PRACTICAL AND DESCRIPTIVE

ESSAYS

ON THE

ART OF WEAVING.

BY JOHN DUNCAN,

INVENTOR OF THE PATENT TAMBOURING MACHINERY.

ILLUSTRATED BY

FOURTEEN ELEGANT ENGRAVINGS.

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1807.

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TO THE

MANUFACTURERS OF CLOTH,

AND

OPERATIVE WEAVERS

OF THE

UNITED KINGDOM

OF

GREAT BRITAIN AND IRELAND,

THESE

ESSAYS,

Intended for their Use,

ARE

RESPECTFULLY DEDICATED.

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INTRODUCTION.

THE motives which induced me to undertake this work, have been shortly stated in the Prospectus, which has been circulated. The great extent to which the manufacture of almost every species of cloth has been carried in this country, undoubtedly renders it an object of the first national importance; and an apology for attempting a collection of facts relative to this business, which, although extensively known, have never been collected and recorded, seems hardly necessary.

A variety of publications relative to the art of weaving, chiefly designed for the use of the operative class of weavers have, indeed, appeared at different periods. But the authors of all these works have acted upon the presumption, that the art itself was fully known to their readers, but that they were wholly, or partially, ignorant of the science of arithmetic. Hence, they contain merely collections of Tables for the purpose of facilitating calculation, many of which are more adapted to the use of the manufacturer, than of the operative warper or weaver. Of the mechanical part of the business, such as the construction of the looms, and other apparatus, requisite for various kinds of work, and the practical instructions necessary for working these looms, they do not at all treat.

That these works have been found useful for the purposes for which they were intended, the extensive circulation of most of them sufficiently evinces. But it seems also evident, that they were better calculated for a former, than for the present state of society. The general knowledge of arithmetic has gradually extended since the times at which most of them were published, while that of the mechanical part of the business, during the same interval, has become, and is still becoming more limited. To those who look in a cursory way, at the immense extension and improvement of the business in all its branches, this observation may appear rash and unfounded. Nothing, however, is more certainly true, and the causes which have produced, and still continue to produce this limitation of general knowledge, both among manufacturers and operative weavers, may be easily and satisfactorily traced.

Forty or fifty years ago, when the manufactures, at least those of Scotland, were conducted upon a comparatively small scale, and almost entirely confined to linens and coarse woollen goods, the materials of which were the growth of the country; most persons spun, or purchased their own yarn, and employed their own weaver, to fabricate either plain or ornamented cloth from it. Every mistress of a family was, then, the manufacturer of her own household cloths, and the character of a good housewife depended, in no small degree, upon the quantity produced under her management. This is still the practice in many parts of Scotland, but it is gradually upon the decline, and, in all probability, must, at no very distant period, cease to exist.

In this state of the manufacture, it was necessary for every weaver, in order to suit the demands of his employers or customers, to be acquainted with the manner of weaving a considerable variety of goods; and hence arose the superiority of the general knowledge of the old, to that of the modern weavers. But this manner of conducting a manufacture can never subsist long, after a country begins rapidly to extend her trade. The great advantages derived from the division of labour, and adoption of a regular system of economy, in the arrangement and direction of every business, are soon felt, and no sooner felt than acted on. The operative who frequently shifts from one kind of work to another, will never attain the same dexterity in any, as he who is constantly employed at the same. His frequent changes also produce much loss of time, and, consequently, his work is both higher in price, and inferior in quality.

It will be admitted, that this general principle, the truth of which is acknowledged by all writers on economy, has been applied to practice, with great rapidity, in all the branches of the manufacture of cloth, both in England and Scotland. The former country, indeed, from the superior extension of her trade, had adopted it in most cases, before it was much thought of in the latter.

The great majority of mankind are ever prone to limit their desire of information, to that which appears at the time, most necessary to their subsistence and comfort. The modern weaver, accustomed to be constantly employed at the same kind of work, seldom troubles himself to inquire by what means other kinds are, or may be produced, and hence the very cause which increases his practical dexterity, tends at the same time, to impede the progress of his knowledge of his profession. Indeed, many of the different species of weaving have, already, become nearly local, and the Manchester weaver is, in general, as ignorant of the mode of mounting and working a gauze or net loom, as he of Paisley or Glasgow is of a corduroy or velveteen. The division of labour, however, is now carried still further. The mounting of a loom is frequently the business of one man, and the working of it that of another; and there are many weavers who work for years upon a loom, of which they hardly know how to arrange a single cord or lever.

That this system of division, the beneficial effects of which have been so much felt in practice, will continue to be still further extended, there is no room to doubt. It is, however, matter of regret, that whilst it is productive of so many practical benefits to society, its effect should tend to preclude thousands of useful and valuable men, from the acquisition of knowledge, which, although they should be seldom called to exercise, may be of essential service in many situations, and will at least afford to an inquisitive mind, a source of rational and innocent amusement.

Besides this consideration, many other circumstances concur, to render records of the state of every art peculiarly desirable. It is well ascertained by the researches of Antiquarians, that many useful and ornamental arts, which were known and practised by the ancients, have been totally lost for want of such records. In the ornamental parts of weaving, such losses have, probably, occurred frequently, and may, very probably, occur again.

The ornamental arts are so much regulated by the prevailing fashion, taste, and, probably, caprice of mankind at the day, that many species of ornamental goods lie neglected for years, and are afterwards revived, if the knowledge of their construction is then existing. When this knowledge is only transmitted by verbal instruction, and when that instruction is confined to the efforts of operative tradesmen, employed in the more active duties of their respective professions, little expectation can be formed of its general diffusion. Their attention is naturally more directed to their present, than to their former employments, and when it is no longer in their power to illustrate the instructions which they may occasionally convey to others, by showing them the practical operation, the task becomes doubly difficult. Labouring under such obstacles, it is scarcely to be doubted that arts which fall into temporary decay, will be either entirely lost, or recovered with great difficulty. Of this the decay of the gauze and net manufacture is a striking instance. Some years ago, this branch of weaving had attained a considerable extent in the west of Scotland, particularly in the town and neighbourhood of Paisley. The material employed was silk, and the manufacture very beautiful. While the fashion continued, the business was prosperous. But it contained in itself, the seeds of rapid decay. The raw material was costly, and from its inherent quality, added to the flimsiness of the texture, ill calculated to undergo the fatigue of any known operation for whitening or clearing. The goods were, of course, expensive luxuries, from the attainment of which the great majority of people were precluded, by the price and want of durability. About this period, in consequence of the invention of spinning cotton by machinery, the muslin trade was introduced. The muslins possessed three advantages over the silk gauzes. They were new —they were cheaper—and, as the cotton would bear washing or bleaching, they were more lasting. The silk gauze manufacture, already rapidly declining, was soon totally abandoned, and a considerable laspe of years intervened, before the weaving of gauzes and nets was resumed, and cotton substituted in the place of silk. Those who were employed in reviving this branch of weaving, know that the progress of it was slow and difficult, and, it is not improbable, that had it remained in disuse for a much longer period, and a generation intervened, it might have been totally lost.

The arts of printing and engraving afford important facilities for preserving and diffusing the knowledge of mechanical operations, and to these we ought to look for the cheapest, easiest, and most effectual means of counteracting the inconveniences alluded to, which naturally obstruct the progress of useful knowledge, and which are much increased by the modern system of economical arrangement.

Having stated the foregoing remarks, as the inducements which led me to apply my attention to the investigating and analysing the various branches of the art of weaving, I shall notice two objections which have been urged against my undertaking.

The first of these is, *That it is improper to divulge the secrets of any trade, because it may operate to the prejudice of those who practise it.* This doctrine is so justly, and now almost universally exploded, that I shall occupy very little room upon it. It will appear at once, without entering at all into the question of the policy of monopolies, whether preserved by secrecy or legal restriction, that the case does not apply to the business of weaving. It is absurd to suppose, that a trade which employs so many thousand people, in almost every quarter of the world, and which has existed for so many thousand years, either is or can be secret. Besides, experience has sufficiently proved, that liberal and unreserved communication between artificers of all descriptions, has always produced good, and never evil. Indeed, it is obvious, that every man, where this takes place, receives the advantage of the instruction of many, and gives only his own in return. The balance, therefore, must always be in his favour. With these short remarks, I shall dismiss this objection.

The second objection which has been urged, although it does not appear, to me, to stand upon a more solid foundation than the former, may require a little more consideration. The objection is, *That by communicating information upon the art of weaving, a knowledge of that art may be acquired out of this country, and, consequently, the manufactures may become less productive.*

Whether a general knowledge of the principles upon which our arts are conducted, would in any respect injure the manufactures of this country, if known abroad; and whether it is possible to prevent them from being known, I confess appears to me, at the least, a matter of very great doubt. But were the proposition admitted, in its fullest extent, respecting arts which have originated or may originate with ourselves, it could have no effect upon the principles of the art of weaving, which has been entirely imported, and has received little other alteration, than what has been derived from the improvement of the machinery, and the various economical arrangements which have taken place.

The history of this art is very little known, and its great antiquity, necessarily, involves the earlier eras of it in the most perfect obscurity. Enough, however, is known to prove that none of the species of it originated in Britain. The silk manufacture was first practised in China, and the Cotton in India. Both the woollen and linen were borrowed by us from the continent of Europe, and all improvements in them we owed, for a long period, to the foreign artificers who settled amongst us. To the present day, our superiority in point of quality, is only acknowledged in the cotton manufacture, whilst in those of silk, woollen, and linen, it is still disputed by other countries. We find that a number of weavers and cloth workers were invited by Edward III. from the continent, and settled in England, for the purpose of introducing and promoting the woollen manufacture, about the year 1330. In the following year, two weavers (probably of linen) came from Brabant, and settled at York, which that monarch considered of such importance, as to declare, that it "may be of great benefit, to us and "our subjects." Many more weavers from Flanders, were driven into England by the persecutions of the Duke of Alva, in the year 1567, who settled in different parts of the kingdom, and introduced the manufacture of baizes, serges, crapes, and other stuffs. Again, about the year 1686, nearly 50,000 manufacturers, of various descriptions, took refuge in Britain, in consequence of the revocation of the edict of Nantz, and other acts of religious persecution, committed by Louis XIV. From this era, we may date the rise of the linen manufacture in this kingdom. I have met with an old, and, I believe, now very scarce book, published at Edinburgh in 1724, by order of "the Honourable Society for Improving in "the Knowledge of Agriculture." It is entitled "A "Treatise concerning the manner of fallowing of ground, "raising of grass seeds, and training of lint and hemp "for the increase and improvement of the linnen manu-"factories in Scotland." The first five chapters of this work, are devoted to agricultural subjects; the sixth, contains directions for spinning linen yarn; the seventh, treats of the weaving of linen cloth; and the eighth, of bleaching.

The title of the seventh chapter is as follows:

" Chap. 7. Concerning weaving of Linnen-Cloth in " Imitation of the Foreign Linnen.

" 1st, What Looms are used in this Kingdom.

" 2dly, The looms of this Kingdom not proper for " weaving good Cloth.

" 3dly, The Dutch Looms and Estilles fit for Hollands, " Cambricks, &c.

" 4thly, French Looms fit for Cloth of Normandy and " Brittany.

" 5thly, Choice of Reeds, and Yarn fit for Reeds and " Geers (*heddles*).

" 6thly, The way of dressing Yarn, and preparing the " Stuff.

" 7thly, The Cloth as yet made in this Country too " thin and sleazy.

" 8thly, The waft to be somewhat finer than the " warp, &c."

To this chapter, are added six coarsely executed engravings of the foreign looms described. The first is a profile elevation, and is called " The side of the French " Loom." The second is a perspective view of the same loom. The third is " The side of a Loom called Estille." The fourth, a perspective view of the Estille. The fifth and sixth, are the side and perspective of the Dutch Loom.

Of these looms, the Dutch is extremely heavy, and is intended for the stoutest fabric, or holland. The French loom is for the next kind of cloth, or linen; and the Estille, for the lightest, or cambric. The construction of them is extremely clumsy, and, however highly prized in those days, would appear very strange to a modern weaver or loom wright. The back posts of the Estille, or cambric loom, rise no higher than the yarn beam, and the whole appearance of the frame work, is not unlike some of the modern *power looms*.

These facts sufficiently prove, that we have no pretensions to superior knowledge, or exclusive possession of any secrets or mysteries belonging to the art of weaving. The very names of most of our manufactures indicate their origin to be foreign. Holland, Florentine, Linau, Cord du roi, Genoa Cord, Marseille, Paduasoy, and many others, as clearly denote the quarters from which we derived the art of manufacturing these stuffs; as the names Nankeen, Ballasore, Madrass, Bengal, &c. used in our cotton manufacture, evince their importation from India, at a more recent period.

It is not, therefore, in our superior knowledge, but in a chain of events, religious, political, and economical, that we ought to trace the causes of the present unrivaled greatness of our manufactures, and their consequent circulation in every quarter of the globe. To the wise and liberal policy of our third Edward, we owe the first introduction of these manufactures; and to the tyranny and cruelty of Alva, and the bigotry and intolerance of Louis, we are indebted for much of their improvement.

To these sources, we may trace the establishment of our cloth manufactures; and the causes, which have produced their gradual progress to their present state, are easily found. Since the period, at which we acquired the benefits of the united skill and labour of the French artizans, whom the folly and caprice of a tyrant drove from his own dominions to seek refuge here, the internal peace of this country has been little disturbed. Two rebellions, neither long in duration, nor extensive in mischief, are the only exceptions. During the same period, we have enjoyed a greater portion of religious and civil liberty, and a more equal administration of justice, than any other country in Europe. The tranquillity, and security of property, arising from these causes, naturally produced confidence, and confidence as naturally produced enterprise and exertion. Our insular situation, besides affording us internal peace amidst the wars which have convulsed and desolated the rest of Europe, gave us uncommon facilities for commercial intercourse with every part of the world. Both the acquisition and security of property were, thus, placed within the reach of genius and industry, and more powerful stimulants do not exist.

It will not appear wonderful, that with such advantages, we should have outstripped competitors, perhaps equally ingenious, and equally industrious, but whose exertions have been thwarted, and whose career has been interrupted by events, from the operation of which we have been, either partially, or wholly exempted. While we have proceeded with little interruption, we have daily had opportunities of improving our knowledge, and profiting both by our prosperity and misfortunes. The former has served us as an example and incentive; the latter, as a warning for the future.

This, I trust, is not an overcharged picture of the general state of almost every extensive manufacture in Britain. The capital employed in them is immense, the principles upon which their prosperity depends have been investigated and matured, the workmen have become skilful and expeditious, regularity has been introduced, and machinery for facilitating operations extensively applied. An order of things like this, is not, nor ever can be, the creature of a moment. It is the gradual result of the exercise of deliberate exertion, of genius, enterprise, and patient industry. The basis upon which the whole system rests, is confidence of personal safety, and security of property. Even this confidence can only be gradually acquired, and years must elapse, before the continent of Europe can assume such a political and commercial aspect, as will induce capitalists to embark their property in permanent establishments, and before mechanics can acquire sufficient skill and dexterity, to prove dangerous rivals to the already established manufacturers of Britain. Besides this, the field for further improvement is still most extensive, and promises to be cultivated both with ardour and with judgment. In every quarter, men of genius and science are busied in applying those elementary and speculative principles, which were formerly confined to the closet of the philosopher, to the purposes of active and useful improvement. The great link, which connects theory with practice in all the useful arts, is rapidly forming, and the result affords a rational prospect of our manufactures being extended and improved, even more than they have been. In such a state, I see nothing to fear in a competition, purely commercial, with the whole world; and, I own, that I can contemplate the prospect of general peace, not only without apprehension for the prosperity of our country, but with real pleasure and sanguine hope. Would to heaven, that every country in Europe had as little to dread from the power of the French arms, as this has from the skill of her manufacturers.

I am almost apprehensive, that after employing so much time upon this subject, many will be inclined to think, that I have raised a phantom merely for the purpose of combating it. I can, however, assert, that the objection has been seriously and repeatedly urged, by persons for whose judgment, on most subjects, I have much esteem, and the purity of whose motives I cannot doubt. As the question is important, I shall offer no apology for having discussed it at some length.

Having explained the objects which I have in view in publishing this work, I shall now proceed to consider the general plan of it.

Extensively as the art of weaving is applied, the variation of one branch from another is by no means so great as may be generally imagined. There are, properly, only two kinds, namely, plain, and cross weaving. Besides plain cloth, tweeling, flushing, spotting, and all the ornamental varieties, are only modifications of the first. Common gauze is the ground of the second, and all the fanciful nets, and other cross woven goods, are entirely founded upon the same principle. This, therefore, I consider to be the most correct method of classing the different kinds of cloths; but, in a first attempt at regular arrangement, I think it better, in order to avoid obscurity and confusion, to make the classification more particular. I have, therefore, allotted particular Essays for every branch which differs in any essential point from another, and I have preferred such distinction as arises from the difference of the mechanical operation, to that which is produced by the nature and quality of the material.

The first Essay is devoted to the weaving of plain cloth, which is by far the most extensive, and in which all the kinds of yarn are used, either separately or combined. The second, relates to tweeling and flushing. This branch comprehends also a great variety of thick goods, manufactured from all the materials generally employed in the texture of cloth.

These two Essays are now submitted to the public, as specimens of the work. The second part is at the press, and considerably advanced, both in the printing and engraving department. It will probably appear early in January 1808, and will consist of the following Essays:

Essay 3d, will treat of the weaving of Double Cloth, and its application to the manufacture of carpets, quilts, &c. It will also contain a description of the Draw Loom, illustrated by plans, sections, and elevations; and of its application to the weaving both of damasks and carpets.

Essay 4th, will contain a description of the methods of Cross Weaving, and of the modes of producing the different kinds of gauze, catgut, and nets. The Plates attached to this Essay will exhibit the plans, elevations, and sections, necessary to enable a mechanic to comprehend the nature of the machinery employed. Plans of the draught and cording of gauzes and nets will also be given, which, in so far as I know, has never been before attempted, and the want of which has greatly increased the difficulty of acquiring a competent knowledge of this branch of the art.

In Essay 5th, the ornaments, such as spots, brocades, lappets, &c. which are interwoven with various grounds, will be investigated, and illustrated by plates.

Essay 6th, will be devoted to the consideration of the economy of weaving, the omission of unnecessary, and the simplification of indispensible processes, the division of labour, and the application of power.

And Essay 7th, will be set apart for the investigation of such facts and subjects, relative to the manufacturing of cloth, as form more properly the business of the manufacturer, than of the operative weaver.

From this abstract of the subjects of the Essays, it will appear that regular arrangement forms an essential part of the plan of the work. I am aware, however, that it has already been, and may still be necessary, in some instances, to deviate from this. Upon a subject so extensive, it is hardly possible to avoid occasional omissions of facts which may be important. Whenever this shall appear to have been the case, I shall, without hesitation, introduce whatever I conceive to be material and important, even out of the regular order; for I conceive any disadvantage arising from this, to be less injurious to the general utility of the work, than the suppression of facts which deserve to be known. In general, I am more solicitous to record facts than opinions, but where the latter are occasionally introduced, I have been careful to give them as such, and to state the reasons which have induced me to adopt them. With respect to the style, much will not be expected in a work of this kind. Mechanical descriptions, and the investigation of processes necessary in manufactures, afford no scope for excursions of fancy, nor declamatory eloquence. If they are clear, accurate, and perspicuous, they will sufficiently answer the ends for which they are intended. The attainment of this has been my sole aim; but I am too conscious of the difficulty of accomplishing even this, to flatter myself that I have always succeeded.

I must here notice a considerable difficulty, which attends a person who writes upon the art of weaving; and indeed the same difficulty, in some measure, accompanies descriptions of all the other mechanical arts, especially those which have been least discussed. This is the want of precise technical words, to express our meaning clearly. Those which are used by weavers, vary in almost every district, and in every branch of the manufacture. Hence, terms which are familiar to the weavers in one place, are almost unknown to those of another. In this state, I had no choice but to adopt those which I have found most generally used, and best understood by the operative weavers, in this part of the country. I hope, from the explanations which accompany all or most of them, few weavers who are accustomed to a different nomenclature, will find much difficulty in comprehending the meaning which I attach to them; and they may then substitute any term most familiar to them, for the one which I have used.

In the course of my inquiries concerning those branches of weaving with which I was least conversant, I have uniformly experienced attention and civility, and have found every person to whom I have applied, liberal and communicative. I must, however, acknowledge the great assistance which I have received from Mr. William Jamieson, King-Street, Glasgow, to whom I am indebted for a number of valuable designs of various kinds of work, collected by him during many years practice in various branches of weaving, and for much useful and accurate information.

The fourth Plate, which contains a miscellaneous collection of specimens of various cloths, and which is generally referred to throughout the whole work, cannot, upon that account, be finished so as to accompany the first part. It will, therefore, be published with the second.

Glasgow, 16*th November*, 1807.

ADVERTISEMENT.

THIS work being now completed, is submitted to the judgment of professional men, and the public in general, with considerable diffidence. The Art of Weaving has been so extensively applied in almost every country, and the knowledge of its various branches acquired from so many different sources, that it is impossible that any individual should have been practically employed in all those branches. When reduced to its original principle, *the insertion of weft by forming sheds*, every part bears a strong analogy to the rest; and the minute knowledge of each of these parts must be acquired by experience and reflection. This, to a certain degree, is the case in all arts and sciences, but many of them have been frequently and minutely investigated, through the medium of the press. The errors and deficiencies of one author, have been corrected and supplied by others; and those who afterwards discuss the subject, possess the advantage of ready access to all the opinions and all the knowledge of their predecessors. In the art which I have undertaken to investigate, no such advantage exists; for little, if any thing, has ever been published upon the subject. With such disadvantages, it is natural to expect that some parts of this work may be considered as erroneous, and others superficial. Respecting the first, I can only say, that I have assiduously used every means of procuring accurate information, upon those points in which I had the least practical experience; and that I have not, knowingly, misrepresented any thing. The drawings and descriptions of the net work, were taken from a loom, upon a small scale, which I was at pains to have mounted successively, for every different species which I have described. Respecting the second, besides the difficulties attendant on the subject, from its novelty, the whole varieties in the Art of Weaving, if investigated in detail, would occupy a work far beyond the size and price, which those, for whose use this is chiefly intended, could be supposed capable of purchasing.

The general plan of the work, the motives for undertaking it, and the objections to the undertaking, were so fully detailed in the Introduction to the First Part, that it does not appear necessary to say much here upon these subjects. The arrangement of the Second Part is very nearly the same as mentioned in the Introduction. The first five Essays, comprehending Plain Weaving, Tweeling, Double Cloth Weaving, Cross Weaving, and Spotting, are chiefly intended for the use of operative weavers, and those whose business it may be to superintend the weaving department of a manufactory of cloth. The mercantile part, evidently does not come within the plan of a work of this nature; nor, indeed, on a business so exceedingly extensive, whose markets extend to almost every part of the known world, whose branches are so widely different, and whose fluctuations, both from natural and political causes, are so frequent, would it be easy to write any thing satisfactory. The mercantile system, forming one of the most important branches of political economy, and having for its object the exchange of all commodities, both in their rude and manufactured state, cannot be properly treated of in a work, confined to the investigation of the principles and practice of a particular application of human art and industry.

In the sixth Essay, I have given some account of the recent plans for the introduction of that species of economy, which, by decreasing human labour, and simplifying the processes necessary to bring the materials used in fabricating cloth from the rude to the manufactured state, tends to reduce the price of the finished goods. This chiefly applies to the manufacture of cotton, where almost all these plans have originated. In this part of the work, I am aware that so much diversity of opinion may exist, that I can only offer, as an apology for the way in which I have treated it, the importance of the subject, and the advantages which society may derive from its investigation. I ought, perhaps, also to apologize for the comparative view of the linen and cotton manufactures, and for the long extract relative to the state of the former, about 75 years ago, which I have introduced into the same Essay. The two branches of weaving, by far the most extensive, at least in Scotland, are, however, certainly subjects both of general and particular curiosity, and for this reason, I conceived the comparison to be, in some degree, within the plan of the work. Since that Essay was printed, I have been informed, although I can by no means pledge myself for the accuracy of the information, that the book, from which the extract is taken, was attributed to the late Duncan Forbes of Culloden, Lord President of the Court of Session, a man universally esteemed for the patriotism and benevolence of his character.

In the seventh Essay, I have republished the only attempt which I have ever met with, to analyse the geometrical principles upon which the adaptation of warps to reeds, depends. I have added the reasons which induce me, partly, to differ in opinion from the ingenious author of that hypothesis.

The remainder of this Essay, relates to the computation of yarn of various kinds, a subject which has been treated of in many former publications; and, indeed, the only branch of the business which has been treated of at all. For this reason I have confined myself to a few practical Tables, and a short account of the arithmetical principles of their construction.

These two Essays, are more particularly intended for manufacturers than operative weavers.

My task being now finished, I have only to add, that I am perfectly aware that every author, who lays his opinions before the public, voluntarily incurs the risk of deserved censure for whatever may be trifling or erroneous. To such censure, where due, I must, of course, submit, and have only to request such leniency as candour may suggest, for the novelty of the undertaking, and the difficulties attending its execution.

Glasgow, 28*th March*, 1808.

ESSAY I.

ON THE

WEAVING OF PLAIN CLOTH.

MATERIALS AND TEXTURE.

THE substances chiefly used in the manufacture of cloth, are wool, silk, flax, and cotton. These, after being manufactured into yarn by various processes, which it is not within the plan of these Essays to investigate, may be used, either separately, or two or more of them may be combined in the same fabric of cloth. The texture of all plain cloth is produced by the same operation, and the only variation in the fabric, arises from the nature, and quality, of the materials employed.

The yarn, of which every web is composed, consists of two kinds, either similar, or dissimilar, in their quality. The first of these, called the warp, after undergoing various preparatory processes, which shall be noticed afterwards, is wound upon a cylinder or beam, and stretched horizontally in the loom. By the operation of weaving, the second, called the woof or weft, is thrown across the former and interwoven with it, to form the texture or cloth. Fig. 1. Plate 4. is a representation of the texture of plain cloth. It is drawn upon a large scale, to show the intersections of the warp and woof, plainly and distinctly; and may be supposed to be a pattern of coarse cloth, of a thin fabric, as viewed through a microscope or magnifying glass. In the different kinds of yarn, used for the weaving of cloth, the fineness of the thread is ascertained by the length, and weight, of given quantities. The modes of counting, however, are different, in the several branches of the weaving business. The thickness of the fabric, of every species of cloth, depends upon the proportion, which the fineness of the yarn employed, bears to the number of splits, or intervals, contained in a certain length of the reed, in which the cloth is woven. These also are differently counted in different places, and in different species of manufactures. In Scotland, the fineness of woollen and linen yarn is generally called its *size* or *grist;* and that of cotton yarn, its number: the measure of the reed is called its *sett;* and the art of proportioning these to each other, is called *caaming* or *sleying*.

As the investigation of these proportions is, more properly, the business of the manufacturer, than of the operative weaver, a separate Essay shall be appropriated for that part of the subject.

GENERAL EXPLANATION OF THE PLATES.

THE *parts*, of which the various instruments, used in the manufacturing of cloth consist, are so numerous, and are placed in so many different situations, that it seems utterly impossible by any description, however elaborate, or minute, to convey a just idea of their construction, without the aid of representation. It would be equally impracticable, to make a perspective drawing of a warping mill, or loom, as they appear from any point of view, without concealing many essential parts, and distorting others. For these reasons, I have adopted the modes of representation used by engineers, architects, and other artificers. These are,

1stly, *Ground plans;*—where the spectator's eye is supposed to be placed immediately above the object viewed, and at a moderate distance from it.

2dly, *Elevations;*—where objects are viewed as they appear perpendicularly. The eye, in this case, is supposed to be placed either in front, behind, or at one side, and nearly on a level with the centre of the object viewed: where the first of these occur, they are distinguished by the name of *front elevations;* the second by that of *back elevations;* and the third are called *profile elevations.*

3dly, *Sections.*—These may be, either on a *ground plan,* or in the same plane or direction with either of the three kinds of *elevations.* They are used, when a part of any object must be supposed to be cut away, in order to represent what is behind, or under it. They are distinguished by the name of *horizontal sections,* when they are in the same direction as a *ground plan: lateral* or *profile sections,* when viewed from one side; and *transverse sections,* when viewed from the front, or back of the object.

In plans, and drawings of this description, all the parts are represented of their natural shapes, and dimensions, without the intervention of oblique, or perspective lines; and those parts which are circular, or which are farther from the eye than others, are distinguished by deeper shading.

In plans, where the end, only, of any particular part appears, it is distinguished, by having diagonal lines drawn upon it, which form a resemblance, to the appearance of the grain of cross cut wood.

These modes of representation are so well known, by most mechanics, that the explanations here given of them, may appear, to many, superfluous. I hope, however, that the introduction of them will not appear altogether unnecessary, when I state, that although common in many other arts, I have never met with a single instance, where such drawings have been used, for the purpose of illustrating the construction of looms, or any other branch of the art of weaving; excepting, *plans* of the *drawing* and *cording* of fancy patterns, which may be considered as horizontal sections of a loom.

Before proceeding to the description of the weaving loom, and of the operation of weaving, it may be proper to consider the previous, and preparatory processes which the yarn undergoes.

WINDING.

The common custom of spinners has been, to reel the yarn into hanks of a given length, and in this state, to deliver it for the purpose of being made into cloth. This process does not come within the compass of the present Essay, although, the arts of spinning, and weaving, which form the two great divisions of labour, in fabricating cloth from the raw material, are so intimately blended, that hardly any thing, analogous to the one art, is entirely foreign to the other. At present, it will be sufficient, to consider yarn delivered in hanks, as the material from which cloth is made.

The first process, in linen and cotton yarn, is boiling in the hank. The fibres of the former, being long and tenacious, require only to be freed from impurities by means of boiling water, and soap or pot-ash. To the latter, a certain proportion of flour is added, to increase its firmness and tenacity. When these operations have been performed, and the yarn has been thoroughly dried, it is wound upon bobbins; and it is customary to wind equal quantities of the yarn upon each bobbin. This is done, generally, by means of the common bobbin wheel, which is so well known, that it has been thought unnecessary to give a figure of it. It consists, merely, of a wheel, whose diameter is about four feet, from which a spindle is driven, by means of a band, and upon this spindle the bobbin is fixed. The yarn, to be wound upon the bobbin, is extended upon two small wheels, revolving on their centres, and called *whisks*.

WARPING.

THE yarn, after having been wound upon the bobbins, is delivered to the warper. His business is, again, to wind it from those bobbins into a form, which will produce the length and breadth of the warp required. The length is a certain and fixed measure, and the breadth is produced by the number of threads which he winds upon the warping mill. In former times, and in a more rude state of the art, it was the practice in warping (which is merely stretching a given number of threads to equal lengths), to fix plugs or pins in the side of a wall, at a certain distance. The operator, having the threads which compose the warp rolled into clues, placed those clues in a box, or other vessel; then fixing the ends of all the threads, to the plugs or pins at one end of the wall, he took all the threads in his hand, and permitting them to slip through his fingers, he went to the other end, where he passed the yarn over the pins fixed there, and then returned to the former. This formed the length of the web, and the breadth was made up, according to the number of times which he passed in succession, and the number of threads in his hand.

This custom, when the manufacture of cloth became extensive, was found to be troublesome and inefficient; because, to produce a proper length, the operation must have been performed, either in the open air, and subject to all the vicissitudes of weather, or if done in a house, the length of that house must have been enormous.

This, probably, gave rise to the invention of the warping mill: a machine very simple in its construction, but of very great utility.

WARPING MILL.

The warping mill forms a circle, or rather a polygon inscribed within a circle, and the yarn is wound around it, in the form of a spiral, or screw, by which means, a very great length may be produced, in a small compass. Warping mills are constructed of different heights and circumferences, according to the particular species of goods for which they are designed, or to the room which they are to occupy. A plan and elevation of those, used in the manufacture of cotton goods, will sufficiently illustrate the principle of their construction, and these will be found in Plate 1.

Fig. 1. is a ground plan, and Fig. 2. a profile elevation of the common warping mill, and the same letters refer to the same parts, in both figures. The circumference of a mill is generally five English ells, of 45 inches each, and is divided into 20 equal parts, of $11\frac{1}{4}$ inches, or $\frac{1}{4}$ of an ell each. The mill is built upon three horizontal frames,

such as represented at A, Fig. 1. The circular piece L is of solid wood, with a square mortise B in the centre, through which passes a square axis, in each end of which is an iron pivot or journal. The lower pivot is fitted in a socket, and the upper in a round hole or bush. The axis being placed perpendicular to the horizon, the mill is turned about by means of a trundle F, from which the motion is communicated to the mill, by a crossed band H passing round its circumference, as near to the floor as convenient. The arms or radii, of which there are 20, are dovetailed into grooves in the centre piece L, and their extremities are mortised into the upright standards which form the circumference of the mill, and which, being exactly 11¼ inches asunder from centre to centre, divide that circumference into 20 equal parts. The arms or radii, numbered from 1 to 20, appear very plainly in Fig. 1. but the standards at their extremities appear only as sections, and are, therefore, distinguished by diagonal lines, to give them the appearance of cross cut wood. In Fig. 2. one half of the upright standards are quite visible, and are numbered from 1 to 10, whereas the arms and centre pieces are almost totally concealed. Near the circumference, the arms are connected and kept firm, by round pieces of wood, as represented in Fig. 1.

E is the *heck*, as it is usually called. It consists of a number, generally 120 or more, of steel pins, with a round hole or eye in the upper end of each, through which a thread passes in the process of warping. The pins are placed, alternately, in two frames distinct from each other, and either of which may be raised at pleasure. By these means, what is called the *lease* is formed. The *lease* is most essential in every stage of the operation of weaving, as the whole regularity of the yarn in the loom depends upon it. Fig. 3. is a front elevation of part of a heck, for the purpose of showing, more distinctly, the way of lifting the alternate threads, when required. The steel pins of the heck ought to be very carefully polished, for the sake of smoothness, and should be tempered hard, to preserve the inside of the eyes from being soon worn, by the friction of the yarn passing through them.

D is a frame of wood, on the upper part of which are fixed a convenient number of pins, in a perpendicular direction, and at equal distances: upon each of these pins is a small pully of hard wood, which runs freely round upon the pin, as a loose axis. These serve to guide the yarn upon the mill, and also to divide it into portions called *half gangs*, which are useful in the subsequent operation of *beaming*, as will be afterwards described. On the end of the frame D is a square box, through which passes a perpendicular post C, upon which the whole frame D slides up, or down, when the mill is turned round. This is effected, by means of a cord passing over the pullies N, and fixed to the end of the axis of the mill. When the mill is turned one way, the cord winds round the axis and raises the frame D; when turned the contrary way, the cord unwinds, and the frame is allowed to sink. Four small rollers are generally placed in the inside of the box to diminish the friction.

G, Fig. 1. is a horizontal section of the frame for containing the bobbins, or, as it is commonly called, the *bank*. By an inadvertency, it has been represented as straight or flat, but it ought to be of a circular form, that every thread may unwind from the bobbin in a direction, as nearly as possible, at right angles to the pin or axis upon which the bobbin turns. G, Fig. 2. is a profile elevated section of the same.

Two cross frames of wood I and K pass between the upright standards which form the circumference of the mill, in each of which are two smooth round pins, on which the leases are formed. Near to the upper lease pins I is another pin M, upon which the warp is turned. The frame at I is fastened to the mill, but that at K may be moved to any part, as the length of the warp may require. It consists of two parallel pieces of wood, connected by a third, joined into the one and passing through the other. In the connecting piece is a mortise, into which a wedge or key is driven, to make the frame fast in any situation in which it may be placed.

OPERATION OF WARPING.

The number of bobbins which are to form the warp, are placed in the bobbin frame or *bank*, so that every thread may unwind from the upper part of the bobbin. The threads are then passed successively through the eyes of the heck, and the whole, being knotted together, are fixed to the upper pin M upon the mill. The mill is then turned slowly, until the upper lease pins at I come nearly opposite to the heck. One frame of the heck is then lifted, and the warper passes the fore finger of his left hand through the space, formed between the threads which are lifted, and those which remain stationary. He then sinks the frame which had been lifted to its former place, and lifts the other. Into the space formed by this he inserts his thumb, and carefully places the yarn upon the two pins at I; the first passing through the interval kept by his fingers, and the second through that kept by his thumb. Every alternate thread is thus crossed, and the upper lease is formed. He now divides his yarn into portions, as nearly as possible equal to each other, to form what are called half gangs. These are kept distinct from each other, by passing along different rollers on the frame D (see Fig. 1.), until he arrives at the lower lease pins K. Turning the mill gradually and regularly round, he winds the yarn about it in a *spiral* formed by the descent of the frame D, until he has completed a number of revolutions sufficient to produce the length of his web (each revolution being five ells), and then fixes the lower pins at the proper place. Upon these pins he turns his warp, forming another lease, by passing every division, or half gang of his yarn, alternately over and under each pin. This lease differs from that formed upon the upper pins only in this respect, that instead of being formed by the crossing of the individual threads, it is produced by crossing the half gangs. As formerly stated, the use of this lease is to preserve regularity in the operation of beaming. The lower lease being formed, the warper turns the mill in a contrary direction until he arrives again at the top, where he opens his heck as before, and places his yarn upon the upper pins; turns his warp upon the pin M, and repeats the former process, until he has collected upon the mill the quantity of warp required. When this has been effected, he secures his leases by tying a piece of twine round one half of the yarn upon each pin, cuts away his threads, and drawing the warp gradually off the mill, links it into a succession of loops called a *chain*, forms it into a bunch, and in this state it is delivered to the weaver. In this consists the whole operation of warping. It is an important part of the duty of a warper, to be very careful that any threads which may be broken in the process, be immediately knotted, and that the broken threads may not be crossed over the others. He ought also, to take particular care that his leases be placed correctly upon the pins, and sufficiently secured, before the warp is taken off the mill. The modes of calculation used to ascertain the quantity of warp, will be investigated afterwards. In the mean time we shall proceed to the next operation, which is

BEAMING.

When the weaver has received his warp in the *chain*, his first care is to wind it upon the beam in a proper manner. Having ascertained the number of half gangs, and the breadth of the web, he passes a small shaft of wood through the interval formed by the last of the lower pins upon the warping mill, and a small cord tied to this shaft through that formed by the first. This gives him the lease for beaming, and keeps the half gangs distinct. When this has been done, and the cord made fast at both ends of the shaft, the knotting left by the warper must be cut, and the warp stretched to its proper breadth. An instrument or utensil, called a *ravel*, is then to be used. I have not given any figure of this, partly for want of room, and also because it differs in nothing from a *reed;* excepting, that the intervals are much wider, and that the upper part may be taken off, for the purpose of placing the half gangs in their respective places. Ravels, like reeds, are of different dimensions, and one proper for the purpose being found, every half gang is to be placed in an interval between two of the pins. The upper part, or *cape*, is then put on and secured, and the operation of winding the warp upon the beam commences. Two persons are employed to hold the ravel which serves to guide the warp, and to spread it regularly upon the beam; one or two to keep the chain, or chains, of the warp, at a proper degree of tension, and one or more to turn the beam upon its centres. The warp being regularly wound upon the beam, the weaver next proceeds to take it through the heddles, and this operation is called

DRAWING.

When the warp has been beamed, two rods are inserted into the lease formed by the upper lease pins on the warping mill; the ends of these rods are tied together, the twine by which the lease was secured is cut away, and the warp stretched to its proper breadth. The beam is then suspended by cords behind the heddles and somewhat higher, the warp hanging down perpendicularly. The weaver then places himself in front of the heddles, and another person is placed behind. The former opens every heddle in succession, and it is the business of the latter to select every thread in its order, and deliver it to be drawn through the open heddle. The succession in which the threads are to be delivered is easily ascertained by the rods, as every thread crosses that next to it. The warp, after passing through the heddles, is next drawn through the reed by an instrument called a *sley hook*, two threads being taken through every interval.

These operations being finished, the *cords or mounting* which move the heddles are applied; the reed is placed in the lay, and the warp is divided into small portions, which are tied to a shaft connected by cords to the cloth beam. The weaver then dresses a portion of his warp, and commences the operation of weaving. But before entering into the investigation of this process, it may be proper to devote some attention to the construction of the

WEAVING LOOM.

The most essential working parts of this machine are represented in Plates 2. and 3.

Fig. 1. Plate 2. is a ground plan, or rather a horizontal section of a common loom; for the upper part must be supposed to be entirely cut away, so low as the upper shafts of the heddles and upper shell of the lay, for the purpose of showing in their proper forms, those parts of the loom, warp, and cloth, which are there represented.

Fig. 2. Plate 2. may be considered either as a profile elevation, or as a profile section of the same loom.

All the parts are there represented as they appear to a person standing at one side of the loom, and many parts, concealed or cut away in Fig. 1. are seen very plainly in Fig. 2. whilst many others which are distinctly seen in Fig. 1. are, of necessity, either partially, or totally hid in Fig. 2.

Fig. 3. Plate 3. is a transverse section of the same loom, as viewed from the front; for the cloth roll, the lay, and all the other parts in front of the heddles must be taken away, that the mounting and other parts contained in the figure may be seen. The lay and reed, which are cut away in Fig. 3. are distinctly represented in Fig. 4. Plate 3.

In all of these figures, the same part of the loom is constantly marked by the same letter of reference, and thus, by comparing the figures, every part is shown in the various forms, in which it would appear when viewed above, in front, or at one side.

It has been deemed best, totally to omit the side and cross frame work of the loom, and to exhibit only the *working, or moving parts.* This has been done for two reasons.

Firstly, Because the construction of the frames of looms are very different, and the particular form is not essential to the operation, but may be varied according to the fancy either of the weaver or the loom wright. The dimensions also vary, according to the nature and breadth of the work for which the loom is intended. The strength of the different parts must depend entirely upon the work to be performed; for it will be obvious, that the quantity of wood necessary to give sufficient strength to the posts and rails of a carpet, sailcloth, or sheeting loom, would prove a useless incumbrance, and add an unnecessary weight, to one designed for the weaving of light fabrics of silk or muslin.

It is sufficient, therefore, in constructing the frame work, that care should be taken to make it of strength equivalent to the stress of the work which is to be performed; that the parts should be accurately squared, the joints tight and firm, and that the frame should be well fitted to the working parts. If these points are sufficiently attained, the most simple and least expensive plan of construction, must in this, as in all other machinery, prove invariably the best.

The second reason for omitting the frame work is, that it would have been difficult, if not impossible, to represent the working parts distinctly, without many additional drawings; because, in most of the representations, many things would have been concealed by the intervention of different parts of the frame. Had additional drawings been resorted to, the expence of this work must have been considerably augmented, without adding almost any thing to its practical utility.

We shall now proceed to explain the different figures contained in the Plates 2. and 3. But, as division of study contributes as much to the extension and simplification of the scientific pursuits, as division of labour does to those of their practical application, the principal parts essential to the process of weaving, shall be shortly enumerated in the first place. It will then be of importance to recapitulate them individually, and to enter more fully and particularly into the investigation of each.

The following are the principal working parts of the common loom: A, the yarn beam or roll, upon which the warp is wound; B, the rods which keep the threads of the warp in their respective places. The rods, as was formerly stated, pass through the intervals which form the lease; that is to say, a thread passes *over* the first rod and *under* the second: the next passes *under* the first and *over* the second, and so on alternately. By this contrivance, every thread is kept distinct from that on either side of it, and if broken, its true situation in the warp may be easily and quickly found. This is of such importance, that too much care cannot be taken to preserve the accuracy of the lease. The third rod divides the warp into what is usually called *splitfuls;* for two threads, alternately, pass over and under it, and these two threads also pass through the same interval betwixt the splits of the reed. A close inspection of the lines which represent the threads of the warp, in Fig. 1. Plate 2. will serve to illustrate what has been stated above, for the lines are drawn so as to show the way in which each thread passes between the rods. The third rod is commonly, although improperly, called the lease rod, for all the rods are lease rods, and the preservation of the lease is the chief cause of using them. C, the heddles through which the warp passes; and which, by raising and sinking one half of the warp alternately, form the sheds or spaces, to receive the weft. D, the reed through which also the warp passes, two threads being drawn through every split, or rather interval; and which, moving along with the lay, strikes home the weft to form the cloth. H, the lay mentioned above, vibrating upon centres placed upon the upper rail or cape of the loom. II are the boxes for receiving, and KK the drivers for giving motion to the fly shuttle: LL, the temples for stretching the cloth to a proper breadth, and M is the cloth roll or beam for receiving the cloth when woven. Below the heddles, and attached to them by cords, are two treddles N, which are moved by the weaver's feet to open the sheds. The shuttle is driven across by a motion communicated by the weaver's right hand, and the lay is moved, backward and forward, by his left: these are all the motions required.

Before proceeding further, it may now be proper to notice shortly the different parts of the loom in succession, to explain the nature of their construction, and application to the purposes for which they are intended.

YARN ROLL OR BEAM.

In constructing this part of the apparatus, particular care ought to be used to select wood perfectly sound, and thoroughly seasoned. Whilst the smallest moisture remains in wood, no operation performed upon it can be trusted. But it is absolutely necessary, that the yarn beam of a loom should be, as nearly as possible, both perfectly straight and perfectly round. In proportion to any deviation from these, the loom will be defective, and the deficiency will prove injurious in proportion to the fineness of the cloth to be woven. It is, therefore, of the utmost consequence, that the wood should be dry, and the iron axles firmly driven into it before the beam is turned, and that the turner should be particularly careful in the execution of his part of the work. Upon this depends the uniform tightness of the warp, and of course the quality of the cloth, in so far as that is concerned. It is, besides, of the first consequence to the operative weaver, because if the beam bends by twisting, one side will be heavier than the other, and oppose greater resistance to the threads of the warp, which may cause many of them to be broken. This greatly retards the work, for every operative weaver will be convinced, that he may throw many shots of woof sooner than he can knot one thread of warp.

The warp is kept to a proper degree of tightness, by means of a cord U rolled, two or three times, round one end of the yarn beam. One end of this cord is fixed to a lever V, moving on a joint at one end. This lever, the end of which only can be seen in Fig. 2. and which does not appear at all in Fig. 1. is parallel to the beam, and directly under the back part of it, so that the cord passing from the lever to the beam, may be in a perpendicular direction. To the other end of the cord, after passing round the beam, is fixed a weight W. A heavier weight X is then hung from the lever V, and as this weight is moved nearer to, or further from the centre of the lever, the tension of the warp will become less or greater as may be needful. This apparatus is called a *pace*. In heavy fabrics, it is still the general custom to tighten the warp by means of a stout pin, which is called a *bore staff*. The yarn beam of looms constructed for heavy work, seldom has iron axles, but is merely rounded at each end. In the end, at the right hand, a number of holes are bored, into one of which an end of the bore staff is put, and the other end is drawn upwards by a cord, until the warp is sufficiently tight.

RODS.

As mentioned before, the principal use of the rods is to preserve the lease. When any threads of the warp are broken, great care ought to be taken to have them returned into their proper places. When this is neglected, the warp gets into confusion, and great trouble, difficulty, and loss of time ensue. The rods are made of hard wood, and should be well smoothed, to prevent them from catching or breaking the warp: the two front ones are of a circular form; the third, or lease rod, is flat, and broader than the others, which is convenient in the process of dressing the warp, as will be afterwards described. The rods are kept at an uniform distance from the heddles, either by tying them together, or by a small cord with a hook at one end, which lays hold of the front rod, and a weight at the other which hangs over the yarn beam.

HEDDLES.

To weave plain cloth, only two leaves of heddles are *really* necessary; but in fine webs, where many threads are contained in the warp, the number of heddles required would be so great, that they would be crowded together, which would cause unnecessary friction, and strain the warp. For this reason, four leaves are now universally used, except in very coarse work. The heddles are made of stout level twine, and are connected together by cords above and below, to which each heddle is fastened. They are then stretched on two thin flat shafts of wood. The upper edges of these four shafts are represented in Fig. 1. at C, and the sections or ends of them at C. Fig. 2. where the front leaves appear raised, and the back leaves sunk, for opening the shed through which the shuttle passes. For plain work, clasped heddles are chiefly used: a representation of these, upon a larger scale, is given in Fig. 1. Plate 3. where the heddle twine is represented by double lines, for the purpose of showing how the upper and lower parts cross each other. The cross line shows the direction in which every thread of the warp passes through the heddle. For many kinds of work, the heddles are constructed with eyes. One of these is shown in Fig. 2. which will also explain, by inspection, the way in which the twine is knotted to form the eye. The apparatus by which the heddles are supported cannot be represented in Fig. 1. Plate 2. that being a plan of the working parts of a loom, as seen from above. In the profile section, Fig. 2. all the connections appear, although in that view, only the ends of the wooden parts, except the treddles, can be shown. In Fig. 3. Plate 3. which is an elevated section as seen from the front, they are distinctly seen, and will render the construction of the whole very apparent. On the upper side rails of the loom, rests the heddle bearer S, stretching across the loom. From this two levers Z are suspended by cords.

From one end of these levers are hung the jacks F, and from each end of these jacks pass the cords which connect them with the upper heddle shafts. The cord connecting one end of each jack with the heddles, is fixed to the first and second leaf, and that connecting the other end, to the third and fourth leaf. Under the heddles are two spring staffs Q, suspended by cords from the under heddle shafts. These are connected with the two marches R, which move upon joints, and these marches are again connected with the two treddles, from which the whole motion is derived. The other end of the lever Z is connected by a small cord with the under heddle shafts, and this end rests in a small notch, fixed to the side frame of the loom. When the heddles are to be pushed back, the levers are relieved from the notches: the weaver then presses down the upper shafts, by means of the small cords; the under shafts are at the same time raised, and thus the heddles are slackened to ease the warp. When heddles with eyes are used, this apparatus is unnecessary, and the jacks may at once be hung from the heddle bearer as in Fig. 2. Another way of easing the heddles is now, most generally, practised. The lower links, or *doups*, are lifted by small rods, and the heddles are pushed back by moving the lay.

In drawing the warp through the heddles, the first thread is drawn through the fourth leaf, the second through the second, the third through the third, and the fourth through the front. When it becomes necessary in the after process, occasionally to draw out the rods, their places may be recovered in the following manner: by raising the third and fourth leaves, and sinking the first and second, the place of the second rod is given, and by reversing this, we find that of the first. By raising the first and third leaves, and sinking the second and fourth, we obtain the place of the lease rod.

LAY AND REED.

FIG. 4. Plate 3. is an elevation of the lay and reed, taken from the front, and exhibits very plainly those parts, which are either concealed or imperfectly seen, in the plan and profile Figs. 1. and 2. Plate 2. The parts of the lay are as follow: H is the sole, or under shell of the lay, in which there is a groove to receive the lower edge of the reed D. O is the upper shell, in which also is a groove for the upper edge of the reed, by which it is kept in its place. bb are the two swords of the lay, which are suspended from the rocking tree T by means of cords cc, as represented in Figs. 2. Plates 2. and 4. Plate 3. When the pins at dd are turned round, they twist the suspending cords, which of course become shorter. By these means, either end of the lay may be elevated or depressed at pleasure, to bring it into a proper working position. Instead of these cords, screws are sometimes used, which is certainly a steadier, though a more expensive plan. The boxes II are constructed of a proper size to receive the fly shuttle, which is driven from either, by pulling forward the driver K, sliding freely on the polished spindle f; it then passes along the race rod g with great velocity, and lodges in the opposite box. The drivers are moved by the cords ee fastened to the handle h, which the weaver moves with his right hand, as before mentioned.

In weaving light fabrics of cloth, the upper rib of the reed is not confined in the upper shell of the lay, but a light shaft of wood with a groove is used. To each end of this shaft is fixed, at right angles, a thin flat piece of wood, which springs easily backward and forward. The extremities of these pieces are nailed to the back of the swords of the lay, and a cord is tied round both, lower down, by which the degree of spring may be regulated. The upper rib of the reed is received into this groove, and the upper shell of the lay is supported above it, but perfectly free from it, and serves merely as a rest for the weaver's left hand to work the lay. By this contrivance, the reed yields when the weft is driven up, and diminishes the danger of making the cloth too thick. These machines are called flyers. In still lighter goods, a woollen cord is stretched very tight between the swords, and to it the upper rib of the reed is tied. It is also common to use a double set of flyers, one of which is above, and the other under the reed.

The reed consists of two ribs, between which are the splits, through each interval of which two threads of the warp are drawn, in plain weaving. The splits of the reed generally consist of thin pieces of split reed or cane, from whence both the names *reed* and *split* are derived. It is now, however, very common to use brass, and sometimes steel wire, rolled flat for this purpose. Whatever may be the substance used, care must be taken to have the splits equal in length, breadth, and thickness, and very smooth. The regularity of the cloth depends much upon the former, and if the latter is neglected, the warp will be frequently much broken and injured. The splits of a reed ought not to be perfectly flat, but thicker in the middle and tapering to either edge. This not only diminishes the friction on the warp, but will allow any small knot or lump to pass much easier, without breaking the thread.

The fineness, or, as it is called among weavers, the *set* of a web, is determined by the number of splits of the reed in a given length. In Scotland, the reed is divided into hundreds, and these hundreds again into five parts, each containing 20 splits, which are called *porters*. Formerly, different lengths were used for different fabrics: a reed for working holland was considered to be 40 inches in length; for linen 37 inches; and for cambric 34 inches; and the number of hundreds contained in these respective lengths, was called the *set* of the reeds. It is probable, that these lengths owed their origin to the breadths of which it was customary to weave these different kinds of cloths. The 40 and 34 inch reeds are now very little used, and the 37 inch, or linen reed, has been universally adopted in the cotton manufacture.

The cause of this seems to be founded upon considering a yard of 36 inches as a proper standard, and as all cloth shrinks considerably in the breadth, the additional inch was, *probably*, allowed for this. But the shrinking of cloth is very different in various fabrics: cloth of a stout thick texture, requires a much greater allowance than light thin goods. The additional quantity of warp is, therefore, allowed by the manufacturer, in proportion to the quality of the web, and this is regulated by observation and experience. The length of the Scotch ell is 37 inches, and it, *probably*, bears this proportion to the English yard of 36 inches, for a similar reason.

In Lancashire and the adjoining counties, where the manufacture of cotton goods, chiefly of thick fabrics, is carried to very great extent, a mode of counting their reeds, different from any of those above mentioned, is in use. Their reeds are divided into portions of 19 splits each, which they call *bares*, and the number of these contained in 24 inches, is called the number of the reed. A comparative Table, of the English and Scotch reeds, is added to this work, by which the one may be brought, *nearly*, to agree with the other.

TEMPLES.

The temples, by which the cloth is kept extended during the operation, consist of two pieces of hard wood, with small sharp points in their ends, which lay hold of the edge, or selvage, of the cloth at either side. These pieces are connected by a cord, passing obliquely through holes, or notches, in each piece. By this cord, they can be lengthened or shortened, according to the breadth of the web. They are kept flat after the cloth is stretched, by a small bar turning on a centre. Their form will appear very plainly at L, in Fig. 1. Plate 2. One end is seen at L, in Fig. 2.

CLOTH ROLL, OR BEAM.

Behind the temples is the roll, or beam M, for receiving the cloth when woven. This, like the yarn roll, ought to be well seasoned, and turned very true. On one end of it is a ratchet wheel, in which rests a catch to hold against the pace, or balance weight, on the yarn beam, and keep the cloth tight. When the warp has been wrought up as near to the heddles as can be done conveniently, the weaver shifts forward the temples, rolls up a proper quantity of cloth, which unwinds an equal length of warp from the yarn roll; then shifts back the rods and heddles, until the latter hang perpendicular, and proceeds with his weaving. This is called *drawing a bore.*

In weaving thick and bulky fabrics of cloth, there is generally a cross beam of wood, called the *breast beam,* where the cloth beam M is represented in the figure, and the beam itself is placed below. The cloth passes over the *breast beam,* before being received on the *cloth beam.*

SHUTTLE AND PIRN.

The shuttle is made of hard wood, *generally boxwood,* and tipped with iron at each end, and on one side are flat pieces of wire, to diminish the friction on the reed. It runs upon two small wheels, or rollers, of iron, hung in centres. Within is the *bobbin, or pirn,* upon which the weft is wound in the form of a cone. The weft thread escaping from the *pirn,* passes through a small eye, generally of glass, fixed in the side of the shuttle next to the cloth. The pirn is fixed upon a screw in the hollow, or box, of the shuttle, and may be taken out at pleasure. Fig. 8. Plate 3. is a representation of both.

In the woollen, and cotton manufactures, the use of the fly shuttle is almost universal: but in the linen, and silk, it is still common to pass the shuttle through the warp by the weaver's hand. The boxes, drivers, spindles, and other apparatus, used for driving the fly shuttle, are unnecessary in working by the hand, and would, indeed, be incumbrances. The construction of the common lay and shuttle is so universally known, that I have not thought it necessary to give figures of them.

OPERATIONS OF WEAVING.

When a warp has been properly placed in the loom, and all the machinery requisite for weaving it into cloth has been added, the business of the operative weaver, depends more upon care and attention, than upon manual dexterity. Silken and woollen warps, which are animal substances, require little preparation after being put into the loom. In these it is only necessary for the weaver, occasionally, to clear his warp behind the rods, and to pick off, or pare away, any knots or lumps upon the yarn, which might present obstructions in passing through the heddles or reed.

The clearing of the warp is generally done with a comb, which is drawn gently through it; the teeth of the comb being kept in an oblique direction, in order to avoid breaking the warp when any obstruction presents itself. For the operations of picking and paring the warp, a pair of small sheers is used. These operations are equally necessary in warps spun from the vegetable substances, flax and cotton. But they require besides, a further preparation to fit them for the purpose of weaving: this is called

DRESSING.

This operation is justly esteemed of the first importance, in the art of weaving warps spun from flax or cotton; for it is impossible to produce work of a good quality, unless care be used in dressing the warp.

The use of dressing is, to give to yarn sufficient strength, or tenacity, to enable it to bear the operation of weaving into cloth. It, also, by laying smoothly all the ends of the fibres, which compose the raw material, from which the yarn is spun, tends both to diminish the friction during the process, and to render the cloth smooth, and glossy, when finished. The substance in common use for dressing, is simply a mucilage of vegetable matter boiled to a consistency in water. Wheat flour, and sometimes potatoes, are the substances commonly employed. These answer sufficiently well in giving to the yarn both the smoothness and tenacity required; but the great objection to them is, that they are too easily and rapidly affected by the operation of the atmosphere. When dressed yarn is allowed to stand exposed to the air, for any considerable portion of time, before being woven into cloth, it always becomes hard, brittle, and comparatively inflexible. It is then tedious and troublesome to weave, and the cloth is rough, wiry, and uneven. This effect is chiefly remarked in dry weather, when the weavers of fine cloth find it indispensibly necessary to have their yarn wrought up, as speedily as possible, after being dressed. To counteract this inconveniency, herring or beef brine, and other saline substances, which have a tendency to attract moisture, are sometimes mixed in small quantities with the dressing: but this has not proved completely and generally successful; probably, because the proportions have not been sufficiently attended to, and because a superabundance of moisture is equally prejudicial with a deficiency. Indeed, the variation of the moisture of the air is so great and so frequent, that it appears difficult, if not impossible, to fix any general, not to say universal rule, for the quantity to be mixed.

It is stated as a fact, which will appear singular to weavers in this country, that in India the process of weaving, even their finest muslins, is conducted in the open air, and exposed to all the heat of the climate, which is intense. We know well that this would be impracticable with fine work in this country, even in an ordinary summer day. I have never been able to procure any accurate account of the substance, which the Indian weavers employ for dressing their warps. It, certainly, would prove of important benefit to the manufactures of this country, were this investigated in a satisfactory manner.

Neither does it appear that this subject, which is of much importance, has hitherto attracted the attention of scientific men, or that it has been treated in an accurate or philosophical manner. It, however, opens a wide field for chemical investigation, and promises to prove equally useful to mankind, and lucrative to the person who may succeed in supplying the desideratum.

It may be necessary to resume the consideration of this part of the subject, in treating of weaving by power, and dressing by machinery. At present, we shall proceed with a short account of the common manual process.

When the warp, previously dressed, has been wrought up, as far as can be done conveniently, the weaver is obliged to suspend the operation of weaving, and to prepare a fresh quantity of warp. It is necessary to stop, when the dressed warp has approached within two or three inches of the back leaf of the heddles, that room may be allowed to join the old dressing to the new. The first operation, as in wool and silk, is to clear the warp, with the comb, from the lease rod to the yarn roll, or beam. The proof that this operation has been properly executed is, by bringing back the rods, successively, from their working situation to the roll. When this has been done, the two rods nearest to the heddles, are drawn out of the warp to one side, and the lease rod only remains. The next duty of the weaver is, to examine the yarn about to be dressed, and carefully to take away every knot, lump, or other obstruction, which might impede the progress of the work, or injure the fabric of the cloth. This being performed, he proceeds to apply the substance used for dressing, which should be rubbed gently, but completely, into the whole warp, by means of two brushes used in succession, one of which he holds in each hand. He then raises the lease rod on one edge, to divide the warp, and sets the air in motion by moving a large fan, for the purpose of drying the warp which has been dressed. It is proper in this stage of the operation, to draw one of the dressing brushes lightly over the warp at intervals, in order to prevent any obstruction, which might arise by the threads, when agitated by the fan, cohering, or sticking to each other, whilst in a wet state. Whenever the warp is sufficiently dried, a very small quantity of grease is brushed over it, the lease rod is again placed upon its flat side, and cautiously shifted forward to the heddles. The other rods are then put again into their respective sheds, and the process is finished.

WEAVING.

The operation of dressing the warp being finished, the weaver again resumes that of forming the cloth. The operations required, are only three, and these are very simple:

1st. Opening the *sheds* in the warp, alternately, by pressing the treddles with his feet.

2d. Driving the shuttle through each shed, when opened. This is performed by the right hand, when the fly shuttle is used, and by the right and left hand, alternately, in the common operation.

3d. Pulling forward the lay, to strike home the woof, and again pushing it back nearly to the heddles. This is done by the left hand with the fly, and by each hand, successively, in the old way.

In describing operations so simple and uniform, it is neither easy nor necessary, to go much into detail. It may be useful, however, in this place, to notice the mistakes, into which unexperienced weavers are apt to fall, and the defects, and inconveniences, which these mistakes occasion.

TREADING.

In the treading of a web, most beginners are apt to apply the weight, or force, of the foot much too suddenly. The bad consequences attending this mistake, are particularly felt in weaving fine or weak yarn. In weaving, as in every other branch of mechanics, the resistance, or reaction, is always nearly as great as the moving power, or force, which it is necessary to apply. From this it follows, that the body of the warp must sustain a stress, nearly equal to the force, with which the weavers foot is applied to the treddle. Besides this, every individual thread is subjected to all the friction, occasioned by the heddles, and splits of the reed, between which the threads pass, and with which they are generally in contact when rising and sinking. But the art of spinning has not been as yet, and probably never can be brought to such a degree of perfection, as to make every thread capable of bearing its proportion of this stress equally. It is equally confirmed, both by mathematical demonstration, and by practical experience, that when any body is to be moved with increased velocity, it is necessary to exert greater power to move it; and as the resistance increases in proportion to the power, this sudden application of the pressure of the foot to the treddle, must cause a proportional increase of the stress upon the warp, and also of the friction. Now, as it is impossible to make every thread equally strong, and equally tight, those which are the weakest, or the tightest, must bear much more than their equal proportion of the stress. This causes them to be broken very frequently, and, even with the greatest attention, more time is lost in tying and replacing them, than would have been sufficient for weaving a very considerable quantity into cloth. But if the weaver, from inattention, should continue the operation, after one or more threads are broken, the consequence will be still worse. When a thread has been broken, it no longer retains its parallel situation to the rest, but crossing over or between those nearest to it, either breaks them also, or interrupts the passage of the shuttle: most frequently it does both.

The same reasons will sufficiently prove the error of another opinion, too common among weavers, especially the younger part of them. This is, that a greater quantity of work will be produced, in proportion as every motion is performed with increased rapidity. It is unquestionably true, that time will be lost by conducting the operations too slowly: but it is equally true, that there is a rate of velocity, beyond which it is imprudent to accelerate the motions of a loom. What the precise rate of this velocity ought to be, has not, as I believe, been correctly ascertained. Indeed, it must vary considerably, according to the breadth of the web, the nature of the fabric, and the strength of the materials.

Instead, therefore, of giving precise rules of motion, I shall here insert a few calculations of the quantities of work, which may be produced by uniform and incessant motion, at rates usually reckoned slow.

In a $\frac{4}{4}$ cotton shawl, let the warp be 1000, and the weft at the rate of 1200: it will follow, that the shuttle must be driven 2400 times across the web, to produce one square yard of cloth. Now if this is done 60 times per minute, the whole will be completed in 40 minutes, supposing no time to be lost. But, as this is impossible, allow one fifth of the whole time to be occupied in tying threads, changing pirns, and other necessary operations, and still the yard of cloth will be completed in 50 minutes.

Again, in a 1200 $\frac{6}{4}$ web (*even wefted*), let the time of weaving a yard *in length*, be computed at the rate of 40 shots per minute; this, with the former allowance of one fifth part of the time for stopping, will be done in an hour and 15 minutes. Yet every weaver will be satisfied, that looms, regularly and constantly wrought at the above rates, will produce more cloth, than is generally effected even by the most rapid motions.

No allowance is made here for the time employed in dressing, because this is supposed to be the same, whether the operation of weaving is performed quickly or slowly.

These illustrations, which are confirmed by the practical observation of every experienced weaver, will be sufficient for the present. The subject will be more fully discussed, when we come to investigate the methods of weaving *by power*, and of dressing whole webs by the aid of machinery.

CROSSING THE SHUTTLE.

This, like the former motion, ought to be performed with a regular and uniform velocity.

In every kind of weaving, and especially in thin wiry fabrics, much of the beauty of the cloth depends upon the woof being well stretched. But if the motion of the shuttle be too rapid, it is very apt to recoil, and thus to slacken the thread. It has also a greater tendency either to break the woof altogether, or to unwind it from the pirn *in doubles*, which, if not picked out, destroy the regularity of the fabric. The woof of muslins and thin cotton goods, is generally woven into the cloth in a wet state. This tends to lay the ends of the fibres of the cotton smooth and parallel, and its effect is similar to that of dressing of the warp. The person who winds the woof upon the pirn, ought to be very careful that it be well built, so as to unwind freely. The best shape for those used in the fly shuttle, is that of a cone; and the thread ought to traverse freely, in the form of a spiral or screw, during the operation of winding.

The same wheel, used for winding the warp upon bobbins, is also fit for winding the weft. It only requires a spindle of a different shape, with a screw at one end, upon which the pirn is fixed. The wheel is so constructed, that the spindles may be easily shifted, to adapt it for either purpose.

STRIKING HOME THE WOOF.

That the fabric of the cloth may be uniform in thickness, it is necessary that the lay should be brought forward with the same force every time. In the common operation of weaving, this regularity must be acquired by practice. It is, however, of consequence to the weaver, to mount his loom in such a manner, that the range of the lay may be in proportion to the thickness of his cloth. As the lay swings, backward and forward, upon centres placed above, its motion is similar to that of a pendulum. Now the greater the arc, or range, through which the lay passes, the greater will be its effect, in driving home the weft strongly, and the thicker will be the fabric of cloth, in so far as that depends upon the weft. For this reason, in weaving coarse and heavy goods, the heddles ought to be hung at a greater distance from the point where the weft is struck up, than would be proper in light work. The point, or rather line, where the last wrought shot of weft is struck up, is called by weavers the *fell*. The pivots, upon which the lay vibrates, ought, in general, to be exactly at equal distances from a line drawn perpendicular to the fell, and one drawn perpendicular to the heddles, and between these two lines. But as the fell is constantly varying in its situation, during the operation, it will be proper to take the medium. This is the place where the fell will be, when a *bore* is half wrought up. From this, the following conclusion may also be drawn: The *bores* ought always to be *short* in weaving light goods; for the less that the extremes vary from the medium, the more regular will be the arc, or swing, of the lay.

The result of what has been stated above is, that in each of the three operations of weaving, the motions ought to be constant and uniform; and that they should follow each other in regular succession. But some observation will be necessary, to adapt these to different species of cloth.

The beauty, or excellence, of some cloths, consists in the closeness of their texture; that of others, in the openness, and regularity of the intervals between the threads. When the latter of these is required, the weaver must vary his process, from that which would be proper in the former.

The extreme tightness of the weft, is a principal excellence in open goods, and is, to a certain degree, necessary in the others, but by no means to the same extent. Two alterations are, therefore, necessary, in the formation of such fabrics. The first is in the mounting of the loom; the second in the operation. By referring to Fig. 2. Plate 2. it will appear, that the threads of the warp pass from the yarn beam to the cloth beam, upon a level, or horizontal, straight line. Consequently, the half of the warp which rises, and the half which sinks, will deviate equally from a straight line, and be equally stretched. When this is the case, the threads of warp which pass through the same interval in the reed, will appear close together in the cloth, with a vacancy between them and those next to them, which vacancy is caused by the intervention of the splits in the reed. But if the yarn beam is raised considerably above the level of the heddles, the warp, when at rest, will no longer be in a straight line, and when the shed is opened, the half of the warp which descends, will be drawn considerably tighter than the half which rises. Thus, each half will be slack alternately, and the consequence of this is, that the warp spreads in the cloth, and the intervals caused by the splits of the reed, are no longer discernable. The former of these ways of placing the beam, is practised in thin work, the latter in thick.

When the weft has been thrown across the warp, if the fabric is thin, the lay is brought home rather before the shed is closed, in order that the weft may be struck up as tight as possible. But in weaving thick goods, the shed is closed before the motion of the lay is applied. In consequence of this, the threads of the warp, to a certain degree, slacken the weft, and give a closer appearance to the cloth. In weaving thick cotton goods, the weft is inserted in a dry state, when the fabric is wanted to appear very close.

It may, now, be proper to notice the defects which most commonly occur in the weaving of cloth, and to explain the causes from which these arise.

When, from any cause, the weft is not regularly interwoven with the warp, a deficiency must happen in the cloth, which is called by weavers *a scobb.* This may proceed from several causes: the most frequent, is some obstruction in the warp, which prevents any portion of it from rising or sinking regularly, when the shed is formed; of course, the shuttle, instead of passing fairly between the threads of the warp, passes either over or under the portion which is obstructed, and the weft, at that place, is not at all interwoven with the warp. A knot or lump upon the warp, if not picked away in the dressing, will often obstruct two or three threads, and form a small *scobb.* When the weaver, from inattention, continues to weave, after a thread of warp has been broken, it very frequently crosses between a number of the threads nearest to it, and, by obstructing the shed in that place, will cause a large *scobb.* *Scobbs* are also sometimes produced by the lay being too low hung, but this is more frequent in weaving with the hand shuttle than with the fly. In this case, the scobbs are always near the *list, or selvage,* of the cloth.

A second fault in cloth is known, among weavers, by the name of a *jisp*. This is most frequent in light fabrics, and is occasioned by any particular thread of weft not being struck up so close as the rest. *Jisps* are very frequently occasioned by defects, either in the construction or mounting of the loom. If either the yarn beam or cloth beam are not turned very true, jisping will be unavoidable. Or if either the heddles, or the lay, be not hung parallel to the beams, the same defect will ensue. If the loom is correctly made and mounted, the fault must be with the weaver, and this is only to be surmounted by attention and practice.

The other faults in cloth, generally proceed from inattention in the management of the warp or weft. If threads are inaccurately drawn through either the heddles or the reed, the defect will be apparent in the cloth.

There is nothing which adds more to the beauty of cloth of every description, and about which good weavers are more solicitous, than a tight uniform selvage. In order to produce this, the warp must be dressed, even with greater care than what is necessary in the middle of the web. The tightness of the weft, also, contributes materially to the beauty of the selvage. It is, sometimes, the custom, to warp a few splitfuls at each selvage, with coarser yarn than the body of the web. In many kinds of cloth, however, the common practice is, to draw the threads which form the selvage, double. That is, to draw two threads through each heddle.

The threads, which form the warp of the selvages, being coarser than the rest, and, also, being more drawn towards the middle of the web, by the weft, the splits of the reed, through which they pass, are apt to be worn much sooner than the others. A weaver should carefully attend to this, for if the reed is injured, the work cannot be good. When cane reeds are used, and when the webs wrought in them are, generally, of the same breadth, it is now very common to make those splits, through which the warp of the selvages passes, of brass.

It is unnecessary to enumerate further, the defects which may occur in the weaving of cloth, for no instructions can altogether supply the want of that skill, which is only to be attained by practical experience.

CALCULATIONS AND TABLES.

As we have confined this Essay, solely, to the operative part of the art of weaving, reserving what is properly the business of the manufacturer for future investigation, it is only necessary to introduce, in this place, such calculations and tables, as may be useful to the operative warper and weaver.

When the yarn, which is to form a warp, is delivered to the warper, upon bobbins, it is usual to give him, at the same time, a ticket, or slip of paper, specifying the length of the web, and its breadth, in porters of 20 splits each. When he has received this, his first duty is to calculate how many revolutions of the mill will be necessary, to produce the length required. This is a very simple operation, being nothing more than dividing the number of ells in the warp, by the number of ells produced by one revolution of the mill. Thus, if the length of a warp is 100 ells, and the circumference of the mill 5 ells, it will be obvious, even to a person little acquainted with arithmetic, that 20 revolutions will produce the length required. If an even number of revolutions does not produce the length required, the difference can be easily counted, each interval between the standards, which form the circumference of the mill, being $\frac{1}{4}$ of an ell, as formerly stated. Thus, if a warp is $76\frac{3}{4}$ ells, 15 revolutions produce 75 ells, and continuing to turn the mill until the warp has passed over 7 intervals more, $1\frac{3}{4}$ ells will be added to the length, making in all $76\frac{3}{4}$. To the length of the warp, it is necessary to add an allowance for the *thrum*. The thrum is that portion of the warp, which remains after the weaving is finished, stretched between the fell of the cloth and the yarn beam. It is used by the weaver either for knotting the threads which may be broken in a succeeding web, if nearly of the same fineness; or if the new web is exactly of the same set and quality of the preceding, he frequently prefers twisting the new warp to the old, *thread by thread*, to drawing it afresh through the mounting. This is particularly the case in fancy or ornamental work. The length of the thrum must vary according to circumstances. One and a half intervals between the standards, or $16\frac{7}{8}$ inches is a common allowance in plain work.

After the warper has ascertained the length of his warp, his next duty is to calculate how often he must repeat his operation, to complete the number of threads required in the breadth. The quantity of yarn wound upon the mill, in going from the upper to the lower pins and returning, is generally called by warpers a *mill gang, or bout*. As the breadth is generally counted in porters of 20 splits each, and as every split contains two threads, it is plain that in turning the mill from the upper to the lower lease pins and returning again, every bobbin in the bank will produce two threads, or one splitful of warp.

Hence it follows, that his calculation must depend upon the proportion which the number of bobbins, or runners, bears to the number of porters required. For every 20 bobbins will produce one porter of warp, each time that the operation is repeated.

Therefore, if the number of porters are multiplied by 20, to reduce them to splits, and the product divided by the number of bobbins, the quotient will be the number of *mill gangs, or bouts.* If, for example, a warp is to contain 93 porters, and the warp is to be run with 100 bobbins: then,

$$93 \times 20 = 1860 \text{ and } 1860 \div 100 = 18\tfrac{60}{100}$$

Of course, 18 mill gangs are to be run with 100 bobbins, and 1 mill gang with 60. Or if the number of bobbins can be divided by 20, without leaving a fraction, the porters divided by the quotient will give the same result, and the operation will be shorter: for,

$$100 \div 20 = 5 \text{ and } 93 \div 5 = 18\tfrac{3}{5}$$

In the first example, the remainder is splitfuls; in the second, it is porters, and 3 porters are equal to 60 splits, so that the result is exactly the same.

Although the above are very simple arithmetical operations, I have added a table, because it may assist those who are not proficients in calculation, and may save time and trouble to those who are. In this table there is little of novelty, for many, upon similar plans, have been formerly published.

Those, however, which are to be met with in former publications, appear in general to have been more adapted to the use of those who conduct small businesses in what is called the line of customer weaving, where the warper generally receives the yarn, which is to form his warp, in small parcels from his employers, and is, of consequence, frequently limited in the number of his bobbins, than for the purposes of general and extensive manufacture, where such inconveniences seldom occur. I have, therefore, calculated the following table on a more extensive scale than has been usually done; whilst, at the same time, it may be rendered useful, in almost every instance, even for small and limited operations. The following description of the mode of using it, will serve to illustrate this.

The first column on each page contains porters (of 20 splits each) from 1 to 150. The number of bobbins, or runners, are contained in the other columns, and the number is marked on the top of each. The column marked 1 contains the number of times required to run a mill gang with one bobbin, to produce the porters opposite. The other columns express the same, with the number of bobbins marked on the top of each. As an example, suppose that a warp containing 114 porters, is to be run with 110 bobbins. Tracing 114 from the first column, and 110 from the top, will give 20-80, signifying that the warper is to run 20 times with his whole number of bobbins, and the last course with 80.

It may appear unnecessary to many, that the numbers 1, 2, 3, 4, 5, 10, and 15, should have been inserted in this table, while the larger numbers have been taken at intervals of 10 bobbins each. The reasons for this arrangement are as follow:

1stly, The first column of *bobbins* marked one, by the former explanation, certainly shows how often the mill must be turned to produce the warp required, with one bobbin. And this, in 150 porters, will be no less than 3000 times. It is obvious that no person, in his senses, would undertake a task of this kind. But besides this,

this column expresses the number of splits contained in the number of porters opposite to it. It also will give the number of hundreds and splits, by placing a point before the two right hand figures. Those on the left are then hundreds: those on the right splits. This will frequently save a calculation.

2dly, The second column, being exactly one half of the first, may be used to obtain the number of splits in one chain, when the warp consists of two, which is often the case.

3dly, A warper who is limited in his quantity of yarn for warp, will often be obliged to diminish the number of his bobbins, when he comes nearly to the end of his operation. The small numbers may, therefore, be of service in a case of this kind; and if less useful to those, whose operations are conducted on an extensive scale, *they* will at least allow that the table would have been defective without them. To the latter, it seems unnecessary to make any apology, for calculating the columns containing the larger numbers, at intervals of 10 each. They are seldom so limited, as to be precluded from warping with as many bobbins as their bank or heck will contain, and the table to them will be merely similar to what a ready reckoner, or interest table is to a merchant, or banker.

WARPERS' TABLE.

WARPERS'

Porters.	BOBBINS, or RUNNERS.								
	1	2	3	4	5	10	15	30	40
1	20	10	6-2	5	4	2	1-5		
2	40	20	13-1	10	8	4	2-10	1-10	1
3	60	30	20	15	12	6	4	2	1-20
4	80	40	26-2	20	16	8	5-5	2-20	2
5	100	50	33-1	25	20	10	6-10	3-10	2-20
6	120	60	40	30	24	12	8	4	3
7	140	70	46-2	35	28	14	9-5	4-20	3-20
8	160	80	53-1	40	32	16	10-10	5-10	4
9	180	90	60	45	36	18	12	6	4-20
10	200	100	66-2	50	40	20	13-5	6-20	5
11	220	110	73-1	55	44	22	14-10	7-10	5-20
12	240	120	80	60	48	24	16	8	6
13	260	130	86-2	65	52	26	17-5	8-20	6-20
14	280	140	93-1	70	56	28	18-10	9-10	7
15	300	150	100	75	60	30	20	10	7-20
16	320	160	106-2	80	64	32	21-5	10-20	8
17	340	170	113-1	85	68	34	22-10	11-10	8-20
18	360	180	120	90	72	36	24	12	9
19	380	190	126-2	95	76	38	25-5	12-20	9-20
20	400	200	133-1	100	80	40	26-10	13-10	10
21	420	210	140	105	84	42	28	14	10-20
22	440	220	146-2	110	88	44	29-5	14-20	11
23	460	230	153-1	115	92	46	30-10	15-10	11-20
24	480	240	160	120	96	48	32	16	12
25	500	250	166-2	125	100	50	33-5	16-20	12-20

TABLE.

Porters.	BOBBINS, or RUNNERS.							
	50	60	70	80	90	100	110	120
1								
2								
3	1-10	1						
4	1-30	1-20	1-10	1				
5	2	1-40	1-30	1-20	1-10	1		
6	2-20	2	1-50	1-40	1-30	1-20	1-10	1
7	2-40	2-20	2	1-60	1-50	1-40	1-30	1-20
8	3-10	2-40	2-20	2	1-70	1-60	1-50	1-40
9	3-30	3	2-40	2-20	2	1-80	1-70	1-60
10	4	3-20	2-60	2-40	2-20	2	1-90	1-80
11	4-20	3-40	3-10	2-60	2-40	2-20	2	1-100
12	4-40	4	3-30	3	2-60	2-40	2-20	2
13	5-10	4-20	3-50	3-20	2-80	2-60	2-40	2-20
14	5-30	4-40	4	3-40	3-10	2-80	2-60	2-40
15	6	5	4-20	3-60	3-30	3	2-80	2-60
16	6-20	5-20	4-40	4	3-50	3-20	2-100	2-80
17	6-40	5-40	4-60	4-20	3-70	3-40	3-10	2-100
18	7-10	6	5-10	4-40	4	3-60	3-30	3
19	7-30	6-20	5-30	4-60	4-20	3-80	3-50	3-20
20	8	6-40	5-50	5	4-40	4	3-70	3-40
21	8-20	7	6	5-20	4-60	4-20	3-90	3-60
22	8-40	7-20	6-20	5-40	4-80	4-40	4	3-80
23	9-10	7-40	6-40	5-60	5-10	4-60	4-20	3-100
24	9-30	8	6-60	6	5-30	4-80	4-40	4
25	10	8-20	7-10	6-20	5-50	5	4-60	4-20

WARPERS'

Porters.	BOBBINS, or RUNNERS.								
	1	2	3	4	5	10	15	30	40
26	520	260	173-1	130	104	52	34-10	17-10	13
27	540	270	180	135	108	54	36	18	13-20
28	560	280	186-2	140	112	56	37-5	18-20	14
29	580	290	193-1	145	116	58	38-10	19-10	14-20
30	600	300	200	150	120	60	40	20	15
31	620	310	206-2	155	124	62	41-5	20-20	15-20
32	640	320	213-1	160	128	64	42-10	21-10	16
33	660	330	220	165	132	66	44	22	16-20
34	680	340	226-2	170	136	68	45-5	22-20	17
35	700	350	233-1	175	140	70	46-10	23-10	17-20
36	720	360	240	180	144	72	48	24	18
37	740	370	246-2	185	148	74	49-5	24-20	18-20
38	760	380	253-1	190	152	76	50-10	25-10	19
39	780	390	260	195	156	78	52	26	19-20
40	800	400	266-2	200	160	80	53-5	26-20	20
41	820	410	273-1	205	164	82	54-10	27-10	20-20
42	840	420	280	210	168	84	56	28	21
43	860	430	286-2	215	172	86	57-5	28-20	21-20
44	880	440	293-1	220	176	88	58-10	29-10	22
45	900	450	300	225	180	90	60	30	22-20
46	920	460	306-2	230	184	92	61-5	30-20	23
47	940	470	313-1	235	188	94	62-10	31-10	23-20
48	960	480	320	240	192	96	64	32	24
49	980	490	326-2	245	196	98	65-5	32-20	24-20
50	1000	500	333-1	250	200	100	66-10	33-10	25

TABLE.

Porters.	BOBBINS, or RUNNERS.							
	50	60	70	80	90	100	110	120
26	10-20	8-40	7-30	6-40	5-70	5-20	4-80	4-40
27	10-40	9	7-50	6-60	6	5-40	4-100	4-60
28	11-10	9-20	8	7	6-20	5-60	5-10	4-80
29	11-30	9-40	8-20	7-20	6-40	5-80	5-30	4-100
30	12	10	8-40	7-40	6-60	6	5-50	5
31	12-20	10-20	8-60	7-60	6-80	6-20	5-70	5-20
32	12-40	10-40	9-10	8	7-10	6-40	5-90	5-40
33	13-10	11	9-30	8-20	7-30	6-60	6	5-60
34	13-30	11-20	9-50	8-40	7-50	6-80	6-20	5-80
35	14	11-40	10	8-60	7-70	7	6-40	5-100
36	14-20	12	10-20	9	8	7-20	6-60	6
37	14-40	12-20	10-40	9-20	8-20	7-40	6-80	6-20
38	15-10	12-40	10-60	9-40	8-40	7-60	6-100	6-40
39	15-30	13	11-10	9-60	8-60	7-80	7-10	6-60
40	16	13-20	11-30	10	8-80	8	7-30	6-80
41	16-20	13-40	11-50	10-20	9-10	8-20	7-50	6-100
42	16-40	14	12	10-40	9-30	8-40	7-70	7
43	17-10	14-20	12-20	10-60	9-50	8-60	7-90	7-20
44	17-30	14-40	12-40	11	9-70	8-80	8	7-40
45	18	15	12-60	11-20	10	9	8-20	7-60
46	18-20	15-20	13-10	11-40	10-20	9-20	8-40	7-80
47	18-40	15-40	13-30	11-60	10-40	9-40	8-60	7-100
48	19-10	16	13-50	12	10-60	9-60	8-80	8
49	19-30	16-20	14	12-20	10-80	9-80	8-100	8-20
50	20	16-40	14-20	12-40	11-10	10	9-10	8-40

WARPERS'

Porters.	BOBBINS, or RUNNERS.								
	1	2	3	4	5	10	15	30	40
51	1020	510	340	255	204	102	68	34	25-20
52	1040	520	346-2	260	208	104	69-5	34-20	26
53	1060	530	353-1	265	212	106	70-10	35-10	26-20
54	1080	540	360	270	216	108	72	36	27
55	1100	550	366-2	275	220	110	73-5	36-20	27-20
56	1120	560	373-1	280	224	112	74-10	37-10	28
57	1140	570	380	285	228	114	76	38	28-20
58	1160	580	386-2	290	232	116	77-5	38-20	29
59	1180	590	393-1	295	236	118	78-10	39-10	29-20
60	1200	600	400	300	240	120	80	40	30
61	1220	610	406-2	305	244	122	81-5	40-20	30-20
62	1240	620	413-1	310	248	124	82-10	41-10	31
63	1260	630	420	315	252	126	84	42	31-20
64	1280	640	426-2	320	256	128	85-5	42-20	32
65	1300	650	433-1	325	260	130	86-10	43-10	32-20
66	1320	660	440	330	264	132	88	44	33
67	1340	670	446-2	335	268	134	89-5	44-20	33-20
68	1360	680	453-1	340	272	136	90-10	45-10	34
69	1380	690	460	345	276	138	92	46	34-20
70	1400	700	466-2	350	280	140	93-5	46-20	35
71	1420	710	473-1	355	284	142	94-10	47-10	35-20
72	1440	720	480	360	288	144	96	48	36
73	1460	730	486-2	365	292	146	97-5	48-20	36-20
74	1480	740	493-1	370	296	148	98-10	49-10	37
75	1500	750	500	375	300	150	100	50	37-20

TABLE.

Porters.	BOBBINS, OR RUNNERS.							
	50	60	70	80	90	100	110	120
51	20-20	17	14-40	12-60	11-30	10-20	9-30	8-60
52	20-40	17-20	14-60	13	11-50	10-40	9-50	8-80
53	21-10	17-40	15-10	13-20	11-70	10-60	9-70	8-100
54	21-30	18	15-30	13-40	12	10-80	9-90	9
55	22	18-20	15-50	13-60	12-20	11	10	9-20
56	22-20	18-40	16	14	12-40	11-20	10-20	9-40
57	22-40	19	16-20	14-20	12-60	11-40	10-40	9-60
58	23-10	19-20	16-40	14-40	12-80	11-60	10-60	9-80
59	23-30	19-40	16-60	14-60	13-10	11-80	10-80	9-100
60	24	20	17-10	15	13-30	12	10-100	10
61	24-20	20-20	17-30	15-20	13-50	12-20	11-10	10-20
62	24-40	20-40	17-50	15-40	13-70	12-40	11-30	10-40
63	25-10	21	18	15-60	14	12-60	11-50	10-60
64	25-30	21-20	18-20	16	14-20	12-80	11-70	10-80
65	26	21-40	18-40	16-20	14-40	13	11-90	10-100
66	26-20	22	18-60	16-40	14-60	13-20	12	11
67	26-40	22-20	19-10	16-60	14-80	13-40	12-20	11-20
68	27-10	22-40	19-30	17	15-10	13-60	12-40	11-40
69	27-30	23	19-50	17-20	15-30	13-80	12-60	11-60
70	28	23-20	20	17-40	15-50	14	12-80	11-80
71	28-20	23-40	20-20	17-60	15-70	14-20	12-100	11-100
72	28-40	24	20-40	18	16	14-40	13-10	12
73	29-10	24-20	20-60	18-20	16-20	14-60	13-30	12-20
74	29-30	24-40	21-10	18-40	16-40	14-80	13-50	12-40
75	30	25	21-30	18-60	16-60	15	13-70	12-60

WARPERS'

Porters.	BOBBINS, OR RUNNERS.								
	1	2	3	4	5	10	15	30	40
76	1520	760	506-2	380	304	152	101-5	50-20	38
77	1540	770	513-1	385	308	154	102-10	51-10	38-20
78	1560	780	520	390	312	156	104	52	39
79	1580	790	526-2	395	316	158	105-5	52-20	39-20
80	1600	800	533-1	400	320	160	106-10	53-10	40
81	1620	810	540	405	324	162	108	54	40-20
82	1640	820	546-2	410	328	164	109-5	54-20	41
83	1660	830	553-1	415	332	166	110-10	55-10	41-20
84	1680	840	560	420	336	168	112	56	42
85	1700	850	566-2	425	340	170	113-5	56-20	42-20
86	1720	860	573-1	430	344	172	114-10	57-10	43
87	1740	870	580	435	348	174	116	58	43-20
88	1760	880	586-2	440	352	176	117-5	58-20	44
89	1780	890	593-1	445	356	178	118-10	59-10	44-20
90	1800	900	600	450	360	180	120	60	45
91	1820	910	606-2	455	364	182	121-5	60-20	45-20
92	1840	920	613-1	460	368	184	122-10	61-10	46
93	1860	930	620	465	372	186	124	62	46-20
94	1880	940	626-2	470	376	188	125-5	62-20	47
95	1900	950	633-1	475	380	190	126-10	63-10	47-20
96	1920	960	640	480	384	192	128	64	48
97	1940	970	646-2	485	388	194	129-5	64-20	48-20
98	1960	980	653-1	490	392	196	130-10	65-10	49
99	1980	990	660	495	396	198	132	66	49-20
100	2000	1000	666-2	500	400	200	133-5	66-20	50

TABLE.

Porters.	BOBBINS, or RUNNERS.							
	50	60	70	80	90	100	110	120
76	30-20	25-20	21-50	19	16-80	15-20	13-90	12-80
77	30-40	25-40	22	19-20	17-10	15-40	14	12-100
78	31-10	26	22-20	19-40	17-30	15-60	14-20	13
79	31-30	26-20	22-40	19-60	17-50	15-80	14-40	13-20
80	32	26-40	22-60	20	17-70	16	14-60	13-40
81	32-20	27	23-10	20-20	18	16-20	14-80	13-60
82	32-40	27-20	23-30	20-40	18-20	16-40	14-100	13-80
83	33-10	27-40	23-50	20-60	18-40	16-60	15-10	13-100
84	33-30	28	24	21	18-60	16-80	15-30	14
85	34	28-20	24-20	21-20	18-80	17	15-50	14-20
86	34-20	28-40	24-40	21-40	19-10	17-20	15-70	14-40
87	34-40	29	24-60	21-60	19-30	17-40	15-90	14-60
88	35-10	29-20	25-10	22	19-50	17-60	16	14-80
89	35-30	29-40	25-30	22-20	19-70	17-80	16-20	14-100
90	36	30	25-50	22-40	20	18	16-40	15
91	36-20	30-20	26	22-60	20-20	18-20	16-60	15-20
92	36-40	30-40	26-20	23	20-40	18-40	16-80	15-40
93	37-10	31	26-40	23-20	20-60	18-60	16-100	15-60
94	37-30	31-20	26-60	23-40	20-80	18-80	17-10	15-80
95	38	31-40	27-10	23-60	21-10	19	17-30	15-100
96	38-20	32	27-30	24	21-30	19-20	17-50	16
97	38-40	32-20	27-50	24-20	21-50	19-40	17-70	16-20
98	39-10	32-40	28	24-40	21-70	19-60	17-90	16-40
99	39-30	33	28-20	24-60	22	19-80	18	16-60
100	40	33-20	28-40	25	22-20	20	18-20	16-80

WARPERS'

Porters.	BOBBINS, or RUNNERS.								
	1	2	3	4	5	10	15	30	40
101	2020	1010	673-1	505	404	202	134-10	67-10	50-20
102	2040	1020	680	510	408	204	136	68	51
103	2060	1030	686-2	515	412	206	137-5	68-20	51-20
104	2080	1040	693-1	520	416	208	138-10	69-10	52
105	2100	1050	700	525	420	210	140	70	52-20
106	2120	1060	706-2	530	424	212	141-5	70-20	53
107	2140	1070	713-1	535	428	214	142-10	71-10	53-20
108	2160	1080	720	540	432	216	144	72	54
109	2180	1090	726-2	545	436	218	145-5	72-20	54-20
110	2200	1100	733-1	550	440	220	146-10	73-10	55
111	2220	1110	740	555	444	222	148	74	55-20
112	2240	1120	746-2	560	448	224	149-5	74-20	56
113	2260	1130	753-1	565	452	226	150-10	75-10	56-20
114	2280	1140	760	570	456	228	152	76	57
115	2300	1150	766-2	575	460	230	153-5	76-20	57-20
116	2320	1160	773-1	580	464	232	154-10	77-10	58
117	2340	1170	780	585	468	234	156	78	58-20
118	2360	1180	786-2	590	472	236	157-5	78-20	59
119	2380	1190	793-1	595	476	238	158-10	79-10	59-20
120	2400	1200	800	600	480	240	160	80	60
121	2420	1210	806-2	605	484	242	161-5	80-20	60-20
122	2440	1220	813-1	610	488	244	162-10	81-10	61
123	2460	1230	820	615	492	246	164	82	61-20
124	2480	1240	826-2	620	496	248	165-5	82-20	62
125	2500	1250	833-1	625	500	250	166-10	83-10	62-20

TABLE.

Porters.	BOBBINS, or RUNNERS.							
	50	60	70	80	90	100	110	120
101	40-20	33-40	28-60	25-20	22-40	20-20	18-40	16-100
102	40-40	34	29-10	25-40	22-60	20-40	18-60	17
103	41-10	34-20	29-30	25-60	22-80	20-60	18-80	17-20
104	41-30	34-40	29-50	26	23-10	20-80	18-100	17-40
105	42	35	30	26-20	23-30	21	19-10	17-60
106	42-20	35-20	30-20	26-40	23-50	21-20	19-30	17-80
107	42-40	35-40	30-40	26-60	23-70	21-40	19-50	17-100
108	43-10	36	30-60	27	24	21-60	19-70	18
109	43-30	36-20	31-10	27-20	24-20	21-80	19-90	18-20
110	44	36-40	31-30	27-40	24-40	22	20	18-40
111	44-20	37	31-50	27-60	24-60	22-20	20-20	18-60
112	44-40	37-20	32	28	24-80	22-40	20-40	18-80
113	45-10	37-40	32-20	28-20	25-10	22-60	20-60	18-100
114	45-30	38	32-40	28-40	25-30	22-80	20-80	19
115	46	38-20	32-60	28-60	25-50	23	20-100	19-20
116	46-20	38-40	33-10	29	25-70	23-20	21-10	19-40
117	46-40	39	33-30	29-20	26	23-40	21-30	19-60
118	47-10	39-20	33-50	29-40	26-20	23-60	21-50	19-80
119	47-30	39-40	34	29-60	26-40	23-80	21-70	19-100
120	48	40	34-20	30	26-60	24	21-90	20
121	48-20	40-20	34-40	30-20	26-80	24-20	22	20-20
122	48-40	40-40	34-60	30-40	27-10	24-40	22-20	20-40
123	49-10	41	35-10	30-60	27-30	24-60	22-40	20-60
124	49-30	41-20	35-30	31	27-50	24-80	22-60	20-80
125	50	41-40	35-50	31-20	27-70	25	22-80	20-100

WARPERS'

Porters.	BOBBINS, or RUNNERS.								
	1	2	3	4	5	10	15	30	40
126	2520	1260	840	630	504	252	168	84	63
127	2540	1270	846-2	635	508	254	169-5	84-20	63-20
128	2560	1280	853-1	640	512	256	170-10	85-10	64
129	2580	1290	860	645	516	258	172	86	64-20
130	2600	1300	866-2	650	520	260	173-5	86-20	65
131	2620	1310	873-1	655	524	262	174-10	87-10	65-20
132	2640	1320	880	660	528	264	176	88	66
133	2660	1330	886-2	665	532	266	177-5	88-20	66-20
134	2680	1340	893-1	670	536	268	178-10	89-10	67
135	2700	1350	900	675	540	270	180	90	67-20
136	2720	1360	906-2	680	544	272	181-5	90-20	68
137	2740	1370	913-1	685	548	274	182-10	91-10	68-20
138	2760	1380	920	690	552	276	184	92	69
139	2780	1390	926-2	695	556	278	185-5	92-20	69-20
140	2800	1400	933-1	700	560	280	186-10	93-10	70
141	2820	1410	940	705	564	282	188	94	70-20
142	2840	1420	946-2	710	568	284	189-5	94-20	71
143	2860	1430	953-1	715	572	286	190-10	95-10	71-20
144	2880	1440	960	720	576	288	192	96	72
145	2900	1450	966-2	725	580	290	193-5	96-20	72-20
146	2920	1460	973-1	730	584	292	194-10	97-10	73
147	2940	1470	980	735	588	294	196	98	73-20
148	2960	1480	986-2	740	592	296	197-5	98-20	74
149	2980	1490	993-1	745	596	298	198-10	99-10	74-20
150	3000	1500	1000	750	600	300	200	100	75

TABLE.

Porters.	BOBBINS, or RUNNERS.							
	50	60	70	80	90	100	110	120
126	50-20	42	36	31-40	28	25-20	22-100	21
127	50-40	42-20	36-20	31-60	28-20	25-40	23-10	21-20
128	51-10	42-40	36-40	32	28-40	25-60	23-30	21-40
129	51-30	43	36-60	32-20	28-60	25-80	23-50	21-60
130	52	43-20	37-10	32-40	28-80	26	23-70	21-80
131	52-20	43-40	37-30	32-60	29-10	26-20	23-90	21-100
132	52-40	44	37-50	33	29-30	26-40	24	22
133	53-10	44-20	38	33-20	29-50	26-60	24-20	22-20
134	53-30	44-40	38-20	33-40	29-70	26-80	24-40	22-40
135	54	45	38-40	33-60	30	27	24-60	22-60
136	54-20	45-20	38-60	34	30-20	27-20	24-80	22-80
137	54-40	45-40	39-10	34-20	30-40	27-40	24-100	22-100
138	55-10	46	39-30	34-40	30-60	27-60	25-10	23
139	55-30	46-20	39-50	34-60	30-80	27-80	25-30	23-20
140	56	46-40	40	35	31-10	28	25-50	23-40
141	56-20	47	40-20	35-20	31-30	28-20	25-70	23-60
142	56-40	47-20	40-40	35-40	31-50	28-40	25-90	23-80
143	57-10	47-40	40-60	35-60	31-70	28-60	26	23-100
144	57-30	48	41-10	36	32	28-80	26-20	24
145	58	48-20	41-30	36-20	32-20	29	26-40	24-20
146	58-20	48-40	41-50	36-40	32-40	29-20	26-60	24-40
147	58-40	49	42	36-60	32-60	29-40	26-80	24-60
148	59-10	49-20	42-20	37	32-80	29-60	26-100	24-80
149	59-30	49-40	42-40	37-20	33-10	29-80	27-10	24-100
150	60	50	42-60	37-40	33-30	30	27-30	25

When the warp has been delivered to the weaver, and he prepares to wind it upon the beam, it is necessary, in the first place, to calculate the number of the ravel which he ought to use. The number of the ravel is ascertained by the number of pins contained in 36 inches, and these are counted by *scores* of 20 pins each. Thus a ravel containing 200 pins in 36 inches, is called a ten score ravel. If, therefore, a warp 36 inches or $\frac{4}{4}$ broad contains 200 half gangs, it will require a *ten score* ravel. But, if, another web containing the same number of half gangs, is to be of a greater breadth, it will obviously require a coarser ravel, and if of less breadth, a finer one will be necessary. The difference is found by an inverse proportion: for,

As 16 = the number of nails in a yard
Is to the number of half gangs,
So is the number of nails in the breadth proposed
To the number of pins in the ravel required, *inversely*.

From this the following rule will arise: Multiply the number of half gangs in the warp by 16, and divide the product by the number of 16ths, or nails, in the breadth required. The quotient will be the number of the ravel sought.

For example, let a warp which is to be beamed $\frac{19}{16}$ broad, contain 236 half gangs. Required the ravel?

$$236 \times 16 = 3776 \text{ and } 3776 \div 19 = 198\tfrac{14}{19}$$

The fraction may be thrown away, and 198 pins or 9 score 18 pins will be the ravel sought.

In those instances where the breadth is counted in 4ths or 8ths of a yard, the operation may be made shorter. In the first case, multiply by 4 and divide by the number of 4ths in the breadth: in the second, multiply by 8 and divide by the number of 8ths.

Upon this principle, the Beaming Table is calculated. But it must be noticed in this place, that some allowance is to be made in the number of the ravel, which ought always to be coarser than the exact number of pins which will give the breadth, for the following reason:

The first part of a warp which is wound upon the beam, must always be broader than what follows it, for the sake of building the selvage properly, which cannot be done perpendicularly, and the breadth must gradually decrease during the whole operation. Therefore, it will be nearest the truth to calculate the ravel, so that an average breadth may be produced. That is to say, the breadth of the warp upon the beam ought to be, as nearly as possible, the same with that at the reed, when the process of beaming is half finished. It is impossible to give any certain rule for the allowance, as a long web will require more than a short one, and a coarse web more than a fine one. The Table, therefore, is calculated to the exact breadth (omitting fractions), and the allowances left to the discretion of the beamer.

Some weavers, after ascertaining the breadth of their web, roll pieces of the list, or selvage, of woollen cloth a certain number of times round the beam, to confine each selvage of their warp. When this is done, the warp may be beamed of equal breadth from the beginning to the end.

This Table is to be used nearly in the same way as the Warpers' Table. The half gangs, from 50 to 348 at intervals of two, are contained in the first column upon each page. The remaining columns contain the number of the ravel, in *scores and pins*, for each breadth from $\frac{10}{10}$ to $\frac{7}{8}$. The breadth is marked on the top of each column, as a fraction of a yard. Therefore, to use the Table, find the number of half gangs in the first column, and on the same line, and under the breadth proposed, will be found the number of the ravel. For instance, suppose that a weaver receives a warp consisting of 270 half gangs, and is instructed to have it beamed $\frac{23}{10}$ wide; by referring to the Table, he will find in the same line with 270, and under $\frac{23}{10}$, 9-7, which is the exact number of the ravel, omitting fractions. He will then make such allowance as his judgment and experience may direct (say 7 pins), which being subtracted from the number found in the Table, will lead him to select a nine score ravel, as suited to his purpose.

In the breadths not exceeding $\frac{4}{4}$, or yard, the calculation is only carried on until a 16 score ravel would be required. It was deemed unnecessary to go farther, for even this is much finer than ravels are generally made, or than will be found useful in common practice. It is not common to make ravels nearer in number to each other than 5 pins, nor is it essentially necessary; for if a ravel is too coarse for the breadth required, by a few pins, the warp may be easily reduced to the proper breadth, by holding the ravel in an oblique direction, instead of parallel to the beam. By the same means, and by gradually increasing the obliquity during the process of beaming, the breadth is decreased to build the selvages.

BEAMING TABLE.

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	$\frac{10}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{4}{4}$	$\frac{17}{16}$
50	4	3-12	3-6	3-1	2-17	2-13	2-10	2-7
52	4-3	3-15	3-9	3-4	2-19	2-15	2-12	2-8
54	4-6	3-18	3-12	3-6	3-1	2-17	2-14	2-10
56	4-9	4-1	3-14	3-8	3-4	2-19	2-16	2-12
58	4-12	4-4	3-17	3-11	3-6	3-1	2-18	2-14
60	4-16	4-7	4	3-13	3-8	3-4	3	2-16
62	4-19	4-10	4-2	3-16	3-10	3-6	3-2	2-18
64	5-2	4-13	4-5	3-18	3-13	3-8	3-4	3
66	5-5	4-16	4-8	4-1	3-15	3-10	3-6	3-2
68	5-8	4-18	4-10	4-3	3-17	3-12	3-8	3-4
70	5-12	5-1	4-13	4-6	4	3-14	3-10	3-5
72	5-15	5-4	4-16	4-8	4-2	3-16	3-12	3-7
74	5-18	5-7	4-18	4-11	4-4	3-18	3-14	3-9
76	6-1	5-10	5-1	4-13	4-6	4-1	3-16	3-11
78	6-4	5-13	5-4	4-16	4-9	4-3	3-18	3-13
80	6-8	5-16	5-6	4-18	4-11	4-5	4	3-15
82	6-11	5-19	5-9	5	4-13	4-7	4-2	3-17
84	6-14	6-2	5-12	5-3	4-16	4-9	4-4	3-19
86	6-17	6-5	5-14	5-5	4-18	4-11	4-6	4
88	7	6-8	5-17	5-8	5	4-13	4-8	4-2
90	7-4	6-10	6	5-10	5-2	4-16	4-10	4-4
92	7-7	6-13	6-2	5-13	5-5	4-18	4-12	4-6
94	7-10	6-16	6-5	5-15	5-7	5	4-14	4-8
96	7-13	6-19	6-8	5-18	5-9	5-2	4-16	4-10
98	7-16	7-2	6-10	6	5-12	5-4	4-18	4-12

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	$\frac{9}{8}$	$\frac{19}{16}$	$\frac{5}{4}$	$\frac{21}{16}$	$\frac{11}{8}$	$\frac{23}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
50	2-4	2-2	2	1-18	1-16	1-14	1-13	1-8
52	2-6	2-3	2-1	1-19	1-17	1-16	1-14	1-9
54	2-8	2-5	2-3	2-1	1-19	1-17	1-16	1-10
56	2-9	2-7	2-4	2-2	2	1-18	1-17	1-12
58	2-11	2-8	2-6	2-4	2-2	2	1-18	1-13
60	2-13	2-10	2-8	2-5	2-3	2-1	2	1-14
62	2-15	2-12	2-9	2-7	2-5	2-3	2-1	1-15
64	2-16	2-13	2-11	2-8	2-6	2-4	2-2	1-16
66	2-18	2-15	2-12	2-10	2-8	2-5	2-4	1-17
68	3	2-17	2-14	2-11	2-9	2-7	2-5	1-18
70	3-2	2-18	2-16	2-13	2-10	2-8	2-6	2
72	3-4	3	2-17	2-14	2-12	2-10	2-8	2-1
74	3-5	3-2	2-19	2-16	2-13	2-11	2-9	2-2
76	3-7	3-4	3	2-17	2-15	2-12	2-10	2-3
78	3-9	3-5	3-2	2-19	2-16	2-14	2-12	2-4
80	3-11	3-7	3-4	3	2-18	2-15	2-13	2-5
82	3-12	3-9	3-5	3-2	2-19	2-17	2-14	2-6
84	3-14	3-10	3-7	3-4	3-1	2-18	2-16	2-8
86	3-16	3-12	3-8	3-5	3-2	2-19	2-17	2-9
88	3-18	3-14	3-10	3-7	3-4	3-1	2-18	2-10
90	4	3-15	3-12	3-8	3-5	3-2	3	2-11
92	4-1	3-17	3-13	3-10	3-6	3-4	3-1	2-12
94	4-3	3-19	3-15	3-11	3-8	3-5	3-2	2-13
96	4-5	4	3-16	3-13	3-9	3-6	3-4	2-14
98	4-7	4-2	3-18	3-14	3-11	3-8	3-5	2-16

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	10/16	11/16	3/4	13/16	7/8	15/16	4/4	17/16
100	8	7-5	6-13	6-3	5-14	5-6	5	4-14
102	8-3	7-8	6-16	6-5	5-16	5-8	5-2	4-16
104	8-6	7-11	6-18	6-8	5-18	5-10	5-4	4-17
106	8-9	7-14	7-1	6-10	6-1	5-13	5-6	4-19
108	8-12	7-17	7-4	6-13	6-3	5-15	5-8	5-1
110	8-16	8	7-6	6-15	6-5	5-17	5-10	5-3
112	8-19	8-2	7-9	6-18	6-8	5-19	5-12	5-5
114	9-2	8-5	7-12	7	6-10	6-1	5-14	5-7
116	9-5	8-8	7-14	7-2	6-12	6-3	5-16	5-9
118	9-8	8-11	7-17	7-5	6-14	6-5	5-18	5-11
120	9-12	8-14	8	7-7	6-17	6-8	6	5-12
122	9-15	8-17	8-2	7-10	6-19	6-10	6-2	5-14
124	9-18	9	8-5	7-12	7-1	6-12	6-4	5-16
126	10-1	9-3	8-8	7-15	7-4	6-14	6-6	5-18
128	10-4	9-6	8-10	7-17	7-6	6-16	6-8	6
130	10-8	9-9	8-13	8	7-8	6-18	6-10	6-2
132	10-11	9-12	8-16	8-2	7-10	7	6-12	6-4
134	10-14	9-14	8-18	8-4	7-13	7-2	6-14	6-6
136	10-17	9-17	9-1	8-7	7-15	7-5	6-16	6-8
138	11	10	9-4	8-9	7-17	7-7	6-18	6-9
140	11-4	10-3	9-6	8-12	8	7-9	7	6-11
142	11-7	10-6	9-9	8-14	8-2	7-11	7-2	6-13
144	11-10	10-9	9-12	8-17	8-4	7-13	7-4	6-15
146	11-13	10-12	9-14	8-19	8-6	7-15	7-6	6-17
148	11-16	10-15	9-17	9-2	8-9	7-17	7-8	6-19

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	$\frac{9}{8}$	$\frac{19}{16}$	$\frac{5}{4}$	$\frac{21}{16}$	$\frac{11}{8}$	$\frac{23}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
100	4-8	4-4	4	3-16	3-12	3-9	3-6	2-17
102	4-10	4-5	4-1	3-17	3-14	3-10	3-8	2-18
104	4-12	4-7	4-3	3-19	3-15	3-12	3-9	2-19
106	4-14	4-9	4-4	4	3-17	3-13	3-10	3
108	4-16	4-10	4-6	4-2	3-18	3-15	3-12	3-1
110	4-17	4-12	4-8	4-3	4	3-16	3-13	3-2
112	4-19	4-14	4-9	4-5	4-1	3-17	3-14	3-4
114	5-1	4-16	4-11	4-6	4-2	3-19	3-16	3-5
116	5-3	4-17	4-12	4-8	4-4	4	3-17	3-6
118	5-4	4-19	4-14	4-9	4-5	4-2	3-18	3-7
120	5-6	5-1	4-16	4-11	4-7	4-3	4	3-8
122	5-8	5-2	4-17	4-12	4-8	4-4	4-1	3-9
124	5-10	5-4	4-19	4-14	4-10	4-6	4-2	3-10
126	5-12	5-6	5	4-16	4-11	4-7	4-4	3-12
128	5-13	5-7	5-2	4-17	4-13	4-9	4-5	3-13
130	5-15	5-9	5-4	4-19	4-14	4-10	4-6	3-14
132	5-17	5-11	5-5	5	4-16	4-11	4-8	3-15
134	5-19	5-12	5-7	5-2	4-17	4-13	4-9	3-16
136	6	5-14	5-8	5-3	4-18	4-14	4-10	3-17
138	6-2	5-16	5-10	5-5	5	4-16	4-12	3-18
140	6-4	5-17	5-12	5-6	5-1	4-17	4-13	4
142	6-6	5-19	5-13	5-8	5-3	4-18	4-14	4-1
144	6-8	6-1	5-15	5-9	5-4	5	4-16	4-2
146	6-9	6-2	5-16	5-11	5-6	5-1	4-17	4-3
148	6-11	6-4	5-18	5-12	5-7	5-2	4-18	4-4

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	10/16	11/16	3/4	13/16	7/8	15/16	4/4	17/16
150	12	10-18	10	9-4	8-11	8	7-10	7-1
152	12-3	11-1	10-2	9-7	8-13	8-2	7-12	7-3
154	12-6	11-4	10-5	9-9	8-16	8-4	7-14	7-4.
156	12-9	11-6	10-8	9-12	8-18	8-6	7-16	7-6
158	12-12	11-9	10-10	9-14	9	8-8	7-18	7-8
160	12-16	11-12	10-13	9-16	9-2	8-10	8	7-10
162	12-19	11-15	10-16	9-19	9-5	8-12	8-2	7-12
164	13-2	11-18	10-18	10-1	9-7	8-14	8-4	7-14
166	13-5	12-1	11-1	10-4	9-9	8-17	8-6	7-16
168	13-8	12-4	11-4	10-6	9-12	8-19	8-8	7-18
170	13-12	12-7	11-6	10-9	9-14	9-1	8-10	8
172	13-15	12-10	11-9	10-11	9-16	9-3	8-12	8-1
174	13-18	12-13	11-12	10-14	9-18	9-5	8-14	8-3
176	14-1	12-16	11-14	10-16	10-1	9-7	8-16	8-5
178	14-4	12-18	11-17	10-19	10-3	9-9	8-18	8-7
180	14-8	13-1	12	11-1	10-5	9-12	9	8-9
182	14-11	13-4	12-2	11-4	10-8	9-14	9-2	8-11
184	14-14	13-7	12-5	11-6	10-10	9-16	9-4	8-13
186	14-17	13-10	12-8	11-8	10-12	9-18	9-6	8-15
188	15	13-13	12-10	11-11	10-14	10	9-8	8-16
190	15-4	13-16	12-13	11-13	10-17	10-2	9-10	8-18
192	15-7	13-19	12-16	11-16	10-19	10-4	9-12	9
194	15-10	14-2	12-18	11-18	11-1	10-6	9-14	9-2
196	15-13	14-5	13-1	12-1	11-4	10-9	9-16	9-4
198	15-16	14-8	13-4	12-3	11-6	10-11	9-18	9-6

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	9/8	19/16	5/4	21/16	11/8	23/16	6/4	7/4
150	6-13	6-6	6	5-14	5-9	5-4	5	4-5
152	6-15	6-8	6-1	5-15	5-10	5-5	5-1	4-6
154	6-16	6-9	6-3	5-17	5-12	5-7	5-2	4-8
156	6-18	6-11	6-4	5-18	5-13	5-8	5-4	4-9
158	7	6-13	6-6	6	5-14	5-9	5-5	4-10
160	7-2	6-14	6-8	6-1	5-16	5-11	5-6	4-11
162	7-4	6-16	6-9	6-3	5-17	5-12	5-8	4-12
164	7-5	6-18	6-11	6-4	5-19	5-14	5-9	4-13
166	7-7	6-19	6-12	6-6	6	5-15	5-10	4-14
168	7-9	7-1	6-14	6-8	6-2	5-16	5-12	4-16
170	7-11	7-3	6-16	6-9	6-3	5-18	5-13	4-17
172	7-12	7-4	6-17	6-11	6-5	5-19	5-14	4-18
174	7-14	7-6	6-19	6-12	6-6	6-1	5-16	4-19
176	7-16	7-8	7	6-14	6-8	6-2	5-17	5
178	7-18	7-9	7-2	6-15	6-9	6-3	5-18	5-1
180	8	7-11	7-4	6-17	6-10	6-5	6	5-2
182	8-1	7-13	7-5	6-18	6-12	6-6	6-1	5-4
184	8-3	7-14	7-7	7	6-13	6-8	6-2	5-5
186	8-5	7-16	7-8	7-1	6-15	6-9	6-4	5-6
188	8-7	7-18	7-10	7-3	6-16	6-10	6-5	5-7
190	8-8	8	7-12	7-4	6-18	6-12	6-6	5-8
192	8-10	8-1	7-13	7-6	6-19	6-13	6-8	5-9
194	8-12	8-3	7-15	7-7	7-1	6-14	6-9	5-10
196	8-14	8-5	7-16	7-9	7-2	6-16	6-10	5-12
198	8-16	8-6	7-18	7-10	7-4	6-17	6-12	5-13

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	10/16	11/16	3/4	13/16	7/8	15/16	4/4	17/16
200	16	14-10	13-6	12-6	11-8	10-13	10	9-8
202	-	14-13	13-9	12-8	11-10	10-15	10-2	9-10
204	-	14-16	13-12	12-11	11-13	10-17	10-4	9-12
206	-	14-19	13-14	12-13	11-15	10-19	10-6	9-13
208	-	15-2	13-17	12-16	11-17	11-1	10-8	9-15
210	-	15-5	14	12-18	12	11-4	10-10	9-17
212	-	15-8	14-2	13	12-2	11-6	10-12	9-19
214	-	15-11	14-5	13-3	12-4	11-8	10-14	10-1
216	-	15-14	14-8	13-5	12-6	11-10	10-16	10-3
218	-	15-17	14-10	13-8	12-9	11-12	10-18	10-5
220	-	16	14-13	13-10	12-11	11-14	11	10-7
222	-	-	14-16	13-13	12-13	11-16	11-2	10-8
224	-	-	14-18	13-15	12-16	11-18	11-4	10-10
226	-	-	15-1	13-18	12-18	12-1	11-6	10-12
228	-	-	15-4	14	13	12-3	11-8	10-14
230	-	-	15-6	14-3	13-2	12-5	11-10	10-16
232	-	-	15-9	14-5	13-5	12-7	11-12	10-18
234	-	-	15-12	14-8	13-7	12-9	11-14	11
236	-	-	15-14	14-10	13-9	12-11	11-16	11-2
238	-	-	15-17	14-12	13-12	12-13	11-18	11-4
240	-	-	16	14-15	13-14	12-16	12	11-5
242	-	-	-	14-17	13-16	12-18	12-2	11-7
244	-	-	-	15	13-18	13	12-4	11-9
246	-	-	-	15-2	14-1	13-2	12-6	11-11
248	-	-	-	15-5	14-3	13-4	12-8	11-13

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	9/8	19/16	5/4	21/16	11/8	23/16	6/4	7/4
200	8-17	8-8	8	7-12	7-5	6-19	6-13	5-14
202	8-19	8-10	8-1	7-13	7-6	7	6-14	5-15
204	9-1	8-11	8-3	7-15	7-8	7-1	6-16	5-16
206	9-3	8-13	8-4	7-16	7-9	7-3	6-17	5-17
208	9-4	8-15	8-6	7-18	7-11	7-4	6-18	5-18
210	9-6	8-16	8-8	8	7-12	7-6	7	6
212	9-8	8-18	8-9	8-1	7-14	7-7	7-1	6-1
214	9-10	9	8-11	8-3	7-15	7-8	7-2	6-2
216	9-12	9-1	8-12	8-4	7-17	7-10	7-4	6-3
218	9-13	9-3	8-14	8-6	7-18	7-11	7-5	6-4
220	9-15	9-5	8-16	8-7	8	7-13	7-6	6-5
222	9-17	9-6	8-17	8-9	8-1	7-14	7-8	6-6
224	9-19	9-8	8-19	8-10	8-2	7-15	7-9	6-8
226	10	9-10	9	8-12	8-4	7-17	7-10	6-9
228	10-2	9-12	9-2	8-13	8-5	7-18	7-12	6-10
230	10-4	9-13	9-4	8-15	8-7	8	7-13	6-11
232	10-6	9-15	9-5	8-16	8-8	8-1	7-14	6-12
234	10-8	9-17	9-7	8-18	8-10	8-2	7-16	6-13
236	10-9	9-18	9-8	8-19	8-11	8-4	7-17	6-14
238	10-11	10	9-10	9-1	8-13	8-5	7-18	6-16
240	10-13	10-2	9-12	9-2	8-14	8-6	8	6-17
242	10-15	10-3	9-13	9-4	8-16	8-8	8-1	6-18
244	10-16	10-5	9-15	9-5	8-17	8-9	8-2	6-19
246	10-18	10-7	9-16	9-7	8-18	8-11	8-4	7
248	11	10-8	9-18	9-8	9	8-12	8-5	7-1

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	10/16	11/16	3/4	13/16	7/8	15/16	4/4	17/16
250	-	-	-	15-7	14-5	13-6	12-10	11-15
252	-	-	-	15-10	14-8	13-8	12-12	11-17
254	-	-	-	15-12	14-10	13-10	12-14	11-19
256	-	-	-	15-15	14-12	13-13	12-16	12
258	-	-	-	15-17	14-14	13-15	12-18	12-2
260	-	-	-	16	14-17	13-17	13	12-4
262	-	-	-	-	14-19	13-19	13-2	12-6
264	-	-	-	-	15-1	14-1	13-4	12-8
266	-	-	-	-	15-4	14-3	13-6	12-10
268	-	-	-	-	15-6	14-5	13-8	12-12
270	-	-	-	-	15-8	14-8	13-10	12-14
272	-	-	-	-	15-10	14-10	13-12	12-16
274	-	-	-	-	15-13	14-12	13-14	12-17
276	-	-	-	-	15-15	14-14	13-16	12-19
278	-	-	-	-	15-17	14-16	13-18	13-1
280	-	-	-	-	16	14-18	14	13-3
282	-	-	-	-	-	15	14-2	13-5
284	-	-	-	-	-	15-2	14-4	13-7
286	-	-	-	-	-	15-5	14-6	13-9
288	-	-	-	-	-	15-7	14-8	13-11
290	-	-	-	-	-	15-9	14-10	13-12
292	-	-	-	-	-	15-11	14-12	13-14
294	-	-	-	-	-	15-13	14-14	13-16
296	-	-	-	-	-	15-15	14-16	13-18
298	-	-	-	-	-	15-17	14-18	14

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	9/8	19/16	5/4	21/16	11/8	23/16	6/4	7/4
250	11-2	10-10	10	9-10	9-1	8-13	8-6	7-2
252	11-4	10-12	10-1	9-12	9-3	8-15	8-8	7-4
254	11-5	10-13	10-3	9-13	9-4	8-16	8-9	7-5
256	11-7	10-15	10-4	9-15	9-6	8-18	8-10	7-6
258	11-9	10-17	10-6	9-16	9-7	8-19	8-12	7-7
260	11-11	10-18	10-8	9-18	9-9	9	8-13	7-8
262	11-12	11	10-9	9-19	9-10	9-2	8-14	7-9
264	11-14	11-2	10-11	10-1	9-12	9-3	8-16	7-10
266	11-16	11-4	10-12	10-2	9-13	9-5	8-17	7-12
268	11-18	11-5	10-14	10-4	9-14	9-6	8-18	7-13
270	12	11-7	10-16	10-5	9-16	9-7	9	7-14
272	12-1	11-9	10-17	10-7	9-17	9-9	9-1	7-15
274	12-3	11-10	10-19	10-8	9-19	9-10	9-2	7-16
276	12-5	11-12	11	10-10	10	9-12	9-4	7-17
278	12-7	11-14	11-2	10-11	10-2	9-13	9-5	7-18
280	12-8	11-15	11-4	10-13	10-3	9-14	9-6	8
282	12-10	11-17	11-5	10-14	10-5	9-16	9-8	8-1
284	12-12	11-19	11-7	10-16	10-6	9-17	9-9	8-2
286	12-14	12	11-8	10-17	10-8	9-18	9-10	8-3
288	12-16	12-2	11-10	10-19	10-9	10	9-12	8-4
290	12-17	12-4	11-12	11	10-10	10-1	9-13	8-5
292	12-19	12-5	11-13	11-2	10-12	10-3	9-14	8-6
294	13-1	12-7	11-15	11-4	10-13	10-4	9-16	8-8
296	13-3	12-9	11-16	11-5	10-15	10-5	9-17	8-9
298	13-4	12-10	11-18	11-7	10-16	10-7	9-18	8-10

BEAMING

Half Gangs.	BREADTHS OF WARPS AND							
	$\frac{10}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	$\frac{4}{4}$	$\frac{17}{16}$
300	-	-	-	-	-	16	15	14-2
302	-	-	-	-	-	-	15-2	14-4
304	-	-	-	-	-	-	15-4	14-6
306	-	-	-	-	-	-	15-6	14-8
308	-	-	-	-	-	-	15-8	14-9
310	-	-	-	-	-	-	15-10	14-11
312	-	-	-	-	-	-	15-12	14-13
314	-	-	-	-	-	-	15-14	14-15
316	-	-	-	-	-	-	15-16	14-17
318	-	-	-	-	-	-	15-18	14-19
320	-	-	-	-	-	-	16	15-1
322	-	-	-	-	-	-	-	15-3
324	-	-	-	-	-	-	-	15-4
326	-	-	-	-	-	-	-	15-6
328	-	-	-	-	-	-	-	15-8
330	-	-	-	-	-	-	-	15-10
332	-	-	-	-	-	-	-	15-12
334	-	-	-	-	-	-	-	15-14
336	-	-	-	-	-	-	-	15-16
338	-	-	-	-	-	-	-	15-18
340	-	-	-	-	-	-	-	16
342	-	-	-	-	-	-	-	-
344	-	-	-	-	-	-	-	-
346	-	-	-	-	-	-	-	-
348	-	-	-	-	-	-	-	-

TABLE.

Half Gangs.	NUMBERS OF THE RAVELS.							
	$\frac{9}{8}$	$\frac{19}{16}$	$\frac{5}{4}$	$\frac{21}{16}$	$\frac{11}{8}$	$\frac{23}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
300	13-6	12-12	12	11-8	10-18	10-8	10	8-11
302	13-8	12-14	12-1	11-10	10-19	10-10	10-1	8-12
304	13-10	12-16	12-3	11-11	11-1	10-11	10-2	8-13
306	13-12	12-17	12-4	11-13	11-2	10-12	10-4	8-14
308	13-13	12-19	12-6	11-14	11-4	10-14	10-5	8-16
310	13-15	13-1	12-8	11-16	11-5	10-15	10-6	8-17
312	13-17	13-2	12-9	11-17	11-6	10-17	10-8	8-18
314	13-19	13-4	12-11	11-19	11-8	10-18	10-9	8-19
316	14	13-6	12-12	12	11-9	10-19	10-10	9
318	14-2	13-7	12-14	12-2	11-11	11-1	10-12	9-1
320	14-4	13-9	12-16	12-3	11-12	11-2	10-13	9-2
322	14-6	13-11	12-17	12-5	11-14	11-4	10-14	9-4
324	14-8	13-12	12-19	12-6	11-15	11-5	10-16	9-5
326	14-9	13-14	13	12-8	11-17	11-6	10-17	9-6
328	14-11	13-16	13-2	12-9	11-18	11-8	10-18	9-7
330	14-13	13-17	13-4	12-11	12	11-9	11	9-8
332	14-15	13-19	13-5	12-12	12-1	11-10	11-1	9-9
334	14-16	14-1	13-7	12-14	12-2	11-12	11-2	9-10
336	14-18	14-2	13-8	12-16	12-4	11-13	11-4	9-12
338	15	14-4	13-10	12-17	12-5	11-15	11-5	9-13
340	15-2	14-6	13-12	12-19	12-7	11-16	11-6	9-14
342	15-4	14-7	13-13	13	12-8	11-17	11-8	9-15
344	15-5	14-9	13-15	13-2	12-10	11-19	11-9	9-16
346	15-7	14-11	13-16	13-3	12-11	12	11-10	9-17
348	15-9	14-13	13-18	13-5	12-13	12-2	11-12	9-18

The only other table, generally used by operative weavers, is that for setting the heddles, so as to correspond with the reed. Few weavers are in possession of a sufficient variety of heddles, to suit every reed in which they may be employed to weave cloth. Therefore, when a weaver receives a warp, to be woven in a reed of any particular *set*, if he has no heddles of the same fineness, he selects those, nearest to, and finer than the reed. The supernumerary heddles are then to be set aside, at regular intervals, so that the breadth of the warp, in the heddles, and in the reed, may be the same.

For example, suppose that a weaver may receive a 1400 web, of any breadth, and that he has a set of heddles, calculated to weave a 1600 web of the same breadth. In this case, it is plain, that 200 of his heddles must be set aside. A little reflection will also make it apparent, that these supernumerary heddles must be set aside at equal intervals, as nearly as can be effected; for were the whole set aside in one place, the breadth of the warp, in the heddles, would differ materially from its breadth in the reed. But it is important, that the breadth of a warp should be as nearly equal as possible, in every part of the loom. For, if it is not, the threads which form the warp, will not be parallel to each other; and those which have the greatest obliquity will be more stretched than the rest. Therefore, when a finer set of heddles is to be adapted to a coarser reed, the superfluous heddles, which are not to be filled with warp, are divided, as equally as possible, among those which are to be filled; and this is called by weavers *setting of heddles*.

In the example quoted, 200 heddles are to be *set*, in order to reduce the number of the heddles (1600) to correspond with the number of the reed (1400); and these 200 heddles which are to be set aside, must be placed, at equal intervals, among the 1400 which are to filled with warp. This, also, is merely a case of direct proportion:

As the number of heddles to be set	=	200
Is to the number to be filled,	=	1400
So is one heddle to be set	=	1
To the number to be filled	=	7

From this, it will appear that 7 heddles are to be filled, and one set aside, or left empty, in rotation through the whole breadth of the web. As both the heddles and reed are calculated on the same breadth, the process will be the same for all breadths of warp. And as one of the middle terms of the proportion is unity, the rules for practice will be,

1st, Substract the number of the reed from the number of the heddles. The difference, or remainder, will be the number of heddles to be set.

2d, Divide the number to be filled, which is the same as the number of the reed, by the number to be set, and the quotient will be the answer.

But it frequently happens, that the number of heddles to be *set*, will not exactly measure the number which are to be filled: that is to say, that a remainder will be left. When this occurs, the remainder is to be added to the figures in the quotient. For example, let it be required to set 1300 heddles to a 1050 reed. In this case, the difference is 5 half hundreds, and the sum of the half-hundreds in the reed is 21: therefore,

$$21 \div 5 = 4 \text{ and there remains } 1.$$

Now, this remainder of 1 is to be added to the number of heddles to be filled, every fifth time; therefore, 4 heddles are to be filled and 1 set, 4 times successively, and 5 are to be filled and 1 set, the fifth time.

It is not frequent now to construct reeds of any other numbers than hundreds and half hundreds, but if a reed of a different number, say, for example, 940, or 9 hundreds and 2 porters, should be sometimes used; in this case, both the sum and difference must be reduced to porters, and the operation will then be the same as before. For example, to set 1100 heddles to a 940 reed: the sum of the porters in the reed is 47, and the difference in porters is 8; therefore,

$47 \div 8 = 5$, and 7 remain; therefore fill 6 heddles 7 times, and 5 heddles once.

In the above examples, the calculations have been made for single heddles, but it is necessary to observe, that both in filling and setting the heddles, one heddle on each leaf is to be understood.

Tables similar to the following, have appeared in different publications. In regular business, the greater part of them will never be used; for as heddles may be set so easily, it appears unnecessary to have them constructed to every single porter. Indeed, heddles are most generally constructed to consist of even hundreds, and even the reeds, as formerly observed, are seldom divided more minutely than into half hundreds.

It may be necessary, however, that very coarse reeds should contain odd porters; and that the differences of their respective sets should advance by small degrees. For the difference between a reed of 400, and one of 420 splits is $\frac{1}{20}$th; and this will, of course, make as great a relative difference as that between 1000 and 1050, or between 2000 and 2100. For this reason, the Table has been inserted upon a more copious scale than will be generally necessary, and will meet almost every case which can possibly occur in any species of weaving.

SETTING TABLE.

Heddles.		Reed.		Draughts, Times.				Heddles.		Reed.		Draughts, Times			
H.	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*	*H.*	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*
5	0	4	0	4	1	0	0	6	1	5	1	5	4	6	1
5	0	4	1	5	3	6	1	6	1	5	2	6	1	7	3
5	0	4	2	7	2	8	1	6	1	5	3	9	2	10	1
5	0	4	3	11	1	12	1	6	1	5	4	14	1	15	1
5	0	4	4	24	1	0	0	6	1	6	0	30	1	0	0
5	1	4	1	4	4	5	1	6	2	5	2	5	3	6	2
5	1	4	2	5	2	6	2	6	2	5	3	7	1	0	0
5	1	4	3	7	1	8	2	6	2	5	4	9	1	10	2
5	1	4	4	12	1	0	0	6	2	6	0	15	1	0	0
5	1	5	0	25	1	0	0	6	2	6	1	31	1	0	0
5	2	4	2	4	3	5	2	6	3	5	3	5	2	6	3
5	2	4	3	5	1	6	3	6	3	5	4	7	3	8	1
5	2	4	4	8	1	0	0	6	3	6	0	10	1	0	0
5	2	5	0	12	1	13	1	6	3	6	1	15	1	16	1
5	2	5	1	26	1	0	0	6	3	6	2	32	1	0	0
5	3	4	3	4	2	5	3	6	4	5	4	5	1	6	4
5	3	4	4	6	1	0	0	6	4	6	0	7	2	8	2
5	3	5	0	8	2	9	1	6	4	6	1	10	2	11	1
5	3	5	1	13	1	0	0	6	4	6	2	16	1	0	0
5	3	5	2	27	1	0	0	6	4	6	3	33	1	0	0
5	4	4	4	4	1	5	4	7	0	5	0	2	5	3	5
5	4	5	0	6	3	7	1	7	0	5	1	2	1	3	8
5	4	5	1	8	1	9	2	7	0	5	2	3	5	4	3
5	4	5	2	13	1	14	1	7	0	5	3	4	1	0	0
5	4	5	3	28	1	0	0	7	0	5	4	4	1	5	5
6	0	5	0	5	1	0	0	7	0	6	0	6	1	0	0
6	0	5	1	6	2	7	2	7	0	6	1	7	1	8	3
6	0	5	2	9	1	0	0	7	0	6	2	10	1	11	2
6	0	5	3	14	1	0	0	7	0	6	3	16	1	17	1
6	0	5	4	29	1	0	0	7	0	6	4	34	1	0	0

Heddles.		Reed.		Draughts, Times.				Heddles.		Reed.		Draughts, Times			
H.	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*	*H.*	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*
7	1	5	1	2	4	3	6	7	4	5	4	2	1	3	9
7	1	5	2	3	1	0	0	7	4	6	0	3	6	4	3
7	1	5	3	3	4	4	4	7	4	6	1	3	1	4	7
7	1	5	4	4	6	5	1	7	4	6	2	4	3	5	4
7	1	6	0	5	1	0	0	7	4	6	3	5	3	6	3
7	1	6	1	6	4	7	1	7	4	6	4	6	1	7	4
7	1	6	2	8	1	0	0	7	4	7	0	8	1	9	3
7	1	6	3	11	1	0	0	7	4	7	1	12	1	0	0
7	1	6	4	17	1	0	0	7	4	7	2	18	1	19	1
7	1	7	0	35	1	0	0	7	4	7	3	38	1	0	0
7	2	5	2	2	3	3	7	8	0	6	2	4	1	0	0
7	2	5	3	3	8	4	1	8	0	6	3	4	2	5	5
7	2	5	4	3	3	4	5	8	0	6	4	5	2	6	4
7	2	6	0	4	5	5	2	8	0	7	1	9	1	0	0
7	2	6	1	5	5	6	1	8	0	7	2	12	2	13	1
7	2	6	2	6	3	7	2	8	0	7	3	19	1	0	0
7	2	6	3	8	3	9	1	8	0	7	4	39	1	0	0
7	2	6	4	11	2	12	1	8	2	6	2	3	8	4	2
7	2	7	0	17	1	18	1	8	2	6	3	3	3	4	6
7	2	7	1	36	1	0	0	8	2	6	4	4	4	5	4
7	3	5	3	2	2	3	8	8	2	7	0	5	1	0	0
7	3	5	4	3	7	4	2	8	2	7	1	6	1	0	0
7	3	6	0	3	2	4	6	8	2	7	2	7	3	8	2
7	3	6	1	4	4	5	3	8	2	7	2 1/2	8	6	9	3
7	3	6	2	5	4	6	2	8	2	7	3	9	2	10	2
7	3	6	3	6	2	7	3	8	2	7	4	13	1	0	0
7	3	6	4	8	2	9	2	9	0	7	0	3	1	4	1
7	3	7	0	11	1	12	2	9	0	7	1	4	1	0	0
7	3	7	1	18	1	0	0	9	0	7	2	4	3	5	5
7	3	7	2	37	1	0	0	9	0	7	2 1/2	5	1	0	0

Heddles.		Reed.		Draughts, Times.				Heddles.		Reed.		Draughts, Times			
H.	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*	*H.*	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*
9	0	7	3	5	4	6	3	11	0	10	2	17	2	18	1
9	0	7	4	6	3	7	3	11	0	10	2½	21	1	0	0
9	0	8	1	10	3	11	1	11	0	10	3	26	1	27	1
9	0	8	2	14	1	0	0	11	0	10	4	54	1	0	0
9	0	8	2½	17	1	0	0	12	0	9	0	3	1	0	0
9	0	8	3	21	1	22	1	12	0	9	1	3	10	4	4
9	0	8	4	44	1	0	0	12	0	9	2	4	8	3	5
10	0	8	1	4	4	5	5	12	0	9	2½	3	1	4	4
10	0	8	2	5	6	6	2	12	0	9	3	4	1	0	0
10	0	8	2½	6	2	5	1	12	0	9	4	5	5	4	6
10	0	8	3	6	6	7	1	12	0	10	1	5	3	6	6
10	0	8	4	7	4	8	2	12	0	10	2	6	4	7	4
10	0	9	1	11	2	12	2	12	0	10	2½	7	1	0	0
10	0	9	2	15	1	6	2	12	0	10	3	7	3	8	4
10	0	9	2½	19	1	0	0	12	0	10	4	9	1	0	0
10	0	9	3	24	1	0	0	12	0	11	1	14	1	0	0
10	0	9	4	49	1	0	0	12	0	11	2	19	1	0	0
11	0	8	0	3	2	2	1	12	0	11	2½	23	1	0	0
11	0	8	1	3	13	2	1	12	0	11	3	29	1	0	0
11	0	8	2	3	10	4	3	12	0	11	4	59	1	0	0
11	0	8	2½	3	3	4	2	13	0	10	0	3	2	4	1
11	0	8	3	5	5	4	7	13	0	10	1	4	9	3	5
11	0	8	4	4	1	0	0	13	0	10	2	4	1	0	0
11	0	9	0	4	1	5	1	13	0	10	2½	4	4	5	1
11	0	9	1	5	8	6	1	13	0	10	3	4	7	5	5
11	0	9	2	5	1	6	7	13	0	10	4	5	10	4	1
11	0	9	2½	6	2	7	1	13	0	11	0	6	1	5	1
11	0	9	3	6	1	7	6	13	0	11	1	6	7	7	2
11	0	9	4	8	5	9	1	13	0	11	2	7	7	8	1
11	0	10	1	12	1	13	3	13	0	11	2½	8	2	7	1

Heddles.		Reed.		Draughts, Times.				Heddles.		Reed.		Draughts, Times.			
H.	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*	*H.*	*P.*	*H.*	*P.*	*D.*	*T.*	*D.*	*T.*
13	0	11	3	8	5	9	2	15	0	11	2½	3	5	4	2
13	0	11	4	9	1	10	5	15	0	11	3	3	10	4	7
13	0	12	1	15	3	16	1	15	0	11	4	4	11	3	5
13	0	12	2	20	1	21	2	15	0	12	0	4	1	0	0
13	0	12	2½	25	1	0	0	15	0	12	2	5	10	4	3
13	0	12	3	31	1	32	1	15	0	12	2½	5	1	0	0
13	0	12	4	64	1	0	0	15	0	13	0	6	1	7	1
14	0	10	0	3	1	2	1	15	0	13	2	9	3	8	5
14	0	10	1	2	6	3	13	15	0	13	2½	9	1	0	0
14	0	10	2	3	16	2	2	15	0	14	2½	29	1	0	0
14	0	10	2½	3	1	0	0	16	0	11	0	2	4	3	1
14	0	10	3	3	15	4	2	16	0	11	2½	3	5	2	4
14	0	10	4	3	10	4	6	16	0	12	0	3	1	0	0
14	0	11	0	3	1	4	2	16	0	12	2½	4	4	3	3
14	0	11	1	4	1	0	0	16	0	13	0	4	2	5	1
14	0	11	2	5	5	4	8	16	0	13	2½	5	3	6	2
14	0	11	2½	5	3	4	2	16	0	14	2½	10	2	9	1
14	0	11	3	5	10	4	2	16	0	15	2½	31	1	0	0
14	0	11	4	5	7	6	4	17	0	12	0	3	2	2	3
14	0	12	1	6	2	7	7	17	0	12	2½	3	7	2	2
14	0	12	2	8	6	7	2	17	0	13	0	3	3	4	1
14	0	12	2½	8	2	9	1	17	0	13	2½	4	6	3	1
14	0	12	3	9	1	0	0	17	0	14	0	5	2	4	1
14	0	12	4	10	2	11	4	17	0	14	2½	6	4	5	1
14	0	13	1	16	2	17	1	17	0	15	0	8	1	7	1
14	0	13	2	22	2	23	1	17	0	15	2½	10	2	11	1
14	0	13	2½	27	1	0	0	18	0	14	0	3	1	4	1
15	0	11	0	3	3	2	1	18	0	14	2½	5	1	4	6
15	0	11	2	3	15	4	3	18	0	15	0	5	1	0	0

Having finished the foregoing general account of the nature and process of plain weaving, it now becomes necessary to pay some attention to the fanciful and ornamental department of the business. Of ornamental goods, many descriptions are woven in the common loom, without any additional apparatus, and with little, if any, variation, from the process of weaving plain cloths. The extent to which this species of manufacture is carried, renders it an object of very great importance, and the variation, in the operative part of the process, is so small, that it may be introduced under the description of plain weaving, with little violation of arrangement.

As the thickness of the fabric in plain cloth, depends upon the proportion which the fineness of the yarn bears to the measure, or *set*, of the reed; it follows, that if yarns of different degrees of fineness are introduced, at regular intervals, into the same web, two distinct fabrics will be produced, and that the appearance of these will be different when the web is finished. Yarns of different colours may also be introduced; and when either of these is practised, the goods are called

STRIPES.

Stripes are formed upon cloth, either by the warp, or by the woof. When the former of these ways is practised, the variation of process is chiefly the business of the warper: in the latter case, it is that of the weaver. In extensive manufactories, where large quantities of striped goods of the same description are to be made, it is common to form the stripes in the warping, because in this case, the stripes and their distances from each other, will be uniform; which cannot be, always, relied upon, when the stripes are formed by the weft.

In warp stripes, where the colour is the same, and the difference is in the fabric, the effect may be produced, either by using yarns of different fineness, or by drawing a greater quantity of warp through a given number of heddles or splits, where the stripes are to be formed. For example, two or more threads may be drawn through the same heddle, or three or more *heddlefuls* may be drawn through the same split; or, thirdly, if the stripe is to be very thick, both these ways may be adopted.

Fig. 8. Plate 4. represents a stripe in the way they are generally drawn by manufacturers, as guides to the warper. Of this, the portion from A to B is called one set of the stripe, because the same pattern, repeated successively, will form all the stripes in the breadth of the web. Suppose then, that a warp striped according to this pattern, is delivered to the warper: his first care will be to examine the pattern, and ascertain the number of splits which each description of warp is to occupy, and the number of threads which are to be drawn between each two splits. These ought, always, to be marked upon the ticket, or pattern, which he receives. For example, let the stripe Fig. 8. be supposed to be formed of warp dyed blue, and the ground, or intervals between the stripes, of white, one set of the pattern will then be

Blue splits		3	1	1	1	1	3	Total 10
White splits	9	3	3	3	3	3	9	Total 33

Thus it appears, that one set of this stripe consists of 43 splits, of which 33 are white, and 10 blue; and supposing the whole to be drawn, with one thread in each heddle, and two in each split, 86 bobbins will be required; of which, 66 will be white, and 20 blue. With this number, properly disposed in the bank and heck, every time that the mill is run from the upper to the lower pins, will produce one set, and the same in returning; or every complete mill gang will form two sets of the pattern. But, if the warper should not have so many bobbins, he must limit his operation to one half of the set, to preserve the regularity of the stripe. The process will, of course, be considerably more tedious; but, in warping stripes, this inconvenience is unavoidable. Again, if he has a sufficient supply of bobbins, and if his bank and heck are large enough to contain the number, he may warp with a set and a half, or 129 bobbins, which will save much time, as each mill gang will produce three sets of the pattern. The arrangement for each of these modes, is as under:

Blue Bobbins		6	2	2	2	2	6			6	2	2
White Bobbins	18	6	6	3	3	6	6	18	18	6	6	3
	1st ½ set.				2d ½ set.				3d ½ set.			

The above explanation of the way in which warpers arrange their bobbins to form stripes, will apply to the greater part of patterns generally adopted; for a certain degree of regularity, in almost every species of ornamental decoration, is found to produce a more pleasing effect, than the most unbounded variety. It often happens, however, that stripes of different forms are combined in the same web. When this is the case, the warper must cut away his ends, and change the arrangement of his bobbins, still forming his pattern by sets, or half sets, as often as may be necessary.

Patterns depend so much on the fancy of the manufacturer, or the purchaser, that no further rule can be given for warping stripes. Study and practice alone, will render a warper expert in this part of his business.

In warp stripes, it is only necessary, on the weaver's part, to be careful to have his warp drawn through the mounting of his loom, agreeably to the pattern: a little additional care is also required in dressing, that the coarse, or dyed yarn, may be as fully smoothed as the rest.

When the stripes are to be formed across the web by the woof, the weaver must have a shuttle for every kind of woof which is to be inserted, and must be careful to change these at proper intervals, according to the pattern. Figs. 5, 6, and 7. Plate 3. represent portions of a fly-lay adapted for two shuttles, which may be shifted when necessary. Fig. 5. is a ground plan of the lay, with two sets of boxes, which are shifted at pleasure, by means of two cranks, connected by a rod, or wire, passing along the upper shell of the lay. Near to the middle of this rod, is a small handle, which the weaver shifts with his left hand, when the boxes are to be changed. Fig. 6. is a front elevation of one set of the boxes, to show how they are hung from centres above. To the back of each driver a small cord is attached, a part of which is represented in the figure. The other end of this cord, after passing under a small pully, is fastened to a spring (generally a piece of cane, or whalebone), fixed to the cape of the loom, and serves to pull back the driver, in order to allow the boxes to shift. Fig. 7. is a profile elevation, or section, of the same boxes. The reference letters, as usual, denote the same parts as in Fig. 4. Lays upon the same, or similar plans, may be constructed with more boxes, when necessary; and the whole difference between this method of working stripes and plain weaving, consists in changing the woof at proper intervals.

When webs are striped by the warp, and also by the weft, they are called

CHECKS.

The patterns of checks may be either similar, or dissimilar, in the warp and weft. The former is the most prevalent. Checks being merely combinations of the two methods of striping, require no further description; and as they contain most frequently a mixture of colours, their beauty depends more upon the taste and fancy of the manufacturer, and the skill of the dyer, than upon that of the weaver, whose business is merely to make the cloth of a good quality, and insert his weft according to his pattern.

Stripes and checks are manufactured in great quantities from all the different materials, especially from woollen, silk, and cotton. When the patterns of checks differ at the borders, from the middle, or bosom of the web, they are called shawls, or handkerchiefs. It is very common to weave these with borders only, the bosom being left plain. In this case, the check work is only at the corners, the rest of the four borders appearing as stripes, two by the warp, and two by the weft.

ESSAY II.

ON THE

WEAVING OF TWEELED CLOTH.

THIS species of weaving, which, probably, derives its name from the French word *touaille*, is, almost exclusively, confined to thick fabrics of cloth. The application of it is very extensive, and it is much used in the manufacturing of cloth from each kind of material. It possesses also this advantage, that, besides forming a species of ground, it is applicable to an infinite variety of ornamental decoration. To the investigation of the first of these properties, we will, for the present, confine ourselves.

In analysing the fabric of plain cloth, it has been shown, that every thread of the warp and of the woof, cross each other, and are tacked together alternately. This is not the case in tweeling, for in this manufacture only the third, fourth, fifth, sixth, &c. threads cross each other to form the texture. Tweeled cloths have been fabricated of many different descriptions. In the coarsest kinds, every third thread is crossed: in finer fabrics, they cross each other at intervals of 4, 5, 6, 7, or 8, threads; and in some very fine tweeled silks, the crossing does not take place until the 16th interval.

Before proceeding further, it may be proper to explain what is known, among weavers, by the appellation of *flushing*. When any thread, or portion, whether of warp or woof, is not regularly interwoven with the fabric, as in plain weaving, that thread, or portion of threads, is said to be flushed. By referring to Fig. 2. Plate 4. this will be better illustrated than by any description.

In Fig. 1. which was referred to as a specimen of plain cloth, as it would appear when viewed through a microscope, the intersections of the threads are evidently alternate. Fig. 2. may be considered as a representation of tweeled cloth, upon the same principle that Fig. 1. represents plain cloth. This figure will show, that the same thread of woof remains flushed, or disengaged from the warp, while passing *over* three threads, and is tacked down by passing *under* the fourth. Now were this cloth turned upside down, the same appearance would take place in the warp. That is to say, every fourth thread of warp would be interwoven with the woof, and the remaining three threads would be flushed. An inspection of the figure will also evince, that the threads, both of the warp and woof, are interwoven in regular succession, and at regular intervals.

To produce these effects, a number of leaves of heddles is required, equal to the number of threads contained in the interval between each intersection, *inclusive*. Thus, when every third thread is to be interwoven, three leaves are required; if every sixth thread, six leaves will be necessary, and so of all the others. For this reason, the different species of tweels are distinguished by the number of leaves which are requisite in weaving them; as a four, a five, or a six *leafed* tweel, &c. The specimen in Fig. 2. is a four leafed tweel.

Tweeling is, in many instances, applied to the weaving of cloths which require a great portion of strength, thickness, and durability.

For instance, in the linen manufacture, every description of bed and table linen, is generally tweeled; sometimes with ornaments, and sometimes without them. In the silk, tweeling is very common. Sometimes it is employed for the sake of strength, but, more frequently, for the display of colour. In the woollen, strength is the general object; and in the cotton, it is most commonly the same.

It may be necessary in this place, to inquire shortly into the causes which render tweeled cloths stronger than plain, and to ascertain the difference.

In so far as the strength of tweeled cloths depends solely on the mode of weaving, that strength will be rather diminished than increased, when compared with plain cloth, containing an equal quantity of similar materials. For, in the texture of plain cloth, every thread is constantly interwoven; whilst in that of tweels, they are only interwoven at intervals. Now, in the latter case, the threads can derive no mutual support from each other, except at the intervals where they are interwoven; and that part of them which is flushed, must depend entirely on the strength of the individual threads; those of the warp being flushed upon one side, and those of the weft upon the other.

The following inference will naturally arise from this: Let two webs of equal length, equal breadth, and equal in the quantity, quality, and fineness of the yarn, be woven. Let the first be plain, and the second tweeled. The quantity, quality, and fineness of the materials being equal, their strength ought to be so also. But, if by *strength*, we understand that quality, which opposes the most effectual, and most continued resistance to the decay of cloth, from common wearing; the tweeled web (if equally used) would be in tatters, long before the plain one was materially injured. This is the idea commonly, although inaccurately, attached to the word strength, when applied to the fabric of cloth; and, indeed, the above remark will not be found universally true, for the durability of cloth, exposed only to common wearing, depends partly upon its strength, and partly upon its flexibility.

It is not, therefore, in the effect of the mechanical operation, but in the facility of combining a greater quantity of materials in the same dimensions, which this mode of weaving affords, that we are to look for superior strength or durability. This may be easily illustrated. When the *shed* of any web is opened, every thread either above or below the thread of woof which has been driven through the web, will oppose a certain resistance to the operation of the lay in driving the shot home; and the sum of all these resistances will be the whole resistance. Now, in plain weaving, every thread is interwoven, and therefore, opposes its portion of resistance; whereas, in a *four leafed tweel*, every fourth thread only is interwoven, and, of course, gives resistance. The ratio of resistance, therefore, will be *inversely* in proportion to the number of leaves in the tweel, compared with unity.

In the warp, the friction in the reed will be diminished in the same proportion; for each thread, instead of changing its place at every shot, changes only once in every four shots. Consequently, much more warp may be crowded into the same space without injury, than could be done in plain weaving.

From the above, we may safely deduce, that the strength, or durability, of a tweeled web will be somewhat less than the proportion of the materials which it contains will be to that of a plain web, supposing each to be of equal strength and quality.

But, when the fabric is very close, tweeled cloth possesses another advantage over plain, in point of durability. When the warp of plain cloth is very much crowded in the reed, and the weft driven very closely home, the threads, in order to cross each other alternately, must deviate very materially from their natural form, which is in a straight line; whereas, when woven, they become serpentine. This renders the cloth very liable to be easily cut, or chafed, especially when composed of hard, and comparatively inflexible materials. This defect is chiefly observable in stout linens, and arises from the inelastic, and inflexible nature of the fibres of the flax. But, when tweeled, as the threads only cross at intervals, the deviation from the straight line is much less, and the flexibility of the cloth, of consequence, much greater.

The same *general* remarks, which have been given in the 1st. Essay, apply, almost equally well, to the operations of the weaver, in all descriptions of weaving. The varieties consist chiefly in the modes of mounting the looms. Our next consideration, therefore, is the

MOUNTING OF LOOMS FOR TWEELING.

As almost every variety of fanciful weaving is effected by the order and succession, in which the weft is interwoven with the warp, the principal difference, in mounting the looms, is in the number and arrangement of the leaves of heddles, and the apparatus for moving these leaves. In weaving plain cloth, the jacks, represented in Fig. 3. Plate 3. at F, answer the purpose sufficiently well, because the raising and sinking, of every thread is alternate. But, in the weaving of tweels, and many other kinds of fanciful and ornamental cloth, the number of leaves is, generally, greater; and these leaves are to be raised, or sunk in a succession, which may be sometimes regular, and, in other cases, not. It is, therefore, necessary, that the mounting of the loom should be adapted to the purpose for which it is intended; and as the succession of moving the leaves, by means of the treddles, may frequently vary, the mounting which connects every leaf with the treddle, and from which its motion is derived, must be such, that the leaf may be raised, or sunk, independent of all the others. A representation of the mechanism used for this purpose, will be found in Fig. 1. Plate 5.

In this figure, *four* leaves of heddles are represented at C; perpendicularly above which, are *four* levers moving upon centres at B. From one end of each of these levers at A, a leaf of the heddles is suspended by the two *(obliquely placed)* cords shown in the figure. These cords, meeting below the lever, continue as a single cord to pass through a groove in its end, and are, then, made fast to it. Below the heddles, are two sets of *marches*, consisting of four marches each, which are moveable at the centres F and I. The long marches are distinguished by the letter E; the short marches by G. Each of the four long marches, is connected with the end of the corresponding top levers at D; each short march is connected with the lower shaft of the leaf of heddles, to which it is to give motion.

Now, as each of these marches is connected with one leaf of the heddles, it follows, that, if a *long* march is pulled down, the leaf will rise; if a *short* march is pulled down, the leaf will sink.

This will be apparent, when it is considered, that the cords, below, form a direct connection between the *lower* heddle shafts and the short marches. Of course, when one of the latter is pulled down, those of the former, with which it is connected, must sink also. But the motion, communicated from the *long* marches to the upper shafts, is reversed at the centre B of the top levers; for when the end at D is pulled down, the end at A will rise, and the leaf will be pulled up by the suspending cords. These top levers are known, among weavers, by the name of *coupers*.

The arrangement of this apparatus, although very simple, ought to be carefully studied, by those who are not conversant with the practice of weaving; for it is very generally used, in almost every species of ornamental work. The ends of the top levers, or *coupers*, at A, which contain the grooves for the suspending cords, ought to be segments of a circle, the radius of which is equal to the distance of the groove from the centre of motion at B, in order that the pull may be uniformly perpendicular. The distance of the centre B from the end D, is generally made twice as great as that from A to B; for otherwise, the long marches would communicate too great a range of motion to the leaves. If greater accuracy is wanted, the ranges of the different levers, and the ratio which they bear to each other, may be calculated by the same rules, which apply to all other motions communicated by means of levers, and these are explained in almost every elementary treatise upon mechanics.

When the connections, between the leaves and marches, have been formed agreeable to the above description, it is only necessary to arrange the treddles, and to connect each treddle with the marches which it is intended to move.

It is a general rule in fancy weaving, that every individual treddle should be connected with all the leaves of the heddles, for the purpose of raising some, and sinking the rest. Some exceptions to this rule occur, but these are few, and will be particularly noticed, when the cases, to which they relate, are to be investigated.

The connecting cords between the marches and treddles, are applied in the manner proper for weaving a web, which may be tweeled or plain, as may be required. This kind of mounting is, generally, used for cloths in which the grounds are woven *plain*, and stripes, *tweeled* by the weft, occasionally introduced. If the figure is carefully examined, the connections of each treddle with the marches may be easily distinguished, by comparing the lines which represent the cords, with the description which will be afterwards given.

But, previous to this, it may be useful to explain the mode of drawing plans upon paper, to direct the weaver in drawing his warp through the heddles, and of applying the cords by which these heddles are to be moved. These plans are, generally, called the

DRAUGHT AND CORDING.

Plans of this description may be considered as horizontal sections of a loom, for the purpose of showing the heddles and treddles. Although the treddles, in a loom, are placed directly under the heddles, it is usual to represent them at one side, upon the paper, for the sake of easier reference from the one to the other.

Fig. 2. is a representation of the way of drawing and cording a common four leaf tweel. The four leaves of the heddles are shown at C, numbered from 1 to 4, and the four treddles at N, also numbered in the order in which the weaver is to tread them.

A portion of the warp, as it passes through the heddles, is represented at D, and the threads of warp, which pass through the same interval of the reed, are connected by cross lines. In this case, four threads pass through each interval. Where the threads of warp cross the heddles, the black marks denote the leaf through which each particular thread is drawn. For example, as it is the most convenient way for weavers, to draw their warps through the heddles from right to left, the order of the figures denoting the warp, is inverted. The first thread is drawn through the back leaf, and so on, successively, to the front. Where the treddles N cross the heddles C, the black marks refer to the mode of applying the cords which form the connections between the marches and treddles, either to raise or sink the heddles. Wherever a black mark is placed, it denotes that the heddle and treddle, which there intersect each other, are to be connected by the long marches; that is to say, that the treddle when pressed down, must raise that leaf. When all the connections, distinguished by the black marks, have been formed, all the remaining connections must be made by the short marches; for the treddle which raises only one leaf, must sink all the others. For example: Where the treddle No. 1. crosses the fourth, or back leaf, in Fig. 2. there is a black mark. A cord, therefore, is to be carried from the long march under the fourth leaf, to the first treddle; and cords are to be carried from the short marches, under the other three leaves, to the same treddle. Thus, the treddle No. 1. when pressed down, will raise the first, or back leaf, and sink the other three. The treddle No. 2. when properly corded, will raise the second leaf, and sink the others: the third treddle will raise the third leaf; and the fourth treddle, the fourth, or front leaf. It will be evident, upon consideration, that if the weaver presses down the treddles, successively as they are numbered, he will raise every leaf, in succession, from the back to the front; and at every tread, one leaf will be raised and three sunk. By comparing this operation with the specimen of tweeled cloth Fig. 2. Plate 4. it will become obvious, that the effect there represented, will be produced. Whether a tweeled web is wrought with three, four, or five leaves, the succession is in the same order, unless when otherwise arranged to produce a different effect.

Fig. 3. and 4. Plate 4. are also representations of tweels of four leaves, and as the fabric of tweeled cloth is generally thick and close, convey a better idea of the appearance than Fig. 2. which is designed merely to give an accurate representation of the intersections of the threads. If we suppose that the warp of a tweeled web is of white yarn, and that the weft is black, Fig. 4. Plate 4. will convey a correct idea of the appearance of the upper side of a web, woven in a loom mounted according to the plan Fig. 2. Plate 5.; and Fig. 3. will represent the appearance of the under side of the same web. For, in Fig. 3. the white warp appears flushed, and in Fig. 4. the black weft is flushed. Now, were the cording in the plan Fig. 2. Plate 5. reversed; that is to say, were three leaves to rise, and one to sink, when each treddle is pressed down, the effect would be quite the same, excepting that the upper side would then be flushed by the weft, and the under

side by the warp. This reversing of the flushing, which may be effected by additional mounting, is the principle upon which the ornamental figures upon many kinds of tweeled cloth depend. We shall have occasion to treat of this afterwards.

Fig. 3. Plate 5. is a plan of mounting, which will produce exactly the same effect as that represented in the transverse section Fig. 1. The only distinction is, that the treddles are arranged in a different order, those in Fig. 1. being in the order 4, 3, A, B, 1, 2; and those in Fig. 3. in the succession 4, 3, 2, 1, A, B. Now, the order in which the treddles are arranged, may be varied as the weaver pleases, and is merely a matter of convenience. It may, however, be proper here, to make a few general observations upon

THE ARRANGEMENT OF TREDDLES.

When a great number of treddles are necessary to produce any effect, it will be, obviously, the best way to arrange them in the succession in which they are to be pressed down by the weaver, when this is practicable. For, if some regular order be not adopted, the weaver will frequently be apt to mistake the treddle, and press down a wrong one. In heavy fabrics, where great power must be applied, the weaver is, generally, obliged to use both his feet; and frequently the whole weight of his body will be no more than sufficient. In this case, it is common to place the treddles in regular succession, from right to left; as,

6 - 5 - 4 - 3 - 2 - 1

But, where the fabric is lighter, and when the pressure of one foot is sufficient, it will be more convenient to arrange the treddles so, that the right and left foot may be applied alternately, without crossing each other. When this is the case, the weaver, while treading with one foot, has sufficient time to shift the other to the next treddle, without impeding the operation. This, naturally, leads us to commence our succession at the centre, and to place the succeeding treddles, alternately, upon each side; as,

5 - 3 - 1 - 2 - 4 - 6

In this case, the treddles 1 - 3 - 5 will be wrought by the left foot, and the treddles 2 - 4 - 6 by the right; and by applying the feet alternately, the treddles, from 1 to 6, will be wrought in the regular order of the numbers. In the plan, Fig. 3. the first of these successions is adopted; in the elevation, Fig. 1. recourse is had to the second. In both, four treddles are required for the tweel, and two for working the web plain. The former are distinguished by numbers; the latter, by the letters A, B.

In all the plans given, it is to be understood, that when two treddles are applied for the purpose of working the web plain, these treddles are, always, distinguished by the letters A, B. All treddles for the fanciful part, are distinguished by numbers; and the placing of these numbers, gives the order in which the treddles are to be wrought.

Fig. 4. Plate 5. shows the draught and cording of a loom, mounted for working a tweel consisting of five leaves. There is no difference between this figure and Fig. 2. excepting in the number of the leaves, and the number of the treddles. The drawing of the warp through the heddles, proceeds in the same regular succession from right to left; and the treddles are arranged in the same order. In this figure, five of the lines,

which represent the threads of the warp, are connected by each cross line: five threads, therefore, are to be drawn through each interval of the reed.

Fig. 5. Plate 4. represents a kind of ornamental tweel, produced, merely, by reversing the order, in which the warp is drawn through the heddles. The plan, for drawing and cording a web of this description, will be found by referring to Fig. 5. Plate 5. The heddles consist of five leaves, and the explanations of the references, already given for Fig. 2. apply equally well to this, and to all the other plans.

Fig. 6. is a plan for mounting a loom, so as to produce both plain and tweeled cloth, at the same time. Such plans are, generally, adopted, when it is requisite to weave webs, the grounds of which are to be plain, and the stripes tweeled by the warp. Two treddles are added, to enable the weaver to work the whole fabric plain, if necessary. If not required, the two plain treddles A, B may be omitted. In this plan, the leaves 1, 2, 3, 4 contain that portion of the warp, which is to form the tweeling, or stripes; the leaves A, B, that portion which is to form the ground, or intervals. An examination of the mode of applying the cording will evince, that when the treddles 1, 2, 3, 4 are pressed down in the order of the numbers, the tweeling leaves 1,2,3,4 will rise successively, and the plain leaves A, B alternately. The draught of the warp, through the reed, as denoted by the cross lines, is, here, adapted to the purpose of rendering the tweeled stripes more close and compact than the plain ground; for, of the former, four threads pass through each interval, and of the latter, only two. But, if the whole is to be wrought plain, occasionally, the whole warp ought to be equally drawn. This case very rarely, if ever, occurs.

Fig. 7. is a plan of a tweeled stripe, where the tweeling is reversed in the draught, in a way similar to that shown in Fig. 5. Stripes of this kind are called, by weavers, *herring bones*, from the resemblance which the stripe bears to the back bone of a fish. The draught and cording will appear by inspection, if the explanations already given are fully understood.

It has been deemed unnecessary to multiply the number of plates, by engraving more plans of plain tweels. As the whole plans are the same in principle, such figures, as may be printed in the text, it is presumed will answer every further purpose of illustration which may be necessary.

We have, hitherto, considered all the threads of warp, in tweeled cloth, as interwoven in progressive succession, for the sake of rendering the general principle of tweeling more obvious, to those previously unacquainted with this branch of weaving. When tweels do not exceed four leaves, this arrangement is always adopted. But, when a greater number of leaves is used, a kind of alternate succession is esteemed preferable: this is called, by weavers,

BREAKING THE TWEEL.

When a tweel consists of many leaves, the flushing of both warp and weft would be so great, that the intervals between the points, at which they are interwoven, would, necessarily, be very flimsy, and the fabric very unequal. To obviate this inconvenience, the broken tweel has been used. The same mounting by which a regular tweel is wrought, will also work a broken tweel, by treading in a different succession. But, this would derange the order of the treddles, and as mentioned before, might be productive of frequent mistakes. Weavers, therefore, prefer placing the cording so, that the regular succession of the treddles may be preserved, while the effect of the broken tweel, is at the same time produced. An example of each of these follows: The first is a regular five leaf tweel, the same as Fig. 4. Plate 5. The second is the same tweel *broken*, and the succession of the treading to produce either the regular, or broken tweel, is expressed by the numbers annexed to each.

FIVE LEAVES.

	Regular Tweel.						Broken Tweel.					
1					0	1					0	1
2				0		2		0				2
3			0			3				0		3
4		0				4	0					4
5	0					5			0			5

R. 5 4 3 2 1 B. 5 4 3 2 1

B. 3 5 2 4 1 R. 3 5 2 4 1

The above example will sufficiently show the two ways of tweeling; and also, that the whole difference in the cording is, solely, to preserve a regular order in the treddles. The same succession of treading, which breaks the tweel in the one case, restores its regularity in the other. In these, and the following examples, each interval, between the lines, denotes a leaf. Numbers are used, instead of the marks in the engraved plans, to show the order and succession in which the threads are drawn; and the cypher, inserted in the squares, denotes a *raising* cord, as the black mark does in the plates.

Fig. 9. Plate 4. is a specimen of the effect, and appearance, of a five leaf tweel broken in this way, as viewed on the side, where the warp is flushed. In the same way, tweels of six and seven leaves are drawn and mounted.

The following are examples of each:

SIX LEAVES.

Regular.

					0	1
				0		2
			0			3
		0				4
	0					5
0						6

R.6 5 4 3 2 1
B.6 4 2 5 3 1

Broken.

					0	1
		0				2
				0		3
	0					4
			0			5
0						6

B. 6 5 4 3 2 1
R. 6 4 2 5 3 1

SEVEN LEAVES.

Regular.

						0	1
					0		2
				0			3
			0				4
		0					5
	0						6
0							7

R.7 6 5 4 3 2 1
B.6 4 2 7 5 3 1

Broken.

						0	1
		0					2
					0		3
	0						4
				0			5
0							6
			0				7

B. 7 6 5 4 3 2 1
R. 6 4 2 7 5 3 1

These examples will show the manner of forming the alternate, or broken, tweel. It is to be observed, that the cording may be adapted in various ways, and the tweel broken in different places, according to the discretion of the weaver. When the number of leaves will admit of it, the succession should be made, as nearly as possible, at equal intervals. For example, in the broken tweel of six leaves, all the leaves ought to follow each other in a succession, passing one leaf between each, until you come to the sixth treddle; but as the first treddle immediately follows the sixth, in repeating the operation, there will be no interval there, and the effect of these two leaves will be that of a regular, while all the rest give that of broken tweel. There is also an interval of two leaves, between the intersection, produced by the third and fourth treddles.

This, however, cannot be avoided in working with six leaves; this number, therefore, although given as an illustration, ought to be avoided in practice. The five leaf tweel also, although much used, has an interval of two leaves between the third and fourth treddle.

When eight leaves are employed, the succession in breaking the tweel, is different, and disposes the warp at intervals, more perfectly than any tweel which can be formed by a smaller number of leaves. In all the former, the interval is formed, by passing one leaf between every two, until the whole are corded; but, in the eight leaf tweel, two leaves are omitted, and the third has the raising cord applied, as will appear by the following example:

EIGHT LEAVES.

								0	1
					0				2
		0							3
							0		4
				0					5
	0								6
						0			7
			0						8
Broken	8	7	6	5	4	3	2	1	
Regular	6	3	8	5	2	7	4	1	

It is unnecessary to give a draught of the regular eight leaf tweel, because it proceeds exactly like those already given; besides, with so many leaves, regular tweeling is seldom, or never, used. By examining this cording, it will appear that the intervals, by which the tweel is broken, are perfectly regular; for the first treddle succeeds the eighth, at the same interval as all the others.

The last specimen of common tweels, which we shall give, is that of sixteen leaves, which is only to be found in some of the very fine Italian and French tweeled silks. Here the tweel is broken, by omitting four leaves, and cording the fifth.

SIXTEEN LEAVES.

															o	1
		o														2
					o											3
								o								3
											o					4
														o		5
	o															7
				o												8
							o									9
										o						10
													o			11
o																12
			o													13
						o										14
									o							15
												o				16
B.16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	

Having finished the observations, and given such examples as appeared necessary, to convey a sufficient knowledge of the principles of common tweeling, of the varieties of which it is susceptible, and of the machinery requisite for weaving the various kinds; our next object is, to investigate the means by which looms are adapted to the weaving of

TWEELED STRIPES.

In the references to Figs. 3. and 4. Plate 4. the flushing upon tweeled cloth has been explained. *On one side, the warp is flushed; on the other, the weft.* Most kinds of ornamental weaving, upon tweels, are produced by this quality of the fabric. The application of it to the forming of stripes is, at present, the subject of description.

Stripes, upon tweeled cloth, differ from those upon plain, in the following respects: Tweeled stripes may be formed without any distinction in the fineness of the warp; nor do they require supernumerary threads to be drawn, either through the heddles, or the reed. It is only necessary, to *flush* the warp and weft alternately.

The examples, necessary to elucidate this, are upon the scale of a five leaf tweel; for the same principle will apply to any number of leaves, used for tweeling.

FIVE LEAFED TWEEL STRIPE.

				0	1 1 1 1
			0		2 2 2 2
		0			3 3 3 3
	0				4 4 4 4
0					5 5 5 5
	0	0	0	0	1 1 1 1
0		0	0	0	2 2 2 2
0	0		0	0	3 3 3 3
0	0	0		0	4 4 4 4
0	0	0	0		5 5 5 5
5	4	3	2	1	

The above is a specimen of a stripe upon ten leaves, five of which flush the warp, and five the weft.

The stripe is produced by two sets of leaves, consisting of five each. The cording of the back set is exactly the same as the regular five leaf tweel, formerly described. That of the front set is the same, *reversed;* for, in the former, there are five raising cords, which raise one leaf successively, while all the rest sink: in the latter, there are five sinking cords, which sink one leaf successively, while all the rest rise. By this arrangement, the one set flushes the warp, the other the weft. The stripe is formed, by drawing a portion of warp through one set of leaves, then another portion through the other set, and so on, alternately, according to the pattern of the stripe, which may be regulated by fancy.

It is usual in this species of tweeling, to invert the order of raising the leaves of the two sets; for it will be obvious, that when the treddles are worked in the order from right to left, the back leaves will rise, in succession, from 1 to 5, and the front leaves will sink, in an inverted succession, from 5 to 1. I do not know whether this produces any improvement in the appearance of the cloth, but it is the general practice.

If a broken tweel is preferred, the leaves are corded exactly as in common tweeling, one set rising, the other sinking. The following example will be sufficient:

TWEELED STRIPE BROKEN.

				0	1 1 1 1	
	0				2 2 2 2	
			0		3 3 3 3	
0					4 4 4 4	
		0			5 5 5 5	
	0	0	0	0		1 1 1 1
0	0	0		0		2 2 2 2
0		0	0	0		3 3 3 3
0	0	0	0			4 4 4 4
0	0		0	0		5 5 5 5
5	4	3	2	1		

All tweeled stripes are mounted upon the same principle. Any number of leaves may be adopted, as in common tweeling. The patterns depend, entirely, upon the succession of drawing the warp through the heddles, and may be varied almost to infinity.

The next species of tweeling, which requires our attention, is a kind of tweeled check. It is much used in the manufacture of table-cloths, and is known in Scotland by the name of Dornock. But as we are now entering upon the fanciful part of this branch of weaving, it will be proper to notice the way of sketching patterns, for weavers, upon

DESIGN PAPER.

To facilitate the sketching of designs for ornamental weaving of most kinds, they are generally drawn upon paper, ruled with a number of parallel lines at equal intervals; and these lines are crossed at right angles, by others, so that the whole exhibits the appearance of a number of small squares. Of these, the lines drawn from the top to the bottom of the paper, are supposed to represent the warp, and the cross lines, the weft of a web. Some of the lines, *generally every tenth line*, in either direction, are drawn bolder than the others, to render the counting of the number of lines easy. Fig. 1. Plate 6. is a specimen of paper of this description, which is known by the name of *design paper*. In drawing any pattern, for weaving, upon design paper, each interval, between two lines, may be supposed to represent any number of threads, either of warp or woof, at discretion. In all the patterns upon the design paper in Plate 6. each interval represents five threads, because the tweel to be formed consists of five leaves. The pattern Fig. 1. which is one of the most simple which can be formed in this kind of weaving, is an imitation of a common checker board, for playing at draughts or chess. Let the squares which are black, be supposed to represent that part of the web, where the weft appears flushed over the warp, upon one side of the cloth, and those squares, which are left blank, to represent that part where the warp is flushed over the weft. The former, then, if we suppose the weft to be black, will give the same appearance as Fig. 4. Plate 4. the latter, that of Fig. 3. But as the squares of the checker are, alternately, black and white, the weaver, to accomplish this, must have it in his power to reverse the flushing at pleasure. This is effected by an apparatus consisting of ten leaves, the same as in the stripes, and ten treddles, being exactly two sets of the mounting necessary for weaving a common five leaf tweel. The plan of the mounting opposite to the design, Fig. 1. Plate 6. will serve to illustrate this.

Every square, in the design, occupies six spaces upon the paper, and it has been already mentioned, that each of these spaces represent five threads, or one set of a five leaf tweel. Each square, therefore, consists of six sets, or thirty threads, and the squares are alternate. Therefore, six sets, of five threads each, are drawn through the first five leaves, the same as in common tweeling; then six sets are drawn through the other five leaves, and so on, alternately, until the whole warp is drawn through the heddles. A careful inspection of the figures, it is presumed, will render this very plain, even to a person not conversant with ornamental weaving, and it is of importance, that this simple pattern should be fully understood, as it forms the base, upon which the whole structure of ornamental tweeling is founded.

The drawing of the warp differs, in no respect, from that used for the stripes; the five additional treddles are used to reverse the flushing. The treddles, from six to ten, raise the tweeling leaves of the back set, and sink those of the front. The treddles, from one to five, exactly reverse this operation. The weaver, therefore, works the treddles 1, 2, 3, 4, 5, successively, until he has completed one range of squares or checkers; he then works those numbered 6, 7, 8, 9, 10, until he has completed another range, and so on alternately.

The Figs. 2, 3, and 4. Plate 6. are wrought by the same mounting as Fig. 1. The whole difference is in the way of drawing the warp through the heddles. In Fig. 2. every individual thread is drawn as in the former examples in the plates. In Figs. 3, and 4. one line drawn across the heddles, represents a set, consisting of five threads drawn successively in the same way as Figs. 1, and 2. The same is expressed, by numbers, in the two draughts under Figs. 3, and 4. The first and second set of heddles, are divided by an interval, and the number of sets, to be drawn upon each, are expressed by the numbers. I have added a number of draughts of patterns on the same plan, all of which are wrought with ten leaves, and ten treddles, or two sets of tweel mounting, the difference being entirely in the drawing. All these patterns, if wrought with only five treddles, will form tweeled stripes.

DRAUGHTS OF TWEELED PATTERNS OF TWO SETS, OR TEN LEAVES.

	No. 1.	No. 2.
2d. set	35 35	10 10 40
1st. set	35 35	10 40 10

No. 3.	No. 4.
10 5 10 10 5 10 40	10 40 10 40
10 5 10 40 10 5 10	10 40 10 40

No. 5.	No. 6.
20 5 20 5 5 5 5	40 5 5 5 5
20 5 5 20 5 5 5	30 30 5 5 5

No. 7.
20 5 20 5 5 5 5 20 5 5 20 5 5 5 5
20 5 5 20 5 5 5 5 20 5 20 5 5 5 5

No. 8.
40 5 5 5 20 5 5 5 5
20 20 5 5 5 10 5 5 5

No. 9.
5 5 10 5 5 5 5 5 10 5 5 5 5
5 5 10 10 5 20 20 5 10 10 5 20 20

No. 10.
5 5 5 5 20 5 20 5 5 5 5 20 10 10 20
5 5 5 5 20 5 5 20 5 5 5 5 15 5 15

No. 11.

15 15 5 5 5 5 15 30 15 5 5 5

15 30 15 5 5 5 5 15 15 5 5 5

No. 12.

5 5 15 5 15 5 30 10 30 5 15 5 15

30 15 30 5 15 5 15 5 5 15 5 15 5

No. 13.

25 10 10 10 15 15 10 10 10

15 15 10 10 10 25 10 10 10

No. 14.

5 30 10 10 30 5 5

30 10 5 20 5 10 30

No. 15.

15 5 15 30 10 15 5 5 15 10 30

15 5 5 15 5 5 15 5 15 5 5

No. 16.

30 30 30 30 10 10 10 10

30 30 30 30 10 10 10 10

No. 17.

10 10 15 5 15 10 10 15 5 15

25 5 25 10 10 25 5 25 10 10

No. 18.

20 20 5 5 5 20 20

20 5 20 5 5 20 5 20

When a greater variety of pattern is wanted than can be accomplished by ten leaves, or two sets of mounting, additional leaves and treddles become necessary, and these go on progressively, by sets of five leaves each, according to the pattern required. Fig. 1. Plate 7. is an example of a pattern wrought by three sets of mounting, or fifteen leaves. Fig. 2. represents one where four sets are necessary. This figure is drawn as a four leaf tweel; therefore, every space in the design represents only four threads, and the four sets of mounting contain only sixteen leaves and sixteen treddles. To render the effect which the mounting produces more apparent, this plate has been coloured, and each set of leaves and treddles are of the same colour, as the spaces in the design paper, where the flushing is reversed, to produce the pattern. For example, where the design is coloured blue, the blue treddles are to be used, and the blue leaves give the reverse, while all the other leaves rise and sink like a common tweel. The same is the case with all the other colours; and it will appear, upon inspection, that the cords are placed exactly upon the same principle as was formerly explained.

In Fig. 1. The cording is applied to produce a broken tweel: in all the others the tweel is regular.

The following is a variety of patterns, wrought by three, four, five, and six sets of tweel mounting: as formerly, the draughts only are given, for the cording in the whole is the same.

PATTERNS OF THREE SETS.

No. 1.

3d. set	6 6 .6 6 2 2 2 2
2d. set	6 6 2 2 2 6 6 2 2 2
1st. set	6 6 2 2 2 2 6 6

No. 2. No. 3.

3 3 3 3 2 ‖ 1 1 8 1 1 8 1
2 2 2 2 2 2 3 2 ‖ 1 4 1 1 3 1 3 3 1 3 1 1
2 3 2 2 3 2 ‖ 1 1 1 3 1 1

No. 4.

1 1 1 6 1 1 6 1
1 1 3 1 1 1 1 1 1 1 1 3 1 1 1 1 1
1 3 3 1 3 3 1 3 3 1 3

No. 5.

1 1 8 1 1 8
1 1 3 3 1 3 1 1 3 1 3 3 1 3 1
1 1 3 1 1 1 1 3 1 1

No. 6. No. 7.

1 3 1 3 1 3 1 3 ‖ 1 2 2 1 1 3 1
1 1 3 3 1 1 3 3 ‖ 3 1 3 3 3 1 3
3 3 1 1 3 3 1 1 ‖ 1 1 1 1 3 3

No. 8.

3 1 1 3 3 1 1 3
1 1 1 1 1 1 1 1 3 1 3 3 1 3
1 1 1 2 1 1 1 10

No. 9.

1 6 1 1 3 3 1 ||
1 3 3 1 1 3 3 1 ||
1 3 3 1 1 6 1 ||

No. 10.

6 6 6
3 3 2 2 2 2 2 2
3 3 2 2 2 2

No. 11.

3 3 1 1 3 3 ||
3 1 1 3 1 1 3 3 1 1 ||
3 1 3 1 3 1 3 1 ||

No. 12.

6 6
3 3 3 2 3
3 2 3 2 2

No. 13.

6 6 ||
3 3 3 3 ||
3 1 3 3 1 3 ||

No. 14.

4 4
3 1 3 1 1 1
3 3 1 1

No. 15.

1 1 2 1 1 10
3 1 3 1 1 1 1 1 1 3 1 3
3 1 1 3 1 1 1 1 3 1 1 3

No. 16.

6 1 1 1 1 3 3 1 1 1 1
3 3 1 1 1 1 6 1 1 1 1
3 3 1 1 1 1 3 3 1 1 1 1

No. 17.

3 3 2 1 1 6 1 1 2
3 3 1 1 1 1 3 3 1 1 1 1
6 1 1 2 3 3 2 1 1

PATTERNS OF FOUR SETS.

No. 1.

```
                 2 1 2     2 1 2
                  2 2   1   2 2
         1 2 2 1        1 1
        3 1 1 1 3     1    1
```

No. 2.

```
          2     3     3     1
           1   1 1   1 1   1
            1 1   1 1   1 1
             3     3     3
```

No. 3.

```
        1     1     1     1     3 1 1 3
         1   1       1   1       1 3 3
   2 1 2  1 1   1 1   1 1  2 1 2
    1 1   1   2 1 2   1   1 1
```

No. 4.

```
    1   1   3       3       3       3   1   1
   1   1   2 1 1 1  2 1 1 2  1 1 1  2   1   1
6 1 6   1   1                           1   1
1 1   1   1   2 1 1 2  1 1 1  2 1 1 2   1   1
```

No. 5.

```
          3     3   1     1     1
         3 1   1 3   1   1 1   1
        3   1 1   3   1 1   1 1
       3    1     3   1     1
```

No. 6.

1 4 1   4 1 1 4   1 4 1   1 4 1
3 1 1 3   1 3 1   3 1 1 3   3 1 1 3
4   4   4   4 1   1 4   4 1   1
1 10 1   1 10 1

No. 7.

1   1 1   1 1   1 3   1   1   3
1 1   1 1   1 1   3   1 1   3
1   1   1   3   1   3
4   4   4   4

No. 8.

1 1 1   1   1   1 1 1   1   1
1 1 1 1   1   1   1 1 1 1   1   1
1   1   1 1   1   1   3 1 1 3
1   1   3   1   1   3 1 3

No. 9.

1 5 1   1 8 1
3   1 1   1 1
3 1 1   3 1 2 2 1 3
1 1 2   1 1 3 1 1

No. 10.

2 1 1 2   2 1 1 2
1 3 1   1 3 1
1 1   1 1 1 1 1
1 9 1   1 1 1 1 1 1

No. 11.	No. 12.
4 4	6 6
3 1 1 3 1	1 1 3 1 3
3 1 1 3	3 1 1 3
3 1 3	3 1 3

No. 13.

2 1 2 2 1 2 1 1 1
2 2 2 2 1 1 2
3 1 3 1 1 1
3 1 1 3 1 1 1

No. 13. continued.

2 2 2 2 1 1 1
2 2 2 2 1 2 2 1 1
3 1 1 3 1 1 1
3 1 3 1 1 1

No. 14.

1 1 2 2 1 2 2
1 1 2 1 2 2 1 2
2 1 2 2 1 2 1 1
2 2 1 2 2 1 1

No. 15.	No. 16.
1 5 1 1 5 1	3 3
3 3 3 3	2 1 1 2
1 1 1 1 3 1 1 1	1 3 1 1 3 1
1 1 2 1 2 2 1 2	2 1 1 2

No. 17.

3 3 2 2 1 1 1 1 2 2 1
3 3 1 1 1 1 1
3 3 1
3 3 3 3 3 3

No. 17. continued.

3 3 3 3 3 3
3 3
3 3 1 1 1 1 1
3 3 1 2 2 1 1 1 1 2 2 1

No. 18.

1 1 1 2 2 1 2 2 1
2 1 2 1 1 1 1 1 1 1
2 1 2 1 1 1 1
1 1 1 1 1 1

No. 18. continued.

1 1 1 1 1 1
1 2 1 2 1 1 1 1
2 2 1 1 1 1 1 1 1 1
1 1 1 2 1 2 1 1

No. 19. No. 20.

4 4 || 3 3 3 3 1
2 1 1 2 1 1 || 1 3 1 1 1
2 2 1 1 || 3 3 1 1
1 2 1 2 || 3 3 2 2

PATTERNS OF FIVE SETS.

No. 1.

5 1 1 5
1 3 3 3
3 3 3 3 3 3
3 3 3 3 3 3
3 3 3 3 3 3

No. 2.

2 2 4
3 3 3 3 2
3 3 3 3 1 1
3 1 3 3 3 2 2
1 1 1 2 2

No. 3.

3 3 2
3 3 3 3 2
3 3 3 2 2 1 2
2 1 1 2 2 1 1 2 2 1 1 2
2 2 2 2 2 2 2 2

No. 4.

3 1 1 3 1 1
3 1 1 3 1 1
3 1 3 1
1 1 1 1
1 1 1 1 1 1

No. 5.

2
1 1 1 1 1 1 2 1
1 1 1 1 1 1 1 1 2 2
2 2 1 1 1 1 1 1 1 2 2
2 1 2 1 1 1 1 2 1 2

No. 5. continued.

4 2 3 3
2 2 1 2 2 1 2 2 1 2 2 1 1 2
2 2 2 2 2 2 2 2 2 1 1 2
2 1 1 2
2 1 2

No. 6.	No. 7.
1	1 1
1 1 4 1 1 1	1 1
1 3 3 1 1 1	1
3 1 3 3 1 3 1 1	3
1 1 5 1 1 1 1	1 1

No. 8.	No. 9.
1 1 1	3 3 3 3
1 1 1	3 3 3
3 3	3 3
3 3	3 3
9 9	1

No. 10. DRAUGHT.	No. 10. ORDER OF TREADING.
3 10	9 10
3 3 2 3 3	1 9 9 3
3 3 3 3	1 1 3 3 3
3 3 3 3	1 1 3 3
3 3 3 3	2 1

PATTERNS OF SIX SETS.

No. 1.

1 1 1 1 1 1

1 1 1 1

1 3 1

1 1 3 1 1

1 1 3 1 1

1 1 3 1 1

No. 1. continued.

1 1 1

1 1 1 1

3 1 1 1 1

3 1 1 1 1

3 1 1 1 1

3 1 1

No. 2.

2 2 2 2 2 2 2

1 1 1 1 1 1 1 1 1 1 1 1 1 1

1 1 1 1 1 1 1 1

No. 2. continued.

1 3 3 1

5 5 5 5

2 1 1 2 2 1 2 2 1 2

2 1 2 2 1 1 2 2 1 1 2

No. 3.

```
                      4    1   1   4
                    4                4
                         1   1   1                                1   4   1
                                       4           4     1     4   1    1
                                         4   1   2   2       4
                                           2   2       2   2
```

No. 3. continued.

```
                                                             4   1   1   4
                                                          4   1    1   1   4
                       4   1
                     1   1    4     1     4     1     4
                                4       2   2       4
                                  2   2       2   2
```

No. 4.

```
      2            2   2           2                       2      2     2
        2            2           2                        2     2     2
          2                    2                       2      2     2
             2               2           2     2     2                        2     2
               2           2           2     2     2                        2     2     2
                 2       2           2     2     2                        2     2     2
```

No. 4. continued.

```
              2           2           2     2     2                        2     2     2
            2           2           2     2     2                        2     2     2
          2           2           2     2     2                        2     2     2
        2           2           2                        2     2     2
                  2           2                        2     2     2
                2            2                       2     2     2
```

These patterns have not been selected for any particular merit which they may possess, but, merely, as illustrations of the manner of weaving them, and all patterns of equal compass.

Every pattern may be varied very much, by working the treddles in a different succession. One pattern, therefore (No. 10. four sets), is inserted where the succession of the treddles is not in the same order as that of the draught.

Those who wish to attain a thorough knowledge of this, and of every branch of ornamental weaving, ought carefully to draw the draughts, given for the mounting of webs, upon design paper.

The rule for this is simple and easy. Select any pattern. Suppose every unit in the figures employed, to be comprehended in one square of the design paper. Draw the whole design of the set which occurs, first across the paper, making each of the largest draughts square by the weft. Continue the pattern, until all the sets, of which the mounting consists, have been inserted, and the pattern will be complete. The patterns may be lengthened, or shortened, by the weft, at discretion. A careful comparison of the figures, upon the design paper, in Plates 6, and 7. with the draughts, will be of much service in rendering this familiar.

The principles before described may be carried to any extent; for, as the patterns assume a greater variety, it is only necessary to increase the number of leaves. This, however, would be attended with much practical inconvenience; for when many leaves are necessary, they not only occupy a great space, but require a greater degree of power applied to move the treddles, than a man can easily exert. Indeed, in fanciful tweeling, it is generally found inconvenient to work with more leaves than fifteen, or three sets. To obviate this, when an extensive range of pattern is required, a very ingenious, although simple, apparatus, has been adopted; which is called, by weavers, a

BACK HARNESS.

THE superiority of the back harness for extensive patterns, consists in this; that in no case to which it is applied, more than one set of treddles, that is, the number requisite for working a common tweel of the same number of leaves, is necessary. Plate 8. contains the various parts of a back harness and other apparatus, consisting of five harness leaves, and five plain leaves, for working a fanciful five leaf tweel. From the construction of the harness, each leaf produces an effect equal to that of five leaves upon the plan formerly described. This mounting, therefore, although it consists only of ten leaves, possesses the means of working any pattern of twenty-five leaves, or five sets.

The five leaves, at A. Fig. 1. represent the back harness. Each heddle contains an eye, which is generally made of tin, and through each of these eyes five threads of the warp are drawn. The harness leaves are lifted, as may be required, by means of the top levers, or coupers, B. Of these there are usually two sets, for the sake of lifting both sides equally. The other end of the levers, at D. are connected by cross shafts, from each of which hangs a cord, passing through a hole in a square board E. Upon each cord is a knot, which, when the leaf is raised, is fixed in a notch in the board E. The proper shape of the holes and notches, appear in Fig. 3. To the end of each cord is attached a handle, which the weaver pulls with his hand, when necessary, to lift a leaf of the harness. The front mounting, at C, consists of five leaves, as in a common tweel, and is worked by treddles and marches, exactly in the same way. The five threads, which are drawn through each eye of the back harness, are drawn in succession through the front leaves, one thread passing through each, as represented in Fig. 2.

The eyes of the front heddles, are of a length rather greater than the whole depth of the shed.

To understand the application of this apparatus, we must again recur to the general principle of fancy tweeling, viz. *flushing by the warp, or by the weft, and reversing the flushing at pleasure.*

The cording is applied to the front leaves, in such a manner, that one leaf rises, one sinks, and the other three remain stationary, at every tread. The order may be either that of the regular, or the broken tweel. This is one of the exceptions to the general rule, of the treddle which raises certain leaves, sinking all the rest. In the plan of cording, Fig. 2. the raising cords are, as usual, distinguished by black marks, the sinking ones are left blank, and where the leaves are to remain stationary, and where, of course, no cord is required, a cross × is placed.

Now, by again referring to Fig. 1, it will appear, that the leaves 1, 2, 3, 4 of the back harness are sunk, and the leaf 5 is raised. The leaf 1 of the front mounting is is raised; the leaf 5 is sunk, and the leaves 2, 3, 4 are stationary. As five threads pass through every eye of the harness, all the threads which pass through the harness leaf 5, will be raised above the shuttle, except those which are sunk by the front leaf 5. Four threads are, therefore, *above*, and one below. This produces a tweel, flushed by the warp. In all the other harness leaves, all the threads will be under the shuttle, except those which are raised by the front leaf 1. Four threads, therefore, are *below*, and one above. This produces a tweel, flushed by the weft; and the flushing may be reversed at pleasure, by raising or lowering the harness leaves.

The length of the eyes of the front leaves, being rather more than the depth of the shed, the leaf which sinks, carries with it one thread of every five which are raised by the harness; the leaf which rises carries up one thread of every five which are sunk. Upon the rest, they produce no effect. The patterns given, answer equally well for the harness, as for leaves; it being always recollected, that one harness leaf answers the purpose of five upon the former plan, supposing the tweel to be one of five leaves.

The last and most comprehensive apparatus, employed by weavers for fanciful patterns of great extent, is the draw loom.

This apparatus, besides being used for weaving the most extensive patterns in ornamental tweeling, is, also, adopted for the same purpose, both in the weaving of double cloths, such as carpets, &c. and also in spot weaving. We shall, therefore, postpone the description of the principles and machinery of the draw loom, until these branches have been investigated.

In the mean time, we proceed to give specimens of a great variety of fancy work, effected by flushing.

The following sixteen patterns, represent the drawing and cording of a species of tweeling, much used for a variety of purposes.

No. 1.

	0			0	0	0	0			0	0			0		0	1	1
0			0	0	0	0			0	0			0		0		2	32
		0	0	0	0			0	0			0		0		0	3	31
	0	0	0	0			0	0			0		0		0		4	30
0	0	0	0			0	0			0		0		0			5	29
0	0	0			0	0			0		0		0				6	28
0	0			0	0			0		0		0					7	27
0			0	0			0		0		0						8	26
		0	0			0		0		0							9	25
	0	0			0		0		0	0	0	0	0	0	0	0	10	24
0	0			0		0		0	0		0	0	0	0	0	0	11	23
0			0		0		0		0	0		0	0	0	0	0	12	22
		0		0		0			0	0	0		0	0	0	0	13	21
	0		0		0				0	0	0	0		0	0	0	14	20
0		0		0					0	0	0	0	0		0	0	15	19
	0		0						0	0	0	0	0	0		0	16	18
0		0							0	0	0	0	0	0	0		17	
17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			

No. 2.

	0	0				0	0		0	0				0	0	1	1
0	0						0	0	0				0	0	0	2	30
0				0				0				0	0	0		3	29
			0	0	0						0	0	0			4	28
		0	0		0	0				0	0	0				5	27
			0	0	0				0	0	0				0	6	26
0				0				0	0	0				0	0	7	25
0	0						0	0	0				0	0		8	24
	0	0				0	0	0						0	0	9	23
0	0				0	0	0				0				0	10	22
0				0	0	0				0	0	0				11	21
			0	0	0				0	0		0	0			12	20
		0	0	0						0	0	0				13	19
	0	0	0				0				0				0	14	18
0	0	0				0	0	0						0	0	15	17
0	0				0	0		0	0				0	0		16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 3.

0		0	0				0		0			0	0	1	1
	0	0				0		0			0	0	0	2	26
0	0				0		0			0	0	0		3	25
0				0		0			0	0	0			4	24
			0		0			0	0	0			0	5	23
		0		0			0	0	0			0		6	22
	0		0			0	0	0			0		0	7	21
0		0			0	0	0			0		0		8	20
	0			0	0	0			0		0			9	19
0			0	0	0			0		0				10	18
		0	0	0			0		0				0	11	17
	0	0	0			0		0				0	0	12	16
0	0	0			0		0				0	0		13	15
0	0			0		0				0	0		0	14	
14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	15	16	17	18	19	20	21	22	23	24	25	26			

No. 4.

0	0					0					0	0		1	1
0					0					0	0		0	2	26
				0					0	0		0	0	3	25
			0					0	0		0	0		4	24
		0					0	0		0	0			5	23
	0					0	0		0	0				6	22
0					0	0		0	0					7	21
				0	0		0	0					0	8	20
			0	0		0	0					0		9	19
		0	0		0	0					0			10	18
	0	0		0	0					0				11	17
0	0		0	0					0					12	16
0		0	0					0					0	13	15
	0	0					0					0	0	14	
14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	15	16	17	18	19	20	21	22	23	24	25	26			

No. 5.

	0							0	0	0	0	0	0		0	1	1
0		0						0	0	0	0	0		0		2	30
	0		0					0	0	0	0		0		0	3	29
		0		0				0	0	0		0		0	0	4	28
			0		0			0	0		0		0	0	0	5	27
				0		0		0		0		0	0	0	0	6	26
					0		0		0		0	0	0	0	0	7	25
						0		0		0	0	0	0	0	0	8	24
0	0	0	0	0	0		0		0							9	23
0	0	0	0	0		0		0		0						10	22
0	0	0	0		0		0		0		0					11	21
0	0	0		0		0	0			0		0				12	20
0	0		0		0	0	0				0		0		0	13	19
0		0		0	0	0	0					0		0		14	18
	0		0	0	0	0	0						0		0	15	17
0		0	0	0	0	0	0							0			16
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 6.

	0		0	0	0	0						0		0		1	1
0		0	0	0	0						0		0			2	30
	0	0	0	0						0		0				3	29
0	0	0	0						0		0					4	28
0	0	0						0		0						5	27
0	0						0		0							6	26
0						0		0								7	25
					0		0		0	0	0	0	0	0	0	8	24
				0		0		0		0	0	0	0	0	0	9	23
			0		0		0		0		0	0	0	0	0	10	22
		0		0			0	0		0		0	0	0	0	11	21
	0		0				0	0	0		0		0	0	0	12	20
0		0					0	0	0	0		0		0	0	13	19
	0						0	0	0	0	0		0		0	14	18
0							0	0	0	0	0	0		0		15	17
							0	0	0	0	0	0	0		0		16
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 7.

	0		0	0	0	0						0		0		1	1
0		0	0	0	0						0		0		0	2	30
	0	0	0	0						0		0		0	0	3	29
0	0	0	0						0		0		0	0		4	28
0	0	0						0		0		0	0			5	27
0	0						0		0		0	0			0	6	26
0						0		0		0		0	0			7	25
					0		0		0	0			0	0		8	24
				0		0		0	0	0				0	0	9	23
			0		0		0	0	0	0					0	10	22
		0		0		0	0	0	0	0						11	21
	0		0		0						0					12	20
0		0		0	0	0						0				13	19
	0		0	0		0	0						0			14	18
0		0	0				0	0						0		15	17
	0	0			0			0	0						0	16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 8.

0	0		0		0		0		0					0	0	1	1
0		0		0		0		0					0	0	0	2	30
	0		0		0		0					0	0	0		3	29
0		0		0		0					0	0	0		0	4	28
	0		0		0					0	0	0		0	0	5	27
0		0		0					0	0	0		0	0		6	26
	0		0					0	0	0		0	0			7	25
0		0					0	0	0		0	0				8	24
	0					0	0	0		0	0					9	23
0					0	0	0		0	0					0	10	22
				0	0	0		0	0	0				0		11	21
			0	0	0		0	0			0				0	12	20
		0	0	0		0	0					0				13	19
	0	0	0		0	0							0			14	18
0	0	0		0	0				0					0		15	17
0	0		0	0				0		0					0	16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 9.

	0	0	0			0			0	0	0		0		0	1	1
0		0	0	0				0	0	0		0		0		2	30
0	0		0	0	0		0	0	0		0		0		0	3	29
0	0	0		0	0	0	0	0		0		0		0	0	4	28
	0	0	0		0	0	0		0		0		0	0	0	5	27
		0	0	0	0	0		0		0		0				6	26
0			0	0	0		0		0		0	0			0	7	25
		0	0	0		0		0		0	0	0		0	0	8	24
	0	0	0		0		0		0				0	0	0	9	23
0	0	0		0		0		0	0			0	0	0	0	10	22
0	0		0		0		0	0	0		0	0	0			11	21
0		0		0		0				0	0	0	0			12	20
	0		0		0	0			0	0	0	0	0			13	19
0		0		0	0	0		0	0	0				0	0	14	18
	0		0				0	0	0	0				0	0	15	17
0		0	0			0	0	0	0	0				0	0	16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 10.

			0	0	0		0	0	0		0	0	0		0	1	1
			0	0			0	0			0	0		0		2	30
			0				0				0		0		0	3	29
0	0	0		0	0	0		0	0	0		0		0	0	4	28
0	0			0	0			0	0		0		0	0	0	5	27
0				0				0		0		0	0	0	0	6	26
	0	0	0		0	0	0		0		0	0	0	0	0	7	25
	0	0			0	0		0		0	0	0				8	24
	0				0		0		0	0	0	0				9	23
0		0	0	0		0		0	0	0			0			10	22
		0	0		0		0	0	0	0				0		11	21
0	0	0		0		0	0	0			0				0	12	20
0	0		0		0	0	0	0				0				13	19
0		0		0	0	0			0				0			14	18
	0		0	0	0	0				0				0		15	17
0		0	0	0	0	1					0				0	16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 11.

		0	0				0	0	0	0			0	0	0	1	I
	0	0				0	0	0	0			0	0	0	0	2	30
0	0				0	0	0	0			0	0	0	0	0	3	29
0				0	0	0	0			0	0	0	0	0		4	28
			0	0	0	0			0	0	0	0	0			5	27
		0	0	0	0			0	0	0	0	0			0	6	26
	0	0	0	0			0	0	0	0	0			0	0	7	25
0	0	0	0			0	0	0	0	0			0	0		8	24
0	0	0			0	0	0	0	0			0	0			9	23
0	0			0	0	0	0	0			0	0			0	10	22
0			0	0	0	0	0					0	0			11	21
		0	0	0	0	0			0				0	0		12	20
	0	0	0	0	0			0	0	0				0	0	13	19
0	0	0	0	0			0	0		0	0				0	14	18
0	0	0	0			0	0				0	0				15	17
0	0	0			0	0			0			0	0			16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 12.

	0		0	0	0	0						0		0		1	I
0		0	0	0	0						0		0		0	2	30
	0	0	0	0						0		0		0	0	3	29
0	0	0	0						0		0		0	0		4	28
0	0	0						0		0		0	0			5	27
0	0						0		0		0	0			0	6	26
0						0		0		0		0	0			7	25
					0		0		0	0			0	0		8	24
				0		0		0	0	0				0	0	9	23
			0		0		0	0	0	0					0	10	22
		0		0		0	0	0	0	0						11	21
	0		0		0						0					12	20
0		0		0	0	0						0				13	19
	0		0	0		0	0						0			14	18
0		0	0				0	0						0		15	17
	0	0			0			0	0						0	16	
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30			

No. 13.

0	0		0		0		0		0				0	0	1	1
0		0		0		0		0				0	0	0	2	28
	0		0		0		0				0	0	0		3	27
0		0		0		0				0	0	0			4	26
	0		0		0				0	0	0				5	25
0		0		0				0	0	0				0	6	24
	0		0				0	0	0				0		7	23
0		0				0	0	0				0		0	8	22
	0				0	0	0		0				0		9	21
0				0	0	0		0		0				0	10	20
			0	0	0				0		0				11	19
		0	0	0						0		0			12	18
	0	0	0				0				0		0		13	17
0	0	0				0		0				0		0	14	16
0	0				0		0		0				0		15	
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	16	17	18	19	20	21	22	23	24	25	26	27	28			

No. 14.

	0		0		0				0				0	1	1
0		0		0				0				0		2	26
	0		0				0				0			3	25
0		0				0				0				4	24
	0		0		0				0				0	5	23
0		0		0				0				0		6	22
	0		0		0		0				0			7	21
		0		0		0				0				8	20
			0		0		0		0				0	9	19
0				0		0		0				0		10	18
			0		0		0		0		0		0	11	17
		0				0		0		0		0		12	16
	0						0		0		0		0	13	15
0				0				0		0		0		14	
14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	15	16	17	18	19	20	21	22	23	24	25	26			

No. 15.

		0	0		0		0	0				0	0	1	1
			0	0		0	0		0	0	0	0	0	2	26
0				0	0	0				0	0	0		3	25
0	0				0				0	0	0		0	4	24
	0	0						0	0	0		0	0	5	23
0		0	0				0	0	0		0	0	0	6	22
	0	0				0	0	0		0	0	0	0	7	21
0	0				0	0	0		0	0				8	20
0				0	0	0		0	0	0				9	19
			0	0	0		0	0	0	0				10	18
		0	0	0		0	0	0	0	0				11	17
	0	0	0		0	0					0	0	0	12	16
0	0	0		0	0	0					0	0	0	13	15
0	0		0	0	0	0					0	0	0	14	
14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	15	16	17	18	19	20	21	22	23	24	25	26			

No. 16.

		0	0	0	0					0	0			1	1
		0	0	0	0					0			0	2	26
0	0					0	0	0	0			0		3	25
0	0					0	0	0			0			4	24
0	0					0	0			0			0	5	23
0	0					0			0			0	0	6	22
		0	0	0	0			0			0	0	0	7	21
		0	0	0			0			0	0	0		8	20
		0	0			0		0			0	0	0	9	19
		0			0				0			0	0	10	18
0	0			0			0			0			0	11	17
0			0			0	0	0			0			12	16
		0			0	0	0	0	0			0	0	13	15
	0			0	0	0		0	0	0		0	0	14	
14	13	12	11	10	9	8	7	6	5	4	3	2	1		
	15	16	17	18	19	20	21	22	23	24	25	26			

Patterns of the description preceding, are used in great variety. The specimens given are sufficient to illustrate the general principle; and, afterwards, the particular figures may be regulated by fancy. The pattern No. 1. consists of seventeen leaves, and seventeen treddles. The figure, which it forms upon cloth, will be found drawn upon design paper, in Fig. 10. Plate 4. By this mounting, a part of the cloth is woven plain, and the rest contains flushing, or tweeling, of different kinds, extending from three to thirteen leaves. If we suppose, as formerly, the warp to be white, and the weft black, the flushing will give the effect, produced upon the under side of the cloth, as stretched in the loom. Each square of the design paper is supposed, in this instance, to represent only one thread of warp or weft. By counting the spaces, therefore, of black or white, the extent of the flushing will be found in any direction, and the single squares which are, alternately, black and white, of course, represent plain cloth.

The figures, upon the part at the right hand of the plan, represent the order and succession in which the threads are drawn through the heddles. The numbers are placed from left to right, in the usual order of writing or printing; but, as weavers draw their webs from *right to left*, the order in the plan will be exactly inverted in practice. For want of room upon the page, the numbers from 1 to 16, and from 18 to 32 are placed in straight lines; but it is to be understood, that the draught is exactly in the order represented in Fig. 5. Plate 5. which was explained in the description of common tweeling. Each number, in all these plans, signifies only a single thread. The order of treading, is exactly that in which the numbers under each plan are placed.

If the plan No. 1. is compared with the pattern upon the design paper, it will be found, that the raising cords, marked by the cyphers, exactly correspond with the squares, which are black, and that the plan is an exact representation of the fourth part of one set of the design. That this must be the case, in all the plans, will be obvious, if we consider, that the draught through the heddles being double, and inverted, will double the plan by the warp, and invert the two sides; and that the treddles being gone twice over, and the succession also inverted, will produce the same effect by the weft. Proper attention to this, will make it easy to draw a design of this kind of work, when the plan of mounting is given; and, on the contrary, to draw a plan of mounting, when a design is given. The pattern on the design paper, contains a set and a half each way, to give the full effect of every part.

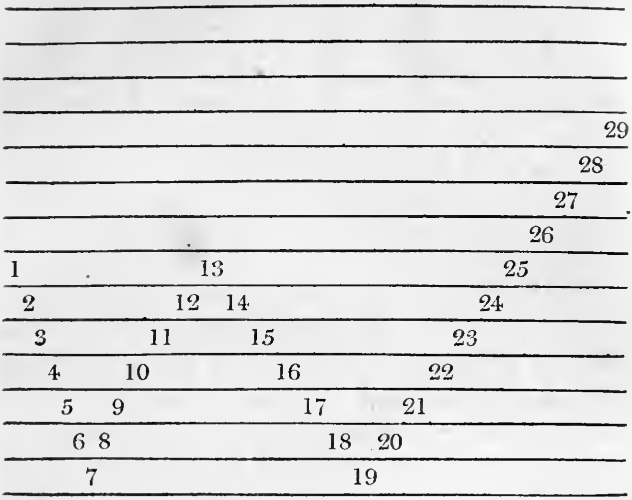
No. 2. is a plan containing sixteen leaves and sixteen treddles. Fig. 11. Plate 4. shows its effect upon the design paper. The description given of No. 1. applies equally to this and to all the others.

In Nos. 3, and 4. which are upon fourteen leaves, the figures, representing the succession of the draught, are placed more nearly in their respective places, as they ought to be drawn.

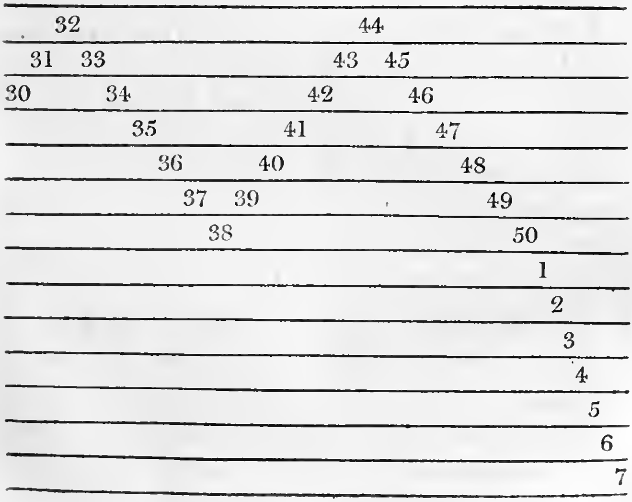
Nos. 5, 6, 7, and 8. are upon sixteen leaves. The appearance of No. 7. is, upon design paper, represented by Fig. 12. and that of No. 8. by Fig. 13. Plate 4. These, it is presumed, will be sufficient to illustrate all the others.

Figures of this kind are sometimes varied, and thrown into squares, by drawing the warp successively over the leaves in two sets, in the manner formerly described.

One example of this draught will be sufficient. It refers to Nos. 3, and 4.



Continued.



The successive numbers, from 1 to 50, contain one set of this draught; the numbers 1 to 7, commence the second draught. The treading may be in the same order as the draught, or varied at pleasure.

The fancy tweels, which have been described, are chiefly employed in the manufacture of table linens and cottons. Besides these, a very great variety of pattern is produced, in the weaving of thick goods, for garments of different kinds. Some of these are woven of silk, or woollen, but cotton is the substance by far the most extensively employed.

The difference, in the effects of these, depends entirely upon the succession of the draught, the application of the cording, and the order of treading. Some of these goods, such as velvets, corduroys, &c. have the flushing cut, at certain intervals, after the weaving is finished, to complete the effect. But the investigation of this, and many other ways of finishing cloth, does not come within the plan of this work.

I have had the good fortune to procure a very extensive, and, I believe, accurate collection of patterns, applicable to these kinds of work. With them I shall conclude this Essay.

The numbers, showing the draught in all these plans, are placed in the order of drawing, and each number denotes one thread. The raising cords are, as usual, represented by cyphers, and the order of treading is pointed out by the numbers placed under each plan.

No. 1.

PILLOW FUSTIAN.

0				4 5 1
	0			3 6 2
		0		6 2 3
			0	5 1 4
2	4	3	1	

No. 2.

PLAIN VELVERET.

	0				3 1
	0	0			5
0			0	0	2
			0		6 4
4	6	2	3	1	
		5			

No. 3.

DOUBLE JEAN.

0			0	1
0		0		2
	0	0		3
	0		0	4
4	2	3	1	

No. 4.

PLAIN THICKSET.

	0				8
	0	0			6 4
			0		5 2
0			0	0	7 3 1
4	6	2	3	1	
		5		7	
		8			

No. 5.

BEST THICKSET.

0			0	0	3 1
				0	5
	0				2
	0	0			6 4
6	4	2	3	1	
		5			

No. 6.

STOCKINET.

		0	1
	0		2
0	0		3
0		0	4
1	2	4	
3			

No. 7.

STRIPE.

0	0	0		6 1
	0	0	0	7 4
0	0			5 2
0		0	0	8 3

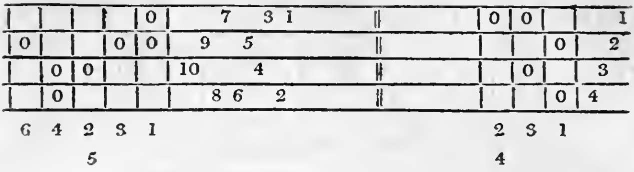
No. 8.

VELVET TUFT.

	0				5 3 1
	0	0			4 2
0			0	0	4 2
			0		5 3 1
6	4	2	3	1	
		5			

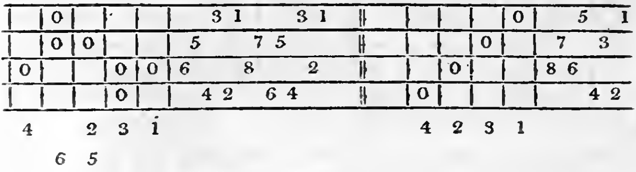
No. 9. No. 10.

PRINCE'S CORDS.



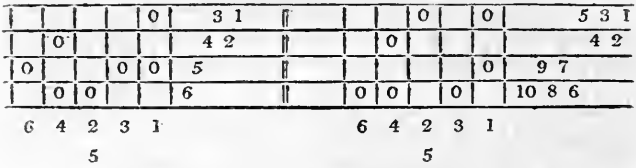
No. 11. CORD AND VELVERET.

No. 12. BARLEY CORN.



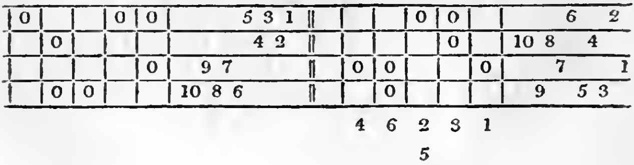
No. 13. PLAIN CORD.

No. 14. BOLTON CORD.



No. 15. THICKSET CORD.

No. 16. ROUND TOP.



No. 17.

VELVERET CORD.

				0	3 1
	0				4 2
0			0	0	5
	0	0			6
6	4	2	3	1	
		5			

No. 18.

JEAN.

	0			0	1
		0			2
0			0		3
6	4	2	3	1	
		5			

No. 19.

CABLE TWEEL.

0					0	1
0			0			2
	0		0			3
	0			0		4
		0		0		5
		0			0	6
6	4	2	5	3	1	

No. 20.

GENNET.

	0		0		1
	0	0	0		4
		0			2
		0			5
0				0	3
0					6
4	6	2	3	1	
		5			

RIBS.

No. 21.

			0	1
0		0		2
0	0			3
0	0	0		4
	0		0	5
		0		6
2	5	3	1	
4				
6				

No. 22.

0	0			1
0			0	2
0				3
	0		0	4
	0	0		5
		0	0	6
1	6	4	2	
3				
5				

No. 23.

DOUBLE KING'S CORD.

			0		0		0	1
	0				0			2
0	0	0	0	0				3
			0		0			4
	0					0		5
	0		0					6
2	4	6	8	10	12	3	1	
						7	5	
						11	9	

No. 24.

GENOA THICKSET.

			0	0	1
		0		0	2
0		0	0		3
	0		0	0	4
0		0		0	5
	0		0		6
4	2	5	3	1	
8	6	11	9	7	
12	10				

QUEEN'S CORDS.

No. 25.

	0			0		1
	0	0				2
		0		0		3
	0			0		4
	0	0	0			5
0		0		0	0	6
4	6	8	2	3	1	
			5			
			7			

No. 26.

		0	0				1
		0		0			2
0			0	0		0	3
	0	0	0		0		4
		0		0			5
			0	0			6
4	2	9	6	3	5	1	
10	8	18	15	12	11	7	
16	14				17	13	

QUEEN'S VELVETEENS.

No. 27.

	0		0	0		1
		0		0		2
		0	0			3
			0	0	0	4
		0		0		5
0		0	0			6
1	3	12	8	4	2	
5	7				6	
9	11				10	

No. 28.

			0		0	1
		0		0	0	2
			0	0		3
	0		0		0	4
				0	0	5
0			0	0		6
2	4	3			1	
6	8	7		5		
10	12	11	9			

No. 29.

PLAIN VELVETEEN.

				0	1
0			0		2
				0	3
		0	0		4
				0	5
	0		0		6
1	3	2	4	8	
5	7	6			

No. 30.

GENOA VELVETEEN.

		0	0		0	1
	0	0				2
0	0		0			3
		0	0			4
	0	0		0		5
	0		0			6
2	4	8	12	3	1	
6				7	5	
10				11	9	

No. 31. No. 32.

GENOA VELVERETS.

No. 31.

	0			0		1	§
	0				0	2	§
		0		0	0	3	§
	0			0		4	§
	0				0	5	§
0			0	0	0	6	§
4	6	2	7	3	1		
16	14	5	10	11	9		
		8	13				
		12					
		15					

No. 32.

	0			0		4 1
	0				0	5 2
0			0	0	0	6
		0		0	0	3
8	6	4	2	3	1	
		7	5	11	9	
12	14	10				
		13	15			
		16				

No. 33.

PLAIN BOLTON CORD.

			0		7 3 1	§
	0				8 6 2	§
	0	0	0		4	§
		0	0		9	§
0				0	5	§
0	0			0	10	§

No. 34.

PLAIN CORD.

	0				1
			0		2
	0				3
			0		4
	0	0			5
0			0	0	6
4	6	2	3	1	
		5			

No. 35.

KING'S CORD.

				0	0	1	§
		0			0	2	§
		0	0			7 3	§
			0	0		8 4	§
	0			0	0	5	§
0		0			0	6	§
1	3	8	6	4	2		
5	7						

No. 36.

CORDED MUSLINET.

0				0	0	1
0		0		0	0	2
	0				0	3
0				0	0	4
0	0	0		0		5
			0	0	0	6
2	4	6	5	3	1	

No. 37.

FANCY TWEEL.

0		0				11 1	§
		0		0		10 2	§
0	0			0	0	9 3	§
0		0	0			8 4	§
		0		0		7 5	§
0				0		12 6	§
8	6	4	2	12	1		
			5		3		
			7		9		
			10		11		

No. 38.

RIB AND JEAN.

0	0		0	1
0				2
0	0	0		3
	0		0	4
	0			5
		0	0	6
1	6	4	2	
3				
5				

No. 39.

VELVET WITH GENOA BACK.

		0			0	1	§
	0	0	0			2	§
0	0					3	§
		0	0			4	§
	0	0		0		5	§
	0		0			6	§
2	4	8	12	3	1		
6				7	5		
10				11	9		

No. 40.

VELVET WITH PLAIN BACK.

0				0	1
		0			2
			0	0	3
		0			4
	0			0	5
		0			6
1	3	4	2	8	
5	7		6		

No. 41.

HONEY COMB.

		0	0		1	§
			0	0	2	§
		0		0	3	§
		0	0		4	§
	0		0	0	5	§
0		0		0	6	§
8	2	5	3	1		
10	4	11	9	7		
12	6					

No. 42.

JEAN RIB.

	0		0	1
	0	0		2
		0	0	3
0	0			4
0			0	5
0		0		6
2	5	3	1	
4				
6				

No. 43.

CORD WITH GENOA BACK.

		0	0		28 25 22 19 16 13 10 7 4 1
		0		0	29 26 23 20 17 14 11 8 5 2
			0	0	9 3
0			0	0	27 21 15
	0		0	0	24 18
0	0		0	0	30 12 6

14	2	5	3	1
16	4	11	9	7
18	6	17	15	13
20	8	23	21	19
22	10			
24	12			

No. 44.

SATINET FACE.

						1	§
0					0	3	§
0				0		5	§
0			0	0		2	§
	0					4	§
0		0			0	6	§

7	5	3	2	4	1
	9	8	6		

No. 45.

GENOA VELVETEEN.

				0	0	1
0			0		0	2
0				0		3
	0			0	0	4
0					0	5
0		0		0		6

7	5	3	2	4	1
	9	8	6		

No. 46.

DUTCH CORD.

						§
		0			4 1	§
	0			0	5 2	§
0			0		6 3	§
	0	0		0	7	§
0		0	0		8	§
0	0		0	0	9	§

6	4	2	3	1
		5		

No. 47.

MOCK MARSEILLE.

					0	1
0		0				2
			0	0		3
	0					4
			0	0		5
0		0				6
					0	7

2	4	6	5	3	1

No. 48.

ANOTHER CORD.

			0	0	28 25 22 19 16 13 10 7 4 1
		0	0		29 26 23 20 17 14 11 8 5 2
		0		0	9 3
0		0		0	27 21 15
	0	0		0	24 18
0	0	0		0	30 12 6

2	14	5	3	1
4	16	11	9	7
6	18	17	15	13
8	20	23	21	19
10	22			
12	24			

No. 49.

GENOA VELVETEEN.

				0	0	1 §
0			0		0	2 §
0				0		3 §
	0			0	0	4 §
0					0	5 §
0		0		0		6 §

7	5	3	2	4	1
	9	8	6		

No. 50.

QUILTING SEED WORM.

0	0			0		4 1
	0	0		0	0	7 1
0	0	0	0		0	5
0		0	0			8 2
0	0	0	0	0	0	6
0	0	0		0	0	9 3

7	3	1	4	6	2
	9	5	8		
			10		

No. 51.

SILK CORD.

		0			0	39 35 31 27 23 19 15 11 7 3
				0	0	38 34 30 26 22 18 14 10 6 2
			0	0		37 33 29 25 21 17 13 9 5 1
0	0	0	0			40 32 24
		0	0			36 28
0		0	0			20 12 4
	0	0	0			16 8

10	2	7	5	3	1
12	4	15	13	11	9
14	6				
16	3				

No. 52.

RIB AND DICE.

	0			33 31 29 26 24 21 19 17 15 13 11 9 7 5 3 1
	0		0	28 23
	0	0	0	34 18 12 6
0				32 27 22 16 14 10 8 4 2
0		0		30 25 20
2	8	3	1	
4	10	5	7	
6			9	
12			11	

No. 53.

GENOA BACK VELVERET CORD.

0				0		1
	0			0		2
0	0					3
0				0		4
	0	0		0	0	3
0	0		0			6
8	6	4	2	3	1	
	14	7	5	11	13	
	16	10	9			
			12			
			15			

No. 54.

ANOTHER CORD.

			0	0	0	31 26 21
	0		0	0		11 5
			0			33 30 28 25 23 19 17 15 13 9 7 3 1
0	0	0				29 24
0	0	0		0	0	34 18
0		0			0	12
		0				32 27 22 20 16 14 10 8 6 4 2
1	3	2	4			
5	7	6	8			
9	11	10	12			
13		15	17	14	16	
		19	21	18	20	
		23		22	24	

No. 55.

GENOA BACK CORD DOUBLE TOP.

	0			0	0	0		1
			0	0				2
		0	0					3
		0			0			4
				0	0			5
			0	0				6
		0	0					7
0		0			0		0	8
4	2	12	9	6	3	5	1	
10	8					11	7	

No. 56.

ROYAL DOUBLE TOP.

	0	0			0		0		1
0				0	0	0			2
			0	0				11	3
		0	0					12	4
		0			0			9	5
				0	0			10	6
	0		0	0			0		7
0		0	0			0			8
2	10	12	9	6	3	5	1		
8	4					11	7		

No. 57.

JEAN BACK AND FACE.

		0			0	5	1
		0	0			6	2
	0		0	0			3
0				0	0		4
0		0			0	9	
	0	0	0			10	
			0	0		11	7
				0	0	12	8
2	4	7	5	3	1		
6	8						

No. 58.

SATIN CORD.

			0	1
				2
0		0		3
	0			4
0		0	0	5
	0	0	0	6
0	0		0	7
0	0	0		8
4	2	3	1	

No. 59.

PLAIN AND WILD WORM.

					0	1
			0	0		2
		0		0	0	3
	0		0	0		4
0		0			0	5
	0			0		6
0					0	7
				0		8
8	6	4	2	3	1	
				7	5	
				11	9	
10	12	14	16	15	13	

No. 60.

VELVETEEN.

			0		0	1
		0		0		2
					0	3
				0		4
	0				0	5
0				0		6
					0	7
				0		8
6	4	2	5	3	1	

No. 61.

GENOA BOLTON CORD.

	0				0	13 7 1
				0	0	11 8 2
	0			0		12 6 3
0	0		0		0	4
		0		0	0	5
0	0		0	0		9
	0	0			0	10
0			0	0	0	14
	0	0		0		15
8	6	4	2	3	1	
12	14	7	5	11	9	
		10	15			
		13				

No. 62.

GENOA BACK CORD.

				0	0	28 22 16 13 7 1
	0				0	26 23 17 11 8 2
	0			0		27 21 18 12 6 3
0	0		0		0	29 5
		0		0	0	10 4
0	0		0	0		15 9
	0	0			0	20 14
0			0	0	0	25 19
	0	0		0		30 24
8	6	4	2	3	1	
12	14	7	5	11	9	
		10				
		13	15			
		16				

No. 63.

ROYAL JEAN CORD.

			0	0	0	15 13
			0		0	14 12
		0				16 11
		0				10
			0	0	0	9
					0	5
0	0				0	4
0	0	0				7 3
		0				6 2
0	0				0	8 1
2	4	6	5	3	1	

No. 64.

WILD WORM CORD.

					0	9 7 3 1
0	0	0	0		0	5
0		0			0	11
0					0	13
			0		0	15
	0		0		0	17
				0		14 8 6 4 2
0	0	0	0	0		18 10
	0			0		12
		0		0		16
8	6	4	2	3	1	
10	12	14	16	7	5	
24	22	20	18	11	9	
				15	13	
				19	17	
				23	21	

No. 65.

CORD.

		0		0			0	20	
			0		0	0		19	
				0			0	18	
					0	0		17	
	0						0	16	
0	0	0				0		15	
	0	0	0	0			0	14	
0	0	0	0	0	0	0		13	7 1
							0	12	10 8 6 4 2
						0		11	9 5 3
12	10	8	6	4	2	1	3		
14	16	18	20	22	24	5	7		
						9	11		
						13	15		
						17	19		
						21	23		

No. 66.

MOCK QUILTING AND SATIN RIB.

DRAUGHT.

32 2
31 3
30 4
29 5
28 6
27 17 7
26 18 16 8
25 19 15 9
24 20 14 10
23 21 13 11
22 12

CORDING.

0		0	0	0	0		0	0	0
0	0	0	0		0	0	0	0	
0	0		0	0	0	0		0	0
	0	0	0	0		0	0	0	0
0	0	0		0	0	0	0		0
									0
0								0	
	0						0		
		0				0			
			0		0				
				0					0
10	9	8	7	6	5	4	3	2	1

No. 67.

SMALL KING'S CORD.

		0	0			12
			0	0		11
				0	0	10 6
		0			0	9 5
		0	0			4
			0	0		3
0		0	0			8
0				0	0	2
	0		0	0		7
	0	0			0	1

No. 68.

DOUBLE BOUND VELVETEEN.

		0	0		0			0	1
				0	0				2
0			0	0				0	3
			0		0				4
0				0	0		0		5
			0	0					6
	0		0		0		0		7
				0	0				8
	0		0	0		0			9
			0		0				10
		0		0	0	0			11
				0					12

No. 69.

DUTCH CORD.

		0	0		0	1
	0		0			2
	0	0				3
		0			0	4
			0		0	5
	0	0	0			6
0	0			0		7
				0	0	8
0					0	9
0	0					10
	0			0		11
0				0	0	12
6	4	2	5	3	1	

The explanations given of the principles of tweeling, and the great variety of examples of its application to different species of manufactures, it is presumed, will be sufficient to convey an adequate knowledge to those who peruse this Essay with attention.

It will be proper to observe, however, that a kind of tweel is used in weaving some goods, which forms an exception to the general rule; that the flushing upon one side of the cloth is by the warp, and upon the other by the weft. Here the warp and weft are equally flushed, and the appearance of the cloth is the same upon both sides.

The following are plans of the draught and cording employed to effect this, upon a scale of four leaves, and four treddles, which is the number generally used. In the first, the treading is progressive; in the second, alternate.

No. 1.						No. 2.				
		0	0	1	‖	0			0	1
	0	0		2	‖	0		0		2
0	0			3	‖		0	0		3
0			0	4	‖		0		0	4
4	3	2	1			2	4	3	1	

In weaving very fine silk tweels, such as those of sixteen leaves, the number of threads drawn through each interval of the reed is so great, that, if woven with a single reed, they would obstruct each other in rising and sinking, and the shed would not be sufficiently opened to allow the shuttle a free passage. To avoid this inconvenience, other reeds are placed behind that which strikes up the weft; and the warp threads are so disposed, that those which pass through the same interval in the first reed, are divided in passing through the second, and again in passing through the third. By these means, the obstruction, if not totally removed, is greatly lessened.

In the weaving of plain thick woollen cloths, to prevent obstructions of the same kind, arising from the closeness of the set and roughness of the threads, only one fourth of the warp is sunk and raised by one treddle, and a second is pressed down to complete the shed, between the times when every shot of weft is thrown across.

Note. In the representation of the back harness, Plate 8. the leaves, both of the harness and front heddles, are drawn upon a scale greatly larger than the other parts. This was done for the purpose of showing, more distinctly, the construction of the eyes; and the other parts could not have been represented on the same scale, without extending the plate to a very inconvenient size.

PRACTICAL AND DESCRIPTIVE

ESSAYS

ON THE

ART OF WEAVING.

BY JOHN DUNCAN,

INVENTOR OF THE PATENT TAMBOURING MACHINERY.

PART II.

ILLUSTRATED BY SEVEN ELEGANT ENGRAVINGS.

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13th, Do. do.
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ESSAY III.

ON THE

WEAVING OF DOUBLE CLOTH.

THE next variety of weaving which claims our attention, is that of double cloth. It is composed of two webs, each of which consists of separate warp and separate weft; but the two are interwoven at intervals. The junction of the two webs is formed by passing each of them occasionally through the other, so that each particular part of both is sometimes above, and sometimes below.

This species of weaving is, almost exclusively, confined to the manufacture of carpets, in this country. The texture is generally the same as that of plain cloth, although some are manufactured with cut flushing, similar to velvet. The material employed is generally dyed woollen, and, as almost all carpets are decorated with fanciful ornaments, the colours of the two webs are different; and they are made to pass through each other, at such intervals as will form the pattern required. Hence it arises, that the pattern on each side of a carpet is the same, but the colours are reversed.

More colours than two are frequently introduced into carpets, but as the most simple mode of illustrating the general principle and process, we shall, in the first instance, confine our attention to

CARPETS OF TWO COLOURS.

As we have formerly supposed the warp of tweels to be white, and the weft black, we shall now suppose that a carpet is to be woven, one web of which shall be white, and the other black. Let us also suppose the pattern to be the same with that given as the first example of fanciful tweeling; that is, a representation of a checker board, the squares of which are black and white alternately, as in Fig. 1. Plate 6. already referred to.

A web of this kind may be wrought with eight leaves of heddles, moved by eight treddles. The draught of the warp, and application of the raising cords, will appear by the plan of draught and cording which follows:

Black above. White above.

			0	0		0	0		7 5 3 1	White 1
	0			0	0	0			8 6 4 2	White 2
	0	0	0			0			7 5 3 1	Black 3
0	0		0	0					8 6 4 2	Black 4
0		0	0				0	7 5 3 1		White 5
0	0	0			0			8 6 4 2		White 6
		0			0	0	0	7 5 3 1		Black 7
0				0	0		0	8 6 4 2		Black 8
8	7	6	5	4	3	2	1			
2d Black Shot	2d White Shot	1st Black Shot	1st White Shot	2d Black Shot	2d White Shot	1st Black Shot	1st White Shot			

White above. Black above.

By examining the preceding plan, the draught of the two warps will plainly appear, for in each of the two sets of heddles, two leaves contain the white warp, and two the black, and one splitful of each, containing two threads, is drawn alternately. The web is also wefted, by throwing across a shot of white and a shot of black, alternately.

Now, we are to suppose, that in the portion of warp, which is represented as drawn through the four front leaves, the black warp is to be wrought above, and the white warp below; and, that the four back leaves exactly reverse this operation. Let us then examine what effect each treddle will produce, when the cording is applied according to the plan. Let the treddle 1 be pressed down, and a shot of white weft be thrown across. The cording which connects this treddle with the leaves, raises the white leaves 1 and 5, and sinks those marked 2 and 6. Thus one half of the white warp is raised, the other half is sunk, and as the warp is drawn through each leaf alternately, plain white cloth will be produced. At this tread, the black warp is not interwoven at all, for, in the back set of leaves, where the white is to be above, both the black leaves 3 and 4 are sunk; and in the front set, where the reverse takes place, both the black leaves 7 and 8 are raised. The white weft, therefore, passes over the former, and under the latter, perfectly clear of both. Let the treddle 2 be next pressed down, and a black shot be thrown across. This treddle raises the black leaves 3 and 7, and sinks those marked 4 and 8. This, therefore, produces plain black cloth, as the former did white. Here the white is not interwoven, for the white leaves 1 and 2, in the back set, are both raised, and those in the front set, 4 and 5, are both sunk. The third treddle again weaves white cloth, sinking the white threads which were raised by the treddle 1, and raising those which were sunk. The fourth treddle again produces black cloth, in the same way.

So long as the weaver continues to tread these treddles in succession, the effect, as in tweeling, will continue the same, and the web, when finished, would have the appearance of a black and white stripe. But, to produce the checker, when one set of squares are completed, he shifts to the second set of treddles 5, 6, 7, 8, which reverse the effect, raising the white where it was formerly sunk, and sinking it where it was raised.

This is the principle upon which all double cloth is woven, and its application to fanciful ornament forms the only variety in the mounting of the looms. Carpets are seldom wrought with leaves and treddles, nor are they well fitted for this branch of weaving. The materials being coarse and ponderous, the webs frequently broad, and the range of pattern generally extensive, there would neither be room for the leaves required, nor could the weaver exert the power necessary for treading.

An apparatus, similar to the back harness, formerly described, may be used for some patterns; and when the range is extensive, carpets must be woven in the draw loom.

Very few carpets, if any, are woven in this country, excepting in draw looms. It will be curious, however, to explain how they may be wrought by a back harness, and to trace the analogy, which subsists between tweeling and double cloth. The mode of weaving carpets, as now practised, will then be investigated.

To illustrate the application of the harness to carpet weaving, we shall again recur to the checker pattern, and compare the effect of working it by a harness, with the explanation already given of mounting it with leaves.

	2d Black Shot	2d White Shot	1st Black Shot	1st White Shot																	
1st Harness leaf					W		W		W		W			B		B		B		B	
2d Harness leaf						B		B		B		B	W		W		W		W		
1	x		x	0		7		5		3		1		7		5		3		1	White
2	x	0	x		8		6		4		2		8		6		4		2		White
3		x	0	x		7		5		3		1		7		5		3		1	Black
4	0	x		x	8		6		4		2		8		6		4		2		Black
	4	3	2	1																	

The checker pattern may be wrought by this mounting, and will produce exactly the same effect as the former. A comparison of the two will be useful to illustrate the difference between leaves and harness mounting. In the former, eight leaves and eight treddles were necessary; in this, six leaves and four treddles are sufficient. The two back leaves form the harness, and are raised by levers and cords, suspended over the weaver's head, as described in the last Essay, and represented in Fig. 1. Plate 8. The letter W represents one splitful, or two threads, of white warp; the letter B, one splitful of black. In this kind of weaving, when the harness is used, two threads are drawn through each eye. The front mounting consists of four leaves, moved by four treddles. The draught of both warps, through the harness, will appear by inspecting the plan; each letter representing two threads, as above stated. Of the front leaves, two contain the white, and two the black warp. The succession of drawing is denoted by the figures.

When the first leaf of the harness is raised, press down the first treddle, and throw a white shot across. The white and black warp, being, alternately, drawn through the harness leaf, according to the range of the pattern, the white will be raised in the one set of checkers, and the black in the other. The cording applied to the first treddle raises the white leaf 1, and sinks the leaf 2. This treddle has no connection with the two black leaves, which remain stationary. In this instance, the letter x is used, where no connection between the heddles and treddles ought to be made. The same letter will be used, wherever a similar case occurs. The leaf 1 raises one thread of every splitful of white in the second harness leaf, and the leaf 2 sinks one thread of every splitful in the first leaf. Plain white cloth is, therefore, produced by the operation of this treddle. The white will be above, or below, according to the situation of the harness leaf through which the warp passes. The second treddle produces the same effect upon the black warp, which the first does upon the white. The third and fourth treddles complete the operation. When one range of checkers has been completed, the first harness leaf is lowered, and the second raised. This reverses the situation of the two warps, and the operation proceeds as before. The eyes of the heddles in the front mounting, are of a length rather more than the whole depth of the shed, as in tweeling. The eyes of the harness leaves are made of tin or copper, and are called *mails*, by weavers.

There are many different plans for raising the harness leaves, whether used for fancy tweeling or for double cloth. It is not easy to determine which is the best; for upon this, as in all other practical applications of the mechanical powers, much diversity of opinion has existed, and probably will continue to exist. In general, the superiority of one plan to another must be ascertained by particular circumstances, rather than by precise rules. In the representations given in Plate 8. the harness leaves are raised by means of two parallel levers, moving upon their centres. When there is sufficient room for an apparatus of this kind, it seems well adapted to the purpose for which it is intended. If accurately constructed, the two ends of the leaf will rise equally, and, consequently, the shed will be equally deep in every part. It is, however, much more common, in extensive harness mountings, to raise all the leaves, by means of cords passing over pullies. A cord is fixed to either side of the leaf, near the extremity, and the two cords meet in the centre, in an oblique direction, nearly similar to what is represented in Fig. 1. Plate 5. Each cord, passing over a pully, is then brought, in a horizontal direction, over the weaver's seat, and made fast to a piece of wood, generally nailed to the upper cross rail of the loom. To each of these cords another is attached, which passes through the board, Fig. 3. Plate 8, as formerly described. When the handle at the lower end of one of these cords is pulled down, the leaf or leaves attached to the cording rise, and as before, the knot upon the cord is secured by the notch in the board, until an alteration becomes necessary.

In comparing these ways of mounting a back harness, it will be obvious, that the plan exhibited in the Plate is more steady and secure than the other. The parallel levers by which the leaves are raised, if made of sound wood, and properly seasoned, will be little affected by the variation of the weather, and the leaves, of course, will rise regularly and equally at both ends. This is very important in weaving tweels and carpets, where the breadth of the web is frequently two or three yards. The mounting by cords, however, is cheaper, and occupies less room. But hempen cords, which are generally used, besides their tendency to stretch when new, are very considerably affected by every vicissitude of the atmosphere, and, therefore, less dependence ought to be placed upon their operation.

I have often thought that when looms are mounted for fancy weaving, particularly where the fabric is thick, and the power required great, the substitution of wires for cords would be a material improvement. A wire remains perfectly uniform in all seasons, and, from its superior strength, would last for many years. Cords, on the contrary, besides being contracted or relaxed by every change of the atmosphere, are very apt to rot from damp or moisture, which is very common in weaver's shops. I am aware, that the expence of mounting a loom with wires, will form a serious objection when a variety of work is wanted, and the mounting, of course, frequently changed. But, when there is a rational prospect of a loom being employed for a length of time upon the same pattern, I am convinced that it will be found not only the best, but eventually the cheapest plan. When a mounting is extensive, and much cordage required, great pains are frequently necessary to keep the whole regular, and much time is lost in regulating and repairing the cords. If wires are used, the leaves must be raised by levers; for wire, however much softened, does not possess sufficient flexibility to bend over a pully. The wires should be lackered or painted, to preserve them from rusting, and their lengths may be regulated with great accuracy, by means of temper screws. The above, however, is given merely as an opinion, for I have never known the experiment tried; but I do not entertain a doubt, that it would be found a material improvement.

But in actual practice, carpets are generally, if not always, woven in the

DRAW LOOM.

I SHALL, therefore, before proceeding, endeavour to describe and illustrate the principle and construction of this extensive and useful machine, and to trace the difference which generally subsists between those which are used for double cloths or carpets, and those employed for the manufacture of damasks, which are fancy tweels of the most extensive range of pattern. Draw looms, as noticed in the Essay on tweeling, are also used for spot weaving, when the pattern is extensive; but the construction of these differs very little from the others, and the small deviations shall be noticed in the proper place. I preferred postponing the description of the damask draw loom, until I could also introduce that for carpets; both for the sake of tracing the analogy between them, and to afford further opportunities of extending my inquiries and examinations, respecting these machines, which are, by much, the most complicated used by weavers. I offer this apology for inserting the observations upon damask, which properly form a part of the Essay upon tweeling, in this place.

It would be difficult, if not impossible, to give representations of the full mounting of an extensive draw loom, for the number of cords is so immense, and they are, necessarily placed so close together to save room, that it would only create unnecessary confusion to attempt to delineate the whole. I have lately seen a damask draw loom at Dunfermline, where that manufacture is carried to great extent and perfection. This loom, which I was assured was not the most extensive in the place, contained 120 designs of 10 spaces each, and, consequently, was adapted to work a pattern as extensive as could have been effected by 1200 leaves, upon the plan of the back harness formerly described. I have, therefore, represented specimens of the working parts upon a limited plan, for the most extensive are only continuations of the most limited, in the same regular succession.

These plans will be found in Plate 9.

The use of the draw loom is to combine much mounting in a small space; consequently, the shafts, and every other part which is composed of wood, are avoided, and the moving apparatus consists entirely of cordage. That part of the apparatus which serves as a substitute for the heddles of other looms, is called the harness, and passes through a flat board containing a number of holes or other divisions. In Fig. 1. the edge of the board is represented at C, and the harness passing through it at H. The figure is a transverse elevation of that part which is peculiar to the draw loom, the front leaves, which are worked by treddles, and all other parts in front being taken away for the purpose of showing these parts. In the draw loom, the draught of the warp through the mails of the harness is always in uniform succession, as in tweeling; but it is customary to draw a number of threads through the same mail, as in the back harness used for the diaper. Indeed, the draw loom harness is merely an extension of the former, effecting the same end by different means. Fig. 2. is a representation of the flat side of the board, the edge of which is seen in Fig. 1. to show the way in which the holes, or divisions, through which the harness passes, are placed. Near the centre of each twine of the harness, is the copper or pewter mail, which serves as the eye, and each is kept tight by a small weight (generally of lead) hung to the bottom. Now, if we are to suppose that the range of the pattern is 100 spaces of the design, for 1000 or any number is only an extension of the same principle, then the 1st, 101st, 201st, &c. twines, after passing through the board are to be knotted together, because all rise at once, each being the first of a new design. In like manner, the 2d, 102d, &c. are knotted, and so on until the whole succession of 100 is completed. To each of these a cord is then tied, which after passing over a pully in the box A (containing in this case 100 pullies) is fastened, in a horizontal direction, to a fixture on one side of the loom, and nearly level with the box A. The horizontal part of these cords is marked B, and this part of the mounting is called the *tail.* To each cord in the tail, another cord is tied at a convenient distance on one side of the loom, and passes perpendicularly towards the floor, near which they are all made fast to a cross piece of wood. These cords are called *simples*, and are distinguished by the letter D. Another stout cord F is then stretched from the roof to the floor, parallel to, and at a small distance from the simples. These operations being performed, the whole must be made uniformly tight, and care must be taken that all the mails are level and of a proper height. The warp is then to be drawn through the mails and front mounting, successively, as before mentioned, and the remaining parts for lifting the harness to form the design are to be applied.

If the connection from the harness to the simples is traced, it will be evident that when any simple is either pulled down, or strongly to one side, it will raise all the twines and mails with which it is connected; and, when relieved, they will be pulled back to their former places, by the weights which are fastened to each. As the simples are very numerous and close to each other, it would be impossible, in a heavy design, to select those which should be successively pulled, without a great waste of time, unless means of regular and speedy selection are employed. This is effected by means of another set of cords called *lashes*, represented at E, and connecting the simples with the cord F, upon both of which the lashes slide easily up and down. The application of the lashes to the simples must be regulated by the pattern to be produced, and this is called

READING ON THE DESIGN.

THIS operation, from the complexity of the patterns, and the necessity of accuracy, is generally performed by two persons. The pattern, being drawn upon design paper, points out what mails are to be raised, or which is the same, what simples are to be pulled at every change of the harness. It is the business, therefore, of one person to read, or rather to select, from the paper what simples are to have lashes applied to them at every change. The other person, following the instructions which he receives, passes a lash round every simple which is pointed out. He then knots the lashes together, and connects the other end with the cord F by a loop round it, so that the lashes may slide freely upon it. The other end passing loosely round each simple, also slides freely upon them. The lashes must be uniformly tied, that the simples may be pulled equally. A single instance will be sufficient, to illustrate how the design is taken from the design paper.

Let Fig. 14. Plate 4. represent the design of a flower, any number of which are to be woven, at certain intervals, by the draw loom. By counting the spaces upon the design paper, it will appear that this flower covers 45 by the breadth, and 35 by the length. The former gives the number of mails in one flower; and the latter, the number of changes which the harness must undergo while it is working. When the warp has been regularly drawn, and the simples applied, the lashes are to be placed according to the design. In this case, every square which is black, represents a simple to be raised. Beginning at the bottom, it appears that only two mails are to be raised for the stem of the flower, and counting from the right hand, these will be raised by the 31st and 32d simple. The instruction, therefore, given to the person who applies the lashes is; Pass thirty and take two. On the second row of squares, part of the flower as well as the stem, must be raised, and by counting as before from the right, passing the white, and taking the black, the direction will be; Pass 18, take 3; pass 8 and take 2. On the third, two other parts come in: therefore, pass 10, take 3; pass 5, take 5; pass 7, take 2; pass 7 and take 4. In the same way, the operations are continued until the whole 35 are completed, always passing the white, and taking the black.

I shall add the whole instructions for this flower, by comparing which with the design, the principle may be sufficiently understood, and all damask patterns, however extensive, are done exactly on the same plan.

1st, Pass 30 and take 2.

2d, Pass 18, take 3; pass 8 and take 2.

3d, Pass 10, take 3; pass 5, take 5; pass 7, take 2; pass 7 and take 4.

4th, Pass 9, take 5; pass 4, take 5; pass 6, take 3; pass 6 and take 6.

5th, Pass 8, take 7; pass 3, take 5; pass 6, take 4; pass 4 and take 7.

6th, Pass 8, take 7; pass 4, take 3; pass 6, take 2; pass 2, take 2; pass 2 and take 8.

7th, Pass 8, take 7; pass 4, take 2; pass 6, take 3; pass 2 and take 11.

8th, Pass 9, take 5; pass 5, take 2; pass 5, take 4; pass 2, take 2; pass 3 and take 4.

9th, Pass 10, take 3; pass 8, take 2; pass 2, take 4; pass 4 and take 2.

10th, Pass 11, take 2; pass 10, take 2; pass 2, take 2; pass 4 and take 2.

11th, Pass 11, take 2; pass 10, take 3; pass 2, take 2; pass 6 and take 2.

12th, Pass 13, take 3; pass 3, take 3; pass 4, take 2; pass 6 and take 5.

13th, Pass 16, take 4; pass 5, take 2; pass 8 and take 8.

14th, Pass 25, take 2; pass 8 and take 9.

15th, Pass 24, take 2; pass 10 and take 9.

16th, Pass 8, take 3; pass 13, take 2; pass 11 and take 8.

17th, Pass 7, take 5; pass 11, take 2; pass 14 and take 6.

18th, Pass 7, take 6; pass 9, take 3; pass 16 and take 3.

19th, Pass 7, take 6; pass 8, take 4.

20th, Pass 7, take 6; pass 7, take 5; pass 7, take 4.

21st, Pass 1, take 3; pass 4, take 5; pass 6, take 2; pass 2, take 3; pass 5, take 6.

22d, Take 6, pass 3; take 4, pass 4; take 3, pass 3, take 14.

23d, Take 7, pass 3; take 2, pass 5; take 2, pass 3; take 9.

24th, Take 8, pass 2; take 2, pass 2; take 2, pass 8; take 2, pass 3; take 7.

25th, Pass 1, take 13; pass 10, take 2; pass 5, take 4.

26th, Pass 2, take 5; pass 3, take 4; pass 10, take 2.

27th, Pass 10, take 2; pass 2, take 4; pass 7, take 2.

28th, Pass 8, take 4; pass 2, take 6; pass 5, take 2.

29th, Pass 7, take 5; pass 3, take 6; pass 5, take 6.

30th, Pass 7, take 5; pass 3, take 6; pass 5, take 8.

31st, Pass 6, take 6; pass 3, take 6; pass 6, take 8.

32d, Pass 6, take 5; pass 5, take 5; pass 6, take 8.

33d, Pass 6, take 5; pass 6, take 3; pass 8, take 7.

34th, Pass 6, take 5; pass 19, take 3.

35th, Pass 7, take 3.

From this it will appear, that the shape of every pattern wrought in the draw loom, depends entirely upon the mode of connecting the lashes and the simples. Of course, the pattern may be altered at pleasure, to any other which does not exceed the range of the mounting, merely by changing the order of this connection. It will also be obvious, that in ascertaining the order from the design paper, the connection of the lashes with the simples, is denoted by counting from right to left, or *vice versa*, and that the number of changes, and consequently the number and arrangement of sets of lashes on the cord F, is, in like manner, ascertained by counting the design from the bottom to the top. The first set is generally placed lowest upon the cord, and the rest in regular succession above it. The sets are connected with each other, at convenient distances, by pieces of twine; so that by a slight pull, they will follow each other in regular order. When the connections are completed, all the sets are pushed up nearly to the top of the cord F. The loom is then to be worked by two persons, one of whom pulls the draught, and the other manages the treddles, shuttle, and lay. The fore mounting is exactly the same, in every respect, as the diaper harness, and the number of leaves equal to one set of the tweel. For the ordinary qualities of damasks, five leaves are commonly used, but many of the finest are wrought with eight.

When the operators are ready to begin, the person who draws, pulls the first set of lashes down, and then by drawing the simples, and consequently the tail, raises that part of the harness attached to the part which is pulled. The weaver then works until a change of the harness becomes necessary. The person who draws, then slacks the simples which had been drawn, pulls down the second set of lashes and draws the simples as before; the weaver proceeds to work until another change is required, and so on until the whole pattern is completed. In the design given, the weaver is to work once over his treddles between every change, and this is generally the case in damask weaving.

When the mounting of the draw loom is very extensive, it is found convenient to have two, and sometimes three boxes of pullies; for were the whole number of pullies placed in one box or frame, it must be extended to a very inconvenient size. These are placed parallel to each other, as represented by the dotted lines Fig. 1. and an equal portion of the cordage is conducted over each. It is also common, to have three or four different sets of simples, and lashes. One set of these is stretched, and the others are loose; and each set is stretched in turn, when a different part of the pattern is to be wrought.

Many different attempts have been made, at various times, and with various success, to supersede the necessity of employing an additional person to draw the lashes, by constructing the apparatus so, that the weaver may draw the harness, as well as work the treddles. The most recent, and probably the most generally adopted of these plans, is one which has been lately invented and introduced at Dunfermline, where it is now very common. It is known there, by the name of the

PATENT DRAW LOOM.

In this loom, the tail of the harness, instead of being carried over pullies to one side, extends perpendicularly upward, and is fastened to the roof of the shop. Upon each cord is a knot, at a convenient distance from the roof, and all the knots must be at an equal heighth. The simples extend horizontally over the weavers' head, where they are made fast; and the lashes hang down from these, and have generally a small handle, or bob, as it is frequently called, attached to each. An instrument, called the *comb*, from its figure, is hung in a horizontal position, and moveable on its centres. The appearance and shape of the comb will be found in Fig. 4. which represents it as it appears when viewed from above or below. In Fig. 5. it appears as viewed on one side. In both these figures, a represents the centres, b the teeth, c the pull, d a few cords representing the relative situation of the tail of the harness to the comb, e cords representing simples, and f Fig. 5. the situation of the lashes. In Fig. 5. the operation is represented by two cords of the tail d, one of which has the knot drawn into the teeth b, and the other is disengaged. When the weaver pulls down any particular set of lashes, those simples to which they are attached, are drawn into the oblique direction, as at e, and, consequently, pull those cords of the tail to which they are tied between the teeth of the comb. The end of the lever projecting at c, being then pulled down, and secured by a knot in a notch, in the same way as the diaper harness mounting, the teeth rise, and by means of the knots, carry up that part of the harness which is drawn betwixt the teeth, whilst all the rest remains free. When a change is wanted, the comb is let down, and the simples being slacked, the cords of the tail quit the comb; another set is drawn in by pulling another set of lashes, the comb is again raised and secured as before, and the operation proceeds. The weaver pulls the lashes with one hand, and raises the comb with the other, so that very little time is consumed in changing the harness.

The patent draw loom seems to possess some very obvious advantages, which are not to be found in the old loom. It saves the labour of an additional person, and the operation seems to be conducted altogether, or nearly, as quick. 2dly, Both the tail and simples are much shorter, and, consequently, require less cordage; the boxes or frames of pullies are unnecessary, and the space occupied by the simples at the side of the loom is saved: and 3dly, The mechanical apparatus is so applied, that much less power is required to raise the harness, which must be of considerable advantage in heavy mounted looms, where the strength required is very considerable.

By reducing the way in which the power is applied in both cases, to the elementary principles, the difference will be found to be very great. In the first case, one end of the tail is made fast, and the other sustains all the weights attached to the harness. The simples which are pulled down to raise the harness are connected to the tail, between the end which is fast and the pullies. Consequently, the simples act in the same *ratio*, as a weight fixed to a moving pully, suspended by a rope passing through the pully, and of which rope one end is made fast. It has been often demonstrated, that a weight, say of 2 lbs. in this situation, will be balanced by another of only 1 lb. suspended from the other end of the rope, after passing over a fixed pully. Hence the weight, or the power, which is the same thing, applied to the simples to pull them down, must be somewhat more than double the sum of all the weights, attached to that part of the harness which is to be raised. See Emerson's Mechanics, Prop. 27, or almost any elementary treatise.

But in the case of the patent loom, the harness is raised perpendicularly by the comb; consequently, no more power is required than will overcome the sum of the weights to be raised; and if the lever, at the end of which the comb is fixed, be divided into three equal parts, and the centres, or pivots, placed at the distance of one of these parts from the comb, the power will be again doubled: Emerson, Prop. 19. From these calculations, we may deduce, that the power required to raise the harness of the patent loom, will be only about one fourth of that required for the other.

But in every species of complicated mechanism, many deficiencies and objections, which may not be obvious to the eye of a transient spectator, frequently become apparent upon practical experience. For this reason, I was at pains to collect from those who were daily employed in working them, their opinions of the comparative merits of the two plans.

When the range of pattern was not very great, I found both the general opinion and practice, which is still more conclusive, decidedly in favour of the patent loom. It was only respecting the very highest mounted looms, that a difference of opinion seemed to exist. I was informed that two looms, of very extensive ranges, had been lately mounted; the first, of 120 designs, upon the old plan; the second, of 125 designs, upon the patent plan. Both looms were allowed to execute their work in a very sufficient manner, but it was stated, that the mounting of the patent loom, although last set to work, was already much decayed, whilst that of the other, which had produced more cloth, was impaired in no perceptible degree.

Should this prove to be generally the case, it will form a just ground of hesitation, in preferring the new to the old plan, in looms of this description. The mounting of an extensive draw loom, is a work necessarily involving much time, labour, and expence, and the loom must therefore, be employed for a very considerable portion of time, before it will indemnify the proprietor. But it may be possible, admitting the fact to be as stated, which I have no reason to doubt, that the difference of the mounting of these two looms, in point of durability, might be produced by some incidental or contingent circumstances in their construction, independent of the general principle. The cordage of the one might be inferior to that of the other, either in the quality of the stuff, in the spinning, or in both. Some part of the machinery might have been imperfect in the workmanship, and caused unnecessary friction; the mounting might have deviated a little from an equal degree of tension, or from the true level, which must produce more strain on one part than another. Whether any of these causes did operate in this case, I had no means of ascertaining; but, in forming opinions respecting complicated and expensive machines, too much caution cannot be used, in investigating not only the direct principles of construction, but all the minute and collateral circumstances which may affect their operations. Want of attention to this, has been more injurious to the improvement and extension of practical mechanism, than any circumstance which has come to my knowledge upon that subject. Therefore, without offering any decided opinion upon the fact stated, it may be sufficient to remark, that speculatively and abstractedly considered, the patent loom, particularly the harness part of it, appears to possess some advantage over the other, even in point of durability. The tail, instead of being conducted over pullies to one side, rises perpendicularly to the roof; consequently, the cords deviate much less from a straight line, and the decay which must be produced, both by the friction of the pullies, and the deflection of the cords, is, almost entirely avoided. It is, however, to be allowed, that some friction will be produced by pulling the cords betwixt the teeth of the comb, and afterwards, by raising the harness, and that, in the former of these motions, the friction is almost at right angles to the staple of the hemp or lint, which is a very unfavourable direction.

In these comparisons of the old and patent draw looms, I have endeavoured impartially, to state both the opinions which I had collected, and the remarks which occurred to myself. Probably, some time may still elapse, before the superiority of either will be universally admitted, even by those who, from their practical experience, have the best opportunities of forming an accurate judgment upon the subject.

But, in whatever way a draw loom is mounted, too much attention cannot be paid, both to the quality of the materials, and accuracy of the workmanship. This, indeed, is a general rule, and will be found to apply to every description of machinery. No plan of economy can be more ruinous in its effects, than that of constructing any piece of mechanism of insufficient materials, and inaccurate workmanship, for the sake of a small reduction of the first expence. The mounting of an extensive draw loom will occupy a man, for at least four months. Estimating these to be lunar months, of 24 working days to each, and the person, employed in mounting the loom, to earn 3*s.* per day, the expence, for labour alone, will amount to 14*l.* 8*s.* before the loom can be set to work. Let us then suppose, that the weaver who works this loom, besides paying the person who draws the harness, if he employs one, can earn 1*s.* per day, more than he could if weaving plain cloth. In this case, it will require 288 working days of constant industry, before the price of labour in mounting is repaid, exclusive of the whole expence of the materials. It is plain, that whether a weaver mounts a loom for himself, or employs another to do it for him, the case will be precisely the same, for in both instances the price is estimated by the labour. In the first instance, labour is given; in the second, money; and, by the supposition, the value is the same. But, to make the calculation simple, let us suppose that an operative weaver mounts the draw loom, which he is afterwards to work. By the suppositions which we have made, he will expend 96 working days, in the mounting, before he begins to weave, and 288 working days in weaving, before he recovers common wages for the time which he has expended. These, taken together, amount to 384 working days, to which adding the intervening Sundays (without any allowance for holidays, sickness, or other causes of impediment), he will at the end of one year and 83 days, or nearly 15 months, be merely paid for his labour. Now let us again suppose that the money expended for materials of the best quality, in mounting a draw loom, amounts to 10*l.* and, that those of inferior quality, might be purchased for 6*l.* Let us suppose also, that these two mountings will last in proportion to their prices, which, in practice, is never the case, for the vulgar adage "the best is always the best penny-worth," will here be found invariably true. In this case, the former will last ten months for every six that the latter will. Let us then suppose, that the worst mounting will last for two years, and the best for three years and four months; the calculation will then be

FOR THE WORST.

For labour, as before	*L.* 14	8
For materials	6	0
	20	8

RETURN.

1*s.* per day for 626 working days . .	31	6

The profit, therefore, to the weaver will be 10*l.* 18*s.* excluding interest.

FOR THE BEST.

For labour	*L.* 14	8
For materials	10	0
	24	8

RETURN.

1*s.* per day for 1043 working days .	52	3
Or of profit, excluding interest . .	28	15

In both cases, it is supposed, that each kind of material has been laid in at the fair market price, and that no imposition has been practised on the buyer.

The grounds upon which these calculations are made, have been taken entirely at random, to illustrate and prove the position advanced. Whether the price of wages, the cost of materials, or the durability of the apparatus, be taken high or low, the inference will be nearly the same. In every state of the price of labour, if good materials only repay a weaver, bad will ruin him; and, if bad materials yield him a profit, good ones would yield him much more. Simple as this principle is, and easily demonstrable, there are few from which there are more deviations in common practice. I have known incalculable loss, in many instances, arise from this deviation, and have, therefore, entered more into the consideration of it, than I should have done, were it more generally understood, and practised in the affairs of common life.

We now proceed to consider the application of the draw loom to the weaving double cloth, and to explain the difference which exists between the Damask, and

CARPET DRAW LOOM.

Carpets, being generally composed of coarse and bulky materials, there are, of course, much fewer splits, or threads, in the warp, than in that of a damask; and, consequently, the drawing apparatus is much less extensive. The common run of carpets do not exceed 10 porters of warp, 4 threads in the split, in the breadth of 37 inches, which is equal to a 500, wrought two in the split or 1000 threads. The harness and mails of the carpet draw loom, are perfectly similar to those of the damask, excepting that they are larger and coarser. In drawing a carpet through the harness, only one thread passes through each mail, and one thread of each of the two warps is drawn alternately. The draught, through the harness, proceeds in regular succession as in the damask, and two threads of each warp pass between the same splits of the reed, which is, generally, of steel. It is found, in general, unnecessary to use simples in the carpet draw loom; the lashes, therefore, are attached directly to the cords of the tail, from which they hang down perpendicularly at one side of the loom. To the lower end of each set of lashes is tied a cord, and to the other end of this cord, is suspended a small handle, or bob.

Fig. 6. is a transverse elevation of part of a carpet draw loom, showing how the lashes and bobs are attached to the tail. A is the box or frame of pullies, B the tail, C the lashes, G the board through which the cords pass, H the bobs. The bobs are suspended in two rows, as represented in Fig. 7. which is a section of the board G, showing two of the bobs. Of these bobs, one lifts that portion of the black warp which is to be uppermost; the other lifts the white in the same manner, supposing still that these are the two colours of which the carpet is composed. The four front leaves open the sheds, two being set apart for the black warp, and two for the white.

The front leaves of the carpet draw loom are exactly similar to those of the diaper, the eyes being of a length rather more than the depth of the shed, so that they may not interrupt the harness in rising. In some looms, the whole is mounted as a harness, and the treddles are connected with certain of the tail cords. Upon inquiring of persons, who had been long in the habit of working both, I could not ascertain that any decided preference was to be given to either plan. Both are found to do very well, and both are generally used in different manufactories.

Let us now suppose, that Fig. 14. Plate 4. is to be wrought as a carpet, and that the figure is black upon a white ground. In this case, when a white shot is thrown across, the figure must be raised, and the ground sunk; and when a black shot is inserted, the ground is to be raised, and the figure sunk. For the first, the instructions, in reading on, will be the same with those given for damask, and for the second, directly the reverse. As the shots of weft are thrown in alternately, the harness must be changed at every shot, and for this reason the bobs are placed in pairs, as represented by Fig. 7. The instructions, therefore, will be

1st. White shot, pass 30 and take 2.
Black shot, take 30, pass 2, take 13.

and so on, whatever is passed in the one case, being taken in the other.

Different plans have been tried in carpet weaving, as well as damask, to supersede the use of the draw boy. Hitherto, none of them have come into very general practice, although there seems no reason to doubt that some saving may be effected in this way. Carpet weaving, however, does not possess the same facilities for this as damask, for in the former, as the harness must be changed at every shot, if the time of doing so should impede the weaver even very little, more will be lost than an equivalent for the wages of a draw boy. Besides this, as the weaver must shift his shuttle at every shot, he is sufficiently occupied without being obliged to change his harness.

Carpets are seldom warped upon mills, for the yarn being very coarse, the warp is found not to be sufficiently stretched. A square frame of wood is, therefore, commonly used, with pins at certain distances, over which the warp is stretched by the warper, in a manner similar to the old practice, described in the first Essay. As the warps of carpets do not contain many threads, this practice is considered sufficiently expeditious.

When carpets consist of more than two colours, they are woven exactly as checks, and merely require additional shuttles to insert the weft, the same as the warp. There is no other difference in the process. It is not yet customary to use the fly shuttle in carpet weaving, and when the webs are too broad for one man to stretch, two are employed, one at each side of the loom.

Many kinds of carpeting for rugs, passage, and stair cloths, &c. are also woven in the plain loom.

Carpets are also manufactured with flushing like velvet, which is afterwards cut. When this is the case, wires are introduced into the shed, to form the length of the flushing. In each of these wires is a groove, and when the weft has been thrown across, a sharp pointed knife is passed along the groove, which serves as a guide for it. The wire is thus relieved, and the cut warp forms the flushing. These may either be wrought plain, or in figures raised by the harness. This manufacture is chiefly carried on at Kidderminster, and has hardly been introduced at all in Scotland. From the name, it appears to have been originally imported from Turkey. Very elegant carpets are also manufactured in France.

Quiltings are also double cloths, and are manufactured exactly upon the same principle as carpets. The two webs are generally of the same colour. This manufacture is also derived from the French, and was chiefly carried on in the neighbourhood of Marseilles. Those made in England, are generally of cotton.

ESSAY IV.

ON THE

WEAVING OF CROSSED WARPS.

THE ornamental kinds of weaving, which form the subject of the 2d and 3d Essays, are those peculiar to stout fabrics of cloth, of various descriptions. That which we are now to investigate, is exclusively adapted to the slightest and most flimsy textures. Like the other branches of the art, we derived our first knowledge of cross weaving from the continent; but, this species of weaving has certainly been much improved, and a considerable variety of nets added, by the invention and ingenuity of weavers in this country.

The manufacture of cross woven goods is, chiefly, carried on in Glasgow, Paisley, and the neighbouring villages in the counties of Lanark and Renfrew, in the west of Scotland. Some attempts have, indeed, been made in different parts of England, to introduce this manufacture; but, whatever may have been the success of these experiments, it does not appear that they have ever been prosecuted to any considerable extent.

The first branch of cross weaving, and of which all the others are only varieties, is

GAUZE.

In all the species of weaving, which we have hitherto considered, the threads of the warp, whether raised and sunk alternately, or at intervals, remain always parallel to each other, and without crossing. But in gauze weaving, the two threads of warp, which pass between the same splits of the reed, are crossed over each other, and twined like a cord at every tread. They are twined to the right and left alternately, and each shot of weft preserves the twine which the warp has received. Fig. 15. Plate 4. is a representation of gauze, drawn, like the other specimens of cloth in the same plate, upon a large scale, and will, by attentive observation, exhibit the crossings of the warp, and intersections of the weft. To produce this appearance, it is only necessary that the warp should really be crossed at every second shot; for its return from the crossed to the open, or parallel state, gives the reversed crossing.

The whole variety in every branch of the art of weaving, consists merely in the way of forming the sheds; and, as this is effected by the heddles, and their connections with the treddles which move them; the whole knowledge of the art, consists in the arrangement of this part of the apparatus of a loom.

Representations of the mounting, peculiar to gauze weaving, will be found in Plate 10. Fig. 1. represents two threads of warp, opened to form the shed, where the warp is not crossed, and Fig. 2. the shed where it is crossed. The mounting, of a gauze loom, consists of four leaves, constructed like common clasped heddles, and of two half leaves. The leaves are raised and sunk, by means of top levers, or coupers, and marches, exactly in the same way as in most other ornamental looms, and as represented in Fig. 1. Plate 5. The open shed of the gauze is formed by the leaves 3 and 4; the cross shed, by the leaves 1 and 2, and by the half leaves. The leaves 1 and 2 are called standards, and the half leaves pass through them, as represented in Fig. 3. It is necessary to observe, that in order to produce the twine, in forming the sheds, the threads do not rise and sink alternately, as in plain weaving, nor at intervals as in tweeling. In both sheds, the thread A is always raised, and the thread B sunk; but in the open shed Fig. 1. the threads are not crossed, and in the cross shed Fig. 2. they are. By examining these figures, the way of drawing the warp through the heddles, will become apparent, and this is an important part of every branch of cross weaving. The thread A is drawn through the third leaf, but, as it always rises, it is not taken through the clasp, or eye, of the heddle, but above it, through what the weavers usually call the upper doup. In like manner, the thread B, which always sinks, is drawn through the under doup of the fourth leaf. When this has been done, the thread A is crossed over the thread B, as will appear more plainly in Fig. 5. which is a horizontal, or ground plan. After being drawn through these two leaves, which are generally called the back mounting, and crossed, it only remains to draw the warp through the fore mounting. Of the half leaves, one is hung from above, and one rises from below. The one hung from above, passes through the lower doup of the leaf, or standard 2, and that, hanging from below, the upper doup of the standard 1. This will appear very plain in Fig. 3. Through the under half leaf, connected with the standard 1, the thread A is drawn, and through the upper half leaf, connected with the standard 2, the thread B passes. In Figs. 1. and 2. the shaft of the upper half b, appears, as hung between the standards 1 and 2; but this is not the usual practice, for it is found more convenient, to place the two standards together; the under half leaf a, in front of the standard 1, and the upper half leaf b, behind the standard 2, as in Figs. 3. and 4. By means of the half leaves, the alternate crossing of the warp is effected; for, in the open shed Fig. 1. the half leaves work in an opposite direction to the standards, and leave room for the warp to rise and sink in the space between the leaves and standards, while, in the cross shed Fig. 2. the half leaves rise and sink with their respective standards, and force one thread of warp across the other. Thus, when the warp is direct, the half leaves are crossed, and when the mounting is direct, the warp is crossed. This will plainly appear, by carefully tracing the threads A and B, in Figs. 1. and 2. and also in Figs. 3. and 4. where sections of the threads are represented by round dots. In Fig. 3. the half leaves and standards are crossed as in Fig. 1. and in Fig. 4. if the standard 1 is sunk, and the standard 2 raised, the mounting will be direct, and the warp crossed as in Fig. 2.

It has not been the custom, among weavers, to represent the drawing or cording of gauzes or nets, upon paper. This may have arisen, in some instances, from the desire of keeping that branch of manufacture secret. But, in general, it may be traced to a different cause. From the very nature of the process, it is much more difficult to represent cross than parallel warp; and, as the crossings take place, alternately, in the warp and in the heddles, these crossings cannot be easily represented, without elevations of the machinery, as well as ground plans. This circumstance, together with the want of attention among operative weavers, to whom the knowledge of cross weaving is chiefly confined, to acquire a knowledge of mechanical drawing, has, hitherto, prevented any attempt at representation. Their views seem never to have gone further than horizontal plans of their heddles and treddles, and the formation of their pattern upon design paper, which is not well adapted to represent crossed warp.

In my attempt to obviate this inconvenience, I have merely applied the modes of drawing described in the first Essay, and well known among engineers, architects, mill wrights, and many other artificers, for the purpose of adapting that kind of illustration to the weaving loom, which they have long practised successfully, to illustrate many other branches of mechanical study.

But, in order to render the mode of mounting a gauze loom as plain as possible, I shall enter into a more detailed description of the mounting, than has appeared necessary in those kinds of weaving, where the horizontal plans of the draught and cording have been long practised and understood by professional men. The novelty of the subject, and its evident utility, should I succeed in my explanation, will, I hope, screen me from the charge of unnecessary prolixity; and should I even fail in rendering this part of the knowledge of the art so perspicuous as I wish, I shall not think either my own or my readers' time wholly misapplied, if the practicability of representing the gauze and net mountings upon paper, shall be established to the satisfaction of those interested in the manufacture.

It has been already stated, that the gauze mounting consists of two back leaves, two standards, and two half leaves. These are moved by two treddles. The intermediate levers are five top levers, or coupers, five long, and five short marches. Tracing the heddles in regular succession from the front, the first is the under half leaf a; the second, the front standard 1; the third, the second standard 2; the fourth, the upper half leaf b; the fifth, the first back leaf 3; and the sixth, the second back leaf 4. The two back leaves and the two standards, are raised or sunk, as the case may require, by connecting cords with the marches and treddles, as in other looms. The half leaves have no connection with any treddle, but are lifted and sunk by the warp, in the open shed Fig. 1. and kept tight by weights, in the cross shed Fig. 2. These weights must, therefore, operate upon the half leaves in the cross shed, and must be relieved in the open.

It will be proper to trace the connections of the leaves with the coupers and marches, in the first place, and, then, to explain the way in which the weights are applied to operate upon the half leaves.

1st, The lower half leaf a, is attached by a cord *below*, to the first short march: it has no connection *above*. See Fig. 1. Plate 11.

2d, The first standard, by oblique cords, to the first couper *above*; the couper, to the first long march; the standard is connected *below* with the second short march.

3d, The second standard, to the second couper *above*; the couper, to the second long march; the standard, to the third short march *below*.

4th, The upper half leaf b, to the third couper *above*; the couper, to the third long march: no connection *below*.

5th, The first back leaf 3, to the fourth couper *above*; the couper, to the fourth long march; the leaf 1 to the fourth short march *below*.

6th, The second back leaf, to the fifth couper *above;* the couper, to the fifth long march; the leaf, to the fifth short march *below.*

These connections being formed, it only remains to apply the weights to their respective marches, and to connect the other marches with the treddles. The mode of applying the weights will appear in Fig. 1. Plate 11. This figure is a transverse section of the *front part* of the mounting of a *whip net,* of which it will be necessary to treat afterwards. In the mean time, as the cording of common gauze is exactly the same as that of the whip net, it will serve to illustrate that part of the mounting.

The lower half leaf a, is connected with the first short march.

The upper half leaf b, with the third couper above, and, from thence, with the third long march.

The application of the weights is, therefore, as follows:

From the first short march two cords descend, one passing on each side of the first long march; and from these cords, the weight is suspended. Above the long march, the cords are attached to each end of a piece of wood (generally a piece sawed or cut from a common bobbin), by which they are kept assunder, to prevent them from rubbing on the long march which works between them. Another piece, of the same kind y, is fixed below, and from this the weight is suspended. The same apparatus is applied to the third short march, and passes upon both sides of the third long march, for the upper half leaf. The pieces of wood are distinguished by the letters v and z.

When the open shed is made, the first standard is pulled down. This raises the first long march, which, consequently, lifts the weight, and allows the under half leaf a, to rise. At the same time, the second standard is raised. This, of course, also raises the third short march, and relieves the pressure of the weight from the third long march. The upper half leaf b, is thus allowed to sink. In forming this shed, the standards and half leaves merely yield to the warp, for the raising and sinking is entirely produced by the back leaves. In the cross shed, the back leaves have nothing to perform, and, therefore, remain stationary, while the motion of the standards being reversed, the weights act with their full power, and keep the half leaves tightly drawn to that part of the standards through which they pass.

From these explanations, and from a careful examination of the Plates 10. and 11. the general principle of weaving gauze may be pretty well understood. The connections of the back leaves, standards, and half leaves, with the long and short marches, have been already stated.

The connections with the treddles, will be found by examining Fig. 5. Plate 10. which is a horizontal plan, similar to those employed, to illustrate other branches of weaving. In order to bring this as nearly as possible to the same plan, as other plans of draughts and cordings, similar marks have been used. The warp thread A, which is drawn through the upper doup of the first back leaf 3, is distinguished by a *black* mark. The thread B, which is drawn through the under doup of the leaf 4, by a *white* mark. The draught of the warp, through the upper half leaf b, is also denoted by a white, and that through a, by a black mark. The connections for *raising* the back leaves and standards, are also marked *black;* and those for *sinking* them, *white.* Where no connection from the marches to the treddles is necessary, the mark × is used.

As the half leaves are raised and sunk by the warp, no mark is used for the cording of them. The open shed is formed by pressing down the treddle 1; the cross shed, by the treddle 2. The treddle 3, merely reverses the motion of the treddle 2, to enable the weaver to work plain cloth as well as gauze, when he finds it convenient. The alternate motion, necessary for plain cloth, is entirely performed by the standards and half leaves, the back leaves remaining stationary, in this as well as the cross shed. But, in this shed, it is necessary to connect the marches with the plain treddle, to keep the half leaves tight when the weights are raised, the fore mounting in the plain shed, being exactly in the same situation as in the open shed.

It does not appear necessary to add more to these explanations; but, although it involves a recapitulation, I trust it will not be deemed improper, to give the whole connection of a gauze loom, for the use of those, who may be neither fully acquainted with the subject, nor conversant with the modes of drawing mechanical designs.

HEDDLES.

Front Mounting.

a, a half leaf; the shaft below.
1, a full leaf; the first standard.
2, a full leaf; the second standard.
b, a half leaf; the shaft above.

Back Mounting.

3, a full leaf; warp through upper doup.
4, a full leaf; warp through under doup.

CONNECTIONS WITH THE COUPERS.

First standard, 1; first couper.
Second standard, 2; second couper.
Upper half leaf, b; third couper.
First back leaf, 3; fourth couper.
Second back leaf, 4; fifth couper.

COUPERS TO LONG MARCHES.

First couper; first long march.
Second couper; second long march.
Third couper; third long march.
Fourth couper; fourth long march.
Fifth couper; fifth long march.

HEDDLES TO SHORT MARCHES.

Under half leaf, a; first short march.
First standard, 1; second short march.
Second standard, 2; third short march.
First back leaf, 3; fourth short march.
Second back leaf, 4; fifth short march.

WEIGHTS FROM MARCHES.

First weight, from first short march; over first long march.

Second weight, from third short march; over third long march.

OPEN SHED TREDDLE 1.

Lower half leaf, a; raised and slack.
First standard, 1; sunk.
Second standard, 2; raised.
Upper half leaf, b; sunk and slack.
First back leaf, 3; raised.
Second back leaf, 4; sunk.

CROSS SHED TREDDLE 2.

Lower half leaf, a; raised and tight.
First standard, 1; raised.
Second standard, 2; sunk.
Upper half leaf, b; sunk and tight.
Both back leaves, stationary.

PLAIN SHED TREDDLE 3.

Lower half leaf, a; sunk and tight.
First standard, 1; sunk.
Second standard, 2; raised.
Upper half leaf, b; raised and tight.
Back leaves, stationary.

To form these sheds, the following connections between the marches and treddles are necessary:

LONG MARCHES.

Treddle 1; second and fourth long march.
Treddle 2; first long march.
Treddle 3; second and third long march.

SHORT MARCHES.

Treddle 1; second and fifth short march.
Treddle 2; third short march.
Treddle 3; first and second short march.

From the drawings, and descriptions, I hope, that any person, who possesses an ordinary knowledge of common weaving, and who will study them with care and attention, will find little difficulty in mounting a gauze loom. When the principle of gauze weaving is thoroughly understood, its application to the weaving of fancy nets, may be easily acquired. Many varieties of net work are used; but a few, which form the ground work upon which the rest are formed, will be sufficient to elucidate the general principle, and the limits, to which it is necessary to restrict this work, will not admit of more particular details. The most simple of these is known by the name of the

WHIP NET.

The term *whip* is used by weavers, to denote a species of warp rolled upon a separate beam, and slackened, as may be required, to form fanciful patterns. In this net, the whole warp is of this description, and, therefore, only one beam, or roll, is required. The mounting of the whip net is, in every respect, the same as common gauze, and the connections are formed exactly in the same way. Fig. 16. Plate 4. is a representation of this net, upon a large scale like the others. In every species of net weaving, it is found proper to use glass beads, in place of the eyes of common heddles, or the metal mails than the gauze, to distinguish them from each other, and to show the way in which both are led in, or drawn. The under shaft of the bead lams is supposed to be raised, and the upper shaft sunk, so that the lams may be perfectly slack. The lams belonging to the upper shaft, which cross above the warp, are represented by double lines to make the crossings distinct. Those belonging to the under shaft, which cross below the warp, are single black lines. The way in which these lines are drawn, will show that the upper lams cross *in front*, both of the standards and under lams.

The connections of the heddles with the treddles, are shown in the same way as before, the *black* marks denoting raising, or long march, connections; the *white*, sinking, or short march, connections; and the mark ×, stationary leaves, or no connection. In the gauze part of this, as in the mail net, the back gauze leaves must be sunk, when the gauze bead lams are raised to form the cross shed; but if the full gauze mounting is used, they remain stationary, as represented in the plan. Fig. 9. is a transverse elevation of the part before the reed, used for the patent net. The bead lams, and part of the standards, are drawn to show the crossings as they appear when viewed in front. The shafts are omitted, being exactly the same as those of the mail net. The threads of warp, being shown in section, are represented by round dots; those of the gauze, *white;* and of the whip, *black*. In both of the Figs. 8. and 9. one set of the pattern is given; and this is to be repeated until the whole warp is drawn. The patent net is wrought either with three, or four beams. If the single bead lam without standards is used, two beams are required for the gauze part; if the full gauze mounting is adopted, only one beam is necessary. In both cases, two are requisite for the whip, in order that each half should be slackened in its turn, for the alternate crossing. As in the mail net, it is most common to use the full mounting for the gauze.

For practical use, I shall give the sheds of the patent net, in the same way as the others.

SHEDS OF THE PATENT NET, OR NIGHT THOUGHT.

FIRST SHED, TREDDLE 1.

Under lams, a; raised and slack.
First standard, 1; sunk.
Second standard, 2; sunk.
Upper lams, b; sunk and tight.
Gauze lams, k; sunk and slack.
First whip leaf, 3; raised.
Second whip leaf, 4; stationary.
First gauze leaf, 5; sunk.
Second gauze leaf, 6; raised.

SECOND SHED, TREDDLE 2.

Under lams, a; raised and slack.
First standard, 1; sunk.
Second standard, 2; raised.
Upper lams, b; sunk and slack.
Gauze lams, k; raised and tight.
First whip leaf, 3; raised.
Second whip leaf, 4; sunk.
First gauze leaf, 5; sunk.
Second gauze leaf, 6; sunk.
The gauze leaves, *stationary*, with full mounting.

THIRD SHED, TREDDLE 3.

Under lams, a; raised and tight.
First standard, 1; raised.
Second standard, 2; raised.
Upper lams, b; sunk and slack.
Gauze lams, k; sunk and slack.
First whip leaf, 3; stationary.
Second whip leaf, 4; sunk.
First gauze leaf, 5; sunk.
Second gauze leaf, 6; raised.

FOURTH SHED, TREDDLE 4.

Under lams, a; raised and tight.
First standard, 1; raised.
Second standard, 2; sunk.
Upper lams, b; sunk and tight.
Gauze lams, k; raised and tight.
First whip leaf, 3; stationary.
Second whip leaf, 4; stationary.
First gauze leaf, 5; sunk.
Second gauze leaf, 6; sunk.
The gauze leaves, *stationary*, with full mounting.

There are many varieties of these nets, but they depend more upon difference in treading, than any variation of the general principle. To give plates representing these varieties, would enhance the price of this work too much to render it susceptible of that circulation which is my chief object. Some descriptions of those varieties will be given, as miscellaneous observations, before the conclusion of this Essay. In the mean time, we proceed to give a short description of a species of gauze, generally called

CATGUT.

To those who are previously acquainted with the manner of weaving gauze, that of producing catgut will be a very simple operation. The principle of both is exactly the same. The gauze, as already explained, is crossed and twined at one treading. It is there kept fast by the intersection of the weft; and, at the next tread, by returning to the open state, the twine is reversed, and the warp again locked by the weft. Consequently, the same threads of warp always rise and sink, being crossed and open alternately. The catgut carries the twine a little further; for, in this species of cross weaving, half a turn more is produced than in the gauze. The most simple way of weaving catgut, will appear in Figs. 10. and 11. Plate 11. Fig. 10. represents the open, and Fig. 11. the cross shed, as they appear when opened. The whole mounting consists of two back leaves, and a set of bead lams, similar to those already described for the gauze part of the mail and patent nets. The open shed is formed by the back leaves, the lams yielding a turn and a half, as represented in Fig. 10. At the next tread, the cross shed is formed by raising the lams, and leaving the back leaves stationary, or sunk, as in gauze, see Fig. 11. Here the threads, A and B, rise and sink alternately, as in direct weaving, but with the gauze crossing added to the plain shed. Catgut, therefore, combines the principles of plain and cross weaving. In the finer kinds of catgut, it is found useful to work the lams through a standard, as represented by Fig. 12. It will appear by this figure, where the threads of warp are in section, and represented by dots, that the whole gauze cross is effected by the lam; and the additional half turn is produced by sinking the standard, when the lam is pulled tight.

Having stated what appeared most essential of the principles upon which cross weaving depends, and their application to common practice, I shall conclude this Essay, with a few

MISCELLANEOUS OBSERVATIONS.

In the net, as in every other species of fancy weaving, a boundless variety may be introduced. As it would be impossible to enumerate and describe all the varieties, I shall only briefly mention a few which are in most common use.

A kind of fancy nets are very common, which are figured by omitting the crossing in particular places, and which leaves a wider interval than in the other parts. These are called, by weavers,

DROPPED NETS.

To effect this, it is necessary to mount the loom with additional back leaves, and treddles for moving them. By this apparatus, the crossing of the warp which is drawn through any of these leaves, may be omitted for a shot, while the other parts of the web are crossed like a common net. The way in which these omissions are disposed, forms the pattern. This is so very similar to the way of disposing the leaves in spot weaving, which will form the subject of the next Essay, that it seems unnecessary to go more into detail in this place.

A net, very simple in the mounting, but which produces a very pleasing effect, is much used, and is called the

SPIDER NET.

This net has merely a common gauze mounting behind the reed, and the gauze is drawn through every second interval. The whip part is, usually, composed of coarser yarn than the gauze. It passes through a bead, to which two lams are attached. These lams pass through the reed, and are attached to separate shafts, so that each may be raised alternately. By these means, the whip, *or spidering*, is alternately pulled to the right and left in a zig zag direction, but the whip threads do not cross each other. On whatever side the whip is lifted, it is secured by the weft shot.

Another net is known by the name of the

DOUBLE PARIS NET.

This net is, in every respect, both of drawing and cording, the same as the patent net, or night thought. It is wrought entirely by the first and fourth treddles, omitting the second and third.

There is also a species of nets called

BALLOON NETS.

These are also mounted like the patent net. The cording is so disposed, that the crossing of the gauze may be continued regularly, while every crossing of the whip part is twice repeated. In this net, the gauze part is slackened, and the whip part kept always tight. By these means the gauze, being drawn alternately to the right and left, forms a waving, or serpentine appearance, instead of being perfectly straight. There are many varieties of these nets.

It is not easy to give practical instructions for the weaving of nets; for the knowledge and dexterity necessary for this, like all other mechanical arts, can only be attained by assiduous practice. Much depends upon having all the cords of the mounting nicely tempered. This may be easily accomplished, by means of the snitch knot formerly described. It is also essential, that the warp and the lams should be equally slackened at the alternate treadings. If this is not the case, the lams when slack, are very apt to be entangled, which produces much inconvenience and trouble. The way of treading is also material, especially in the cross shed. It is very important that the shed should be gradually opened, while the lay is going back, and, after throwing the shot, that the weft should be driven home in the same gradual way, while the treddle is relieved. The crossing of the warp, both before and behind the reed, necessarily creates an obstruction in the moving of the lay, which exists in no species of direct weaving.

In gauze mountings, where beads are not used, the twine of the half leaves is made of silk. This is proper, both on account of strength, and to diminish the friction.

In weaving catgut, it is common to add a treddle for weaving the cloth plain, as in gauze. When the bead lams, without standards, are used, the open shed and plain shed are wrought alternately, by the two back leaves; the bead lams, in both instances, being sunk and slack. When the bead lam is used with a standard, the open shed, as formerly described, is formed by the back leaves, one being raised, the other sunk, and the lams slack. The cross shed, by raising both back leaves, sinking the standard, and keeping the lams tight. The plain shed is formed, by reversing the latter motion, that is to say, by raising the standard, and sinking both back leaves, the lams being still kept tight. In forming the plain shed in cross weaving, the weights suspended from the marches are relieved; but, as the back leaves remain stationary, the half leaves, or bead lams, generally remain tight by their own weight. If, however, they have any tendency to slacken, they may be easily secured, by taking a cord from the short march of the under half leaf a, and from the long march of the upper half leaf b, to the plain treddle.

ESSAY V.

ON THE

WEAVING OF SPOTS, BROCADES, AND LAPPETS.

HAVING now finished our descriptions of the grounds, or fabrics, in common use, we proceed to investigate the mode of adding flowers, and other ornamental figures, to these grounds. These ornaments are, frequently, interwoven either with plain, tweeled, or gauze grounds; and form a very extensive branch of fanciful weaving.

The most simple of these figures, are the

COMMON SPOTS.

THE weaving of spots is effected by additional leaves and treddles, as in tweeling, and the manner of mounting is, in every respect, similar to that used for other kinds of ornamental work. The apparatus consists of coupers, long and short marches, and treddles, as represented in Fig. 1. Plate 5. already frequently referred to. For the sake of reference, and to ascertain the exact range of the pattern, it is customary in this, as in other branches of ornamental weaving, to draw the spots upon design paper, each interval generally denoting one splitful, or two threads of warp. The most simple figure of a spot, is that represented in Fig. 1. Plate 12. being what is called a common barley-corn spot, covering three splits, with an interval of nine splits between every spot. To weave this, only three leaves would be required, namely, two for the ground, and one for the spot; but, as one row of spots is thrown into the bosom of the other, forming a kind of diamond figure, four leaves are necessary. A, B, 1, 2, represent a ground plan of the heddles, the same as formerly described. The cross lines, 1 to 12, show a portion of the warp, as it passes through the heddles, every two lines being joined, to denote that these pass through the same interval in the reed. The black marks on each leaf of the heddles, show that the thread, to which the mark is attached, passes through the eye of the heddle in that leaf, and no other. Opposite to the plan, the spot appears upon the design paper. The left hand thread between every split, forming one half of the whole warp, is drawn through the front leaf A; and the other half is divided between the remaining three leaves, as represented. From this way of disposing the warp, it will be obvious, that when the front leaf is raised, and the other three sunk, and these leaves reversed alternately, plain cloth will be produced. When the third leaf, 1 alone is raised, and all the rest sunk, the left hand row of spots is formed, by throwing across coarser weft, by means of a separate shuttle. As this leaf raises only one half of three splits, while the whole of the next nine splits are sunk, only the portion of the coarse weft passing under those threads which are raised, is interwoven in the cloth, the remainder passing loosely over the interval unto the next spot. When the weaving is completed, and the cloth taken out of the loom, these loose intervals are clipped away, when the spots appear as in the design. The back leaf 2, works exactly in the same way; but it will appear, that the threads to be raised are exactly in the centre betwixt the former, and this places the alternate rows of spots in the diamond form. The leaf B, contains the remaining portion of warp, to complete that part of the plain cloth which lies in the interval between the spots. The portion of warp represented, consisting of twelve splits, is called one set of the figure, and along the whole breadth of the web the same is exactly repeated. The leaf A, containing half the warp, is generally called the ground leaf; B, containing the intervals, the plain leaf; and the two others, the spot leaves. From the design, it will appear, that the set of twelve splits is thus divided—1, 2, and 3, form the left hand spot; 4, 5, and 6, the first interval; 7, 8, and 9, the right hand spot; and 10, 11, and 12, the second interval. The cross bars a, b, 1, 2, as usual, show a plan of the treddles. Each of the four treddles is connected with all the four leaves. The squares formed by the crossings, are distinguished by black marks, when the leaf which forms that crossing is to be raised; or, in other words, that leaf is to be connected with the treddle by the long marches, as formerly described. Where the square at the crossing is not blackened, the connection is made by the short marches, that the treddle may sink the leaf. To work this pattern, beginning with the left hand spots, the leaf 1 is raised, and one shot of the coarse spotting weft thrown across; then, two shots of plain weft are interwoven; again, one of spotting; and so on, until the spot is sufficiently large. Six shots of plain are then wrought to form an interval by the weft, equal to the three splits in the warp; after which the leaf 2 is to be raised, and the right hand spots formed in the same way as the former. Another interval of plain is then wrought, and so on.

Upon this principle, a boundless variety of figures may be formed upon cloth, if a sufficient number of leaves be employed. It would very far exceed any moderate limits, to investigate the whole range of patterns which may be produced; nor, indeed, is it practicable. The general principle being studied and understood, all the rest may be accomplished at the fancy of the operator. The spot described, is called a common spot, and is the most simple, because one half of the whole warp being included in the ground leaf, the whole of the spotting is thrown upon the other half. But, in this case, the spots will only appear to advantage on one side of the cloth, and scarcely at all upon the other. The texture of the cloth is also inferior, as the spotting is not fully incorporated into the fabric. For this reason, recourse has been had to another mode of forming spots, which appear equally on both sides, and which are much superior in point of effect to the former. These are usually called

PAPER SPOTS.

These spots not only require nearly double the mounting, or apparatus, on the loom, but are much more tedious in the process of weaving. This increases the expence so greatly, as to prevent them from being manufactured to any great extent, although large quantities have been made at different times.

Fig. 2. is a plan of drawing, and cording a paper spot, such as the pattern opposite to it upon the design paper. But it will also work any other spot pattern, standing upon the same, or a smaller number of splits, and of which the two sides are similar to each other. This pattern stands upon ten splits, for each spot, with an interval of twenty splits between those on the same row; and, of course, one set of the pattern is thirty splits. Like the former, and, indeed, like most spot patterns, the second row is thrown into the bosom of the first; and, of course, is wrought by additional leaves. The mounting of this spot consists of twenty-two leaves, of which the leaves A and B, are, for the intervals of plain cloth, between the spots, and the remaining twenty, are spot leaves. The eleven leaves, from A to 10, contain one half of the warp, and those from B to 20, the other half. Of course, when these two sets of leaves are raised, or sunk, alternately, plain cloth is produced. The leaves from 1 to 5, on the front set, and from 11 to 15, on the back set, work the left hand spot; and those from 6 to 10, and from 16 to 20, the right hand spot. The cording is represented at the left hand; the black squares, at the crossings, denoting rising, or long march connections, and all the others the reverse. By examining the figure upon the design paper, it will appear, that the lower part of it contains ten splits by the warp, and five splits, or ten spots, by the weft; and a comparison of this with the draught will show, that if the ten treddles on the left hand are pressed down in succession, they will raise the leaves so as to produce a spot similar to the figure. The second part of the spot is merely a repetition of the first, and the small spot is made by the treddles 1, 2, 3, and 4. The right hand treddles, wrought in the same

way, produce the second spot, standing in the bosom of the first. In weaving paper spots, one shot of plain, and one of spotting, are thrown in alternately. The paper spot, here represented, may be reduced to a common spot of the same figure, by taking away all the leaves from A to 10, and drawing the warp contained in them through one ground leaf. Twelve leaves then, instead of twenty-two, will be sufficient. If a solid spot is wanted, like the lowest one in the figure, those crossings marked by small black dots, must be changed from sinking to raising connections. Having thus shown a specimen, both of common and paper spots, what other examples may be necessary, for the further illustration of the nature of spot weaving, will be given as common spots. As above mentioned, the only difference is, that in the former, half of the warp is drawn through the ground leaf, and the other half through the spot leaves and the plain leaf; while, in the latter, the number of spot leaves is doubled, the intervals only being plain leaves.

ALLOVER SPOTS.

FIG. 3. represents the figure and plan of an allover spot, set upon twenty splits, with a small round spot in the bosom of each diamond. In this, the leaf A, as formerly, forms the ground containing half the warp; the leaf B, contains only a few plain heddles at each side of the web, to form the selvage: all the bosom of the web being covered with spotting, in the form represented in the design, from which it is called an allover pattern. The splits of warp, one to twenty, form one set of the pattern; and, at the left side, two splits of the next set,

nineteen and twenty, are added, to show that the spotting is to be continued in sets exactly the same all over the web, without any intervals of plain.

Any allover spot pattern, not exceeding twenty splits, and whose sides are similar, may be wrought by this mounting, only some variation in the cording, or in the succession of treading, may be required. To work the pattern represented, the spot treddles, from one to eleven, are to be pressed in succession, and then from eleven back to one. The black spots, denoting, as usual, the raising cords, which extend in the diagonal direction from corner to corner of the treddle plan, form the diamond, or allover part of the pattern. Those at the other corners, form the round spot. A careful inspection of the figure, will render this apparent. If the last mentioned raising cords are taken away, and sinking cords substituted, the allover part will remain the same; but there will be no spot in the bosom. Or a spot of any other shape, within the range of the mounting, may be substituted, by adapting the raising cords to lift the leaves required. Upon principles the same as the above, all spot patterns may be formed, where the two sides of the figure are similar to each other; but, where this is not the case, a different and more extensive mounting becomes necessary.

Fig. 1. Plate 13. is an example of this. The spot drawn upon the design, it will evidently appear, does not correspond in the two sides. It becomes, therefore, necessary to allow a leaf of heddles for every thread contained in the range of the spot, which is ten splits. The other thread of the split is, as usual, drawn through the ground leaf A; and the warp, to form the intervals, through the plain leaf B. The remaining leaves are for

the spot, ten being allowed for each, and forming, in all, twenty-two leaves; that is, twenty for the two spots, and two for the plain work. This mode of drawing, is equally well calculated for any figure, regular or irregular, not exceeding ten splits; and the alteration, whether the figure is solid like that represented, or hollow, will depend entirely upon the cording, or way of forming the connections.

A careful and attentive consideration of the different designs, and modes of mounting them, which have been given, will evince that figures may be wrought upon cloth in immense variety, upon principles perfectly similar. When the spot is regular, or when the two sides of it are similar, two threads, in every figure, are drawn through the same leaf, because these threads are uniformly raised at the same time in working. But where the figure is irregular, or when no two parts of it correspond, only one thread, in each, can be drawn through the same leaf, because every thread must be raised independent of the others. Figs. 1. 2. and 3. Plate 12. are examples of the first. In Fig. 2. Plate 12. it will be obvious, that the spot extending to ten splits, the fifth and sixth form the centre; and that the two sides, from five to one, and from six to ten, are exactly similar, diverging equally from the centre. Five leaves, therefore, are sufficient for ten splits, for numbers five and six pass through one leaf, numbers four and seven through one; and, in the same way, numbers three and eight, numbers two and nine, and numbers one and ten, pass respectively through the same leaves. In Fig. 1. Plate 13. however, the case is different. The two sides of this flower are totally different. Like the former, it covers ten splits, and because every thread must be independent of all the others, requires ten leaves. The particular form of the spot, is then ascertained by the manner of cording.

To fix the plan of the cording, it is only necessary to number the divisions on the design paper, which represent splits of warp, and to place corresponding numbers also to distinguish the leaves and treddles; as, for example, in Fig. 1. Plate 13. Let the warp splits on the design be supposed to be numbered from one to ten, beginning at the right. Let the spot leaves on the plan be also numbered from one to ten, beginning at the front, and then let the spotting treddles be numbered in the same way, beginning at the centre, or plain treddles. First, then, mark the black spots, or raising connections, for the plain work. One half of the whole warp is drawn through the front leaf A, and the other half through the remaining leaves. Therefore, where the plain treddle a, crosses the leaf A, the raising mark is placed; and where the other plain treddle b, crosses each of the others, a similar mark is also placed. Then, when the leaf A is raised, all the others will sink, and when A is sunk, all the others will rise. This will form the ground, or plain work. Proceed next to the left hand spot. The first threads to be raised in this spot, are numbers four and five. Two raising marks, are, therefore, placed where the treddle number one crosses the leaves numbers four and five. The second threads to be raised, are three and four; and the marks are placed where the treddle number two crosses the leaves numbers three and four. In the same way, proceed until the spot is finished, observing only that it often occurs, that a number of lifts upon the same threads may be in the design, and when a connection for raising these is once formed, it is unnecessary to repeat it, because pressing down the same treddle will produce the effect as often as may be required. In Fig. 1. Plate 13. the tenth, eleventh, and twelfth lift, are all the same, and, therefore, require only one treddle. The right hand spot is merely the left hand one reversed, and the manner of placing the marks exactly the same.

When the plan of cording is completed, it will always appear that the black, or raising marks, form exactly a copy of the design, only that it appears across the drawing, instead of being from top to bottom as in the design. When the two sides of the figure are similar, as in Figs. 2. and 3. Plate 12. the cording will represent only one half of the design. This appears very plainly in Fig. 3. Plate 13. where the leaves and treddles are represented as being placed close together, and the intervals omitted. When this has become familiar, from study or practice, it will be unnecessary to draw plans of the cording, as it can be taken equally well from the design.

BROCADES, OR FINGER SPOTS.

In the spots, hitherto described, as the figure is formed by coarser weft thrown across by a shuttle, when the yarn crossing the intervals is clipped away, a certain degree of roughness always appears, and, besides, all which is clipped is totally lost. To remedy these inconveniences, another mode of spotting has been practised, and goods of this description, are called *brocades*, or *finger spots*. The mounting of these is very similar to that of common spots, but the yarn, which forms the spotting, instead of being thrown across the whole fabric, consists of a separate thread for every flower, which is generally interwoven into the fabric by the hand, or finger, whence they receive the name of finger spots.

In mounting brocade looms, it is not necessary that there should be an additional set of spot leaves to place the one flower in the bosom of the other; for, as the spotting is interwoven by the hand, and as every spot is formed by a thread totally independent of all the others, every second flower may be omitted in the fingering, which will exactly produce the effect.

A specimen of the draught and cording of a finger spot, will be found in Fig. 2. Plate 13. The draught comprehends every figure which does not exceed twenty splits in breadth, and the pattern may be varied to any figure of that extent, by adapting the cording to the figure required. That upon the design is only seventeen splits in breadth, and, of course, the interval is twenty-three splits. The treddles and cording are double, for the purpose of reversing the flower, and every second flower, only, is to be fingered in working. The plain leaf b, is only for the selvage, as in the allover pattern, Fig. 3. Plate 12.

In working brocades, one half of the fingering is generally performed by the weaver, and the other half by a boy or girl, employed for the purpose. To reduce the expence, by rendering the labour of fingering unnecessary, various plans have been devised. In one, the spotting is passed through the spot sheds, by a number of small shuttles, in a way nearly similar to the tape, or incle loom. In another, the spotting is carried through by circular pieces of metal, generally brass, which are moved by a rack, and have a segment of each circle cut out. The number of plates, which it has already been found necessary to give, necessarily prevent us from representing these kinds of apparatus, and without figures it would be difficult, if not impossible, to render any description, however minute, sufficiently perspicuous. The want will be the less regretted, that brocades have not been for some years manufactured to any considerable extent. In the specimen, it will appear that the spotting of the brocade is not woven plain like the other spots, but flushed somewhat like tweeling. This is generally the case, because the flushing renders the effect more brilliant. When spotting patterns are too extensive to be wrought with leaves and treddles, recourse is had, as in the damask, and carpet weaving, to the

SPOT DRAW LOOM.

The principle and construction of the draw loom, have been so fully investigated in the third Essay, that very little remains to be added. The spot draw loom, besides the harness, consists of four leaves for working plain cloth, two of which are raised and sunk alternately, as in common weaving. The spotting is effected by the harness, and the plain, by the leaves in front. The heddles, as in the other draw looms, have long eyes, to allow the spotting to rise freely. In the spot harness, mails are not used, but merely eyes like those of heddles. Various contrivances, for raising the harness, and superseding the necessity of employing a draw boy, have been adopted in this mounting. Of these, the principal are the barrel, and saw. Neither of them have been brought to such perfection as to save much labour, and, indeed, the spot draw loom is, in general, very little used. The reading on of the design, is exactly the same as in damask, the spot part being corded, and the plain omitted. Only one thread passes through each eye of the harness. The draw loom may be mounted, either for common, or paper spots. The principle, being the same as in mounting with leaves, does not require to be repeated.

The next species of ornamental weaving, and which, from its cheapness, is very extensively used, is the

LAPPET.

The lappet is a species of flushing done with whip, which is generally considerably coarser than the yarn which forms the fabric of the web. In most instances, the whip consists of two threads twined together. It is not interwoven with the fabric, but crossing over a certain number of splits of warp, rises through the shed, and is tacked to the cloth by the weft shot passing under it. Until within these few years, lappets were generally wrought by bead lams, without standards, passing through the reed, and raised by shafts above. When either of these shafts was raised, the whip, traversing over the under surface of the cloth, was lifted through the shed. and intersected by the weft. But, a much more simple, and sufficiently accurate apparatus, has lately been brought into practice, and has completely superseded the bead lams. This consists of a shaft of well seasoned wood, into which a number of lappet needles, as they are called, are driven at equal lengths. The lappet needle is formed of a piece of brass wire, one end of which is flattened by hammering. A small hole is then drilled through it to receive the whip. The hole is countersunk on each side, and the needle being polished and pointed, the other end, after being sharpened, is driven into the shaft. This shaft is suspended under the warp, the points of the needles being up. It is susceptible of two motions, the first, from right to left, and vice versa, produces the traversing of the whip upon the under surface of the cloth, to form the pattern. The second is a vertical motion, by which the needles rise through the shed, and raise the whip above the shuttle that it may be intersected by the weft. This motion is communicated by the lay, for whenever the lay is pushed back to form the shed, the lappet frame is pulled up, and when the lay is brought to the fell, to strike home the weft, the frame again sinks by its own weight. When a greater variety of pattern is wanted, more frames are used. When two are employed, the fabric is called a

DOUBLE FRAME LAPPET.

THIS apparatus consists of two frames of needles, which move in an opposite direction to each other, when the pattern is forming; for, while one goes to the left, the other comes to the right, and the contrary. Sometimes, the frames are only made to approach each other, or to meet, and, sometimes, they cross each other and return. When the pattern is uniform, that is to say, when the same number of splits are to be crossed, the horizontal, or pattern motion, is communicated by the weaver's left hand, and the length of the traverse, regulated by a rack and spring, fixed upon the upper shell of the lay. But, when it is necessary that the length of the traverse should vary, to form any particular flower or figure, a wheel of a particular construction is used, and the goods fabricated in this way are called

WHEEL LAPPETS.

The construction of these wheels is very ingenious, although very simple. In no part of this work, have I had more occasion to regret, that, without additional drawings, it will not be in my power to elucidate my descriptions so perfectly as I wish, than in the present instance. But, after mature consideration, I have thought it of less disadvantage to forfeit, at least for the present, the ample details which it would be necessary to give upon this and many other branches of the art of weaving, than to create an expence upon this work, which might preclude many of the operative part of the community, from the means of access even to those parts, which have been pretty fully discussed.

The wheels are made of wood, and placed at one side of the loom. The circumference is formed like a ratchet wheel, having as many teeth as there are shots of weft in the pattern, and one tooth is moved between every shot, the wheel revolving in centres. To lay down the pattern, upon a wheel of this kind, from design paper, the following instructions are necessary, which, indeed, bear a strong analogy to the way of reading on a pattern for the draw loom. The pattern being drawn, the number of squares from the bottom to the top, gives the number of teeth, whether the wheel is to work one flower, two flowers bosomed, or an allover pattern. The teeth being cut, the flat side of the wheel has a line drawn from the centre, to every division between the teeth. A number of concentric circles are then described, equal to the number of squares from right to left upon the design paper. By marking these, as the pattern increases or diminishes in breadth, a rule is found for forming a groove in the flat side of the wheel, to regulate the traverse, or shift of the lappet frame, at every shot. An iron pin is fixed in the frame, which works in this groove, and the frame being, as formerly, traversed by the weaver's hand, the two sides of the groove stop the frame at the places proper to form the pattern required. The diameter of the pin must be added to the range of the pattern, in cutting this groove. A mode of spotting, by the application of a wheel of this kind, has been lately introduced, which supersedes the use of spot leaves, and is called

PRESSED SPOTTING.

The looms of this description, which I have seen, produce a spot upon a tweeled ground; but, it is, evidently, equally applicable to plain, as to tweeled weaving. The fabric is of cotton, and the spotting coloured in imitation of the Norwich shawls. The loom has merely a plain tweel mounting. Two frames, or shafts, are suspended below the warp, like a double frame lappet. Instead of lappet needles, these frames have pressers of brass, flat on the upper edge, driven into them. These pressers, when raised, force up that portion of warp which is to form the interval between the spots, while that part which is to be interwoven, being between the pressers, is not forced, and leaves the shed open to receive the spotting. As the pressers recede, or advance to each other, the breadth of the flower is increased or diminished. The pressers are raised by an additional treddle, placed close to each of the working treddles. These treddles are called *tongues*, and are about six inches shorter than the other treddles, so that the weaver, by shifting his foot, can either press down the tongue along with the treddle, to form the spot, or leave the tongue unpressed, to form the interval. In this case, the centres of the treddles and tongues are behind, and the weaver works upon the ends of them. The same apparatus is used for lappets, where there are intervals. One of the presser frames is wrought by each side of the groove in the wheel, and these sides are cut to form the pattern.

This apparatus is simple, and seems very well adapted for fabrics where the warp is sufficiently strong to bear the pressing, and where the spots are broad; but, when the warp is weak, and the spot terminates in a sharp point, requiring, perhaps, only a single splitful of warp to be open, it will be better to work with leaves. For, the pressed warp must be always more strained than the rest; and it may frequently happen, that the presser may pass a thread which ought to be pressed, and render the spot irregular where much accuracy is required.

The principle of the wheel, carried a good deal further, was that which I adopted to form the patterns of the Patent Tambouring Machinery; and the very ingenious machinery, exhibited by Monsieur Maillardet, at Spring Gardens, is, in general, merely a combination of wheels upon the same principle as that which forms the lappet. Some further account of the construction of wheels of this kind, will be given in describing the mode of weaving by power.

When spots are formed upon nets, they are only interwoven with the gauze part, the whip, or net part, being left perfectly free.

In the Essay upon cross weaving, it ought to have been stated, that the selvages of nets, are wrought plain. I think it better to mention this here, than not to notice it at all. Indeed, it is not much out of place, for, as has been already observed, the selvages of allover spots, are woven in the same way. In common spots of this description, half of the warp of the selvages is included in the ground leaf, as in Fig. 3. Plate 12. and Fig. 2. Plate 13. In those paper spots, which are allovers, the selvages only are on the two plain leaves, as in the intervals Fig. 2. Plate 12. The case is the same in net weaving. Two plain leaves, which only contain a few heddles at either side for the selvages, are added to each of the mountings, shown in Plate 11. They are, generally, placed behind the net leaves, and are corded to the treddles by the same means used in other fancy weaving, namely, coupers, long and short marches, so as always to produce plain cloth.

ESSAY VI.

ON THE

ECONOMY OF WEAVING, SIMPLIFICATION, OR OMISSION OF PROCESSES, DIVISION OF LABOUR, AND APPLICATION OF POWER.

IN the five preceding Essays, we have endeavoured to investigate the common manual processes, most frequently used in the art of weaving, and gone as much into detail upon the various branches, as the plan and limits of this work would admit. As already noticed in the introduction to the first part of the work, the knowledge of weaving all the varieties of cloth, has been imported, and, although undoubtedly, many important improvements have been made, both in the construction of the looms, and economy of the manufactures, nothing entirely original has been invented in the business. The woollen trade, introduced by Edward the third, was the original staple of England; and, although considerable quantities both of linen and silken goods, have long been manufactured in that country, they have been by no means nearly equal in value to the woollen goods. The cotton manufacture, which has been much more recently introduced, has rapidly arrived at an amazing extent and improvement. Still, however, in so far as the greatest branch of the cloth trade, and the raw material of which is chiefly the growth of the country, may be considered as its staple, the woollen remains in the same comparative situation as formerly. The manufacture of linens has been long the staple trade of Ireland, and, previous to the introduction of the cotton manufacture, many attempts were made for its extension and improvement in Scotland. An anonymous publication was printed at Edinburgh, in the year 1733, entitled, "The Interest of Scotland considered, with regard to its police, in employing the poor, its Agriculture, its Trade, its Manufactures, and Fisheries."

As no name appears in the title, I have not been able to ascertain who was the author of this work. But, it is evidently the production of a man of talent and education. The sentiments contained in it, are liberal and benevolent, and, when a reasonable allowance is made for the prevalent opinions of the age in which it was written, it appears a work of uncommon merit. Many of the author's opinions, indeed, have been either exploded, or at least rendered very doubtful, by the experience, which the prosecution of a more extended trade, since the period at which he wrote, has produced; and, by the able and satisfactory reasonings of Dr. Adam Smith, and other modern economists. In general, he reasons very justly on the state of the manufactures at the time, and gives many hints for their extension and improvement, some of which appear to be very judicious, and others have been proved, by experience, to be fallacious. He admits, that the industry of the inhabitants, properly directed and exerted, is the solid and efficient cause which produces national wealth and prosperity; and strenuously contends, that a fair and liberal commercial intercourse between nations, which produce commodities desirable to each other, must be more advantageous to both, than the vain attempt to monopolize the manufacture of every article, used for internal consumption, to the exclusion or supersession of all foreign traffic. Upon this principle, which seems perfectly just, he censures a number of injudicious experiments, which had been made to establish manufactures of silk, woollen, gloves, earthen ware, and many other articles, by subscriptions, resolutions against using articles manufactured out of Scotland, bounties, and other expedients of a similar nature. He alleges that the capital lost in these speculations, all of which proved abortive, would have been, if judiciously applied, more than sufficient to establish and promote a staple manufacture, congenial to the situation of the country and habits of the people, and sufficiently extensive to exchange for other articles, better and more cheaply manufactured in other countries. This staple he assumes to be flax, but seems to admit that the climate and soil of Scotland, are not the most favourable for its culture, and that the management, in every stage of the process, was much inferior to that of the Dutch and Flemish artizans. To remedy the first, he proposes, that bounties shall be given for raising flax in the American colonies, which have since been severed from this country, most probably for ever. For the next, he wishes, that foreign artists should be invited, by premiums, to settle in this country, for the purpose of instructing the inhabitants. He then proposes his plans for inciting the people to industry, the prevention of theft and begging, and encouragement of manufactures.

The machinery, by which he means to effect these objects, seems very complicated. Indeed, it appears singular, that a person who had seen so clearly the inefficiency of the projects which he reprobates, should immediately propose regulations nearly similar, for the improvement of what he considers the staple manufacture. He conceives the erection of work-houses in every parish, the compulsory confinement of all idle persons in these places, and the flogging them until they become good and industrious weavers, to be expedients admirably calculated to promote industry and emulation. He also proposes the establishment of hospitals for the reception of orphan and destitute children, where, at a proper age, they may be taught to weave and spin. He considers the only way of saving the weavers from idleness and other vices, into which young and unexperienced persons are apt to fall, will be to confine them to the hospital, until they arrive at twenty-five years of age, when, he says, they may enter the world without danger.

He considers that the manufacture might be greatly promoted by Acts of Parliament, requiring *at least* seven years apprenticeship before any person should be allowed to weave upon his own account; security found by him for his performance of every piece of work in the best manner; the trade made liable to the constant inspection of overseers; these overseers amenable to the magistrates of the royal boroughs, and justices of the peace; and those magistrates directed to enforce, *with the utmost rigour*, severe penalties for every defect in the cloth, or malversation in the weaver. In short, the trade is to be thrown entirely under the controul of justices and magistrates, and the whole funds for his hospitals and bridewells, raised by collections at church doors, and voluntary contributions.

The work appeared soon after the formation of the Board of Trustees for Manufactures and Fisheries, and the author appears, either to have been a member of that board at the time, or, at least, to have had access to all their minutes. As I have only met with a single copy of the book, and, therefore, suppose that it cannot be generally known, and as the preface contains an account of the prevalent opinions, respecting the state of manufactures and trade in Scotland at that period, and of the means by which their improvement was expected, I shall insert it entire.

'THE PREFACE.

'Many and just Complaints have been made of our 'Poverty, and the Decay of our Trade; and of the 'Decrease of our People for want of Business to imploy 'and subsist them. This is imputed, and justly, to the 'great Use of foreign Manufactures for wearing Apparel, 'Furniture, &c. whereby the poor of other Countries 'are partly imployed at our Expence. The manufactured 'Goods we export bear no Proportion in Value to those 'we bring in; we must therefore send out our Product 'to purchase Clothing for the Rich, while the Poor must 'either starve at home, or go abroad to seek their Bread, 'where it is to be earned by Labour and Industry.

'Many Schemes have been framed to cure these Evils, 'but in vain. Numbers of Gentlemen have, at different 'Times, entred into Resolutions, to use no foreign 'Manufactures: But these could have no Effect, because 'we had no Manufactures of our own to serve them; 'nor indeed can any Nation, where the Poor are imployed 'in Manufacture, serve itself with every Thing. It is 'enough to have one Staple which sells to Advantage in 'foreign Parts, and to be capable to export it in such 'Quantities, as may be equal in Value to all the foreign 'Goods we consume at home. An Attempt of this 'Kind would be to hurt and ruine our Staple. Where 'too many Irons are in the Fire at once, some of them 'must cool, and where the Staple-manufacture of a 'Country is neglected, and no other Branches of Business 'brought to Perfection, the whole will run a Risk of 'being lost; for Mankind, generally speaking, prefer 'their own private Interest to that of the Publick, and 'will hardly be prevailed on to buy the Manufactures of 'their own Country, if foreign Goods of the same Kind, 'and of the same, or of a better Quality, are to be pur-'chased at a lower Rate. Every one buys where he 'finds his Commodity best and cheapest; and unless 'our own Manufactures are as good of their Kinds, and 'as low in their Prices as the same Goods of other 'Nations are, they will not sell either abroad or at home. 'Trade cannot be forced, but Manufacture may be 'improven.

'Linen Cloth is our Staple-commodity, and a Manu-'facture we have been possest of now Time out of 'Mind: It is carried on by private Hands, the only Way 'in which a Manufacture can thrive or prosper; it is a 'Commodity of universal Use at home, and of great 'Demand at those Markets abroad, where we purchase 'foreign Goods of divers Kinds, which we neither can 'want, nor can we make them our selves without Loss; 'it is a Manufacture capable of employing all our spare 'Hands, and, was it fully improven and extended, it would 'be sufficient to answer our all Demands for foreign 'Commodities. But it has been miserably neglected and 'discouraged; it has suffered from many Causes, and 'from none more, than the indiscreet and fruitless 'Attempts that have been made to introduce other 'Manufactures, which are already brought to Perfection, 'and carried on with all possible Advantages by other 'Nations, and by these inconsiderate Resolutions to 'furnish our selves with every Thing, without the Aid 'of foreign Trade.

'Had all the Money that has been sunk and lost by 'publick and private Companies, and private Persons, 'upon these Projects, been imployed in the Improvement 'and Extension of the Linen Trade, those Evils we have 'so long complained of, had been long ere now cured 'and prevented; but our Thoughts were, from Time to 'Time, turned upon new Projects, which we pusht up 'Hill with great Eagerness, until they became too heavy 'for us, while our Linen Trade, which we could have 'carried on with Profit and Success, was intirely neglected. 'Ever since the Beginning of the Confusions in the Reign 'of King *Charles* I. it has been upon the Decay, and our 'Manufactures of Silk Goods, fine broad Cloths, and 'several others of less Moment, which were introduced 'at a great Expence, and too long carried on with Loss 'to the Nation, have nevertheless, in a great Measure, 'totally failed. We have been long sensible of this, and 'the present Generation saw the Linen-manufacture 'reduced to a very low Ebb, but saw an evident Possi-'bility of retrieving it, if we bent all our Thoughts that 'Way. This was our Condition when the Royal 'Boroughs, who are the Guardians of our Trade, took 'under their serious Consideration the State of our 'Trade and Manufactures in their general annual Con-'vention held at *Edinburgh* in *July*, in the Year 1725.

‘ and in several subsequent Meetings, of their grand ‘ annual Committee in that Year.

‘ The Society for the Improvement of Agriculture, ‘ and several private Persons, who understood Trade and ‘ Manufactures of different Sorts, gave in Proposals and ‘ Schemes, for the retrieving our Manufactures and ‘ Fisheries, to these Meetings; and Committees of that ‘ Society, and other Gentlemen, from several Parts of ‘ the Country, likewise attended and assisted at these ‘ Meetings: The Result of all which, was, that in their ‘ Meeting the Seventeenth of *February* $172\frac{5}{6}$ they unani- ‘ mously resolved to address his Majesty, and to make a ‘ proper Application, by their Representatives in Parlia- ‘ ment, and other Persons of Distinction then at *London*, ‘ who were capable to serve their Country, to have the ‘ Monies (settled by Law for the encouraging of our ‘ Manufactures) effectually applied for that Purpose, in ‘ such a Manner, as that all Misapplication of them ‘ might be absolutely prevented; and the Royal Boroughs ‘ appointed one of their Number to repair to *London*, at ‘ their Expence, to make this Application effectual.

‘ The effect of this was, that his late Majesty was ‘ graciously pleased to write the following Letter to the ‘ Royal Boroughs, which was presented to the Convention ‘ by his Majesty's Advocate, one of their Number, upon ‘ the Sixth of *July* 1726.

Superscribed *George R.*

“ Trusty and well beloved, We greet you well. We “ having observed, that the several Sums of Money “ reserved and provided by the Treaty of Union, and by “ divers Acts of Parliament, to be imployed for the “ Improvement of Fisheries and Manufactures in *Scotland*,

" have not hitherto been applied to the Uses for which " they were intended principally, because no particular " Plan or Method hath been concerted, directing the " Manner in which those Sums should be applied for the " said Purposes. And being desirous to remove that " Hindrance, as speedily as may be, We have thought " good to recommend it to you, that, at your first general " Meeting in the Month of *July* next, you do take into " your Consideration the State of the said Fisheries and " Manufactures, and of the Monies provided for encour-" aging the same, and that, by yourselves, or by Com-" mittees of your Number, you do devise and propose " the particular Methods, Rules and Regulations, which " to you shall seem the most proper, for the Application " of the said Sums towards the encouraging and pro-" moting Fisheries, and such other Manufactures and " Improvements in *Scotland*, as shall most conduce to the " general Good of the united Kingdom; and that you " do return to Us the Propositions in which you shall " have agreed, to the end, that, upon due Consideration " thereof, a certain Method may be settled for the Appli-" cation and Management of those Sums for the future. " The Welfare of our loving People of *Scotland*, and the " Prosperity of the Royal Boroughs, is so much concerned " in what We recommend to you, that We doubt not " you will go on in the Execution of what is expected " from you, with the utmost Diligence, Unanimity, and " Impartiality: And, on Our Part, We assure you of Our " Countenance and Encouragement in what you shall " propose for the real Good of your Country, consistent " with the general Interest of Our united Kingdom. " And so We bid you heartily farewel. Given at our " Court of *Kensington* the seventh Day of *June* 1726. in

" the twelfth Year of Our Reign. Counter-signed by " his Majesty's Command. *Holles Newcastle.*"

' The same Day that this Letter was read, the Convention prepared and agreed upon an Answer, wherein ' they exprest their great Joy and Gratitude to his Majesty, ' for his tender Concern for the Welfare of this Country, ' and for that particular Instance of his great Goodness ' towards them, which must fill the Hearts of all his ' loyal Subjects in this Part of *Britain*, and promised, ' with great Cheerfulness, to prepare without Loss of ' Time, by themselves and Committees of their Number, ' Propositions to be laid before his Majesty, for answering ' the Ends of his Majesty's most gracious Intentions.

" Upon the Eighth of *July* a large Committee was " appointed to consider and devise such Methods as might " most effectually answer his Majesty's most gracious " Intention of encouraging the Trade of Fishing, and " other Manufactures of this Part of the united Kingdom, " and impowered them to receive Proposals relative " thereto, from any particular Royal Borough, or any " other Society, or private Persons, *&c.*"

" On the Twelfth of *July* particular Instructions were " drawn up for this Committee, who were to sit after " the rising of the Convention, and were appointed to " have their Plan in readiness to be laid before the next " Convention, which was then appointed to meet at " *Edinburgh* upon the first *Wednesday* of *November* following. This Committee was directed to take the " Advice and Assistance of, and to consult with all " Persons who had Skill and Experience, in any of the " Branches of Trade or Manufacture that might be propos'd to be improven, and were specially directed in " their Plan to propose a Method for the Application of

" the whole Monies that might annually arise for the " Purposes intended by his Majesty, in such Manner, " as the Distribution might be diffusive, and secured " effectually against Misapplication; and, as it might not " be charged with the ordinary Expence of Management, " it being the Intention of the Convention, from their " earnest Desire to promote the publick Good, and " thereby, to the utmost of their Power, to second his " Majesty's gracious Intentions, voluntarily to propose, " that they should defray the ordinary expence of Man- " agement."

'This Committee met very often to receive in, and ' consider Proposals that were sent them from different ' Places of the Country, upon the Subject-matters com- ' mitted to them, and, at all those Meetings, several ' Gentlemen, skilled in Trade and Manufactures, who ' were not Members, assisted; and upon the Eighth of ' *November* 1726. they presented to the general Convention ' a particular Plan for the Distribution and Application ' of the several Funds destined by Law for the Improve- ' ment of Fisheries and Manufactures, to be laid before ' his Majesty, which, after due Consideration, and some ' Amendments made, was approven of by the Conven- ' tion. The Sum of this Plan is ingrost in his present ' Majesty's Letters Patents, bearing Date at St. *James's* ' *July* 5. and passed the Seals *July* 18. 1727. which are ' printed.

'The Convention, at the same Time, appointed their ' annual Committee to prepare the Heads of an Act of ' Parliament for regulating the Linen-manufacture; and ' the annual Committee did, the same Day, pursuant to ' the Powers and Instructions given them by the Con- ' vention, take under their Consideration, " That the

" future Happiness and Welfare of their Country, very " much depended on the Success of their Proposals, and " that it was their Duty to do every Thing in their " Power to make the same effectual, and did authorize " and impower one of their Number to repair to *London* " upon their Expence, and there, in Name and Behalf of " the Royal Boroughs, to lay before his Majesty, in " obedience to his most gracious Letter, the general and " particular Plans agreed upon by the Convention, for " promoting the Fisheries and other Manufactures of " this Part of the united Kingdom, and Distribution of " the Funds to the particular Purposes therein mentioned, " and to endeavour to obtain such Acts of Parliament as " might be most effectual for promoting, encouraging, " and regulating the Linen-trade, agreeable to the Heads " then approven by the said Committee." All which ' are contained in the said Act of Parliament itself, which ' was past that same Session of Parliament; and this ' Act was printed by itself, and several Thousand Copies ' of it were dispersed.

' In consequence of this Application from the Royal ' Boroughs, another Act of Parliament was past that ' same Session, directing the Appropriation of all the ' Funds formerly provided by Parliament (which till ' then had never been applied) to the several Purposes ' for which they were designed. These Funds are ' severally enumerated in the Act itself, and are particu- ' larly resumed in his Majesty's Letters Patents, wherein, ' pursuant to the Powers vested in the Crown by the said ' Act, the several Uses and Purposes to which they are ' to be applied, are specially directed, and, agreeable to ' the Act, Twenty-one Commissioners and Trustees are ' therein named and appointed, and the several Matters

‘ committed to their Trust, are therein likewise specially ‘ directed: And I shall here beg Leave to refer the ‘ Reader, for his better Information, to the Patent itself, ‘ which was printed by Order of the Trustees.

‘ These Commissioners and Trustees, pursuant to the ‘ Directions of the Charter, held their first Meeting in ‘ the Borough Room at *Edinburgh* upon the Twentieth of ‘ *July* 1727. and then proceeded to lay down proper Rules ‘ and Methods for their own Procedure, and directed Books ‘ to be prepared for that Purpose. In concert with the ‘ Royal Boroughs they made Choice of a well-qualified ‘ Gentleman to be their Secretary, whose Conduct ever ‘ since has very much justified their Choice. His Suffi-‘ ciency, Diligence, Accuracy and Exactness, and singular ‘ Fidelity in the Discharge of this great Trust committed ‘ to him, have given universal Satisfaction.

‘ The Trustees, in obedience to the Directions given ‘ them by their Charter, applied themseves directly to the ‘ first Part of their Work, *namely*, to prepare and form ‘ a particular Plan of Distribution of the Funds, upon ‘ the several Conditions therein specially set forth. This ‘ Plan was finished, printed, and publish’d the seventeenth ‘ of *November* 1727. to which I also beg Leave to refer ‘ the Reader for a full Information.

‘ The Rules and Regulations, appointed, by the Act of ‘ Parliament, to be observed in the Linen-manufacture, ‘ took Place the First of *November* in the same Year 1727. ‘ Since this Period, we have happily turned our Eyes ‘ upon the Improvement of our Manufactures, which is ‘ now a common Subject in Discourse, and this contributes ‘ not a little to its Success. People thereby pick up ‘ Knowledge and Information, by Degrees, of our Faults ‘ and Defects in the Management of our Manufactures, ‘ and of the proper Ways to cure and amend them.

'The Trustees bestow their Time and Attendance 'upon the Service of the Publick without Fee or Reward. 'And I observe, from their Minutes, that their Meetings 'are regular and frequent. It appears almost from every '*Sederunt*, that their Service is of great Use and Import-'ance to the Country, and contributes greatly to advance 'the Improvement and Extension of our Fisheries and 'Manufactures of every Kind. Many missive Letters, 'for the Solution of Doubts and Questions, Petitions 'and Applications for Encouragements of various Kinds, 'upon different Branches, *&c.* Memorials and Complaints 'of Abuses, Defects, slovenly and unprofitable Practices 'in the Management of many Parts of the Manufacture, 'and Proposals of Improvements, and of the most frugal 'and expeditious Methods of carrying on several Branches 'to the best Advantage, are frequently sent to the Secre-'tary from every Corner of the Country. And I observe, 'from their Minutes, that all these are always duly 'weighed and considered by the Trustees, and Satisfac-'tion, by regular Answers, given to the Persons who 'send them. The good Effects of a Correspondence of 'this Kind are obvious.

'I might here enter into a particular Detail of the 'whole Proceedings of the Trustees, from the Com-'mencement of their Trust, to this Time, were it not 'that such an Account would swell this Preface to a 'greater Length than the Discourse itself; and that their 'whole Conduct, in the Distribution and Application of 'the Funds, under their Care, in each Year, is summed 'up in their annual Report to the King; and that, pursuant 'to the Directions of his Majesty's Charter, a Duplicate 'or true Copy of this Report is annually given in, within 'thirty Days after *Christmas*, to the annual Committee of 'the Royal Boroughs, and is by them laid before the 'general Convention in *July* thereafter, where it lies upon 'the Table during the Sitting of the Convention, to be 'perused by all the Members; and that these Reports are 'all in the Hands of the Clerks to the Royal Boroughs, 'where any Person may have Access to see them; any 'Person may likewise have Access to the Minutes of 'Procedure of the Trustees, at any Time, in the Hands 'of their Secretary.

'Persons of all Ranks express, on many Occasions, a 'generous Concern for the publick Good, and an honest 'Curiosity to be particularly informed of the State and 'Progress of our Manufactures, since they have become 'the Objects of the Care and Concern of the Publick; 'what Effects the Observations of the Regulations of 'the Linen Act of Parliament have had upon the Im'provement of Linen Cloth in its Quality; what new 'Branches of that Trade formerly unknown to us, have 'been introduced at the publick Charge: How far these 'are already improven; and what other Parts are still to 'be introduced, improven and extended, and how far 'the Application of the publick Funds, destined by Law 'for the Encouragement of our Fisheries and Manufac'tures, have already contributed towards these Ends.

'Many are desirous, and have been long expecting to 'see something publisht upon this Head; and the Author 'observing that nothing of that Kind hath hitherto 'appeared, he lately resolved, notwithstanding of the 'just Sense he has of his own Unfitness for the Perform'ance, to bestow as much Time (as his necessary Attend'ance upon his own private Affairs would allow him) to 'reduce his Observations on this Subject, in which he 'has been pretty much conversant, to Writing, to the end 'that others of better Skill, and more Knowledge in these 'Matters, may be excited to Publish something of the 'same Kind to better Purpose. And now, that nothing 'of this Sort appears from any other Hand, he has 'adventured to send it abroad, such as it is, and submits 'it to every Reader, who, he hopes, will consider it with 'the same View he had in it, namely, to create a Spirit 'of Industry and Diligence in the People, to promote 'the Improvement and Extension of our Manufactures, 'at least of such of them as are, or may be carried on 'with the greatest Profit, upon which the Happiness 'and Prosperity of this Country depends.

'In the first Part, he takes Notice of Idleness, and the 'bad Effects of it, as it hurts Individuals, and as it affects 'the whole Body of the People nationally; and proposes 'a few Rules of Police, for suppressing of Theft and 'Begging, and imploying of the Poor in Work-houses. 'He then speaks of the Causes of the Non-improvement 'of our Grounds, and of the great Advantages of 'Agriculture; and proposes the same Method for the 'Improvement of our Lands, by which the Estates of '*England* were at first improven.

'In the second Part, he treats of Industry as the 'Source of national Wealth and Power, and of the 'common Motives to Industry; of Trade and Manufactures 'in general, of our Trade in particular, and of the Staple-'manufactures of *England*, and of this Country; of the 'Causes of the Neglect and Non-improvement of our 'Staple; of such Branches of Manufacture as are now 'carried on with Loss; of several Trades that now are, 'and are liable to be overstockt, and proposes some 'Methods to prevent this; of the Improvement and 'Extension of our Staple, as the only Way to imploy 'all our spare Hands of every Condition; of the Plantation Trade, and the great Benefit of these Settlements 'in *America* to their Mother Country, especially if they 'were duly encouraged to raise Materials for Home-'manufactures; of the Necessity of the Improvement 'and Extension of the Manufacture of home-made 'Linen Cloth in *Scotland*, *England* and *Ireland*.

'In the third Part, he gives a particular Account of 'the State and Condition of the Linen-manufacture of 'this Country, as it is at this Time, and of its Progress 'since the First of *November* 1727. Upon Perusal of 'this Part since it was printed, he observes something, he 'intended to have spoke of, omitted, *namely*, a bad 'Practice in the Sale of Linen Yarn, of false and short 'Tale notwithstanding of the Directions of the Act of 'Parliament to the contrary.

'This is said to be owing to the Use of Hand-reels, a 'Method of making up Yarn so uncertain and precarious, 'that no Persons who use them, can possibly be exact in 'their Numbers of Threads. No Buyer can pretend to 'tell the Threads of every Cut of Yarn he buys, much 'less can the Stamp-master controul the Tale of all the 'Yarn that is presented to Sale in a Fair or Market; and 'as Yarn can be subjected to no Stamp or other certain 'Check, if the Buyer discover not the Fraud until he 'come to sort his Yarn for Use, it will then be too late 'for him to recur upon the Seller.

'The most probable Way to cure and prevent this 'Evil, is to introduce the Practice of Check-reels every 'where, and if the Funds appropriated for encouraging 'the Linen-trade might allow it, it is propos'd that the 'Trustees, for the more speedy furnishing of the Country 'with Check-reels, might give annually a certain Number, 'by Way of Prizes upon Spinning, in the same Way 'that spinning Wheels are propos'd to be given at the 'small spinning Schools: And when any Alteration or 'Amendment of the Linen Act of Parliament is propos'd, 'the Use of Hand-reels may be discharg'd, and every 'false Tale of Yarn subjected to a severe Penalty, because 'every Mistake in a Check-reel must be made with a 'fraudulent Intention to deceive the Buyer.

'Another Practice discharg'd by Law, still prevails in 'several Places in the North, that proves a Loss to the 'Spinners, which is the Use of the eleven-quarter Reel, 'altho' the Act directs that all Yarn shall be made up by 'the ten-quarter Reel, being two Yards and an Half, or 'ninety Inches in Circumference, and that all Reels, 'wherever found, other than 2½ Yards, or 90 Inches in 'Circumference, shall, at the Sight of the proper Officer, 'be destroyed, and all Yarn otherwise made up shall be 'confiscated. All Stamp-masters ought therefore to be 'strictly enjoined to make diligent Search for all such 'illegal Reels, and to seize all Yarn otherwise made up 'than as the Law directs.

'The Use of Weights and Scales is the only sure 'Way to prove Yarn, both as to its Quantity and Fine-'ness; every good Weaver uses this Method in making 'up a Parcel of Yarn for every Piece of Cloth, because 'he discovers, to a Certainty, if all the Yarn intended to 'be used in the same Piece, is precisely of the same 'Fineness; for two equal Quantities, or Cuts of Yarn, 'containing the same Number of Threads each, and each 'Thread of the same Length, if they differ in Weight, 'must also differ in Fineness. This Practice would 'likewise be of great Use to the Dealers in Yarn; they 'have no more to do than to tell one Cut, and to prove 'all the rest by Weight with it, and every Cut that differs 'in Weight, must likewise differ either in Fineness, or in 'Tale and Quantity.

'The Parliament of *Ireland* give great Funds for the 'Improvement of their Linen-manufacture, no Defect is 'sooner discovered, that can be supplied by Encourage-'ment, than it is done. The Trustees in *Ireland* gave, 'at one Time, 10000 Check-reels, which were all made, 'and sent and distributed to the Spinners in different 'Places of the Country, at the publick Charge; they also 'at several Times have made great Numbers of good 'Looms, completely mounted, of the best Kind, and give 'them *gratis* to the best Weavers. They are likewise 'careful to remove, by publick Laws, every Thing that 'has the least Appearance of a Discouragement to the 'Linen-trade. They, by Act of Parliament, exempted 'Linen Cloth of every Kind from the Payment of all 'petty Customs, or small Duties that were in Use to be 'paid upon it at weekly Markets and Country Fairs.

'This Act well deserves our Consideration, to put our 'Linen-trade upon the same Footing of Freedom and 'Immunity with that of *Ireland*. Those petty Duties 'are a Part of the Revenue of those Boroughs and 'Towns, where Linen Cloth and Linen Yarn are sold at 'weekly Markets and Fairs; and a very small Part of 'the Revenue they are; for the collecting of them costs 'very near as much as they yield. The Manner of 'raising those small Customs occasions frequent Com-'plaints and Disputes between the Dealers and Collectors, 'which hurt the Dealers, in their Imagination, and the 'Communities themselves in Reality: For when the 'Dealers take Offence, they often fall on Ways to dispose 'of their Goods, without bringing them to Market; and 'this so far diminishes the Trade, and the Consumption 'of Provisions in those Towns where the Markets and 'Fairs are held.

'The Town-council of *Dundee* had this Matter under 'their Consideration some Years ago, and very wisely 'they remitted the Duties that used to be paid on Linen 'Cloth. They struck this small Branch of their Revenue 'out of their Rent-roll, and exempted Linen Goods of 'every Kind from the Payment of Custom of every 'Kind. The Effect of this was, that numbers of Country 'Weavers, who used to carry their Cloth for Sale to the 'Towns that ly nearest them, where the same Duties are 'still levied, do now bring their Cloth to *Dundee*, altho' 'it lyes at a much greater Distance from them.

'I must humbly beg Leave to submit this, with the 'other Matters proposed in the following Discourse, to 'the Consideration of the Royal Boroughs in their next 'general Convention, to be held in *July* 1734. They 'are the Guardians of Trade and Manufacture, and the 'chief Gainers and Losers by both: And when this 'Matter is duly weighed, they will, no doubt, prefer 'their real Interest, (which obviously depends upon the 'Improvement and Extension of our Staple-manufacture) 'to this imaginary Branch of a Trifle of Revenue, scarce 'worth collecting, and prepare a proper Application to 'Parliament for exempting Linen Goods of every Kind 'from the Payment of all Duties and petty Customs 'whatever, either at weekly Markets, or in Country 'Fairs.

'The Parliament of *Ireland* did likewise (for the En-'couragement of Weavers) by a public Law, allow any 'Weaver to set up and carry on his Trade in any Town 'or Incorporation in the Kingdom wherever he pleased, 'notwithstanding any Monopolies or seclusive Privileges 'that had been formerly granted in favours of any Company or Corporation of Weavers. The Weavers in this 'City are indeed exceedingly easy upon this Head, they 'are in Use to admit any good Tradesman to the Freedom 'of their Incorporation, upon Terms that are easy and 'reasonable: But if any Foreigner or Stranger, who is a 'good Weaver, inclined to set up his Trade in any Town 'or Burgh, without being a Freeman or a Member of 'the Incorporation; it would prove a very great Encouragement to the Linen-manufacture, if they were allowed 'to work and carry on their Trade, where they imagined 'they could do it to the best Advantage, upon this single 'Condition on their Part, *Residence*, and weaving of good 'Cloth as the Law directs: And if all Weavers were 'likewise exeemed from all publick Burdens, and Parish-offices, it would be the better, and contribute much to 'increase their Number.

'It is observed, that any diligent young Lad, of an 'ordinary Genius, who applies himself close to his 'Business, can work and finish a Piece of Cloth very 'well under the Direction of a good Master, when he 'has been but two Years at the Trade: But it is found 'from Experience, that no man ought to be intrusted to 'sort and size a Parcel of Yarn, to warp, put in the 'Loom, weave and finish a Piece of Cloth by himself, 'before he has wrought constantly six or seven Years at 'least, under the Eye of a skilful Master. It is therefore 'proposed, when any Amendment is made to the Linen 'Act, that there ought to be a Clause in it to this 'Purpose, to restrain any Weaver from setting up as a 'Master, until he has wrought constantly under a good 'Master or Masters for the Space of seven Years, and 'then to be allowed to practise their Trade as Masters 'wherever they please, upon finding Bail, as the Law 'directs, to conform themselves to the Observation of 'all the Rules and Regulations contained in the Linen 'Act of Parliament.

'In the fourth and last Part of this Discourse, the 'Author takes notice of the Advantages of our Situation 'in an Island, that our Security depends chiefly upon our 'naval Force, and that our Navigation depends chiefly 'upon our Fisheries, which ought therefore with great 'Care to be encouraged. He speaks of several Discour-'agements and Hardships, that several Branches of our 'Fisheries labour under at present, and proposes some 'Methods for relieving them, and of several probable 'Ways for improving and extending our Fishing-trade in 'every Branch, by proper Encouragement.

'Throughout the whole of this Discourse, the Author 'has spoke his Mind, with Freedom, of our Abuses, bad 'Habits, and unfrugal Practices of our Tradesmen and 'Dealers of different Kinds, as they occurred to him; 'and in this, he hopes, he has given no Offence, as, it is 'apparent from his Manner of writing, he intended none. 'It is a Privilege peculiar to the Subjects of free States, 'to speak or write what they think, and to publish what 'they write, so long as they observe the Rules of Decency, 'and express that Regard and Respect for Dignities, and 'Persons of high Rank, and in high Offices, that the 'Nature, Peace, and good Order of every civil Society 'requires.

'The Liberty or Servitude of a Nation, appears as 'much from their Writings, as from any other Part of 'their Conduct in Life. Free States are liable to be 'disturbed by Faction, and Party-struggles for publick

'Imployments: And their Writers, especially of History 'and Biography, discover a Biass for that Side to which 'they are attach'd; but both Parties speak out their Sen-'timents with great Boldness and Freedom. Indecent 'Liberties are often taken with Men in Power, and even 'these are sometimes of Use; they serve to check and 'controul the Conduct of great Men, to put them on 'their Guard to confine themselves, in all their Actions, 'within the Bounds prescribed by Law, which is their 'greatest Security. The Conduct of Princes, Ministers, 'and other great Men, is, in free States, variously repre-'sented, as the several Writers affect; but, by comparing 'the Accounts of both Sides, the Truth is easily discerned.

'Whereas, under arbitrary Governments, their Writ-'ings are stuft with Panegyrick and fulsome Flattery: 'Every Man in Power is a great and a good Man, at least 'so long as his Power remains with him; and the worst 'and weakest of Princes are dubb'd with the Characters 'of the best and greatest, so long as they live. The same 'Characters are given to a *Julius Cesar*, or an *Oliver Crom-'wel*, (who betrayed their Country, and trampled upon 'Law and Liberty) that properly belong to a *George Castriot*, 'a *William Wallace*, or a Prince of Orange, who spent their 'Lives in the Defence of Law and Liberty, and devoted 'themselves to the Service of their Country, to rescue the 'People from Servitude and the Bondage of a foreign 'Yoke.

'When an enslaved Nation have the rare Happiness 'to be blest with the Reign of a *Titus* or a *Trajan*, then, 'and not till then, the Truth and true Characters of 'former Tyrants come out: Then the Spirit of Liberty 'revives, and Truth is allowed to walk abroad in Day-'light, during the short Season of such a Sun-shine.

'This is apparent from the Writings of *Tacitus*, where 'the justest Sentiments of Liberty, and the strongest Dis- 'position to assert it, appears almost in every Page: But 'so strong an Impression do the Restraints of Tyrants 'make upon the Minds of Men, that *Tacitus* appears, on 'many Occasions, to be under a Kind of Awe and Dread 'of going too far: So terrible is uncontroulable Power, 'even in the Hands of the best of Princes.

'The Author submits his Observations, upon the sev- 'eral Subjects he treats of, to the Examination and Judg- 'ment of every candid and impartial Reader; and hopes, 'those who discover any Errors, Mistakes, Defects, or 'Omissions, will publish their Remarks with the same 'Intention that he has done, *for the Benefit of the Publick*: 'Or if they incline not to put themselves to that Trouble, 'if they transmit them to Mr. *Flint*, Secretary to the 'Trustees, where the Author may have Access to see 'them, they may be published by Way of an Appendix 'or Supplement to this Discourse; or if another Edition 'shall be wanted, by Way of Notes, in the proper Places 'to which they refer.'

In a subsequent part of the work, the author gives, in a note, the quantities of linens, stamped during the first five years after the passing of the Linen Act, which I shall also copy.

'The Linen Act of Parliament commenced the first '*November* 1727. There was stamped for Sale the first 'Year preceeding first *November* 1728. in the West, and 'Countries on the Southside of the River of *Tay*.

	Yards.	Value.		
	1,047,254¼	*L*.66850	10	04
'In the Countries 'Be-north *Tay*,	1,136,723¼	*L*.36461	18	11
'Total Quantity,	2,183,978	*L*.103312	09	08

'Second Year preceeding first *November* 1729.

'South, - - - -	1,213,013½	*L.*59815	14	09
'North, - - - -	2,012,142¼	54568	04	11⅛
'Total, - - - -	3,225,155¾	*L.*114383	19	08½
'Increas'd 1729.	1,041,177¾	11071	10	00

'Third Year preceeding first *November* 1730.

'South, - - - -	1,537,011¼	*L.*68777	00	09¼
'North, - - - -	2,218,651	62485	15	02½
'Total, - - - -	3,755,622¼	*L.*131262	15	11¾
'Increase, - -	530,506¼	16878	16	03¼

'Fourth Year preceeding first *November* 1731.

'South, - - - -	1,621,679¾	*L.*79477	18	04¾
'North, - - - -	2,269,93¼	66178	15	10¼
'Total, - - - -	3,891,573	*L.*145656	14	03
'Increase, - - - -	135,910¾	14393	18	03¼

'Fifth Year preceeding first *November* 1732.

'South, - - - -	1,751,038¼	*L.*86566	17	07
'North, - - - -	2,633,794¼	81955	17	03¼
'Total, - - - -	4,384,832¼	*L.*168322	14	10¾
'Increase, - - - -	493,259¼	22666	00	07¾

'This is besides Cloth made for private Use, of which 'large Quantities of high pric'd Cloth for Shirting have 'been lately made since the Commencement of this Act. 'The Values are taken up by the Stamp-masters at the 'lowest Estimate.

'Increased in five Years, in consequence of the 'Execution of this Act of Parliament, and the small 'Encouragements in Quantity, - - 2,200,854¼ Yards,

'In Value, - - - - - - - *L.*65,010 5 2

In the year 1784, the quantity was 19,138,593 yards, valued at *L*.932,617 : 1 : 11½; so that, from the year 1732, until 1784, the increase of yards was 14,753,761¾, and of value *L*.764,294 : 7 : 6¾.

The author, it will be observed, ascribes the promotion of the linen manufacture and its extension, during the years which he quotes, to the salutary effects of the Linen Act, and this encourages him to offer many proposals of restriction and encouragement, some of which have been enumerated. But the unprecedently rapid improvement of the manufacture of cotton, which was then hardly known, and which was not prosecuted to any extent until many years afterwards; with which the legislature have scarcely, if at all, interfered; which has neither been cherished by bounties, nor fettered by statutory restrictions, affords sufficient grounds *to doubt at least* the truth of his hypotheses, and to trace the extension of manufactures to very different causes.

It is a very trite observation, that mankind will always purchase where they are cheapest and best served, but its truth cannot be disputed, and it applies forcibly in the present case. The invention of the art of spinning cotton by machinery, which originated in England, and which, whether invented or not, was brought into practice by the late Sir Richard Arkwright; and the many subsequent improvements which have been made in that art, are, unquestionably, the primary and consequent causes of the almost incredible extension of the cotton manufacture. The first web, entirely of cotton, which was woven in Scotland, was manufactured by Mr. James Monteith of Anderston, near Glasgow, about the year 1773. Both the warp and woof of this web were spun in this country by women, upon the common small wheel.

The introduction of cotton warps in Lancashire was not much earlier, for the first calicoes were made in 1772. Little, however, was done in weaving goods wholly of cotton, until the water, or engine twist, was generally introduced about 1780. Some water twist was indeed brought to Scotland for sale, so early as 1776, but it did not begin to be generally used for warps until some years afterwards. From that period, the manufacture began gradually to extend, and the invention of the *mule jenny*, which came generally into use a few years afterwards, enabled the spinners to produce warps fitted for much finer muslins, than any which had been spun upon the water frames. The manufacture now extended with astonishing rapidity, and the application of power to drive the mules, together with many other improvements, both in the machinery and economy of cotton mills, whilst they daily ameliorated the quality of the yarn, rapidly reduced the prime cost of it to the spinner. This, again, very soon produced a competition, which by generally supplying, and frequently overstocking the market, reduced the price to the manufacturer; and the same competition naturally arising among manufacturers, the prices, as will ever be the case under similar circumstances, were lowered to dealers, and, consequently, to consumers. The want of stamp-masters, bounties, penalties, &c. have never been felt in the cotton trade; and, consequently, it is fair to presume, that whatever extension has taken place in the linen, was not occasioned by the operation of these expedients.

Some frauds, indeed, must have been practised, where goods could not be sufficiently examined by the purchaser, and to these the cotton is equally exposed as the linen yarn, for it is equally impossible, in either case, to count or examine every thread. But these have always been found to cure themselves, without the necessity of legal interference, by the loss of character, and consequent difficulty of sale which they occasioned. The same consequence has always resulted after the yarn has been manufactured into cloth; for the price has, in general, borne a pretty fair proportion to the quality, when the goods were of a similar description, and equally in demand at the particular market. It is, however, fair to admit that some restrictions, for the prevention of frauds, might have been necessary, when the inhabitants of a country were little acquainted with the principles of trade; but these restrictions become totally useless, and often vexatious, at a more advanced period.

At the present advanced stage of the cotton manufacture, a good spinner, with the assistance of three children, can work two power-mules of 300 spindles each, and from every spindle of these two machines, can produce, of an average fineness, say No. 72, 12 hanks of 840 yards each, weekly, making in all 7200 hanks, or six millions and forty-eight thousand yards, when the mules are well constructed, and the stuff good, and well prepared. What the reduction of labour is between this and the old practices of spinning by the distaff or common wheel, it is not easy to ascertain, for to the labour of the spinner, is to be added that proportion of the labour of all those, employed in the preparatory processes, which are necessary to supply him with materials. Besides the number quoted, 72, although now esteemed rather coarse than fine, is very much finer than any thing ever spun in this country in the old way. I have heard the reduction of labour estimated at the proportion of 200 to 1, but I should suppose it much more.

The position of Dr. Smith, that " It is the natural effect of improvement to diminish gradually the real price of almost all manufactures," was never, perhaps, more strikingly exemplified, than in this manufacture, which has entirely arisen since his work was published. No. 73, was currently sold in the year 1787, for thirty-six shillings and sixpence per pound weight. In 1792, for nine shillings and eightpence-halfpenny; and in 1807, for four shillings and fourpence-halfpenny. During the same period, the raw material has, upon the whole, rather advanced than declined in price, fluctuating between two and three shillings per pound. Occasional scarcity has, indeed, at times, produced a temporary rise of price, and when the market was again fully supplied, a depression has taken place in this, as in all other commodities. On the average, however, the money price has not varied greatly, the exchangeable value may perhaps rather have sunk, for the price of freight occasioned by the war premium of insurance, and the rise of seamen's wages, naturally form part of the money price. Taking, therefore, the average price of cotton wool, fit for this number of yarn, during these years, to have been two shillings and sixpence per pound (which is very high) in the first price quoted (1787), the price of labour, interest of capital, waste of machinery, and spinner's profit, will be thirty-four shillings. In the second (1792), seven shillings and twopence-halfpenny; and in the third (1807), one shilling and tenpence-halfpenny. In the last instance, the price of manufacturing is, probably, more than the calculation gives; but the comparison between the value of the material in its raw state, and after being spun, does not affect this calculation more than the others, perhaps not so much; for it will be observed, that the two years, formerly quoted, were years of peace, the last a year of most extensive war.

During the same period, the general price of labour has constantly increased; a very singular proof of the prodigious efficacy of judiciously applied improvement in the mechanical arts.

In the manufacture of linen, and other goods woven from flax, no reduction of labour to nearly equal extent has been effected. Machinery for spinning flax has, indeed, been invented, and constructed upon a plan pretty similar to that used for cotton. This machinery has been found useful in effecting some reduction, especially in the coarser kinds of linen yarn; but the very nature of the raw material presents obstacles to the improvement of the spinning of flax by machinery, which do not exist with regard to cotton, nor even in the same proportion with wool. The fibres of flax, although very strong, from their length, and inelasticity, are not nearly so well calculated for the process of drawing by rollers as the cotton, which is short in the staple, and extremely elastic. Further mechanical inventions and experiments, if judiciously conducted, may, no doubt, still greatly improve the art of spinning flax, but there seem to be unsurmountable physical objections, to its ever becoming a rival to the cotton in price.

Here, then, seem natural reasons, sufficient to account for the very different advances which these two manufactures have made. The linen trade, like a ricketty child, unable to stand upon its own legs, has constantly required to be cherished and fostered by bounties. That, at this moment given upon the coarse goods, manufactured chiefly in the county of Angus, is not less than twenty-five to thirty per cent. *ad valorem.* The cotton, on the contrary, from the superior facilities which it presents, has, by the mere enterprise of individuals, risen with the growth of a giant; so far from requiring aid or encouragement from the state, the raw material has been for some years an object of taxation; and, short as its course has been, it has already reached that advanced stage of trade, where the chief difficulty lies in finding markets and consumers for the supply.

The great reduction of labour, and, consequently, of price, which has taken place in the cotton manufacture, lyes, however, almost wholly in those stages of the process of manufacture, which bring the raw material into yarn. Much has not yet been effected in the weaving, nor does it appear to afford facilities, nearly equal to those which presented themselves, and have been seized upon in the spinning. The great improvement in the quality of the yarn, and the dexterity acquired by extensive practice, have, no doubt, considerably reduced the prices of weaving, but a good deal remains still to be done.

In a national point of view, this has become of very great importance, for the high price of labour in this country, renders every means of facilitating all the operations of manufacturing, not only peculiarly desirable, but essentially necessary.

Until the continent of Europe was almost completely shut against us, the immense exportation of cotton yarn has sufficiently proved, that our great superiority lay in the spinning, and that, in many instances, foreigners have found it, at least, equally beneficial to employ their own looms, as to purchase cloth in this market. Considerations such as these have actuated a number of persons, for some years past, to endeavour to reduce the expence of weaving, particularly plain coarse goods, by various mechanical contrivances, and modes of economy. Of these I shall now endeavour to give some account.

Cotton yarn is wound upon the spindle, in the form of a cone, and these are called *cops*. The usual practice has been to reel these cops into hanks, for the conveniency of starching, dying, or bleaching, when required. When plain white goods are to be manufactured, starching only is required for the warps; for the process of bleaching takes place after the yarn has been made into cloth. After starching, the next process is winding, and then warping, as noticed in the first Essay. The first means of saving labour, are by the omission of the process of reeling, and by winding the yarn at once from the *cop* upon the bobbin, by means of a machine, by which a number of bobbins are wound at the same time. To accomplish the starching, different experiments have been made.

It has been considered a very desirable object, if practicable, to starch and dry the yarn in the cop, before undergoing any of the subsequent processes. The chief obstruction was found to arise from the dense form in which the yarn was rolled together, which rendered it difficult both to impregnate the cop thoroughly with the starch, and afterwards to dry it. To remove the first, an expedient was found, by exposing the cops to the operation of the starch in an exhausted receiver; for it was considered, that when the pressure of the atmosphere was removed, the starch would penetrate easily to the very heart of the cop. Upon trial, this was found to succeed very well, but the drying was still found excessively tedious, and the glutinous nature of the starch rendered the subsequent operation of winding very difficult. I am not aware that these impediments have as yet been effectually removed, nor that the plan of starching in the cop, has been brought into practice. The general mode, therefore, is to wind the yarn from the cop upon the bobbin, to warp the yarn by the common process, and to starch the warp in the chain. Of the winding machines, different kinds have been constructed, some driven by the hand, others by the foot like a turning-lath, and others by the application of power. The latter mode is unquestionably the best, where it can be applied, for where a number of bobbins are running at the same time, the person who attends the machine will be sufficiently employed in removing obstructions, knotting threads, which occasionally break, and other necessary operations, without being also obliged to drive the machine, either by the foot or hand. When power is employed, if the cops are well built, it is very seldom necessary to stop the machine, for any bobbin may be stopped without affecting the others. But when driven by the hand, or even by the foot, when any impediment occurs, it is generally necessary to stop the whole, until that is removed. By this, much time is lost, and, of course, the work produced by one person much less.

For the reasons already stated, I am sorry that I cannot give drawings of these machines. They are simple in their principle and operation. The bobbins are placed upon vertical spindles, similar to the spindle frame of a mule, and the spindles are driven by cotton bands, from a hollow tin cylinder, or drum, in the same way. The threads are traversed upon the bobbin, by a wheel similar to the common *heart* traverse, as it is called, used in water spinning. The most recent and best constructed, which I have seen, is that lately introduced by Mr. James Dunlop, at Barrowfield, near Glasgow. As the bobbins are in general wound rather in the form of a barrel than perfectly flat, Mr. Dunlop constructs his traverse wheel so, that one side of it should wind the yarn equally on every part of the bobbin, and the other side so that the traverse should be gradually retarded at the middle of the bobbin, and accelerated at each end. By these means, more yarn is wound upon the middle than the ends, at every alternate traverse, and the yarn gradually arising in the middle, the bobbin assumes the barrel shape. A small quantity of starch is applied to the yarn during this operation, by means of a horizontal wooden cylinder, revolving on its axis in a trough filled with starch, over the upper surface of which the threads pass in their progress from the cop to the bobbin. It is calculated, that a woman, by one of these machines, can wind about 70 spyndles of yarn, of an average number, say No. 70 to 80, in a day. Eight or ten years ago, the price of winding No. 70, on the common wheel, was about two-pence per spyndle. Although these prices are now considerably reduced, still a considerable saving must take place by using the machines, where business is conducted upon a scale sufficiently extensive to employ them constantly. In dyed warps, it does not appear that this plan of economy has, as yet, produced any beneficial effect. Yarn can only be dyed in the hank, and, consequently, the process of reeling cannot be saved. I have seen winding machines, constructed for the purpose of winding dyed yarn from the hank, but these machines were so frequently stopped by the breaking which took place, in consequence of the yarn being both weakened and matted together by the dye stuffs, that no saving, in point of expence, was effected by employing them.

A general system of economy in the manufacture of cotton cloths was, some years ago, introduced at Stockport, near Manchester, and partly imitated in Scotland; of which I shall now proceed to give some account.

This system, in so far as regards the preparatory processes, is not very much different from that already described. The cloths manufactured were plain, and rather coarse. A portion of warp, composed of water twist, was wound from the bobbins upon which it was spun, upon a roller or beam. A certain number of these beams being combined, the yarn was again wound from these upon another beam, which formed one half of the warp. By these means, the operations of winding and warping were wholly omitted. The warp received no starch in the process. The next object, was to avoid that combination of operations which form the chief obstacle to the speed of weaving. A machine was therefore invented, for the purpose of dressing a whole web, before it was put into the loom, that the subsequent operation of weaving might not be impeded. Two beams, each containing one half of the warp, being placed at opposite extremities of the machine, the warp was gradually wound from these beams, upon another beam placed in the centre, and elevated above the other parts of the machine. During this process, each part was supplied with the stuff for dressing, by means of a horizontal roller, revolving in a trough containing the stuff, in a manner similar to that used in the winding machine. The dressing was then brushed into the yarn, by means of two brushes, one applied to the upper, and the other to the under surface of the warp. These brushes received a motion, similar to that communicated by a weaver's hands in the common process; and this motion was effected by *cranks*, the brushes being sufficiently long to include the whole breadth of the warp. After this, the warps passing under rollers, placed to guide the direction, met upon the centre beam, immediately under which was placed an apparatus, consisting of a horizontal axis, to which were attached six or eight flat boards, diverging from the centre, like the radii of a circle. These, by a rapid motion round the axis, generated a current of air, for drying the warp after being dressed and brushed, previous to its being wound upon the receiving beam. During the process of dressing, the threads were kept distinct in the wet state, by passing through two or three coarse reeds, placed at convenient distances from each other. The lease was preserved by a set of heddles, through which the warp passed, after being dried, and before being wound upon the beam. Upon the beam were *flanches* of wood, to keep the selvages of the warp perpendicular, and the whole at an equal breadth.

The only improvement in the construction of the loom, was an apparatus for winding up the cloth as it was woven; and, consequently, saving the time necessary to shift the cloth at intervals, or, as it is generally called, to *draw bores*. The apparatus consisted of ratchet wheels, moved by a hanging catch, to which motion was given by a lever attached at right angles, to the upper extremity of the swords of the lay, above the centres. Some saving must, undoubtedly, have been produced by this plan, in weaving plain coarse fabrics; but many obstacles presented themselves against it. The chief of these obstacles occurred in the dressing.

It has been already remarked in the first Essay, that the stuff used for dressing, although it increases the strength, tenacity, and smoothness of the warp, is not fitted to resist the operation of the atmosphere for any length of time, especially when in a very dry state. It may be easily conceived, that in the early stages of weaving, especially in a cold or moist climate, this defect would not excite much attention, nor produce much inconvenience. Weavers' shops, in those days, and even still, are almost universally upon the ground floor, and are only floored with earth. In consequence of this, the air in the shops is generally moist and humid, and from the process of only dressing a small portion of warp at once, and weaving it up almost immediately afterwards, little inconvenience is found. In one respect, the facility with which the dressing material is acted on by a current of air, seems rather advantageous. For, as the weaver dries his warp, after being dressed, merely by setting the air in motion by a fan, moved by his hands, greater difficulty of drying would both fatigue the operator and impede his progress. But in the efforts now making to improve the economy of weaving, nothing appears more likely to promote the end, than a total division of the labour of dressing and weaving, and this can only be fully effected, by dressing a whole warp at once. It will also be necessary, that this warp should be of considerable length to produce any saving. For as much time will be employed in drawing a short web through the heddles and reed, as a long one, or in twisting one web to the end of another. Now, until means are devised to preserve the warp in a proper state for weaving, until a whole web can be wrought, it does not appear that this object can be fully accomplished. Besides this, in establishing extensive manufactories and regular economy, it would be expensive and inconvenient, if not impracticable, to have all the buildings only one story high, more especially if the looms are to be driven by the application of power. I have stated, in the first Essay, the practice of weaving in India in the open air. Since the time when that Essay was written, I have earnestly inquired of different persons who have resided in India, concerning the stuff used for dressing in that country; but I am sorry to say, that the results of these inquiries have been far from satisfactory. None of those with whom I have conversed, being immediately concerned with the business, any observations which they had made were merely cursory and transient. They agree, however, that the substance used is a decoction of rice, formed by boiling the rice with a small quantity of water, and then expressing the juice. This juice, when cooled, forms a thick glutinous substance. I have been also informed, that before using it for dressing, it undergoes a certain process of fermentation; but whether this fermentation is produced, or accelerated, by any mixture, or if it is entirely caused by the weather, I have not been able to learn. Whether also the stuff is used after undergoing a partial or complete fermentation, I am still equally ignorant.

In this country, the common flour or potatoe dressing, is generally considered to be better after it has been fermented, especially in very dry or hot weather. Yest or barm is, therefore, sometimes mixed with it, to promote fermentation. Butter milk is also sometimes added, and, as before noticed, herring brine or other saline substances. But while these experiments are only made by operative weavers, totally unacquainted with the laws of chemical combination; and while the warp is to be dried by the manual operation of the fan, there seems to be little reason to expect much discovery in this part of the art. It seems not unreasonable to conjecture, that any substance capable of adding to the smoothness and tenacity of the warps, and which would resist the operation of the atmosphere for a considerable time, if not too expensive for common use, would answer the purpose. It seems also probable, that a substance which, when dried, would possess this property, must also require a much greater portion, either of circulation of air, or artificial heat, to reduce it from the wet to the dry state, in a reasonable time. But these are merely given as probable conjectures, and without a train of accurate and judicious experiments, it is not probable, that much practical benefit will be derived.

A second disadvantage, incidental to all the dressing machines hitherto contrived, has much impeded their practical utility. In the common process of dressing, the threads of warp, when in the wet state, have always a tendency to cohere, or stick together, and the agitation of the air, produced by the fan, naturally increases this tendency. To prevent this, the yarn is slightly brushed at intervals, while drying. The same tendency to cohesion, occurs in warps dressed by machinery, and presents a very great obstacle to their speed. The reeds through which the warp passes, are intended, in some measure, to remove this, but the great friction caused by the yarn passing through them in a wet state, and their tendency to be clogged by the dressing, are serious disadvantages. From these causes, threads are frequently broken, and when this is the case, the operation must be suspended, the machine stopped, and the warp left in a wet state, until these threads are repaired. When the threads are tied, it is necessary, in most cases, to pass them through all the reeds; and this, necessarily, occupies a considerable portion of time. Of course, when many are to be tied, the operations of brushing and fanning are so long suspended, that the warp frequently gets entangled, and is separated with difficulty, and often with more breakage. Besides this, when long exposed, it is often too much dried and hardened by the mere action of the air, to be in a proper state for weaving.

A dressing machine, somewhat different in principle, was invented since, by Mr. Quintin Macadam, Anderston, and brought into practice by Mr. John Monteith, at his manufactory, at Pollockshaws, near Glasgow. For this machine, a patent has been obtained. The warp, as in the other, is wound from two beams at the ends of the machine, and after being dressed and dried, is lodged upon a beam in the middle. The chief novelty in this machine consists in the brushes, which are constructed on cylinders, similar to those of a carding engine. The circumference of these cylindrical brushes, being placed in contact with the under surface of the warp, they communicate the brushing by revolving upon their own axles. Upon each end of the machine, there are two of these cylinders, and two circular wooden fans to agitate the air. Between the brushes, the first fan is placed, to dry the warp partially after the first brushing. It then receives the second brushing, and is completely dried by the second fan, which is placed between the second brush and the receiving beam.

This mode of brushing the warp between the wet and dry state, assimilates the operation of the machine more to the common manual process, and may, in that respect, be productive of some advantage; but it does not appear, that the inconveniences arising from the chemical properties of the dressing, or the friction caused by the reeds, are more obviated by this machine than the former.

For another process, essentially useful in dressing yarn, no provision, whatever, is made in either of these machines. This is picking the warp, previous to the application of the dressing. With all the improvements in spinning, no yarn is entirely free from inequalities, lumps, and snarls. Every good and careful weaver is at pains to remove these, and any knots which may have been carelessly tied in the preparatory processes, both to prevent obstructions in his sheds, and to improve the appearance of his cloth, when woven. As this process depends upon discrimination and selection, and consequently involves an operation of the mind, it is impossible to effect it by mere machinery. It seems, however, perfectly possible, that this part of the operation may be effected by human labour, and the remaining operations, which are uniform, by machinery, with considerable economical advantage. An experiment of this nature was lately made, upon a small scale, by Mr. Dunlop, at Barrowfield, but has not as yet been sufficiently followed up, to enable us to decide practically upon its merits in point of quality, or of the saving of labour actually produced. The machine constructed, combined the principle of dressing by the common manual operation, and part of that of the two dressing machines, already noticed. The web was warped on the common warping mill, and beamed in the usual way. The beam upon which the warp was rolled, was then placed in the machine, in a situation similar to the yarn beam of a common loom. At the other extremity of the machine, was the beam for receiving the yarn when dressed, placed nearly in the same situation as the cloth beam of a loom. The heddles, lay, and reed, were, of course, omitted, and the lease was preserved by three rods, exactly in the common way. When the web was stretched in the machine, in a direction nearly horizontal, the receiving beam being only raised a few inches above the other, to afford the operator more facility in picking and brushing, the operation commenced. The rods were combed down, from the receiving to the discharging beam, the warp picked and brushed by manual labour, in the usual way, and the lease rod placed on its edge. Under the warp was a circular wooden fan, which was now set in motion by the power, while the operator continued to brush the warp while drying. The fan was inclosed in a circular wooden box, with an aperture only in the upper part of its circumference. During the operation of drying, this box was moved upon its centre by a common heart traverse; and as the air set in motion by the circular revolution of the fan, could only escape by the aperture, whose position might be varied at pleasure, every part could be sufficiently dried, without any part being too much hardened. When the yarn was sufficiently dried, the portion of warp which had been dressed, was wound, by another part of the machinery, from the discharging upon the receiving beam, and a fresh portion of warp presented to undergo the same operation, which was repeated in the same manner, until the whole warp was dressed and wound upon the receiving beam, which was then carried from the dressing machine to the loom. To this process, as here described, there certainly occur some serious objections; but from what I saw of the principles and effects of it, I am inclined to think, that something of a similar kind, if prosecuted with judgment, energy, and perseverance, might be essentially useful, in promoting the process of weaving both linen and cotton goods, upon principles of economy superior to any yet introduced, more especially if the chemical part can also be improved. I shall shortly state my reasons for adopting this opinion, premising, as usual, that it ought to be considered merely as hypothetical; no opportunity of practical proof being yet in existence. The first defect which appears in the process, is the conducting the operation of brushing, by manual labour, instead of using power. Every weaver knows that the situation of his body bending over a warp, while picking or dressing his web, is painful and fatiguing to an uncommon degree. It is only the intervals of ease, which he enjoys, while weaving up what he has dressed, when the body is in an erect and natural posture, and the small proportion of his time employed in dressing, which enables him to support this. But in this process, the body must be almost incessantly in this fatiguing and unnatural position; for no sooner has he finished the dressing of one portion of warp, than he must commence another.

Whatever allowance may be made for the effects of habit, in accustoming the human body to support exertions, which, when first tried, prove uncommonly fatiguing, I am inclined to doubt, whether any practice would enable a man to work incessantly at this operation for a sufficient number of hours daily, to render it productive. Besides this, so much is to be done by the hand, and so little by the power, that it does not appear, that, although a division of labour is created, almost any consequent reduction can be expected. By moving the brushes by power, the toil of the operator will be at an end, so soon as he has combed and picked his warp, excepting, that it will be necessary to set his brushes first in motion, and afterwards his fan; or, the first of these may engage the second at a proper time. In this interval, by placing two machines together, he may be employed in combing and picking another warp, and thus, without impeding the operation, the labour of one man may keep two, or, perhaps, three machines employed, with less fatigue and exhaustion, than would be necessary for one. The picking and combing of the warp, when yarn is well spun, which is now generally the case, especially in cotton, requires much less time and labour than the brushing; consequently, one warp might be combed and picked much faster than the other could be sufficiently dressed, dried, and wound upon the receiving beam.

To a plan of this kind, it may be objected, that the motion of the brushes is not uniform, nor the range equal in all stages of the process. Weavers find it necessary to brush that part of the warp nearest to the yarn beam first, and gradually to extend the range of the brushes, until they have brushed the whole undressed warp. The reason of this is as follows. Every kind of yarn has upon it a certain proportion of loose stuff, not sufficiently incorporated by the twine, to retain its situation, when acted upon by the brushes. Therefore, when the whole range of the stretched warp is brushed at once, these loose particles are drawn by the brushes to the lease rod, or yarn beam. In a few dressings, these accumulate to such a degree, that they mat the yarn together, and form very serious obstructions to the operations of weaving. But when the warp is gradually dressed from the lease rod upwards, the glutinous nature of the dressing makes those nearest to the beam adhere to the yarn, before the uppermost are touched by the brushes. Of consequence, instead of being all collected in one point, they are scattered over the whole surface of the warp, and occasion little, if any, impediment. That it would be of advantage to imitate this motion in brushing, by machinery, seems very reasonable to suppose, for the same effects would be produced in both ways. But the great, and almost boundless variety of motion which may be communicated by machinery, in the hands of an ingenious mechanic, would prove quite sufficient to surmount any obstacle which might arise here.

This mode of dressing, if adopted and perfected, would obviate every objection against the others, except that which arises from the quality of the dressing, and even here the disadvantage would be considerably lessened. In the first place, the facility of picking the warp would be of great service, by removing impediments, both to the succeeding parts of the dressing process, and the subsequent operations of weaving. 2dly, All obstacles, arising from the friction of the reeds, would be removed; for none are necessary in this process. This would also prevent any necessity of suspending the operation in the wet state, which produces so much difficulty in the other modes. For any threads, which might be broken during the brushing, would be brushed down to the lease rod, where they would remain, without producing any injury, until the web was sufficiently dried, and they might then be knotted, before the dressed yarn was wound upon the receiving beam. 3dly, Every dressing might be equally dressed and dried, which is of most essential importance, and if speedily wound up when in a proper state, might remain so for a considerable time; for only the last yarn rolled on the beam, would be much exposed to the action of the air. Lastly, were it found by experience, that one person could keep three, or even two, of these machines in constant motion, I am persuaded, that the labour of that person would produce more work, and superior in quality, to that effected by any other scheme, which has been tried.

I have thrown these hints, which occurred to me upon comparing the various modes of dressing which have been tried, loosely together, for the consideration of those who are interested in the prosecution and improvement of this branch of the manufacture. As this is still in a state of infancy, I have done this with considerable diffidence; for as I have never been practically employed in constructing or employing machinery of this description, facts and considerations, important in practice, may have escaped my notice. In all mechanical inventions and improvements, experience has convinced me, that before proceeding to put them in practice, the theories and principles should be maturely weighed, and the obstacles likely to arise, with the means of removing them, carefully investigated. Even when all this has been done, unforeseen difficulties always occur, which can only be surmounted by decision, energy, and perseverance.

I now come to consider the various plans, which have been lately adopted for the purpose of working the weaving loom, by the application of power. Many experiments, upon a small scale, have been made for a considerable number of years past, and looms, upon various plans, constructed. The first attempt to establish a regular manufactory of this description, in Scotland, was, I believe, that of Mr. Robert Millar, at Milton Printfield, Dumbartonshire, which is still prosecuted. These looms, for which a patent was obtained, receive their motion from treddles, moved by those excentric wheels, which are known among mechanics by the name of wipers.

Another loom, the origin of which I believe to be English, but which has lately been introduced in Scotland to considerable extent, is the crank loom. The last, invented by Mr. Johnson, and brought into practice by Mr. Robert Shirreff, for which also a patent has been granted, is the vertical loom.

In these looms, different modes of construction have been adopted, without any material deviation from the same general principle. The plan of weaving by power has been so recently introduced, and hitherto confined to so few hands, that it is natural to suppose, that many improvements still remain to be made, and that much difference of opinion, respecting the relative merits of the different plans does, and will, for a considerable time, exist. I shall, for these reasons, confine my observations and descriptions to the principal moving parts of each, leaving the connections, and framing of the machines, to the judgment and discretion of those, who may apply them to practice.

With the exception of the motion for winding up the cloth, and unwinding the warp, which is rotatory on the axes of the beams, all the motions of a loom are alternate, or reciprocating. The two methods, most common among mechanics, of producing these motions, are cranks and wipers, or excentric wheels.

The reciprocating motion derived from the revolution of a crank on its own axis, is not uniform, but accelerated at one time, and retarded at another. By means of wipers, the motion may be made uniform, accelerated, or retarded, at any part of the revolution, according to the effect which the engineer wishes to produce. In many machines, this property gives the wiper a very decided advantage over the crank; but, in the weaving loom, the retardation of the crank, so far from being disadvantageous, is of considerable service.

In Plate 14. will be found representations of the chief working parts of the different power looms; and as the vertical loom is the one most recently invented, I have given a profile and transverse elevation of it, from drawings, for which I am indebted to Mr. Shirreff.

WIPER LOOM.

Fig. 1. is a representation of the way of moving the heddles in this loom, so as to open the sheds. This figure is a profile elevated section of the heddles L, connected with the treddles S, much in the same way as in a common loom. In some power looms, the cords above the heddles pass over pullies, as in the figure; in others, Jacks are used, as in the common loom. The motion is given to this loom, by a horizontal cross shaft, upon which are a number of wipers. A section of this shaft, with the double wiper, which sinks the two treddles alternately, is represented at S.

These wipers may be constructed for any range of motion, in the following manner. Describe a circle of a convenient diameter on the piece of wood, or other substance, which is to form the wiper. Having considered the range which the wiper is to communicate to the treddle, draw a diameter line through the circle, and upon this line set off the length of the proposed range on the outside of the circle. At this point, describe a second circle concentric with the first, and divide the circumference into a great number of equal parts. From the centre draw a radius to each of these divisions, and the wiper will be ready for setting off. If a uniform reciprocating motion is wanted during the whole revolution of the wiper, it is only necessary to divide the space between the inner and outer circle into as many equal parts as half the number of radii. Set off one of these parts on the first radius line, two on the second, three on the third, and so on, until the whole are set off, when the semi-circumference of the wiper will be marked off; and the same operation reversed, will give the other or returning side. This forms exactly the common heart traverse. In the figure, a few radii are drawn upon S, to show the principle; but it will appear that each of these two wipers is constructed on half the circle, so that each may operate alternately on its respective treddle, when both sheds will be opened by one revolution of the shaft. As it is necessary that the shed should remain open while the shuttle is passing through, all the range must be set off some time before the wiper arrives at the centre, and the extremity left circular to suspend the motion for the time required. This is the case with the two wipers at S.

Fig. 2. is a profile elevation of the apparatus for moving the lay. E is the lay vibrating on its centres above, as in the common loom. The lay is pulled back by the operation of the wipers S upon the treddle R, by means of the connection represented in the figure. After the shuttle has passed through the shed, the lay is pulled forward by a weight attached to a cord or belt, passing over a pully, as represented. These wipers are also constructed on semi-circles, that the lay may operate twice in one revolution, as well as the heddles. Both wipers, however, operate upon the same treddle, as they are only intended to repeat the same motion, while those which move the heddles must reverse the shed. There is an apparatus of this kind at each side of the loom, to keep the lay steady. The wipers for this motion are upon the same shaft with those for the heddles. In some power looms, the swords of the lay are reversed, and move in centres below. There are different ways

for driving the shuttle. In some, the driver cords are attached to the point of a lever with two cross tails, as represented by T, Fig. 3. This lever, being placed perpendicularly under the warp, with its flat side parallel to the horizontal shaft, and moving freely on its centre, the cross tails are alternately struck by two pieces of iron, fixed to the shaft, as represented at U, in Fig. 7. and, by moving the lever, drive the shuttle across the web. In other looms, two treddles are used, which are moved alternately, by wipers on the shaft, and produce the same effect. Various means are also used for winding up the cloth, of which some notice will be taken when we come to consider the vertical loom. In the mean time, we proceed to the

CRANK LOOM.

In this loom no treddles are necessary, for the motion is communicated directly by the cranks. Fig. 4. is a profile of the heddles, and section of the heddle crank shaft. The shape of the cranks will appear by Fig. 5. where a small portion of the shaft is represented in a transverse direction. Fig. 6. is a profile of the lay, and section of the lay crank shaft. Fig. 7. is a transverse view of the shaft, to show the way of disposing the cranks. It will be obvious, that in this loom two horizontal shafts are necessary, for only one stroke of the lay can be effected by a whole revolution of the lay shaft, whereas in the wiper loom the double wiper gives two. These shafts are placed parallel to each other, and on the same level, the heddle cranks being perpendicularly under the heddles, and the lay cranks behind. As it is necessary that the lay shaft should revolve twice, while the heddle shaft revolves once, the latter takes its motion from the former, by a spur wheel and pinion, as represented by Fig. 8. The wheel, containing double the number of teeth of the pinion, is fixed on the heddle shaft, the pinion on the lay shaft. The pully, which receives the motion from the power, is also on the lay shaft. The swords of the lay are lengthened below the boxes, to bring the connecting rods level with the shaft, and these connecting rods, in both motions, are usually of iron. The shuttle motion is effected by either of the two plans formerly described. We now come to the last invention, the

VERTICAL LOOM.

FIG. 14. is a profile elevation of two of these looms, constructed at opposite sides of the same frame, and will convey a tolerably correct idea of their framing and appearance. Fig. 15. is a transverse elevation of one end. The remaining figures on the plate, 9 to 13 inclusive, are the several working parts. The whole reciprocating motions of the vertical loom, are also effected by cranks, and these cranks are upon two shafts.

A is a balance wheel on the lay crank shaft, one side of which is so much heavier than the other, as to counterpoise the weight of the lay and swords, and make them ascend and descend with equal ease. The swords rise and sink between sheers, or guides, to keep them steady.

B is the pully which takes the motion from the power, and which is also on the lay shaft.

C is the lay shaft, with a crank at either end, similar to those of the crank loom.

D is a wheel on the heddle shaft, receiving motion from a pinion of half the number of teeth on the lay shaft, as in the crank loom.

E is the lay and boxes, with the reed placed horizontally, and on which the shuttle runs.

F is the yarn beam, from which the warp ascends perpendicularly through the mounting.

G is the cloth beam above, for receiving the cloth when woven.

H the wheels by which the cloth is wound up.

I is the lever and fork, for engaging or disengaging the machine at pleasure.

K is a catch, by which the loom will be instantly stopped, if the shuttle should remain in the shed. All the power looms have contrivances of this kind, which will be more particularly noticed afterwards.

The nature and construction of each particular motion will appear more plainly, by inspecting the supplementary figures.

Fig. 9. contains a profile of the horizontal heddles, and the apparatus for moving them.

At L are the heddles, placed horizontally, and guided by belts, passing over pullies before and behind. To one of these belts is attached one end of the bended lever M, moving freely on its centre, and the other end of which is connected with the crank N. The shape of this shaft and crank will be plainly seen in Fig. 10. Besides the crank for the heddles, upon this shaft is a projecting stud P, operating like a crank for giving motion to the shuttle. Fig. 11. is a profile elevation of the apparatus by which the shuttle motion is communicated. O is a sliding bar which moves freely in two bushes backward and forward. Upon the edge of this slider, is a rack which moves a pinion Q, fixed upon an upright shaft, on the upper part of which is a cross lever, to which are attached two leather thongs, which are also connected with the drivers. The stud P, the end of which appears here like a round dot, moving round in a hollow elliptical piece, forming part of the slider, alternately moves it rapidly backward and forward, by means of the catches above and below. This motion drives the cross lever upon the top of the upright shaft to the right and left alternately, by means of the pinion Q, and thus the motion is communicated to the drivers.

Fig. 12. is a ground plan of the rack and pinion.

Fig. 13. is an outline of the plan for winding up the cloth. On the axis of the cloth beam is fixed a wheel, on the outside of which is a ratchet wheel, loose upon the axis. This ratchet, one tooth of which is represented, is moved by a catch, jointed to the end of a spring connected with a lever; the other end of this lever is connected with the lay. This spring may be slackened, or stiffened at pleasure. Every time the lay rises, the spring and lever are pulled down, to move the ratchet one tooth; but the spring is made sufficiently slack, to yield without moving the ratchet, unless assisted by the stroke of the reed upon the fell of the cloth. Consequently, if the weft breaks, no winding-up motion is produced. This is very necessary; for, were the loom to go a shot or two without weft, and the cloth to be wound up, it must either be let back, or a large unwefted interval would be produced. Upon the ratchet is fixed a pinion, which moves a wheel turning loosely upon a stud. Another pinion, fixed to this wheel, gives the motion to the fast wheel on the axis of the cloth beam, and consequently to the beams. The relative

numbers of these wheels and pinions, must depend on the quantity of weft in a given space, and they must be fitted on so as to be easily altered at pleasure.

In all the different experiments upon weaving by power, hitherto made, it has been found advantageous to confine the shuttle when lodged in either box, to prevent it from recoiling. This has been effected by a circular piece of wood, pressed through one of the edges of the box by a slight spring, which yields to the pressure of the shuttle when entering, and by its friction, prevents the recoil. It is also material to disengage the loom from the power *instantly*, if the shuttle should stop in the shed; for if driven up by the lay, much damage will be the probable consequence. This disengaging motion, is taken from these springs, which are connected by bended levers, and a wire across the lay, so that either will operate. In the vertical loom, the disengaging lever I, is strongly pressed by a spring, to force out the driving pully, whenever the catch above is lifted. To the spring for securing the shuttle, an upright piece of iron K, moving on a joint is attached. When the spring is pressed back by the shuttle, the upper part of this is thrown forward, clear of a notch in an upright slide, attached to the disengaging catch; but if one spring is not pressed, K not being thrown forward, will strike the notch, and instantly disengage the machine. The contrivances for disengaging the other looms, are exactly upon the same principle, a little differently modified to suit the construction of the looms.

When the vertical loom is to work yarn which requires dressing, an iron roller is placed where the yarn beam is represented, and the beam itself in a small additional frame, parallel to, and on a level with the roller, so that the part to be dressed is in a horizontal position, as in a common loom. Every power loom is generally furnished with a circular fan, such as formerly described, placed under the warp, and which is occasionally set in motion to dry the yarn after being dressed. Two pair of temples are generally used in power weaving.

It is not easy to decide, justly, upon the comparative merits of these looms, and upon this subject a considerable difference of opinion still prevails. The wipers are, without doubt, susceptible of a modification of the motion, to suit different fabrics, in a much greater degree than the cranks; but in the coarse fabrics, hitherto woven by power, the crank motions are found sufficiently correct. The mode of striking up the lay, by means of a weight, is found productive of one very considerable inconvenience. The force of the lay has a tendency to slacken, and, consequently, to spread the warp, and when the shed closes in this state, the threads are apt to obstruct each other, and occasion breaking. A very simple and ingenious apparatus, has lately been added to the vertical loom, to obviate this disadvantage, which also attends the crank loom, although not to an equal degree. This is merely a flat board, the edge of which is parallel to the warp, and which moves on centres. By means of two bended levers, connected by cords, or thongs, to the lay, this board presses the warp when the shed closes, and recedes from it when the shed is opened. Thus the warp is kept uniformly tight. The same contrivance might easily be applied to either of the other looms.

The vertical loom certainly appears to possess some decided advantages over the others.

1stly, It occupies a much smaller space of room, and, consequently, in a large manufactory, a considerable saving might be effected, both in the expense of building, and in that of shafts and other mill work.

2dly, From the shuttle running upon the reed, a larger pirn may be used, without any risk of injuring the warp by friction.

3dly, When it is necessary to dress the warp, which, in power weaving, is usually done without stopping the loom, it presents the following very important advantage. The operator, while dressing, remains exactly in the same situation as when attending the working, and can, therefore, see in a moment, any thing which may go wrong; whilst in the other looms, the person, while attending the working, must be in front, and when dressing, behind, where it is very difficult to see any obstruction which may happen before the reed.

In the 1st Essay, some remarks were made on the danger and inconvenience arising from working a loom beyond a proper rate of velocity. Practical experience has uniformly proved this to be highly injurious in the manual operation, and I am fully convinced, it must be equally, if not more prejudicial, in weaving by power. It has been common to drive power looms at the rate of 80 or 90 shots per minute, and attempts have even been made, to accelerate this velocity much beyond 100 shots. Mechanics know that even rotatory motion, when urged beyond a moderate speed, always fails in producing the effect expected. This has been sufficiently proved in spinning, where almost all the motions are rotatory. In weaving, where there are no less than three reciprocating motions, the effect must be still more injurious, especially in the lay and heddle motions. The shuttle, indeed, may be driven with considerable swiftness, for no injury can arise from this, unless the shuttle is thrown out of the box, or the weft too much strained and frequently broken. Suppose, as in Essay 1st, a 1000¾ shawl cloth, with 1200 weft, to be woven at the rate of 80 shots per minute. This will give a yard in 30 minutes, or 24 yards per day of 12 working hours, if no stop were to take place. I cannot state with certainty, what has been the greatest quantity of cloth of this description produced by power looms. The average quantity on the vertical loom, I have been informed, is about 15 yards, so that, if the loom works at the velocity quoted, more than one third of the time must be lost by stopping. Besides, I do not think that goods of this description have, in general, so much weft as I have taken in the calculation. Upon the whole, I should suppose 70 to 80 shots to be the *maximum* of velocity, at which it is prudent to drive a power loom, even with the coarsest and strongest materials; and if these looms are applied to weave finer and lighter fabrics, I suspect even this velocity must be considerably diminished.

The last plans of economy in weaving, which it will be necessary to discuss, are those which relate to the insertion of the weft. The process of winding the weft upon the pirn, whether from the hank or the cop, is tedious, and, consequently, expensive. Two means of reducing this expense, have been devised. The first of these is, by placing the cop itself in the shuttle upon a skewer, by which the whole expense of winding is saved. As the cops, however, are generally too large for an ordinary shuttle, it has been usual to compress them. This is effected by means of two hollow inverted cones, generally of brass, with a hole through the vertex of each to admit the skewer. The cop being placed upon the skewer, the two cones are pressed together by means of a lever or screw. The cop, being between the cones, is thus compressed to a much smaller space than it originally occupied. The compression is most effectual when the cop has been boiled, but this can only be done when the weft is to be inserted in a wet state.

Machines have also been lately constructed for winding a number of pirns at the same time. The principle is entirely the same with that of the machine for winding the warp bobbins. The only difference is in the shape of the traverse, which must be constructed to wind the yarn in the form of a cone, instead of being flat or barrel shaped. Those which I have seen are turned by the hand, which I cannot think is proper, for the same reason which I stated before; namely, that in all these machines, the person who attends ought to have both hands free, and should be at liberty to shift from one part of the machine to another, to remove obstructions, and knot broken threads. I do not think that these machines are, as yet, very generally employed, and, perhaps, they have not yet reached such a state of improvement, as to render the use of them an object of much importance, in point of economy.

ESSAY VII.

ON THE

MANUFACTURING OF CLOTH.

HAVING concluded our account of the operative processes and modes of economy, connected with the Art of Weaving, it only remains in this Essay to discuss the subjects which form more properly the province of the manufacturer, or foreman, than of the operative tradesman. The great extension of the business in modern times, and the competition naturally arising from this, have, of late, attracted the attention of most manufacturers, more to the mercantile than the operative part of the profession. Any investigation of this part of the business is evidently foreign to the plan of this work, and would render this part of it, rather an Essay upon commerce, than upon any branch of the Art of Weaving.

Much of the business of the person who superintends the manufacturing department, has been discussed in the preceding Essays; for a thorough knowledge of the operative part of the business is essentially necessary, to enable him to conduct that department with propriety. There only remain, therefore, two points to be investigated.

The first, is the selection of proper yarn, to form the fabric required; the second, the calculations necessary to ascertain the prime cost of the goods, as a direction to the salesman.

A very essential part of the business of a skilful manufacturer is, to adapt the fineness of the warp which he uses to the reed, so as to produce the fabric of cloth required, whether light or heavy. This is called

CAAMING, OR SLEYING.

LITTLE has been done to reduce this to any regular system, and, hitherto, the rules generally laid down are nothing else than the results of observation and experience. For this reason, the tables for caaming almost every species of cloth, are almost as various as the manufacturers who use them; and scarce any two people agree upon this subject. That this is a great desideratum in the theory of weaving, will be readily admitted, and that it may be reduced to geometrical precision, there seems no room to doubt.

The only attempt which I have ever seen, to analize geometrically the construction of yarn, and, consequently, its application to the manufacture of cloth, is contained in a small tract, printed by Robert Urie, Glasgow, 1759, and entitled, "An Essay on the construction of Sleying Tables, by a Manufacturer."

An uncommon portion of ingenuity, and considerable mathematical knowledge is displayed in this work. It has now become so scarce, that I have only met with one printed copy, considerably mutilated; but, having been favoured with the perusal of the original manuscript, by a gentleman of Glasgow, related to the Author, I shall endeavour to give a short account of his method, and of the principles upon which his calculations are founded.

In the first place, the author considers every thread as a cylinder, and, of course, justly infers, that supposing the *density* of every thread to be equal, the matter contained in it would be as the square of the diameter multiplied into the length. He also concludes, that as every thread, in proportion to its fineness, requires more twisting in the process of spinning, that, therefore, the fibres which compose the thread, will be more condensed in fine yarn than coarse, and that, consequently, the diameter of a fine thread will be less than that of a coarse one, in proportion to its weight.

He further assumes, that the base of one thread being to the base of another, as the squares of their diameters, and the circumgyrations by which the twine is produced, directly *as their diameters;* that the ratio of one thread to another will be, as the cube of each diameter, or, which is the same thing, as the square multiplied into the diameter.

The following extract from this curious little tract, will serve to convey the author's opinions in his own words.

" A RIGHTLY CONSTRUCTED SLEYING-TABLE is a " scheme which exhibits the proper reeds for disposing " warp-yarns, of every given degree of fineness, in such " a manner, that (due regard being had to the quality, " and insertion of the weft) all the cloths, produced from " those different warps, shall be exactly similar in fabric " or compacture."

' In order to compose such a scheme for any one species ' of cloths, the following *data* are previously requisite.

'1. The number of the reed, employed in making the 'cloth, the fabric of which is intended for the model.

'2. The fineness of the warp-yarn of said cloth. And,

'3. The fineness of the warp, the reed for which is 'sought.

'By the number of the reed is understood the number 'of splits, or rather of the intervals of the splits contained 'in a given dimension; without having any regard to the 'number of those intervals that may in fact have been 'occupied by the warp: for the reed is precisely the *scale* 'by which the distance between the threads of the warp is 'regulated; and it equally affects the fabric of the cloth, 'whether the breadth of the cloth be a yard, or an inch.

'The comparative fineness of any two parcels of yarn 'may be ascertained by the number of threads, of a deter-'minate length, contained in a given weight of the one, 'compared with the number of threads of the same length, 'contained in the same weight of the other; due regard 'being always had to the degree of compression which the 'mass of each receives in the spinning. For, if two par-'cels of equal weight, but of different fineness, be spun 'from the same materials, and the degree of compression 'be precisely the same; the threads in both, like all other 'cylinders of equal solidity, will reciprocate their bases 'and altitudes: in proportion as the base of the one thread 'is diminished, *i. e.* as it becomes finer than the other; 'the altitude will be increased, *i. e.* it will become longer 'than the other: and if the threads of both parcels be 'wound up in convolutions of equal circumference, there 'will be a greater number of those convolutions in the 'one parcel than in the other, in proportion as the one 'is finer than the other: and the two bases will be to 'each other inversely as the lengths of the threads.

'Thus, if the number of convolutions in the coarser parcel 'be *a*, and the number in the finer be *b*; the base of the 'coarser will be to the base of the finer, *b* : *a*; or, $\frac{1}{a} : \frac{1}{b}$.

'But the parcel that has the greater number of convolutions, in a given weight, will have its thread *more* 'compressed by the action of the spinning-wheel, than 'the parcel which has the less number in the same weight. 'How this comes about falls to be explained a little.

'Every country-girl knows, that, in making yarns, for 'like purposes, and from the same materials, her wheel 'must be oftener turned round in spinning a finer thread 'of a given length, suppose a yard of the parcel *b*, than 'in spinning a coarser thread of the same length, suppose 'a yard of the parcel *a*. The reason is this: all yarns 'that are spun from the same materials, and destined to 'like purposes in manufacture, how different soever they 'may be with respect to fineness, ought to be *equally hard*, 'or *equally slack* in the twine: that is to say, the fibres, 'which compose their surfaces, ought to be twisted to the '*same degree* of tension. Now, as the two threads of the 'parcels *a* and *b* are supposed to have been spun from the 'same materials; if they are likewise supposed to be designed for similar purposes, they ought *so to be twisted*, 'as that the superficial fibres of both may become *equally tense;* these of the one, with those of the other. But 'the periphery of the base of the finer thread being less 'than the periphery of the base of the coarser; the superficial fibres of the finer will be less stretched by a 'given number of circumgyrations than the superficial 'fibres of the coarser thread will be by the same number: 'and in order to give the same degree of tension to the 'superficial fibres of the finer thread with that of the superficial fibres of the coarser; the number of circumgy-

'rations must be increased, by how much the periphery 'of the base of the finer is less than the periphery of the 'base of the coarser.

'However, though the superficial fibres of the finer 'thread, in receiving the same degree of tension with 'those of the coarser, require a greater number of cir-'cumgyrations; that greater number will be effected by 'a *less* force than what is needful to produce the less num-'ber which the coarser thread requires. In other words, 'the superficial fibres of the finer thread, taken together, 'will be stretched to any *given* degree, by a *less* force than 'what is needful to stretch the superficial fibres of the 'coarser thread, taken together, to the *same* degree. For 'the superficial fibres of the two threads are evidently as 'the surfaces of the two threads: and in order to give 'them the same degree of tension, the forces applied to 'them ought to be in the same *ratio*. Now, as the two 'threads are of the same length, and the base of the finer 'thread less than the base of the coarser, its periphery, 'and therefore its surface, will be less than that of the 'coarser; and the force, required to give its superficial 'fibres the same degree of tension with those of the 'coarser will likewise be less. Thus the two threads 'being of the same length, their surfaces, omitting the 'bases, will be as the peripheries of their bases; and the 'peripheries of their bases are as the diameters of their 'bases; and their bases are as the squares of their dia-'meters: therefore, the surfaces of the two threads will 'be as the square roots of their bases. But their bases 'are to each other, upon the supposition of an equal 'compression, $\frac{1}{a}:\frac{1}{b}$; their surfaces will then be, and the 'forces employed against them ought to be, $\sqrt{\frac{1}{a}}:\sqrt{\frac{1}{b}}$: 'and as $\frac{1}{b}$ is less than $\frac{1}{a}$, the $\sqrt{\frac{1}{b}}$ will be less than the $\sqrt{\frac{1}{a}}$, 'as has been said.

'But although the force applied to the surface of the 'finer thread, in the spinning, be less than what is applied 'to the surface of the coarser; the finer will be *more compressed* than the coarser. For while the compressing 'forces diminish and increase in the *ratio* of the surfaces 'of the threads, *i. e.* in the *ratio* of the peripheries of 'their bases, and, consequently, in the *ratio* of their 'diameters; the masses of the threads diminish and increase in the *ratio* of their bases, *i. e.* in the *duplicate ratio* 'of their diameters: the force, then, which is applied to 'the surface of the finer thread, though less than what is 'applied to the surface of the coarser, will bear a greater 'proportion to the mass upon which it acts, than the 'force which acts upon the coarser bears to the mass of 'the coarser. The finer thread, therefore, being subjected to a force proportionally greater than that which 'affects the coarser thread, will be *more strongly compressed* 'than the coarser, and become more dense, and less 'bulky, *i. e.* finer, by how much its mass is more 'diminished than the compressing force which is employed against it.

'It appears, then, that two things are to be regarded 'in ascertaining the comparative fineness of a yard of the 'parcel *a*, and a yard of the parcel *b*; the *mass* of each, 'and the *force* applied to the surface of each, in the spinning. As the threads are of equal lengths, their masses 'will be as their bases; and the forces applied to them 'are as the peripheries of their bases, or as the diameters 'of their bases respectively: the two threads will, therefore, be to each other in a *ratio* compounded of the '*ratios* of these two. Thus their bases being, forces 'equal or apart, $\frac{1}{a} : \frac{1}{b}$; and the forces, $\sqrt{\frac{1}{a}} : \sqrt{\frac{1}{b}}$; the 'coarser thread will be to the finer, $\frac{1}{a}\sqrt{\frac{1}{a}} : \frac{1}{b}\sqrt{\frac{1}{b}}$.

'These things being premised, the question to be discussed is simply this:—If yarn, the number of which in 'a given weight is a, and, consequently, its finenes $\frac{1}{a}\sqrt{\frac{1}{a}}$, 'be properly sleyed, for any one sort of cloth, in a reed, 'the number of which upon a given dimension is c; in 'what reed, of the same dimension, ought yarn to be 'sleyed, for cloth of the same fabric, the number of 'which, in the same weight, is b, and its fineness $\frac{1}{b}\sqrt{\frac{1}{b}}$?

'Here, for the present, let it be admitted, that the 'yarn, the fineness of which is $\frac{1}{a}\sqrt{\frac{1}{a}}$, is sleyed by one 'thread only in each interval of the reed c; and that the 'yarn, the fineness of which is $\frac{1}{b}\sqrt{\frac{1}{b}}$, is to be sleyed in 'the same manner: and let it further be allowed that the 'intervals of the reed c are so exactly commensurate to 'the threads $\frac{1}{a}\sqrt{\frac{1}{a}}$, that each thread is touched upon both 'sides by its neighbouring splits, without being pressed 'by them, and thereby deprived of its cylindrical form. 'These things granted, each interval of the reed c will 'be equal to the diameter of the circular base of the 'cylindrical thread contained in it. Now, as circles are 'to each other as the squares of their diameters; so, *vice* '*versa*, the square of the diameter of one circle will be 'to the square of the diameter of another circle, as the 'one circle is to the other. But the circular bases of the 'two threads are, $\frac{1}{a}\sqrt{\frac{1}{a}} : \frac{1}{b}\sqrt{\frac{1}{b}}$; and an interval of c, or $\frac{1}{c}$, 'is equal to the diameter of a thread $\frac{1}{a}\sqrt{\frac{1}{a}}$; therefore, the 'square of $\frac{1}{c}$* will be to the square of an interval of the

* 'Here it is presumed, that the thickness of each of the splits, in the 'one reed, is to the thickness of each of those, in the other, *inversely* as 'the number of splits, in the one, to the number of those in the other.

'The strictest regard is due to this proportion in making reeds for the 'same sorts of cloth; as otherwise, the best scheme of sleying, that can 'be devised, will, in many instances, be rendered impracticable.

‘ reed sought, $\frac{1}{a}\sqrt{\frac{1}{a}} : \frac{1}{b}\sqrt{\frac{1}{b}}$. Or, to express it in the al‘ ternate way,

$$\frac{1}{a}\sqrt{\frac{1}{a}} : \frac{1}{c}^{2} :: \frac{1}{b}\sqrt{\frac{1}{b}} : \frac{1}{x}^{2}.$$

‘ Each interval, then, of the reed x will be equal to the ‘ diameter of a thread $\frac{1}{b}\sqrt{\frac{1}{b}}$ in the same manner that an ‘ interval of c is equal to the diameter of a thread $\frac{1}{a}\sqrt{\frac{1}{a}}$. ‘ And if it should be supposed, that an interval of c is ‘ commensurate to two, three, four, or any given num‘ ber of threads $\frac{1}{a}\sqrt{\frac{1}{a}}$; it will follow, that an interval of ‘ x will be equally commensurate to the same number of ‘ threads $\frac{1}{b}\sqrt{\frac{1}{b}}$.

‘ And if an interval of c, equal to the diameters of a ‘ given number of threads $\frac{1}{a}\sqrt{\frac{1}{a}}$, have only a part of that ‘ number sleyed into it; and an interval of x, equal to ‘ the diameters of the same number of threads $\frac{1}{b}\sqrt{\frac{1}{b}}$, have ‘ the like part of that number sleyed in it; the empty ‘ space in the interval c will be to that of the interval x, ‘ as the one interval is to the other: and the occupied ‘ space in the one will be to the occupied space in the ‘ other, in the same *ratio:* and the empty space in the ‘ interval x will be to the thread, or threads, contained in ‘ that interval, as the empty space in the interval c is to ‘ what is contained in it.

‘ In like manner, if there be sleyed into an interval of ‘ c a greater number of threads $\frac{1}{a}\sqrt{\frac{1}{a}}$ than that interval is ‘ equal to the diameters of; and an equal number of ‘ threads $\frac{1}{b}\sqrt{\frac{1}{b}}$ be sleyed into an interval of x; the ‘ threads in the interval c, will be to the threads in the ‘ interval x, as the one interval is to the other: and the ‘ excess in the one will be to the excess in the other in ‘ the same *ratio:* and the excess in the interval c, will be ‘ to the threads in the interval c, as the excess in the in‘ terval x is to the threads in the interval x.

‘ Hence, if yarn $\frac{1}{a}\sqrt{\frac{1}{a}}$ be high-sleyed, or thick-set in the
‘ reed c; the yarn $\frac{1}{b}\sqrt{\frac{1}{b}}$ will be so likewise in the reed x:
‘ if the former be low-sleyed, or thin-set; so will the lat-
‘ ter: and, universally, whatever the fabric of the cloth
‘ made from the one is, such will the fabric of that made
‘ from the other be; so far as the fabric of cloth depends
‘ upon the sleying of its warp.

‘ The method, however, which obtains here, in Scot-
‘ land, of coming at the comparative fineness of yarns, is
‘ not by taking the number of convolutions in a given
‘ weight; but by—what amounts to the same thing—the
‘ weight of a given number of convolutions. For instance;
‘ a spyndle, which, in this country, is the highest denom-
‘ ination of yarn, contains 5760 convolutions of two yards
‘ and an half in circumference; or, to use the common
‘ phrase, 5760 threads, ten quarters of a yard in length.
‘ Now, if a spyndle weighs a pound; to say that it does
‘ so, is, in effect, the same as saying that there are 5760
‘ threads in a pound. Again, if another spyndle weighs
‘ a quarter of a pound; with respect to this second, to
‘ say that a spyndle is equal to a quarter of a pound; or
‘ that a pound contains four times the number of threads
‘ of this yarn that it does of the former, comes to the
‘ same thing. And, no doubt, it is much easier in as-
‘ sorting any considerable quantity of yarn, to weigh it
‘ by half, or even by quarter, spyndles; and then to class
‘ the different parcels according to their respective
‘ weights *, than it would be, first to divide the quantity
‘ into pounds; and then—sit down, and count the num-
‘ ber of threads in each pound; and after that—to range

* ‘ This supposes that every spyndle has its full tale: and, indeed,
‘ partly owing to wise regulations, and partly to national honesty, there
‘ is little ground of complaint here.

'the several parcels according to the number of threads 'in the pound. But then, this easier method varies the 'state of the terms, as well as the terms themselves, in 'ascertaining the comparative fineness of yarns; and, 'consequently, varies the operation in finding the value 'of x. For, as in any two yarns, that are spun from the 'same materials, the number of threads in a given weight, 'of the one, is to the number of threads in the same weight, 'of the other, *inversely* as the bases of the threads, ab-'stract from their compression; so the weight of a given 'number, of the one, is to the weight of the same number 'of threads, of the other, *directly* as their bases. This is 'evident from the example just now given: there it is 'seen that a pound contains four times the number of 'the finer yarn that it does of the coarser; at the same 'time, a spyndle of the coarser is four times the weight 'of a spyndle of the finer. And, in every case, as threads 'of the same length and density have their masses in the '*ratio* of their bases; so, *e contra*, their bases will be in 'the *ratio* of their masses. Now, as the two spyndles 'are spun from the same materials; their masses will be 'as their weights: and as they are of the same length, 'their bases will be in the *ratio* of their masses, *i. e.* in 'the *ratio* of their weights: and as the compressing force, 'applied, in the spinning, to the surfaces of threads, of 'the same length, is in the *ratio* of the square root of the 'mass; and the mass is as the weight; the two spyndles 'will be to each other *directly* as their weights into the 'square roots of their respective weights. Thus, if the 'weight of a spyndle of yarn be d, the number of which 'in a pound is a; and the weight of another spyndle be 'e, the number of which in a pound is b; the compara-'tive fineness of the two is equally ascertained by saying, 'that the coarser is to the finer, $d\sqrt{d} : e\sqrt{e}$; or, $\frac{1}{a}\sqrt{\frac{1}{a}}$: '$\frac{1}{b}\sqrt{\frac{1}{b}}$. In either case, the value of x will turn out to be 'the same—whether the question be stated *inversely*, as 'the *numbers*; or *directly*, as the weights.'

At the time when this extract was written, all the yarn manufactured into cloth was spun by the distaff, or common spinning wheel. For this reason, the ingenious author had not the same opportunities, which now exist, of calculating with accuracy the ratio of twine which every size or grist of yarn required; nor the effect of that twine upon the thread, considered as a cylinder. The mule jenny, from the nature of its operation, is well calculated for this computation; for as a given length is spun at every draught of the mule, it becomes very easy to ascertain with great accuracy the average twine which every number requires in that length, and, consequently, in any other length.

If the principle, that the increase of twine necessary for fine yarn above coarse, by compressing the stuff more, diminishes the thickness or diameter of the thread be correct, the whole of the subsequent reasoning must be allowed to be strictly mathematical, and the deduction perfectly conclusive.

But there seems just reason to doubt the accuracy of this part of his hypothesis, because he appears to have entirely overlooked an effect of the operation of spinning upon the yarn, very important to be taken into the calculation. When any kind of material is prepared for spinning, the fibres are all placed parallel to each other, and the subsequent operation of twisting gives them the cohesion necessary to give the thread a proper degree of strength and solidity. The natural effect of this is, that the fibres, by the twining, deviate from a straight line into that of a spiral or screw; and the same quantity of materials when twined, become considerably shorter than before. In spinning cotton yarn upon the mule, the carriage, after being drawn out to its full length, evidently recedes again towards the rollers, as the twine increases; and when the stuff is not equal, the coarse threads always begin to break, before the fine ones are sufficiently twined. In the twisting of ropes, where the diameter is great, this effect is still more perceptible. From this the natural inference seems to be, that the increase of twine diminishes the length, not the diameter of the thread. No allowance whatever is made for the shrinking in the length by our Author's hypothesis, but the whole is supposed to affect the diameter, which is evidently not the case.

But it may be supposed, that as the twine increases some diminution may take place, both in the length and in the diameter; and it becomes necessary to ascertain whether this is really the case, and if so, what ratio these bear to each other, before a correct rule for caaming or sleying can be found.

To ascertain these points, I made different inquiries, calculations, and experiments, the results of which I shall now lay before the reader, leaving him to decide, whether the conclusion which I have drawn from them is satisfactory or not.

It is perfectly impossible, by any known instrument, to measure the actual diameter of fine yarn with any degree of accuracy, but a rope of considerable diameter may easily be measured; and as it seemed probable that the same ratio might exist in coarse spinning, as in fine, my first inquiries were directed to this branch of spinning. The form which the strands of a rope assume, when twisted, is exactly similar to that of a common screw. I, therefore, first endeavoured to compare the one with the other, and observe the effect. Most mechanics know the way in which the spiral is marked on a wooden or iron screw, before it is cut, by drawing a succession of right angled triangles upon a piece of paper, equal in length to the circumference of the cylinder upon which the screw is to be cut. This piece of paper is afterwards pasted round the cylinder, when the hypothenuses of the triangles form the spiral lines. Upon the same principle, the circumference of a rope may be considered as the base of a triangle; the distance between the parts of the same strand, after one whole revolution, as the perpendicular; and the spiral described by the strand in revolving, as the hypothenuse. Now as the rope shortens as the twine increases, the strands will be forced nearer to each other. Consequently, the perpendicular will decrease in length, and the angle at the base will become more acute.

The report of practical ropemakers is, that a shroud laid rope shortens one third in the twisting. Let us, therefore, suppose, that when the strands are laid, before twining, the circumference, or base line, is three inches, and the perpendicular the same. When the rope has been fully twined, the perpendicular will be only two inches, and if the diameter of the rope has continued the same, the base will still be three inches. Now, by a very simple operation in right angled trigonometry, the angle at the base, forming the obliquity of the spiral, will be 33° 42', which, by inspecting the common run of ropes, will be found very nearly the case. From this we may infer, that the whole contraction and compression has been in the length, and that the diameter has undergone no diminution. Next, as every thread, when twisting, appears to shorten in proportion to the twine which it receives, it seemed expedient to inquire what ratio the twine of different numbers of cotton yarn bear to each other, and how far this coincided, or differed from that of the effect which the Author of the extract just quoted supposes twining to produce, in diminishing the diameter.

Upon applying to several extensive spinners, I found their answers, in general, to be, that the twine required for different numbers was as the square roots of the numbers. One of these answers, given to me by Mr. Dunlop of Barrowfield Mill, I shall quote.

The number of twists upon an inch of yarn being given, say No. 70=24. To find the proper twist for No. 60, the proportion will be

$$\sqrt{70} : 24 :: \sqrt{60} : 22.2$$

The number of twists for every inch of the following numbers of yarn, is

No. 50	20.2	80	25.6
60	22.2	90	27.2
70	24.	100	28.6

From the above, it will appear, that the ratio of twine is exactly the same as the Author assumed that of diminution to be, or directly as the diameter of the cylinder, which is, therefore, the square root of the number.

This seems a second proof, that the whole compressing power of the twine is exerted upon the length.

I next tried the following practical experiment: Having bored a very smooth hole, of an inch diameter, in a piece of hard wood, I passed through it a number of pieces of soft smooth twine about 30 feet long. When the twine was stretched without being twisted, the board could be shifted with little difficulty along them. I then twisted them, and found the length to decrease sensibly as the twine increased, but upon the diameter I could perceive no difference. When pretty hard twined, indeed, from the oblique form which the strands had assumed, it was more difficult to shift the board than before; but this appeared to rise more from friction, than any increase of diameter; diminution there was certainly none.

From these different trials, it seems to result, that the shortening of any thread or rope, proceeds from the fibres or strands of which it is composed changing their direction from a longitudinal to an oblique or spiral position; and that no further compression is produced than what is necessary to bring them all into close contact. Were more compression produced than the fibres would yield to, the diameter must increase instead of diminishing, for, as at every twist, the length, or altitude, becomes less, the stuff, when no longer susceptible of compression, must swell in thickness. But so great a quantity of twine as would effect this, so far from being of any service to yarn, would be extremely injurious.

These considerations induce me to believe, that the fibres of every kind of material from which yarn is spun, undergo nearly an equal degree of compression, and that, therefore, the diameters may be estimated as those of other solid cylinders. The general rule which has been adopted seems, on this account, to be the best for practical use. This is, that the square roots of the numbers are as the measure of the reeds, to produce similar fabrics. For example, if No. 40 of cotton yarn is wrought in a 1200 reed, and it is necessary to work cloth of a similar fabric in one of 1600, the proportion will be

$$12 : \sqrt{40} :: 16 : \sqrt{71.1}$$

The fraction may be thrown away, and the number required will be 71. But as the extraction of roots by common arithmetic, is tedious, and not generally known, the same effect will be produced by squaring the reeds. The operation will then stand thus,

12×12 or $12^2 = 144$ and 16×16, or $16^2 = 256$, therefore,

$$144 : 40 :: 256 : 71.1$$

The difference between this plan and that of the essay quoted, is, that this is as the squares, the other as the cubes of the diameters. No precise definition has ever been given of what really is similarity of fabric in cloth. Both of the preceding plans, are formed upon the idea that the diameter of the threads of warp should be in proportion to the measure of the reed; and this is, perhaps, the best way of fixing the standard. If we suppose that every thread touches the one next to it in a coarse fabric, and upon that supposition calculate what will produce the same effect in a fine web, we will naturally call it a similar fabric. To a certain degree, it will be so; but when we consider cloth as a solid, although the threads of the fine web should be placed as much in contact as those of the coarse, the thickness of the cloth will be diminished in the arithmetical ratio of the respective diameters. In this case, I do not mean by the word *thickness*, the crowding together of warp and weft, which is the sense in which it is generally used by weavers; but the distance from the under to the upper superficies of the cloth. Upon the whole, by far too little attention has been paid to reduce this part of the business of fabricating cloth to any regular system. It is certainly proper to have some fixed standard, and from this every manufacturer may deviate, according to the fashion of the times, or the taste of his customers.

We come now to the last part of this work, and upon this it will not be necessary to go much into detail. This is to consider the arithmetical part of the business of a manufacturer. It is the only part of the business which has been introduced into books, formerly written on the subject of weaving, and it is, therefore, less necessary to enlarge upon it. For practical purposes, a few tables may be useful, which I shall add in a miscellaneous way, with such remarks as may seem necessary.

COMPUTATION OF LINEN YARN.

THE circumference of the reel, for linen yarn, is fixed, by the Act of Parliament, at 90 inches, or $2\frac{1}{2}$ yards, Once round this is called a thread, and the quantities of yarn are measured as follows:

1 thread	=		=	$2\frac{1}{2}$	yards
120 threads	=	1 cut	=	300	do.
2 cuts	=	1 heer	=	600	do.
3 heers	=	1 slip	=	1800	do.
2 slips	=	1 hank	=	3600	do.
2 hanks	=	1 hesp	=	7200	do.
2 hesps	=	1 spyndle	=	14400	do.

In general, however, the calculations are made by spyndles, heers, cuts, and threads, the intermediate divisions being omitted. The length of warps, as formerly stated, is rated by the number of English, or mill ells of forty-five inches, or five quarters each.

There are two ways of calculating the warp of webs necessary.

1st, Given the quantity of warp and breadth in porters, to find the length which will be produced in ells.

For this, the common practical rule is, multiply the spyndles by 288, and divide the product by the number of porters; the quotient is the answer.

One example will be sufficient.

Given 34 spyndles of yarn, to warp a web
72 porters broad.
Required the length in ells.
$288 \times 34 = 10192$ and $10192 \div 72 = 141\frac{40}{72}$ ells.
Thus the answer is 141 ells and 20 inches.

This rule is chiefly useful to customer weavers, who find it necessary to accommodate the length of their webs, to the quantity of warp which they receive.

2d, Given the length in ells, and breadth in porters, to find the warp required.

This rule is exactly the converse of the former; namely, multiply the ells by the porters, and divide by 288.

Given 100 ells 56 porters wide.
Required the quantity of warp.
$100 \times 56 = 5600$ and $5600 \div 288 = 19\frac{128}{288}$, or
19 spyndles, 11 heers, and 1 cut.

This is chiefly used in extensive manufactories, where they have large quantities of warp, and make their webs uniform lengths for the sake of regularity.

The following Table is calculated upon these principles, and may be useful to save calculation in common practice. On the top, are the lengths in ells; and in the first column, the porters in the breadth. The remaining columns, contain the quantity required for each of the respective lengths at the top. It is made as comprehensive as the limits of the work will admit. Other lengths may be found, by adding two or more of those given to make the number required. For instance, if 75 ells are required, take 50, and the half of 50; or take 50, 10 twice, and 5, and so of others. It may, in some cases, be shorter, to subtract one length from another. Suppose 95 ells; 5 subtracted from 100, will give the answer.

Both the calculations and the Table, it is to be remarked, are computed exactly to the length of the reel, and number of yards in the spyndle, without any allowance for waste, breakage, short measure, or count. But as this can never be expected, it is customary to allow one heer, to every spyndle, for these deficiences, and even this allowance is often found too little.

TABLE OF WARPS.

TABLE OF

Porters.	ELLS.															
	1				2				3				4			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
18	0	1	1	0	0	3	0	0	0	4	1	0	0	6	0	0
19	0	1	1	20	0	3	0	40	0	4	1	60	0	6	0	80
20	0	1	1	40	0	3	0	80	0	5	0	0	0	6	1	40
21	0	1	1	60	0	3	1	0	0	5	0	60	0	7	0	0
22	0	1	1	80	0	3	1	40	0	5	1	0	0	7	0	80
23	0	1	1	100	0	3	1	80	0	5	1	60	0	7	1	40
24	0	2	0	0	0	4	0	0	0	6	0	0	0	8	0	0
25	0	2	0	20	0	4	0	40	0	6	0	60	0	8	0	80
26	0	2	0	40	0	4	0	80	0	6	1	0	0	8	1	40
27	0	2	0	60	0	4	1	0	0	6	1	60	0	9	0	0
28	0	2	0	80	0	4	1	40	0	7	0	0	0	9	0	80
29	0	2	0	100	0	4	1	80	0	7	0	60	0	9	1	40
30	0	2	1	0	0	5	0	0	0	7	1	0	0	10	0	0
31	0	2	1	20	0	5	0	40	0	7	1	60	0	10	0	80
32	0	2	1	40	0	5	0	80	0	8	0	0	0	10	1	40
33	0	2	1	60	0	5	1	0	0	8	0	60	0	11	0	0
34	0	2	1	80	0	5	1	40	0	8	1	0	0	11	0	80
35	0	2	1	100	0	5	1	80	0	8	1	60	0	11	1	40
36	0	3	0	0	0	6	0	0	0	9	0	0	0	12	0	0
37	0	3	0	20	0	6	0	40	0	9	0	60	0	12	0	80
38	0	3	0	40	0	6	0	80	0	9	1	0	0	12	1	40
39	0	3	0	60	0	6	1	0	0	9	1	60	0	13	0	0
40	0	3	0	80	0	6	1	40	0	10	0	0	0	13	0	80
41	0	3	0	100	0	6	1	80	0	10	0	60	0	13	1	40

WARPS.

Porters.	ELLS.															
	5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
18	0	7	1	0	0	15	0	0	3	3	0	0	6	6	0	0
19	0	7	1	100	0	15	1	80	3	7	0	40	6	14	0	80
20	0	8	0	80	0	16	1	40	3	11	0	80	6	22	1	40
21	0	8	1	60	0	17	1	0	3	15	1	0	7	7	0	0
22	0	9	0	40	0	18	0	80	3	19	1	40	7	15	0	80
23	0	9	1	20	0	19	0	40	3	23	1	80	7	23	1	40
24	0	10	0	0	0	20	0	0	4	4	0	0	8	8	0	0
25	0	10	0	100	0	20	1	80	4	8	0	40	8	16	0	80
26	0	10	1	80	0	21	1	40	4	12	0	80	9	0	1	40
27	0	11	0	60	0	22	1	0	4	16	1	0	9	9	0	0
28	0	11	1	40	0	23	0	80	4	20	1	40	9	17	0	80
29	0	12	0	20	1	0	0	40	5	0	1	80	10	1	1	40
30	0	12	1	0	1	1	0	0	5	5	0	0	10	10	0	0
31	0	12	1	100	1	1	1	80	5	9	0	40	10	18	0	80
32	0	13	0	80	1	2	1	40	5	13	0	80	11	2	1	40
33	0	13	1	60	1	3	1	0	5	17	1	0	11	11	0	0
34	0	14	0	40	1	4	0	80	5	21	1	40	11	19	0	80
35	0	14	1	20	1	5	0	40	6	1	1	80	12	3	1	40
36	0	15	0	0	1	6	0	0	6	6	0	0	12	12	0	0
37	0	15	0	100	1	6	1	80	6	10	0	40	12	20	0	80
38	0	15	1	80	1	7	1	40	6	14	0	80	13	4	1	40
39	0	16	0	60	1	8	1	0	6	18	1	0	13	13	0	0
40	0	16	1	40	1	9	0	80	6	22	1	40	13	21	0	80
41	0	17	0	20	1	10	0	40	7	2	1	80	14	5	1	40

TABLE OF

Porters.	ELLS.															
	1				2				3				4			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
42	0	3	1	0	0	7	0	0	0	10	1	0	0	14	0	0
43	0	3	1	20	0	7	0	40	0	10	1	60	0	14	0	80
44	0	3	1	40	0	7	0	80	0	11	0	0	0	14	1	40
45	0	3	1	60	0	7	1	0	0	11	0	60	0	15	0	0
46	0	3	1	80	0	7	1	40	0	11	1	0	0	15	0	80
47	0	3	1	100	0	7	1	80	0	11	1	60	0	15	1	40
48	0	4	0	0	0	8	0	0	0	12	0	0	0	16	0	0
49	0	4	0	20	0	8	0	40	0	12	0	60	0	16	0	80
50	0	4	0	40	0	8	0	80	0	12	1	0	0	16	1	40
51	9	4	0	60	0	8	1	0	0	12	1	60	0	17	0	0
52	0	4	0	80	0	8	1	40	0	13	0	0	0	17	0	80
53	0	4	0	100	0	8	1	80	0	13	0	60	0	17	1	40
54	0	4	1	0	0	9	0	0	0	13	1	0	0	18	0	0
55	0	4	1	20	0	9	0	40	0	13	1	60	0	18	0	80
56	0	4	1	40	0	9	0	80	0	14	0	0	0	18	1	40
57	0	4	1	60	0	9	1	0	0	14	0	60	0	19	0	0
58	0	4	1	80	0	9	1	40	0	14	1	0	0	19	0	80
59	0	4	1	100	0	9	1	80	0	14	1	60	0	19	1	40
60	0	5	0	0	0	10	0	0	0	15	0	0	0	20	0	0
61	0	5	0	20	0	10	0	40	0	15	0	60	0	20	0	80
62	0	5	0	40	0	10	0	80	0	15	1	0	0	20	1	40
63	0	5	0	60	0	10	1	0	0	15	1	60	0	21	0	0
64	0	5	0	80	0	10	1	40	0	16	0	0	0	21	0	80
65	0	5	0	100	0	10	1	80	0	16	0	60	0	21	1	40

WARPS.

Porters.	ELLS.															
	5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
42	0	17	1	0	1	11	0	0	7	7	0	0	14	14	0	0
43	0	17	1	100	1	11	1	80	7	11	0	40	14	22	0	80
44	0	18	0	80	1	12	1	40	7	15	0	80	15	6	1	40
45	0	18	1	60	1	13	1	0	7	19	1	0	15	15	0	0
46	0	19	0	40	1	14	0	80	7	23	1	40	15	23	0	80
47	0	19	1	20	1	15	0	40	8	3	1	80	16	7	1	40
48	0	20	0	0	1	16	0	0	8	8	0	0	16	16	0	0
49	0	20	0	100	1	16	1	80	8	12	0	40	17	0	0	80
50	0	20	1	80	1	17	1	40	8	16	0	80	17	8	1	40
51	0	21	0	60	1	18	1	0	8	20	1	0	17	17	0	0
52	0	21	1	40	1	19	0	80	9	0	1	40	18	1	0	80
53	0	22	0	20	1	20	0	40	9	4	1	80	18	9	1	40
54	0	22	1	0	1	21	0	0	9	9	0	0	18	18	0	0
55	0	22	1	100	1	21	1	80	9	13	0	40	19	2	0	80
56	0	23	0	80	1	22	1	40	9	17	0	80	19	10	1	40
57	0	23	1	60	1	23	1	0	9	21	1	0	19	19	0	0
58	1	0	0	40	2	0	0	80	10	1	1	40	20	3	0	80
59	1	0	1	20	2	1	0	40	10	5	1	80	20	11	1	40
60	1	1	0	0	2	2	0	0	10	10	0	0	20	20	0	0
61	1	1	0	100	2	2	1	80	10	14	0	40	21	4	0	80
62	1	1	1	80	2	3	1	40	10	18	0	80	21	12	1	40
63	1	2	0	60	2	4	1	0	10	22	1	0	21	21	0	0
64	1	2	1	40	2	5	0	80	11	2	1	40	22	5	0	80
65	1	3	0	20	2	6	0	40	11	6	1	80	22	13	1	40

TABLE OF

Porters.	ELLS.															
	1				2				3				4			
	s.	h.	c.	t.	s.	h.	c.	t.	s.	h.	c.	t.	s.	h.	c.	t.
66	0	5	1	0	0	11	0	0	0	16	1	0	0	22	0	0
67	0	5	1	20	0	11	0	40	0	16	1	60	0	22	0	80
68	0	5	1	40	0	11	0	80	0	17	0	0	0	22	1	40
69	0	5	1	60	0	11	1	0	0	17	0	60	0	23	0	0
70	0	5	1	80	0	11	1	40	0	17	1	0	0	23	0	80
71	0	5	1	100	0	11	1	80	0	17	1	60	0	23	1	40
72	0	6	0	0	0	12	0	0	0	18	0	0	1	0	0	0
73	0	6	0	20	0	12	0	40	0	18	0	60	1	0	0	80
74	0	6	0	40	0	12	0	80	0	18	1	0	1	0	1	40
75	0	6	0	60	0	12	1	0	0	18	1	60	1	1	0	0
76	0	6	0	80	0	12	1	40	0	19	0	0	1	1	0	80
77	0	6	0	100	0	12	1	80	0	19	0	60	1	1	1	40
78	0	6	1	0	0	13	0	0	0	19	1	0	1	2	0	0
79	0	6	1	20	0	13	0	40	0	19	1	60	1	2	0	80
80	0	6	1	40	0	13	0	80	0	20	0	0	1	2	1	40
81	0	6	1	60	0	13	1	0	0	20	0	60	1	3	0	0
82	0	6	1	80	0	13	1	40	0	20	1	0	1	3	0	80
83	0	6	1	100	0	13	1	80	0	20	1	60	1	3	1	40
84	0	7	0	0	0	14	0	0	0	21	0	0	1	4	0	0
85	0	7	0	20	0	14	0	40	0	21	0	60	1	4	0	80
86	0	7	0	40	0	14	0	80	0	21	1	0	1	4	1	40
87	0	7	0	60	0	14	1	0	0	21	1	60	1	5	0	0
88	0	7	0	80	0	14	1	40	0	22	0	0	1	5	0	80
89	0	7	0	100	0	14	1	80	0	22	0	60	1	5	1	40

WARPS.

Porters.	ELLS. 5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
66	1	3	1	0	2	7	0	0	11	11	0	0	22	22	0	0
67	1	3	1	100	2	7	1	80	11	15	0	40	23	6	0	80
68	1	4	0	80	2	8	1	40	11	19	0	80	23	14	1	40
69	1	4	1	60	2	9	1	0	11	23	1	0	23	23	0	0
70	1	5	0	40	2	10	0	80	12	3	1	40	24	7	0	80
71	1	5	1	20	2	11	0	40	12	7	1	80	24	15	1	40
72	1	6	0	0	2	12	0	0	12	12	0	0	25	0	0	0
73	1	6	0	100	2	12	1	80	12	16	0	40	25	8	0	80
74	1	6	1	80	2	13	1	40	12	20	0	80	25	16	1	40
75	1	7	0	60	2	14	1	0	13	0	1	0	26	1	0	0
76	1	7	1	40	2	15	0	80	13	4	1	40	26	9	0	80
77	1	8	0	20	2	16	0	40	13	8	1	80	26	17	1	40
78	1	8	1	0	2	17	0	0	13	13	0	0	27	2	0	0
79	1	8	1	100	2	17	1	80	13	17	0	40	27	10	0	80
80	1	9	0	80	2	18	1	40	13	21	0	80	27	18	1	40
81	1	9	1	60	2	19	1	0	14	1	1	0	28	3	0	0
82	1	10	0	40	2	20	0	80	14	5	1	40	28	11	0	80
83	1	10	1	20	2	21	0	40	14	9	1	80	28	19	1	40
84	1	11	0	0	2	22	0	0	14	14	0	0	29	4	0	0
85	1	11	0	100	2	22	1	80	14	18	0	40	29	12	0	80
86	1	11	1	80	2	23	1	40	14	22	0	80	29	20	1	40
87	1	12	0	60	3	0	1	0	15	2	1	0	30	5	0	0
88	1	12	1	40	3	1	0	80	15	6	1	40	30	13	0	80
89	1	13	0	20	3	2	0	40	15	10	1	80	30	21	1	40

TABLE OF

Porters.	ELLS.															
	1				2				3				4			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
90	0	7	1	0	0	15	0	0	0	22	1	0	1	6	0	0
91	0	7	1	20	0	15	0	40	0	22	1	60	1	6	0	80
92	0	7	1	40	0	15	0	80	0	23	0	0	1	6	1	40
93	0	7	1	60	0	15	1	0	0	23	0	60	1	7	0	0
94	0	7	1	80	0	15	1	40	0	23	1	0	1	7	0	80
95	0	7	1	100	0	15	1	80	0	23	1	60	1	7	1	40
96	0	8	0	0	0	16	0	0	1	0	0	0	1	8	0	0
97	0	8	0	20	0	16	0	40	1	0	0	60	1	8	0	80
98	0	8	0	40	0	16	0	80	1	0	1	0	1	8	1	40
99	0	8	0	60	0	16	1	0	1	0	1	60	1	9	0	0
100	0	8	0	80	0	16	1	40	1	1	0	0	1	9	0	80
101	0	8	0	100	0	16	1	80	1	1	0	60	1	9	1	40
102	0	8	1	0	0	17	0	0	1	1	1	0	1	10	0	0
103	0	8	1	20	0	17	0	40	1	1	1	60	1	10	0	80
104	0	8	1	40	0	17	0	80	1	2	0	0	1	10	1	40
105	0	8	1	60	0	17	1	0	1	2	0	60	1	11	0	0
106	0	8	1	80	0	17	1	40	1	2	1	0	1	11	0	80
107	0	8	1	100	0	17	1	80	1	2	1	60	1	11	1	40
108	0	9	0	0	0	18	0	0	1	3	0	0	1	12	0	0
109	0	9	0	20	0	18	0	40	1	3	0	60	1	12	0	80
110	0	9	0	40	0	18	0	80	1	3	1	0	1	12	1	40
111	0	9	0	60	0	18	1	0	1	3	1	60	1	13	0	0
112	0	9	0	80	0	18	1	40	1	4	0	0	1	13	0	80
113	0	9	0	100	0	18	1	80	1	4	0	60	1	13	1	40

WARPS.

Porters.	ELLS.															
	5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
90	1	13	1	0	3	3	0	0	15	15	0	0	31	6	0	0
91	1	13	1	100	3	3	1	80	15	19	0	40	31	14	0	80
92	1	14	0	80	3	4	1	40	15	23	0	80	31	22	1	40
93	1	14	1	60	3	5	1	0	16	3	1	0	32	7	0	0
94	1	15	0	40	3	6	0	80	16	7	1	40	32	15	0	80
95	1	15	1	20	3	7	0	40	16	11	1	80	32	23	1	40
96	1	16	0	0	3	8	0	0	16	16	0	0	33	8	0	0
97	1	16	0	100	3	8	1	80	16	20	0	40	33	16	0	80
98	1	16	1	80	3	9	1	40	17	0	0	80	34	0	1	40
99	1	17	0	60	3	10	1	0	17	4	1	0	34	9	0	0
100	1	17	1	40	3	11	0	80	17	8	1	40	34	17	0	80
101	1	18	0	20	3	12	0	40	17	12	1	80	35	1	1	40
102	1	18	1	0	3	13	0	0	17	17	0	0	35	10	0	0
103	1	18	1	100	3	13	1	80	17	21	0	40	35	18	0	80
104	1	19	0	80	3	14	1	40	18	1	0	80	36	2	1	40
105	1	19	1	60	3	15	1	0	18	5	1	0	36	11	0	0
106	1	20	0	40	3	16	0	80	18	9	1	40	36	19	0	80
107	1	20	1	20	3	17	0	40	18	13	1	80	37	3	1	40
108	1	21	0	0	3	18	0	0	18	18	0	0	37	12	0	0
109	1	21	0	100	3	18	1	80	18	22	0	40	37	20	0	80
110	1	21	1	80	3	19	1	40	19	2	0	80	38	4	1	40
111	1	22	0	60	3	20	1	0	19	6	1	0	38	13	0	0
112	1	22	1	40	3	21	0	80	19	10	1	40	38	21	0	80
113	1	23	0	20	3	22	0	40	19	14	1	80	39	5	1	40

TABLE OF

Porters.	ELLS.															
	1				2				3				4			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
114	0	9	1	0	0	19	0	0	1	4	1	0	1	14	0	0
115	0	9	1	20	0	19	0	40	1	4	1	60	1	14	0	80
116	0	9	1	40	0	19	0	80	1	5	0	0	1	14	1	40
117	0	9	1	60	0	19	1	0	1	5	0	60	1	15	0	0
118	0	9	1	80	0	19	1	40	1	5	1	0	1	15	0	80
119	0	9	1	100	0	19	1	80	1	5	1	60	1	15	1	40
120	0	10	0	0	0	20	0	0	1	6	0	0	1	16	0	0
121	0	10	0	20	0	20	0	40	1	6	0	60	1	16	0	80
122	0	10	0	40	0	20	0	80	1	6	1	0	1	16	1	40
123	0	10	0	60	0	20	1	0	1	6	1	60	1	17	0	0
124	0	10	0	80	0	20	1	40	1	7	0	0	1	17	0	80
125	0	10	0	100	0	20	1	80	1	7	0	60	1	17	1	40
126	0	10	1	0	0	21	0	0	1	7	1	0	1	18	0	0
127	0	10	1	20	0	21	0	40	1	7	1	60	1	18	0	80
128	0	10	1	40	0	21	0	80	1	8	0	0	1	18	1	40
129	0	10	1	60	0	21	1	0	1	8	0	60	1	19	0	0
130	0	10	1	80	0	21	1	40	1	8	1	0	1	19	0	80
131	0	10	1	100	0	21	1	80	1	8	1	60	1	19	1	40
132	0	11	0	0	0	22	0	0	1	9	0	0	1	20	0	0
133	0	11	0	20	0	22	0	40	1	9	0	60	1	20	0	80
134	0	11	0	40	0	22	0	80	1	9	1	0	1	20	1	40
135	0	11	0	60	0	22	1	0	1	9	1	60	1	21	0	0
136	0	11	0	80	0	22	1	40	1	10	0	0	1	21	0	80
137	0	11	0	100	0	22	1	80	1	10	0	60	1	21	1	40

WARPS.

Porters.	ELLS.															
	5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
114	1	23	1	0	3	23	0	0	19	19	0	0	39	14	0	0
115	1	23	1	100	3	23	1	80	19	23	0	40	39	22	0	80
116	2	0	0	80	4	0	1	40	20	3	1	80	40	6	1	40
117	2	0	1	60	4	1	1	0	20	7	1	0	40	15	0	0
118	2	1	0	40	4	2	0	80	20	11	1	40	40	23	0	80
119	2	1	1	20	4	3	0	40	20	15	1	80	41	7	1	40
120	2	2	0	0	4	4	0	0	20	20	0	0	41	16	0	0
121	2	2	0	100	4	4	1	80	21	0	0	40	42	0	0	80
122	2	2	1	80	4	5	1	40	21	4	0	80	42	8	1	40
123	2	3	0	60	4	6	1	0	21	8	1	0	42	17	0	0
124	2	3	1	40	4	7	0	80	21	12	1	40	43	1	0	80
125	2	4	0	20	4	8	0	40	21	16	1	80	43	9	1	40
126	2	4	1	0	4	9	0	0	21	21	0	0	43	18	0	0
127	2	4	1	100	4	9	1	80	22	1	0	40	44	2	0	80
128	2	5	0	80	4	10	1	40	22	5	0	80	44	10	1	40
129	2	5	1	60	4	11	1	0	22	9	1	0	44	19	0	0
130	2	6	0	40	4	12	0	80	22	13	1	40	45	3	0	80
131	2	6	1	20	4	13	0	40	22	17	1	80	45	11	1	40
132	2	7	0	0	4	14	0	0	22	22	0	0	45	20	0	0
133	2	7	0	100	4	14	1	80	23	2	0	40	46	4	0	80
134	2	7	1	80	4	15	1	40	23	6	0	80	46	12	1	40
135	2	8	0	60	4	16	1	0	23	10	1	0	46	21	0	0
136	2	8	1	40	4	17	0	80	23	14	1	40	47	5	0	80
137	2	9	0	20	4	18	0	40	23	18	1	80	47	13	1	40

TABLE OF

Porters.	ELLS. 1				2				3				4			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
138	0	11	1	0	0	23	0	0	1	10	1	0	1	22	0	0
139	0	11	1	20	0	23	0	40	1	10	1	60	1	22	0	80
140	0	11	1	40	0	23	0	80	1	11	0	0	1	22	1	40
141	0	11	1	60	0	23	1	0	1	11	0	60	1	23	0	0
142	0	11	1	80	0	23	1	40	1	11	1	0	1	23	0	80
143	0	11	1	100	0	23	1	80	1	11	1	60	1	23	1	40
144	0	12	0	0	1	0	0	0	1	12	0	0	2	0	0	0
145	0	12	0	20	1	0	0	40	1	12	0	60	2	0	0	80
146	0	12	0	40	1	0	0	80	1	12	1	0	2	0	1	40
147	0	12	0	60	1	0	1	0	1	12	1	60	2	1	0	0
148	0	12	0	80	1	0	1	40	1	13	0	0	2	1	0	80
149	0	12	0	100	1	0	1	80	1	13	0	60	2	1	1	40
150	0	12	1	0	1	1	0	0	1	13	1	0	2	2	0	0
151	0	12	1	20	1	1	0	40	1	13	1	60	2	2	0	80
152	0	12	1	40	1	1	0	80	1	14	0	0	2	2	1	40
153	0	12	1	60	1	1	1	0	1	14	0	60	2	3	0	0
154	0	12	1	80	1	1	1	40	1	14	1	0	2	3	0	80
155	0	12	1	100	1	1	1	80	1	14	1	60	2	3	1	40
156	0	13	0	0	1	2	0	0	1	15	0	0	2	4	0	0
157	0	13	0	20	1	2	0	40	1	15	0	60	2	4	0	80
158	0	13	0	40	1	2	0	80	1	15	1	0	2	4	1	40
159	0	13	0	60	1	2	1	0	1	15	1	60	2	5	0	0
160	0	13	0	80	1	2	1	40	1	16	0	0	2	5	0	80
161	0	13	0	100	1	2	1	80	1	16	0	60	2	5	1	40

WARPS.

Porters.	ELLS.															
	5				10				50				100			
	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.	S.	H.	C.	T.
138	2	9	1	0	4	19	0	0	23	23	0	0	47	22	0	0
139	2	9	1	100	4	19	1	80	24	3	0	40	48	6	0	80
140	2	10	0	80	4	20	1	40	24	7	0	80	48	14	1	40
141	2	10	1	60	4	21	1	0	24	11	1	0	48	23	0	0
142	2	11	0	40	4	22	0	80	24	15	1	40	49	7	0	80
143	2	11	1	20	4	23	0	40	24	19	1	80	49	15	1	40
144	2	12	0	0	5	0	0	0	25	0	0	0	50	0	0	0
145	2	12	0	100	5	0	1	80	25	4	0	40	50	8	0	80
146	2	12	1	80	5	1	1	40	25	8	0	80	50	16	1	40
147	2	13	0	60	5	2	1	0	25	12	1	0	51	1	0	0
148	2	13	1	40	5	3	0	80	25	16	1	40	51	9	0	80
149	2	14	0	20	5	4	0	40	25	20	1	80	51	17	1	40
150	2	14	1	0	5	5	0	0	26	1	0	0	52	2	0	0
151	2	14	1	100	5	5	1	80	26	5	0	40	52	10	0	80
152	2	15	0	80	5	6	1	40	26	9	0	80	52	18	1	40
153	2	15	1	60	5	7	1	0	26	13	1	0	53	3	0	0
154	2	16	0	40	5	8	0	80	26	17	1	40	53	11	0	80
155	2	16	1	20	5	9	0	40	26	21	1	80	53	19	1	40
156	2	17	0	0	5	10	0	0	27	2	0	0	54	4	0	0
157	2	17	0	100	5	10	1	80	27	6	0	40	54	12	0	80
158	2	17	1	80	5	11	1	40	27	10	0	80	54	20	1	40
159	2	18	0	60	5	12	1	0	27	14	1	0	55	5	0	0
160	2	18	1	40	5	13	0	80	27	18	1	40	55	13	0	80
161	2	19	0	20	5	14	0	40	27	22	1	80	55	21	1	40

The principle upon which these calculations are founded is very simple, and may be very easily explained. As the length of a thread is 90 inches, or double the length of an ell, and there are two threads in every split, it is plain that one thread will make exactly one splitful of warp of one ell long. Of course, 240 threads, or one heer, will make 240 splitfuls, or 12 porters of the same length. Or, which is the same thing, a heer will make one porter 12 ells long. If, therefore, the number of ells be multiplied by the number of porters, and the product divided by 12, the number of heers will be found, and these again, divided by 24, will give the spyndles. But, 24 multiplied by 12 is 288; therefore, that is the number quoted for the divisor in the last case. The remainder, divided by 12, gives heers.

When the length admits, it is common to shorten the operation by multiplying dozens of ells by the porters. The divisor is then 24 for spyndles. For example, 100 ells is $8\frac{1}{3}$ dozens. Therefore,

$8\frac{1}{3} \times 60$ porters $= 500$, and $500 \div 24 = 20\text{-}20$, or
100×60 do. $= 6000$, and $6000 \div 288 = 20\text{-}20$,
which give exactly the same result.

A very common length, in the muslin manufacture, is 100 ells. Another practical rule is, therefore, very generally used for this length. By the former rules it will be found, that 3 porters of 100 ells long, contain 1 spyndle 1 heer of warp. Therefore, divide the porters by 3, and add one heer for each spyndle in the quotient, and in proportion for any fraction of a spyndle. For example, 60 porters $\div 3 = 20$ spyndles, to which adding 20 heers, the result is as before.

Many other practical rules may be used, to answer particular lengths, upon the same principle.

When a warp contains what are called odd splits, they must be calculated as fractions of porters. The length may then be multiplied by the whole number of splits, and the quotient divided by 20, before the succeeding operations.

The size, or fineness, of linen yarn is ascertained by the weight of one spyndle, excepting the French, which is counted by the *pinee*, containing 28 heers.

COMPUTATION OF COTTON YARN.

The measure of the cotton reel has never been fixed by any act of Parliament, like the linen. The universal practice of the spinners, however, both in England and Scotland, is to use reels of 54 inches, or 1½ yards, in circumference. The account is as follows:

1 thread			=	1½	yards
80 threads	=	1 skein	=	120	do.
7 skeins	=	1 hank	=	840	do.
18 hanks	=	1 spyndle	=	15,120	do.

It will be found, that the length of one spyndle of cotton, is to one spyndle of linen, exactly in the proportion of 21 to 20. An allowance of 5 per cent. has, therefore, been made in calculating the cotton reel, probably for waste during the successive operations which it undergoes.

From the prevalent desire of following old customs, the spyndle of cotton yarn is still almost universally counted by heers, cuts, and threads, as the linen; although both the length and divisions of the reel are totally different. By this mode, no account is made of the surplus 5 per cent. which is, therefore, supposed to be wasted. The following way is also adopted by some, which is founded on a similar principle to that of the linen: 18 hanks, or numbers, of cotton yarn being supposed equal to 24 heers of linen, the proportion is as 3 to 4. The divisor, therefore, in the same ratio, is taken to be 16 instead of 12. The rule, therefore, is, Multiply the length by the porters and divide by 16; the quotient will be hanks, or numbers, and these again divided by 18, will give spyndles. The former example, repeated in this way, will stand as follows:

$$100 \times 60 = 6000,\ 6000 \div 16 = 375,$$
$$\text{and } 375 \div 18 = 20\text{-}15$$

The result is still the same, for, in the assumed ratio of 3 to 4, 15 hanks are exactly equal to 20 heers, each being $\frac{5}{6}$ of a spyndle. Here then, also, the surplus 5 per cent. is left totally out of the account.

But were cotton yarn counted to its full extent, like linen, the account would stand thus:

$$21 : 20 :: 20\text{-}15 : 19\text{-}16\ .\dot{0}9523\dot{8} \text{ or } \tfrac{2}{21}$$

As, however, there seems every reason to believe, that this allowance upon the cotton was merely intended to counterbalance waste, it appears most adviseable, whether the account is made by numbers or heers, to leave it entirely out. Besides, the linen reel is evidently adapted to the length of the ell to avoid fractions: the cotton, if counted to its full extent, is by no means so.

The size, or fineness, of cotton yarn is determined by the number of hanks in one pound, avoirdupoise weight.

COMPUTATION OF WOOLLEN YARN.

In Scotland, the coarse woollen yarn spun by the hand has usually been reeled upon the same reel, and counted in the same way as the linen. The woollen yarn, spun by machinery, is usually reeled upon a reel 72 inches, or 2 yards in circumference, and the spyndle divided into 12 equal parts of 600 yards, or 2 heers, each. The calculations for linen will, therefore, serve equally well for woollen. The woollen, like the linen, is sized by the weight of the spyndle.

COMPUTATION OF SILK.

The silk, which is imported chiefly from Bengal and China, is never made up in any precise or determinate length, to assist computation or ascertain the fineness. In the preparatory processes, therefore, the only check is weighing the stuff when delivered and received.

After being warped, the warp may be weighed, and as the quantity of warp can then be ascertained, an estimate of its fineness may be formed, as in other yarn. When received, it is generally assorted merely by the eye, in three or four parcels of different fineness.

COMPARISON OF REEDS.

It has been noticed in the 1st Essay, that the scale of reeds in Scotland, has been ascertained by the number of splits in 34 inches for cambric, 37 inches for linen, cotton, woollen, and silk, and 40 inches, for holland. The 34 and 40 inch reeds are now completely exploded, and 37 inches, being the measure of the Scotch ell, is the universal standard. In Bolton and Manchester, the reeds are counted by the number of beers in 24¼ inches. These beers sometimes contain 19, and sometimes 20 splits, or as they are called there, *dents*. The latter is the most prevalent. What is called a beer in England, therefore, in general, corresponds with what the Scotch weavers term a porter. At Stockport, the reeds are counted by the number of *ends*, or threads, in an inch. The dents, or splits, in two inches are, therefore, the number of the reed.

The two following Tables, will exhibit a comparative view of the Scotch 37 inch reed, with each of these. The first column contains the number by which the English reed is known. The second, the dents in one inch in integers and decimals. The third, the number of dents in an English yard of 36 inches. And the fourth, fifth, and sixth, the number of a Scotch reed of equal fineness, in hundreds, porters, and splits.

COMPARATIVE

TABLES OF REEDS.

MANCHESTER AND BOLTON

TABLE.

Reed.	Dents Inch.	Dents Yard.	H.	P.	S.	Reed.	Dents Inch.	Dents Yard.	H.	P.	S.
20	16.49	593	6	0	9	54	44.53	1603	16	2	8
22	18.14	653	6	3	11	56	46.18	1662	17	0	8
24	19.79	712	7	1	12	58	47.83	1722	17	3	10
26	21.44	771	7	4	12	60	49.48	1781	18	1	11
28	23.09	831	8	2	14	62	51.13	1840	18	4	11
30	24.74	890	9	0	15	64	52.78	1900	19	2	13
32	26.39	950	9	3	16	66	54.43	1959	20	0	13
34	28.04	1009	10	1	17	68	56.08	2018	20	3	14
36	29.69	1068	10	4	18	70	57.73	2078	21	1	16
38	31.34	1128	11	2	19	72	59.38	2137	21	4	16
40	32.98	1187	12	1	0	74	61.03	2197	22	2	18
42	34.63	1247	12	4	2	76	62.68	2256	23	0	19
44	36.28	1306	13	2	2	78	64.32	2315	23	3	19
46	37.96	1366	14	0	4	80	65.97	2375	24	2	1
48	39.58	1425	14	3	5	90	74.22	2672	27	2	16
50	41.23	1484	15	1	5	100	82.47	2969	30	2	1
52	42.88	1543	15	4	6						

STOCKPORT

TABLE.

o.	Dents Inch.	Dents Yard.	H.	P.	S.	No.	Dents Inch.	Dents Yard.	H.	P.	S.
34	17	612	6	1	9	90	45	1620	16	3	5
38	19	684	7	0	3	94	47	1692	17	1	19
40	20	720	7	2	0	96	48	1728	17	3	16
44	22	792	8	0	14	100	50	1800	18	2	70
46	23	828	8	2	17	104	52	1872	19	1	4
50	25	900	9	1	5	106	53	1908	19	3	1
54	27	972	9	4	19	110	55	1980	20	1	15
56	28	1008	10	1	16	114	57	2052	21	0	9
60	30	1080	11	0	10	116	58	2088	21	2	6
64	32	1152	11	4	4	120	60	2160	22	1	0
66	33	1188	12	1	1	124	62	2232	22	4	14
70	35	1260	12	4	15	126	63	2268	23	1	11
74	37	1332	13	3	9	130	65	2340	24	0	5
76	38	1368	14	0	6	134	67	2412	24	3	19
60	40	1440	14	4	0	150	75	2700	27	3	15
84	42	1512	15	2	14	166	83	2988	30	3	11
86	43	1548	15	4	11						

To enable manufacturers to ascertain the measure of the reed by inspection, an instrument has been long used in Scotland, and more recently adopted in England. It combines the properties both of a microscope and micrometer, for, while the dimensions of the threads are magnified by a convex glass, the measure is ascertained by a hole in the bottom of the standard. Those used in Scotland, when correctly constructed, show one thread for every hundred splits. Of course, the diameter of the hole must be the two hundredth part of 37 inches.

The English glasses are calculated upon the same principle, to adapt them to their particular uses.

FINIS.

JAMES HEDDERWICK AND CO. PRINTERS, GLASGOW.

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