No. 42 is an Eight Leaf Diaper with 14 Treads. It is a sort of double figure, and looks very neat in fine cloth.

No. 42.



No. 43 is an Eight Leaf Diaper with 14 Treads. This one makes a kind of star.

No. 43.



From No. 26 to No. 43 inclusive are all drawn the diamond draught, which is shown at No. 27. By the late improvements made on the Dobie machine it has been more generally used for larger tweels, which were done before by the barrel.

CHAPTER III.

ON STARTING POWER-LOOMS.

In the preceding pages we have given a general outline of how a web should be prepared, and brought it forward till it is ready for the loom; also a number of draughts, and how the heddles should be treaded. We will now endeavour to show how the yarn is to be made into cloth; and, as it is the loom that makes the cloth, an explanation of how it should be worked is deemed necessary.

Manufacturers, managers, and tenters, or those who have the charge of setting power-looms agoing, should have a complete knowledge of the whole Theory; and, as this is intended alike for beginners, as well as for those who have got a little practice, no excuse will be made for placing before the reader, in the plainest language possible, the whole system of starting power-looms. In another part of this work it will be taken notice of how a power-loom should be made.

The reader is now to suppose himself in a factory where the gearing is already up, all right and ready for motion. Well, the first thing to be done is to get a plummet; take the line that is attached to the plummet, and hang it from the end of the first shaft that is to drive the looms, and, where the point of the plummet touches the floor, make a mark with the point of it, and put a chalk mark round the plummet mark; then go to the other end of the shaft and plum it in the same manner. After this is done, take a cord and rub it all over with chalk, then fix it on the floor, being careful to have it passing right over the two plummet marks; then take hold of the cord with the points of the finger and thumb, near the centre, and lift it up a few inches from the floor, and then let go; this will leave the mark of the line on the floor. This line should also be drawn with a sharp point, to leave a permanent mark on the floor, so as it may be referred to at any time when required; and in some mills it is required pretty often when shifting looms, or taking down shafts and hangers. If the gearing is properly put up, all the shafts will be parallel with each other, and also with the line on the floor, so that there is no necessity for plumming all the shafts, if care be taken in the measurements.

Now that the first line has been got across the flat of the mill or shed, as the case may be, draw a line at right angles with the first line, along the whole length of the flat. As the walls of the mill are not in general straight, it is not the proper way to take measurements from them; the proper way to get this line is off the first. Take a rod of wood or a cord about ten feet long, and fix a nail or draw-point at each end, then put one point into the plummed mark which is on the first line, and draw part of a circle with the other point; then take the rod and go to the other plummet mark, and describe another part of a circle, till it intersects or crosses the other line drawn as part of a circle. When this is done, find the centre between the two plummet marks on the first line, then stretch a cord the whole length of the flat, causing it to pass over the marks in the centre of the first line, and over that part where the circle lines cross each other. Having got both the lines drawn to take the measurements from, for placing the looms, care must be taken to have them all set parallel with the shafts, or the belts which drive the looms will not work well. At the same time that they are set with the cross line, they must be kept at the proper distance from the line that is drawn along the flat, and that distance will depend upon the space that is to be allowed for the passages. If the looms are made with the driving pulleys to suit, then they are all set at the same distance from the long line; but if the looms are made with the driving pulleys all at the same distance from the ends of the looms, then they must be set to answer the belts, by keeping the one out from the long line one inch and the breadth of the pulleys farther than the other, and so on alternately. This is done for the purpose of giving the belts room to work. When the looms are all set in their places, the next thing to be done is to get them made level. A straight-edge and spirit-level is required for this work. Place the straight-edge along the loom, and put the level on it. If the loom is not standing fair, put a piece of wood under the foot at the low side, to bring it up to the level. If the looms are to be placed down on stones, the stones should be made level before placing the looms upon them.

When the looms have been all set fair and square and bolted down to the floor, the next thing to be done is to look if all the wheels are properly pitched; and the workman should not mind who is the maker of them, for the very best machine makers have sometimes careless workmen, and a bad job may escape the eye of the manager at times. It is therefore better to look and see that all is right about the working parts himself, and to put a little oil on each journal before putting the driving belts on. To ascertain the length of the belt, the usual way is to take a cord and pass it round the drum and loom pulley, and measure the belt from it; but, if the looms are to be driven from the flat below them, this will not be so easily done; and the method for finding the length of the belt in this case, is as follows:—Take the distance from the loom pulley to the floor, and from the floor to the shaft below; and find out the distance from the loom to the shaft, by boring a small hole in the floor, and putting down a plum-line right below the loom shaft, then measure from the cord to the shaft, and draw the drum and loom pulley on the floor at the distance found by the measurement; also draw a line to represent the floor, and the exact place will be seen where the floor should be cut for the belt. The length of the belt can be taken from this drawing.

When putting the belt on to drive the loom, care must be taken to have all the joinings of the belt running in the same direction, and they should also run with the pulley or drum. The writer has seen workmen that had been years at the trade, who did not know, or, if they did, they paid no attention to this simple rule, although it is a very important one. After fixing up the protector, and taking off the weft stopper fork, the belt should be put on and the loom allowed to run for a few hours without the shuttles; then put a reed into its place in the lay. A pair of shuttles should now be selected, and, to ascertain if they are a pair, try them with callipers to see that they are both the same breadth, and place them on the race of the lay, or some other plain surface, to see if their tips are all the same distance from the bottom of the shuttle; this can be done by bringing the tips of each shuttle in contact with the tips of its neighbour; if the shuttles are not properly matched, the workman need not expect to have a good working loom; for, if the shuttle box is made to fit the one, it cannot fit the other, and the shed may answer for one of the shuttles and the other dip below some of the yarn, which will spoil the cloth.

HOW TO PITCH THE LOOM.

The common meaning in the trade as applied to Pitching a Loom, is to set the shedding and picking motion in the proper relation to each other; but the correct definition of pitching the loom extends to the fixing and setting of all its working parts; and the first thing to fix is the shuttle boxes, and the front box side should be set parallel with the back one (not wider at the one end than it is at the other, as is very commonly done by some workmen who do not understand their business). The shuttles should go into the boxes quite easy, but not to have too much play; the boxes should be about the tenth-part of an inch wider than the shuttle is broad. After the shuttles are fitted into their boxes, the next thing is to put on the drivers, and if the lay has spindles, the drivers should be made to slide along on them quite free, and not to touch the race of the lay. When the drivers are got on, then put on the shuttle cords, keeping them both the same length, and when the lay is half way back, the drivers should come within one inch of the end of the lay. If the drivers are allowed to strike against the end of the lay, the weft copes will be in danger of being torn, and also the drivers themselves will have a tendency to be split.

The loom will now require to be what is (commonly) called pitched—that is, setting the shedding and picking motion in their proper positions in relation to the other working parts of the loom. If it is for heavy work, the shed must be full open when the lay is just at the turn to go back; if it is for muslins, then the shed should be close when the lay begins to go back. This is in general done by taking the main wheel out of gear, and turning the wyper shaft round until it comes to the proper place for the shedding. After this is accomplished, the picking pulley (or cone, or whatever other article the loom has got for giving motion to the shuttle) is next set in its proper place, and, as a general rule, the lay should be nearly half way back when the shuttle begins to move. To ascertain that the picking is properly set, the workman takes hold of the lay with the one hand, and the driver with the other, and turns the loom until he feels the driver begin to move; he can then see if the lay is at its proper position, and, if it is not, he alters the picking pulley to suit. If the loom is made on the right principle, the driver should come within two inches of the spindle head when the shuttle is full picked; if the driver comes up tight to the spindle head, the form of the picking apparatus has not been made right, which will cause a loss of power.

The protector or mechanism that stops the loom when any accident occurs, can now be arranged and put in right working order, so that when the shuttle is out of its place, the loom will be stopped in a proper manner. This should be attended to very carefully, as carelessness in setting this motion causes many smashes in the warp. If it is a loom with the old knock-off (or chap-off as it is called in Scotland) motion, with the spike and frog, the spike should be allowed to touch the frog, when the shuttle is out of the box, and be of sufficient length to have the loom stopped when the lay wants at least two-and-a-half inches from being full forward The distance of the lay from the fell of the cloth will depend upon the size of the shuttle and the kind of yarn that is to be woven; and when the shuttle is in the box, it should clear the frog about a quarter of an inch. But if the loom be made with the fly reed motion, then the spike for stopping the loom does not act, except when the shuttle stops in the shed, and the reed is thrown back. The spike in this loom should be set so as just to touch the small nob on the handle of the loom, and the weight or spring which keeps the reed in its place when the shuttle is running, must be so set as to allow it to go back at the instant the cloth begins to press upon the shuttle.

The loom should now be put on to work for a short time with the shuttles, before the web is put into it. This is the best time to examine all the working parts again to see if they are all in good working trim; it is also the best time to see how the shuttle runs along the lay. If it runs straight, and enters the box without any stammering, it is all right; but if it has a quaver when it runs across the lay and does not go easily into the box, then there is something wrong, and that something must be made right. The following are a few of the things that occur to cause the shuttle to run uneven:—The shuttle itself may be round on its back, which will cause it; the reed may not be fair with the back of the shuttle box; the race of the lay may not be straight; the spindle for the driver, or the groove for the tongue of the driver may be wrong; the box sides may be so placed as to cause it, or the picking itself may be too strong; and many a time it is caused by obstructions which occur for want of cleanliness, by allowing oil and dust to cluster in small pieces about the box.

After all has been ascertained to be right, the web can be placed in the loom; the cords are now put into the heddle shafts at the places where they will suit for the roller above, and the marches or treadles below; the heddles are then hung to the small straps for supporting them, and the reed is fixed in the lay. The eyes of the heddles should now be made to hang opposite the centre of the reed, and parallel with the race of the lay; the pace cord is next put on, and then the yarn of the web is tied to a rod which is fixed with cords to the cloth beam. This is knotting up the web (as it is termed in the trade). While knotting up the web, the workman uses a brush to bring forward all the slack ends before he ties them; after all is tied, the heddles are moved a little backwards, and as much yarn unwound from the beam as will allow the rod to pass over the breast-beam. The heddles are next attached to the treadles, and are adjusted with the cords, straps, or screws, in such a manner as both the heddles and treadles will be even at the same time when the treadles are in contact with the wypers. By moving the loom now, it will be seen how the warps are shedded; if the sheds do not please, the heddles can be taken up or down by means of the cords, or straps, till once a proper shed is made. When the shed is full open, the warp threads should not be rubbing on the race of the lay, but as far down as just to clear it, nor touching the top rim of the reed; indeed, for light work the smaller the shed is the better, if the shuttle has sufficient room to pass freely through it; but in heavy work the sheds are made larger, for the purpose of putting a proper finish on the cloth, by spreading the warp threads, &c.

The loom and the web is now ready for making cloth, which can be done by putting the shuttle in with weft in it, and setting the loom in motion, either with the hand for a few shots at first, or putting on the belt. It is the workman's duty who starts the loom, to see that the proper quantity of shots are on the cloth, and that all other things are right about the loom and web before it is left to the superintendence of the weaver; it is very annoying to the weaver to have occasion to call him back frequently to adjust some trifling thing which might have been done at first.

If the loom has a regular uptaking motion for the cloth, which requires the pinion to be changed to alter the quantity of shots, the pinion required is in general found by simple proportion; but when the loom is new, as the reader may suppose the one under explanation, the rule is very different, which will now be explained. The first thing is to ascertain the number of shots that are to be on the cloth; then find the circumference of the beam that winds up the cloth (commonly called the card or emery beam), also the number of shots contained in the cloth, the length of which will be equal to the circumference of the beam; also count the teeth of the wheel on the end of the beam, and the number of teeth in the ratchet wheel, and from these the proper pinion will be found.

EXAMPLES.

Suppose the cloth is to have 10 shots on the glass, (Scotch glass), or 54 shots on the inch, which is nearly the same; and, suppose the circumference of the beam to be 13 inches, and the wheel on the end of the beam to have 140 teeth, and the ratchet wheel 120; multiply the shots on one inch by the circumference of the beam, and divide by the number of teeth in the ratchet wheel, and the answer will be the divisor for the beam wheel, and when divided, the quotient will be the number of teeth for the pinion.

```
   Shots on one inch,           54
   Circumference of Beam        13 Inch.
                               ----
                               162
                               54
                               ----
 Teeth in Ratchet Wheel    120)702(5·85
                               600
                               -----
                                102·0
                                 96·0
                               -----
                                 600
                                 600
                               =====
```

The teeth in the wheel on the end of the beam is divided by this number, 5·85, as under:—

```
5·85)140·0(23·93, nearly 24 Teeth.
     1170
     ----
      2300
      1755
      ----
       5450
       5265
       ----
        1850
        1755
        ====
```

It will be seen from the above calculation, that the pinion required has 24 teeth, and for any other number of shots more or less, the pinion can be found by simple proportion. For example, if 10 shots require 24 teeth, how many will 8 require? Eight will require more: thus—

$$\begin{array}{r} 24 \\ 10 \\ \hline 8)240 \\ \hline 30 \end{array}$$ Teeth for 8 Shots.

On the principle upon which looms are made at present, a proper pinion cannot at all times be found to answer the exact number of shots; but if they were made with the shifting pinion to be the driven instead of the driver, then the proper number of teeth could be got for any given quantity of shots, and this would only require a little alteration in the construction of the loom for the uptaking motion.

Suppose the loom is all in good working order for making cloth, the weaver's principal work is to fill and shift the shuttles, and tie and take in through the heddles and reed all the broken ends. The weft stopper will stop the loom when the weft is exhausted in the shuttle; and when a warp thread breaks in the shed in a position to make a scob or float, the scob preventor will also stop the loom, and an apparatus may also be applied to change the shuttle without stopping the loom. But those things will be explained in the next chapter, along with a number of other things that are now attached to the power-loom.

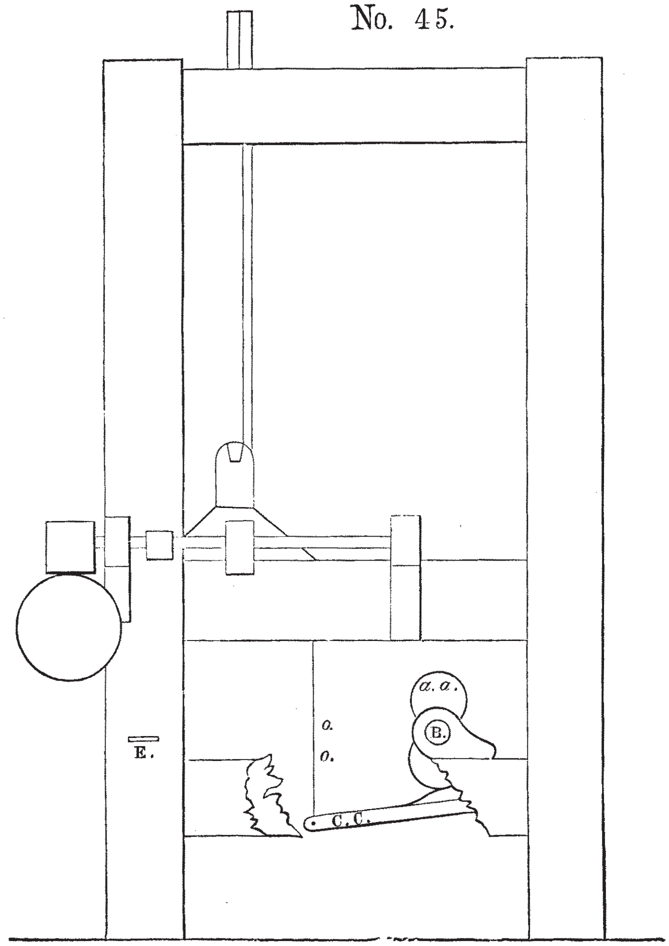
CHAPTER IV.

ON POWER-LOOMS.

The construction of power-looms, as they were made some sixty years ago, will still be remembered by many people yet living, as it is only a comparatively short time since they were working in Messrs. John and Robert Cogan's Mill at Pollokshaws. They were at first started by Mr. John Monteith, at that village, and they are taken notice of here for the purpose of showing the young reader how the power-loom has progressed; and it may be mentioned that the principle of some of the movements about this loom has formed subjects for patents within the last twenty-five years.

The framing of the loom was made of wood, much in the same manner as the common hand-loom, and the lay swung from the top, and was made on the same plan as a hand-loom weavers'. This loom had no crank shaft or connection rods to give motion to the lays; it had only one shaft, which was called the wyper shaft, placed in the same position as the wyper shaft

No. 45.



is in the common power-loom at the present day, its length being the full breadth of the loom. This shaft received its motion from a small shaft with a fly-wheel upon it, which shaft was placed between two looms for the purpose of driving them both with one belt. Each loom had a movable clutch or coupling on the wyper shaft, which was thrown into gear with the fly-wheel shaft when the weaver wished to put the loom in motion.

By referring to Figure No. 45 it will be seen that the lay was taken back with the cams *a*, *a*, on the shaft B, by coming in contact with the treadles C, C, and depressing them, and pulling along with them the straps *o*, *o*, which are fixed to the lay. As soon as the full part of the cams had passed over the pulleys on the treadles C, C, the spring E pulled the lay forward to the fell of the cloth; but it will be evident that when no cloth was there (as at the beginning of a web) the lay would strike against the posts of the loom, so that the person who put the web in, had to hold back the lay with his hand till once a certain quantity of shots were woven. After the web was started, the uptaking motion regulated the traverse of the lay, and this uptaking motion was a very simple and ingenious one. The yarn beam was placed in the loom in the usual way, with a spring added to the end of the pace cord for the purpose of allowing the warp yarn to yield to the shedding, and this spring was fixed to the floor. The reed was so placed in the lay that it was at liberty to move back a little when it came in contact with the cloth, if the cloth was too thick. The spring for the purpose of pulling the lay forward was set to suit the force that was required for putting on the quantity of weft desired. With this explanation, the following description of the uptaking motion will be easily understood:—As will be seen from the drawing at Figure No. 45, the beam for winding up the cloth has a wheel on its end, with the worm on the end of the small shaft working into it. On this small shaft was a ratchet wheel with its teeth about half-an-inch long, the teeth of which was made on its side, and the catch for giving motion to it was so arranged as it would take one tooth every pick of the loom just at the instant the lay was at the fell of the cloth; but if the lay moved the smallest space further forward than was necessary, it struck the top end of the catch and prevented it from turning the ratchet wheel, so that, when the loom was working without weft, the cloth beam did not move. It will be obvious that the traverse of the lay could be made short or long by the setting of the uptaking motion catch. If it was set towards the breast beam, the traverse would be made long in proportion; if it was set back, then the traverse of the lay would be made shorter. This was a very simple way of altering the travel of the lay, and it had its advantages as well as its defects. But it will be evident to the reader who is acquainted with power-loom weaving, that this loom could never have been made to make heavy work, unless a very powerful spring had been applied to it to pull the lay forward; and as it had no protector to stop it, when the shuttle, by any accident stopped short in the shed, a strong spring would have broken the warp yarn, but with a proper protecting apparatus, this loom was well adapted for giving the weft shot a double stroke, as is done by the hand-loom customer weaver—a thing that has occupied the attention of many in the power-loom trade, and a thing that could be very easily done if it was absolutely wanted. It was only necessary in this loom to make the cams that took back the lay with a double perfory, and then the fell of the cloth would get a double stroke with the lay every shot.

As already stated, the reed in this loom was allowed to move back a little when it came to the fell of the cloth, so that when the loom went without weft, the reed met with no resistance from the cloth, and the uptaking motion ceased to work. Mr. Stone had a patent loom, the reed motion of which was something similar, and he took advantage of this motion of the reed for the purpose of delivering the warp from the yarn beam, with an apparatus the same as was on this loom for- the cloth beam; indeed the movable reed has been the principal feature in a great number of patents both here and in America. We will take notice of some of them further on. In writing the first edition we did not think it worth the trouble to give them; but as the writer has been repeatedly asked about some of these old things, they will be given in this edition.

To prevent any one who may read this from troubling himself about inventing things that have already been done, it may not be out of place to state here a number of things that have been tried in connection with the power loom, and now all given up, or at least not in general use.

There was a power-loom mill put up in Glasgow that had no belts at all for driving the looms; it was four or five stories high, and an upright shaft went from the bottom to the top between each pair of looms for the purpose of driving them. The bevel wheels on the upright shafts geared into bevel wheels on the looms, and when the loom was to be put in motion the weaver drew a clutch into gear with the bevel wheel which was running loose on the loom shaft. This did all very well for driving the looms, but when it had to be stopped with the old frog motion, it very often broke something about the loom.

Another mill was built about the year 1824, in a fine airy situation. It was got up with considerable taste and expense. The looms were placed in such a manner that the weavers all looked in the same direction when working; this looked very well, but the arrangement caused expense for double the quantity of gearing. Whatever was the cause, the party that started it did not succeed, and the work passed into other hands.

DOUBLE LOOM.

There was a great anxiety with some of the power-loom weavers at one time for working two webs in one loom, and one of them made a vertical loom for that purpose The yarn beams were placed next the floor, and the cloth beams at the top of the loom, and the lay or lays went up and down by means of cranks and connection rods. As a matter of course the heddles were placed below the lay horizontally, and were tied across the loom from front to back beneath the reeds. When the sheds were opened the shuttles began to run along the face of the reed to the other side of the loom. The other movements for pacing the warp and winding up the cloth, &c., need not be explained, as this loom never came into practical use. Another party, in the year 1846, got two looms made (for which a patent was obtained) for working two webs in each loom. This loom will be readily understood, as it was just one loom fixed on the top of another, arranged to allow the weaver to work them (of course the framing was made to answer this arrangement) with as much facility as possible. As this loom had some advantages for working plain light work, it deserves a few words of explanation. The top or crank shafts were the same as those in the common loom now in use. The lay was placed on slides fixed at the sides of the loom, instead of being on swords, and the con nection rods were fixed to the back of the lay so as to have the space all clear between the two webs. This loom had no wyper shafts, and for the shedding motion, which is generally worked off the under shaft, it was mounted with a common heddle roller below the heddles, the same as above, and on the end of one of these rollers was a pinion, which geared into a segment of a wheel that received its motion from the wheel driven from a pinion on the crank shaft. (This shedding apparatus was almost the same as that in Todd's patent loom for working the heddles); the crank shaft pinion made two revolutions for one of the wheel, and on this wheel was placed a picking pulley for the purpose of giving motion to the shuttle, in the same manner as what is understood in the trade by the name of dog-leg pick. This loom had a wheel and pinion at each side of it, which was necessary for picking the shuttle, and for the purpose of giving the weaver as much space as possible for working the under web. The breast beam was made of cast iron, hollow below, to allow the cloth beam to be placed as close to it as possible; the uptaking motion for the cloth beam and the pace for the yarn beam were of the common kind. In this double loom the two webs were perfectly distinct, the one could be working while the other was standing. Each web had its own weft stopper, protector, and driving belt.

The inventor of this loom expected to have got the following advantages from it:—He had a mill that was put up for four hundred common looms, and the same space filled with the double looms would have woven eight hundred webs; the same gearing except the drums would have done, and had there been no disadvantages, the saving would have appeared thus:—

For space 400 at 15s. each,..........	£300	℔ year
,, interest on gearing,...............	45	,,
,, interest on first cost of looms,..	20	,,
	£365	

But a larger saving was expected from another source, and that was the working of four webs by one weaver. At the time this loom was brought out, a very strong prejudice existed among the power-loom workers in Glasgow against working four looms, and it was thought they could be got to work four webs in two looms at a lower price per piece; taking the whole into consideration, it was not at all what may be called a bad idea.

We made no mention in the first edition who the party was that took out the patent for this double loom, but as the writer has been asked about it by several persons, we shall state something regarding it. The gentleman who took out the patent was Mr. James Clark of St. Rollox. After experimenting for a considerable time with one loom, he and the workman that he employed being unable to manage to get the one web to work when the other was standing, which was one of the things Mr. Clark was anxious to accomplish, he sent for the writer, and showed him the loom that they had made, and wished to have his opinion about it. He told Mr. Clark that it was quite a practical thing to make double looms, or a loom to weave two webs, the same as the one for which he had taken out a patent, but that he was afraid it would not pay him, as it would be quite new to the workers, and they would accordingly require to be trained to work it, and that as the principal saving was in the space occupied by the looms the inconvenience the weaver might have would counterbalance that saving. However, the consultation ended in Mr. Clark giving the writer an order to make two pairs of looms. New patterns were made for the framing, and the two looms were made and started to Mr. Clark's entire satisfaction, but not to the writer's.

The other loom we are about to describe was also made by the writer for Mr. David Smith, manufacturer, St. Rollox. Mr. William Syme was manager with Mr. Smith at the time the loom was made, and he was quite delighted with it, and being very fond himself to go and see any new thing in power-looms he showed this loom off to all who asked to see it. As stated, the only novel thing about this loom was the mechanism for the centre box, which was called "the monkey." It consisted of a lever hung by the centre on the catch that was attached to the protection rod, and in each end of the lever there were set screws for adjusting it.

This loom for two webs was made about the year 1847, but no patent was taken out for it, and it seemed to have answered the purpose of the manufacturer at the time, as he got a lot of them made after experimenting with two of the looms for some months; for what reason they were given up the writer does not know. This loom was made sufficiently broad so as to take in the two webs, with room in the centre of the lay for a shuttle box; the two shuttles were picked at the same time. Suppose one shuttle to be in the right hand box, and the other in the centre box. When the loom is set in motion, the shuttle in the centre box is driven to the left hand box, and the one on the right hand is driven into the centre box; the next pick will be the reverse, and so on alternately. It is evident that the centre box will always have a shuttle in it every shot, and the only novel thing about this loom was the protection for stopping it when any thing happened to keep the shuttles from getting into the boxes, and this was managed by a double protecting rod, with a little extra mechanism at the centre box. The centre box had double slots or swells, and unless the shuttle was full in the box to operate on both swells, the loom would be stopped. The working of two webs in the hand-loom on this plan is very old, and is much adopted in some districts at the present time; but this system of weaving is most profitable where expensive mountings are required, such as those that are used in weaving damasks and brocades. The mode of weaving ribbons, braces, and all kinds of narrow cloth will be explained in another place.

AIR PUMP PICK.

The driving of the shuttles (or what is called picking) has occupied the attention of many, and many different contrivances have been tried and failed, but only one of them will be taken notice of in this place. The inventor no doubt had in his mind the great expense that power-loom weavers are at for shuttle cords, treadles, and picking sticks, and the annoyance that tenters had in adjusting the shuttle cords. It is a great pity the invention did not succeed. The shuttle in this loom was driven by air, and to accomplish this, a small pump was placed at one side of the loom which was driven off the under shaft by means of a crank and connection rod, which gave motion to the piston of the pump that forced the air into a vessel, and from this vessel there was a pipe taken to a small cylinder which was fixed on the under side of the sole of the lay near its centre. The cylinder was similar to the cylinder of a horizontal steam engine, with its piston rod coming out at both ends. These piston rods were made of sufficient length so as to extend to be right under the centre of the shuttle boxes, and on the ends of the rods were fixed the brackets for giving motion to the drivers; the valve of the cylinder was moved by the motion of the lay, and the air was admitted into the cylinder in the same manner as steam is admitted into a steam engine. But it will be evident that the loom would require to be driven for a short time to get up the required pressure of air before the shuttle was put in; the force given to the shuttle was regulated by the pressure of air in the chest or air vessel, and the pressure in the chest was regulated by a safety valve, which allowed the air to escape when it became too strong The length of stroke in the air pump could be made short or long at pleasure, so as to give just the proper quantity of air required, without a waste of power in driving the air pump.

Since the foregoing remarks were published, in the first edition, under the head "Air Pump Pick," a loom was brought out by some party in England (I do not know the name of the inventor), and exhibited at Swan Pier, London, and from the remarks made in the newspapers at the time, it would appear that it was working well. But I think there must have been some drawbacks, or it would have been taken up by the trade before this time, if it had been an improvement on the present mode of picking.

THE COMMON POWER-LOOM.

What is meant here by the Common Power-Loom, is a loom for working plain cloth, and a description of one of the best that is in use at the present time will be given in this place. The writer believes that the credit belongs to James and Adam Bullough, of Blackburn, for the introduction of this loom, which has been a great acquisition to the manufacturer of plain power-loom cloth; indeed, before the introduction of Bulloughs' weft stopper and fly reed, the power-loom was (comparatively speaking) very deficient, for without the weft stopper the looms used to run at times hundreds of picks without putting in a single shot of weft, and it was not only the loss of time and power when the loom was working in this way, but the selvages of the web got all chaffy and out of order when the loom was working without weft, and this also caused a considerable time to be lost in getting the selvage yarn put right again, besides spoiling the cloth. The advantages of the weft stoppers are so evident to any power-loom weaver, that no more need be said about them, for in fact, the half of the weaver's time was taken up in watching the shuttles, so as the loom would not go without weft, knowing well the bad consequences.

I remember of hearing a conversation in the year 1826, in a small power-loom factory in Mitchell Street, Glasgow. There was only 40 $^{8}/_{4}$ looms in the factory, and they were to weave what was then termed "foundation muslin:" it was a 7^{00} with 7 shots 70^{s} or 80^{s} warp, and 70^{s} or 80^{s} weft; and as no weft stopper was on the looms, there was considerable difficulty in getting the cloth properly made at the joining of the weft. The machine maker and manager of the mill had been for some time trying to make the up-taking motion stop when the weft broke, or got exhausted in the shuttle. This was accomplished by allowing the reed to move a little back by the pressure of the weft shot. At this time some one had been trying experiments to stop the loom when the weft broke, and the conversation was about the probability of its success. Both were agreed that it would be a good thing for the power-loom, but both came to the conclusion that it would require machinery as fine as watch work to do it, and they thought that that would never do for the power-loom. The machine maker died, but the manager lived to see the weft stopper as it is at present used. I merely mention this to show that although it may take a long time to complete an invention, we should not be too positive in saying that it will never do.

THE FLY REED.

When Mr. Bullough introduced his loom with the Fly Reed, it created quite a sensation in the trade; for before its introduction it was not considered profitable to drive above one hundred and twenty shots per minute, and now they may be driven at two hundred shots per minute with perfect safety. The difficulty of driving the old loom, as it is now called, at a high speed was caused by the knock-off motion. Whenever it was attempted to run the looms beyond a certain speed there was great danger of breaking the swords of the lay, or the connection rods, or something else; even the framing of the loom was sometimes broken so that the fly reed gave the manufacturer the advantage of driving his looms quick without the risk of these breakages; it also gave him the advantage of having a much lighter loom to do the same work. Another saving that this loom has over the old one