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.

ENTERED IN STATIONERS' HALL.

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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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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 em-

ployers 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 be-

tween 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, Balhasore, 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, 28th 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 $11\frac{1}{4}$ 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 inter-

vention 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 re-

quired 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 $76\frac{1}{4}$ ells, 15 revolutions produce 75 ells, and continuing to turn the mill until the warp has passed over 7 intervals more, $1\frac{1}{4}$ ells will be added to the length, making in all $76\frac{1}{4}$. 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 $16\frac{1}{2}$ 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 $\frac{10}{16}$ to $\frac{1}{4}$. 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 $\frac{11}{16}$ wide; by referring to the Table, he will find in the same line with 270, and under $\frac{11}{16}$, 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							
	10/16	11/16	3/4	13/16	7/8	15/16	4/4	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.							
	2/8	10/16	5/4	11/16	12/8	21/16	6/4	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.							
	$\frac{9}{8}$	$\frac{10}{16}$	$\frac{1}{4}$	$\frac{11}{16}$	$\frac{12}{8}$	$\frac{13}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
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.							
	8/8	18/16	4/4	34/16	14/8	34/16	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
210	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	1/4	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.							
	$\frac{9}{8}$	$\frac{10}{16}$	$\frac{5}{4}$	$\frac{11}{16}$	$\frac{12}{8}$	$\frac{31}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
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							
	10/16	11/16	1/4	11/16	7/8	15/16	4/4	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.							
	$\frac{9}{8}$	$\frac{19}{16}$	$\frac{1}{4}$	$\frac{21}{16}$	$\frac{13}{8}$	$\frac{21}{16}$	$\frac{6}{4}$	$\frac{7}{4}$
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
310	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,

$21 \div 5 = 4$ 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 $\frac{1}{10}$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	2½	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	2½	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.

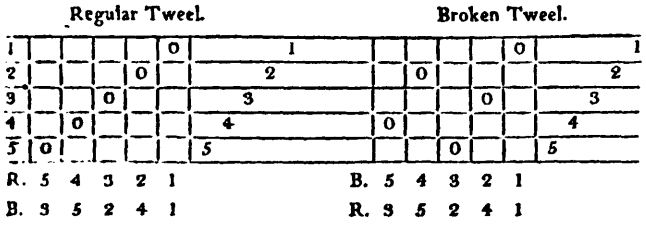
We have, hitherto, considered all the threads of warp, in tweeled cloth, as interwoven in progressive succession, for the sake of rendering the general principle of tweeling more obvious, to those previously unacquainted with this branch of weaving. When tweels do not exceed four leaves, this arrangement 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.



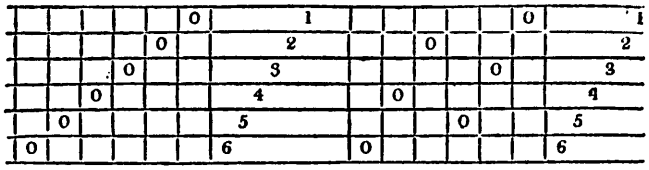
The above example will sufficiently show the two ways of tweeling; and also, that the whole difference in the cording is, solely, to preserve a regular order in the treddles. The same succession of treading, which breaks the tweel in the one case, restores its regularity in the other. In these, and the 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.



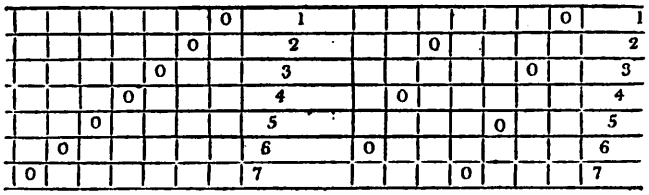
R.6 5 4 3 2 1
B.6 4 2 5 3 1

Broken.

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

SEVEN LEAVES.

Regular.



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

Broken.

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

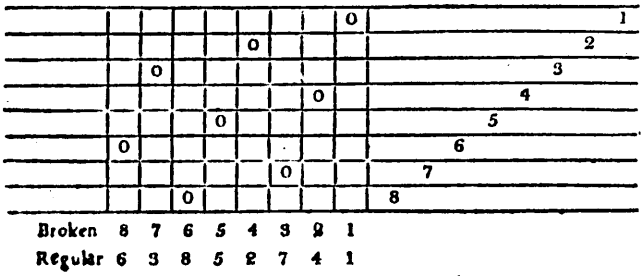
These examples will show the manner of forming the alternate, or broken, tweel. It is to be observed, that the cording may be adapted in various ways, and the tweel broken in different places, according to the discretion of the weaver. When the number of leaves will admit of it, the succession should 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:

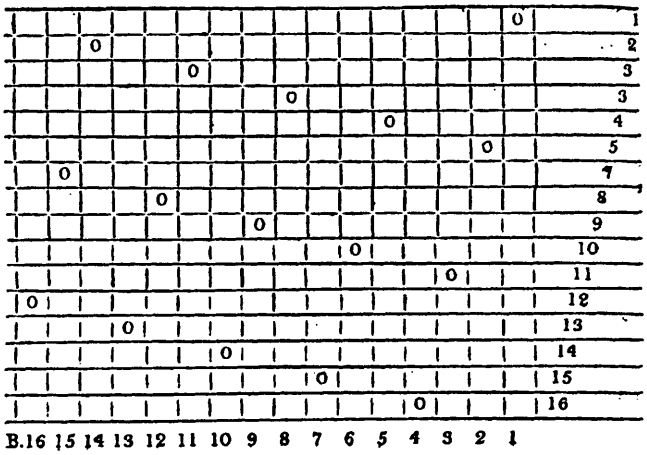
EIGHT LEAVES.



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.



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.

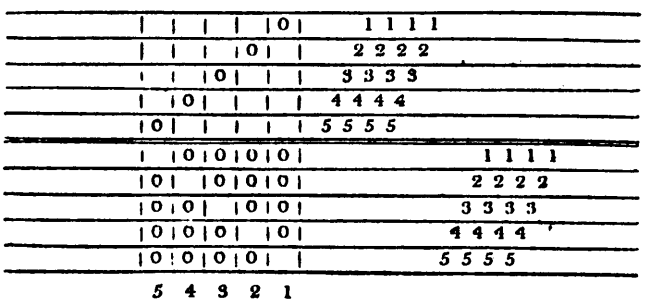
In the references to Figs. 3. and 4. Plate 4. the flushing upon tweeled cloth has been explained. *On one side, the warp is flushed; on the other, the weft.* Most kinds of

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.



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

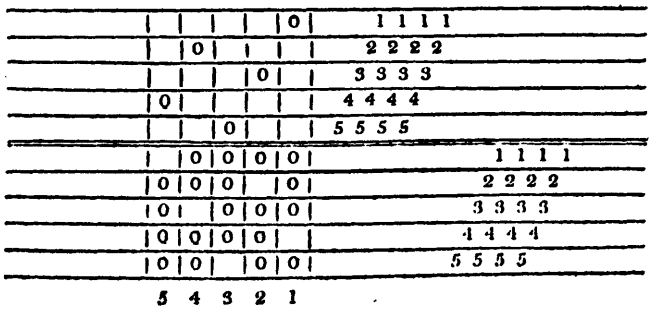
The stripe is produced by two sets of leaves, consisting of five each. The cording of the back set is exactly the same as the regular five leaf tweel, formerly described. That of the front set is the same, *reversed*; for, in the former, there are five raising cords, which raise one leaf successively, 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.



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.

	3 3 3 3 2 ‖
	2 2 2 2 2 2 3 2 ‖
	2 3 2 2 3 2 ‖

No. 3.

	1 1 8 1 1 8 1
	1 4 1 1 3 1 3 3 1 3 1 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.

1 3 1 3	1 3 1 3 ‖
1 1 3	3 1 1 3 3 ‖
3 3 1 1	3 3 1 1 ‖

No. 7.

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

No. 8.

	3 1 1 3 3 1 1 3
1 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		3	3		1		1	1	1
	3	3		1		1		1		1	6		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.

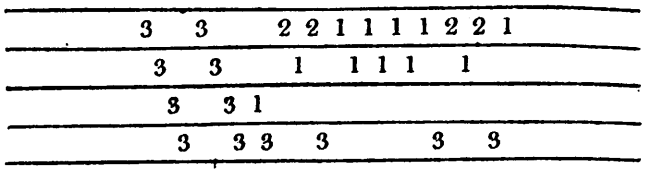
2 2 2 2 1 1 1
2 2 2 2 1 2 2 1 1
3 1 1 3 1 1 1
3 1 3 1 1 1

No. 14.

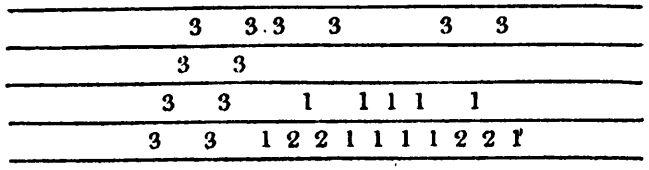
1 1 2 2 1 2 2
1 1 2 1 2 2 1 2
2 1 2 2 1 2 1 1
2 2 1 2 2 1 1

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

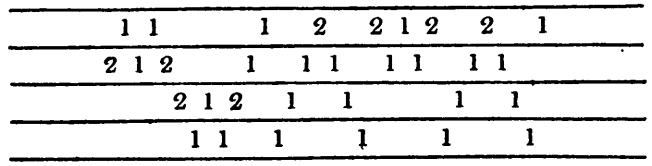
No. 17.



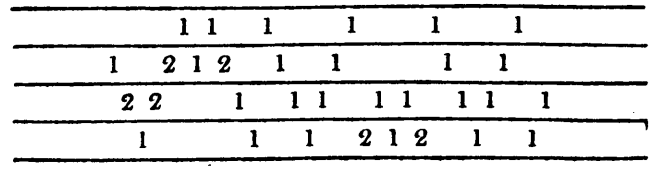
No. 17. continued.



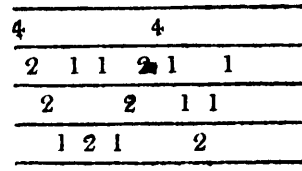
No. 18.



No. 18. continued.



No. 19.



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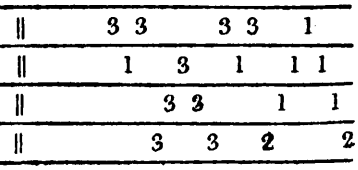

PATTERNS OF FIVE SETS.

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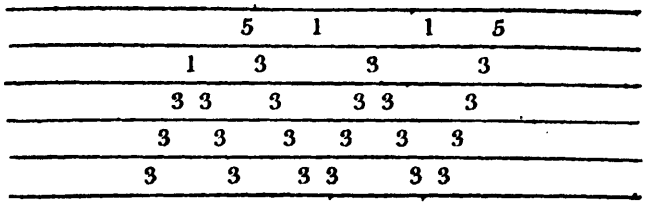

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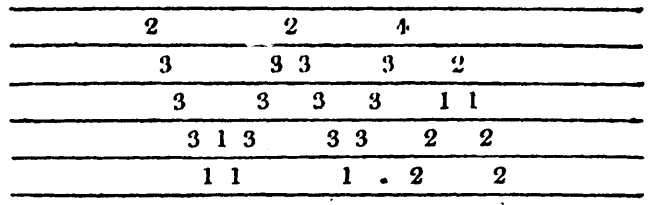

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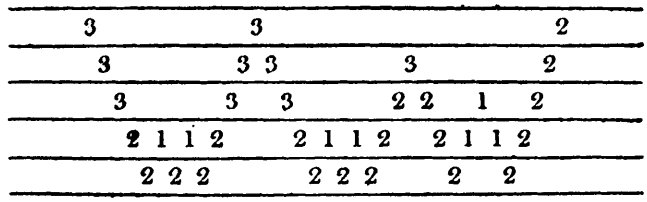

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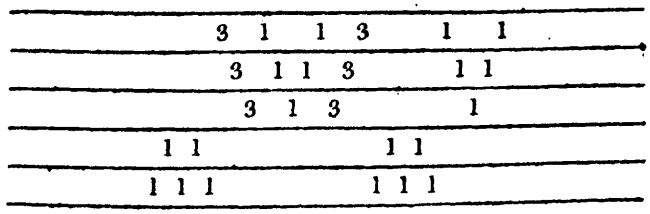

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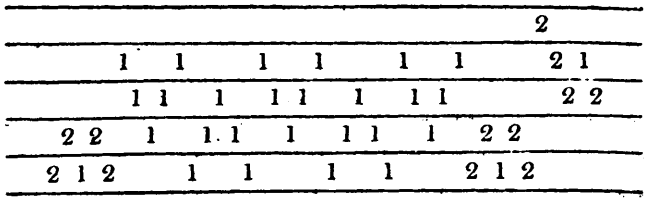

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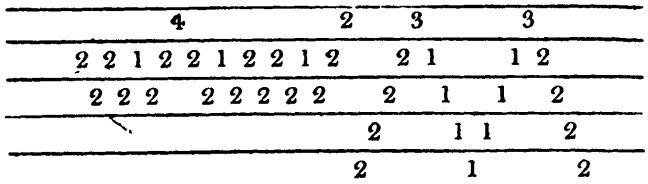

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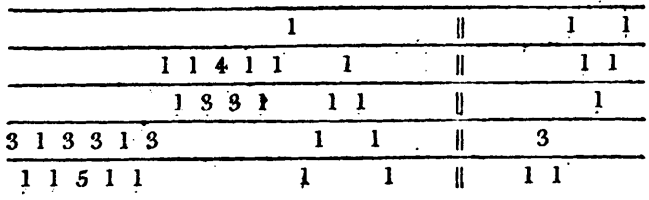

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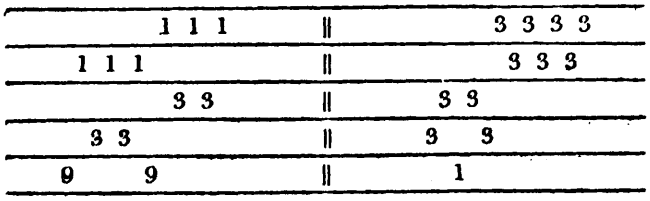

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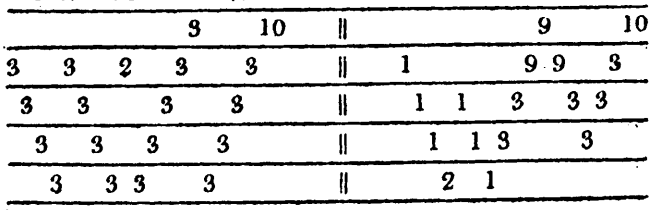
No. 10. DRAUGHT.



No. 10. ORDER OF TREADING.

PATTERNS OF SIX SETS.

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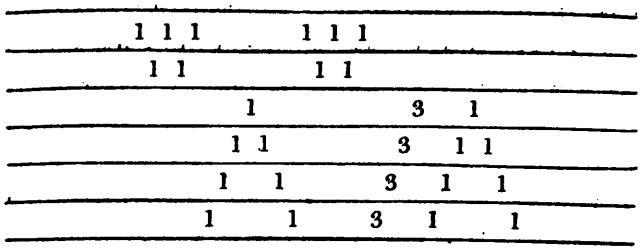

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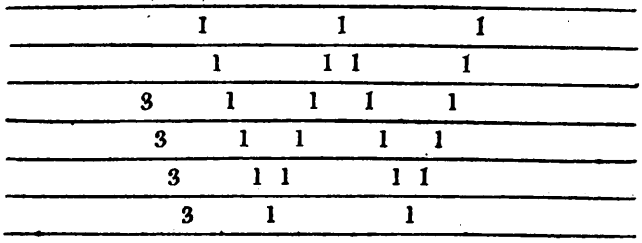

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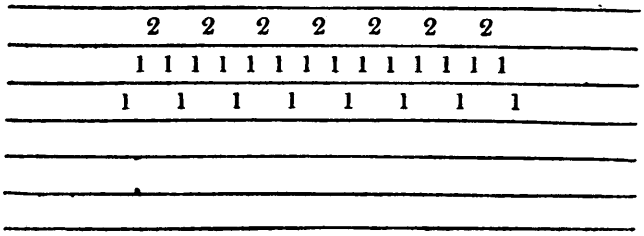

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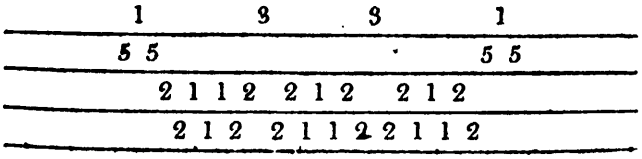

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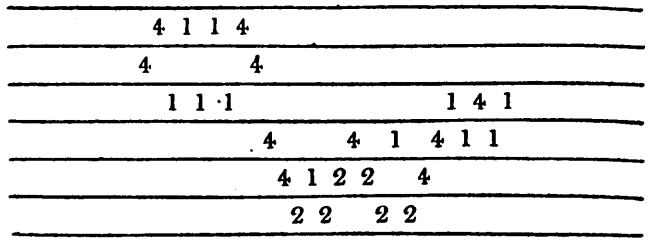

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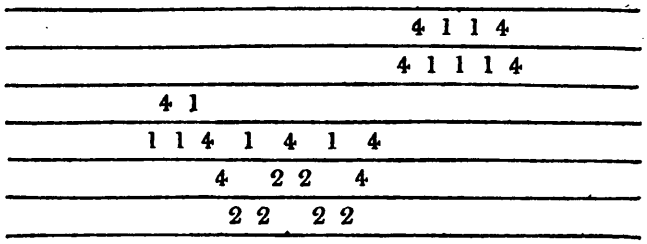

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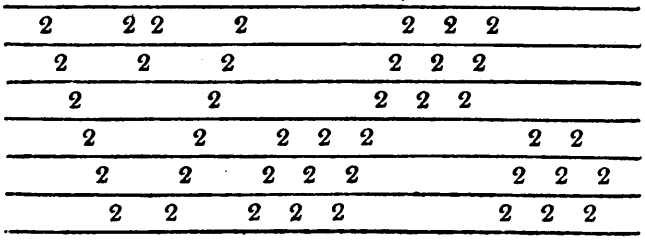

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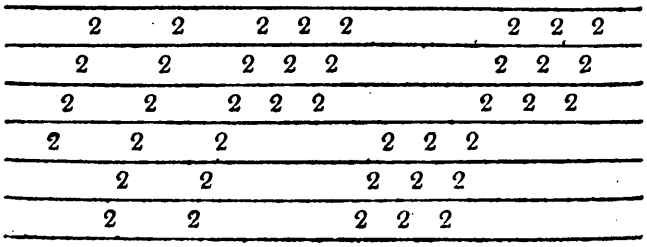

THESE patterns have not been selected for any particular merit which they may possess, but, merely, as illustrations of the manner of weaving them, and all patterns of equal compass.

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.

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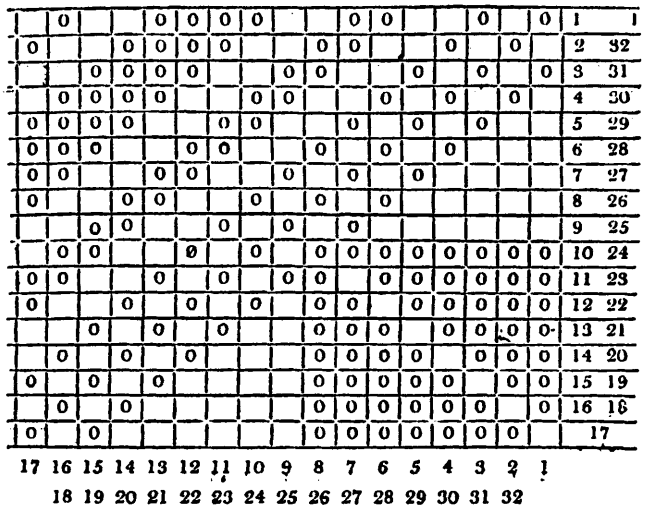

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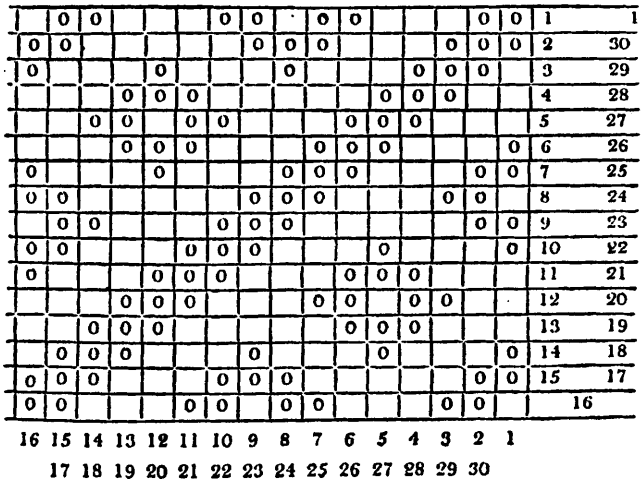

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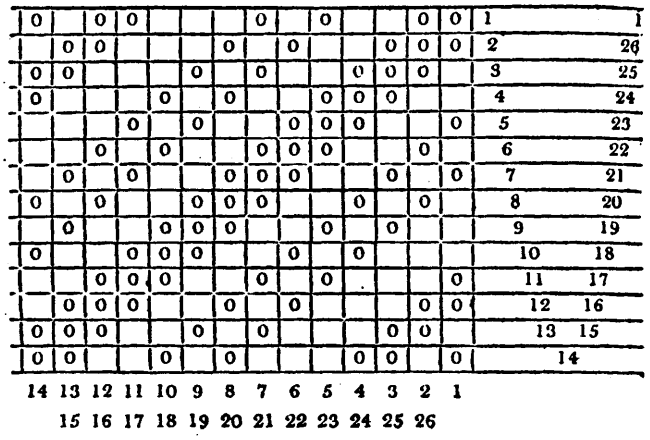
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15 16 17 18 19 20 21 22 23 24 25 26

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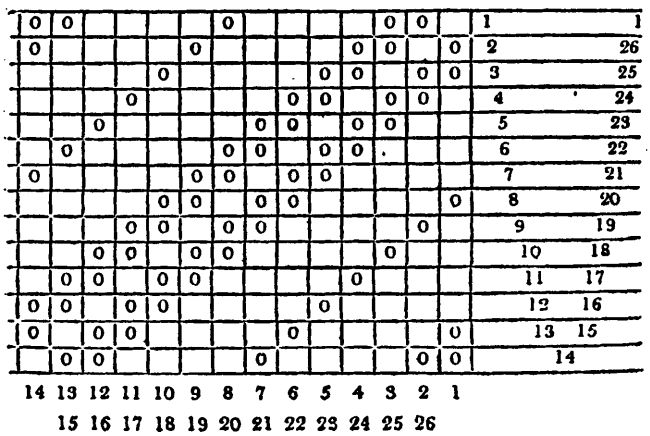
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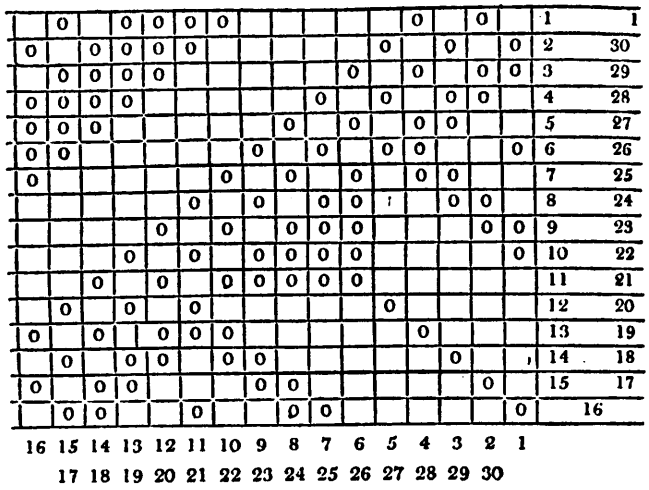

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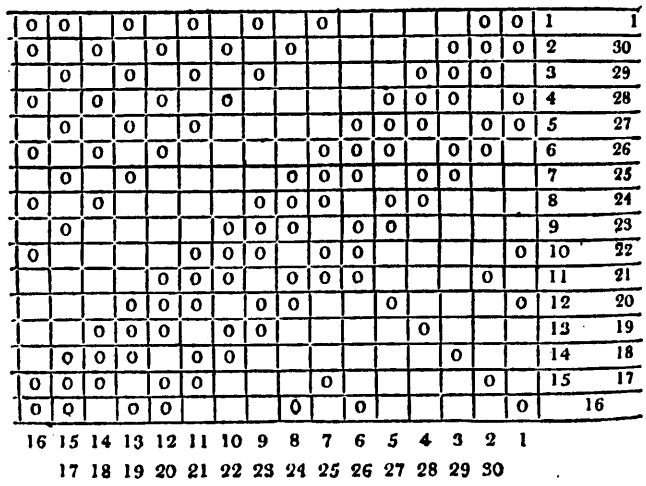

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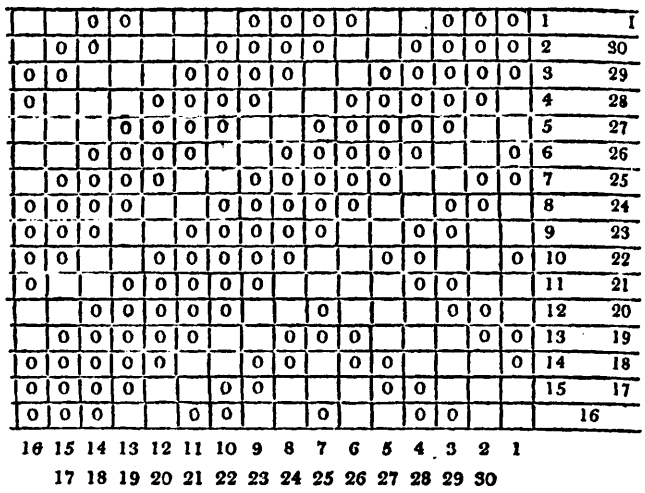

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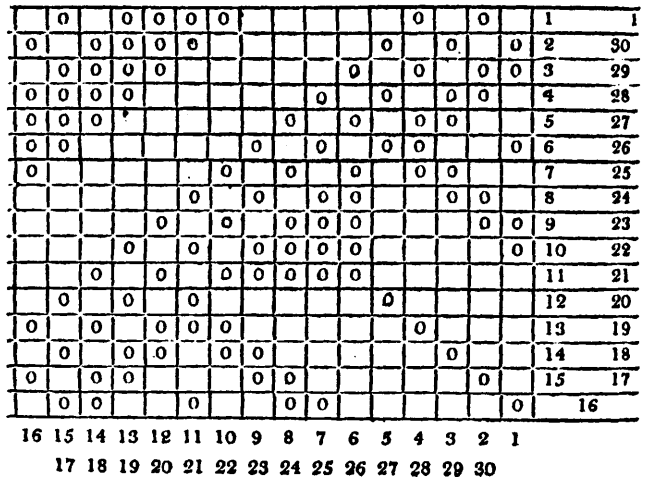

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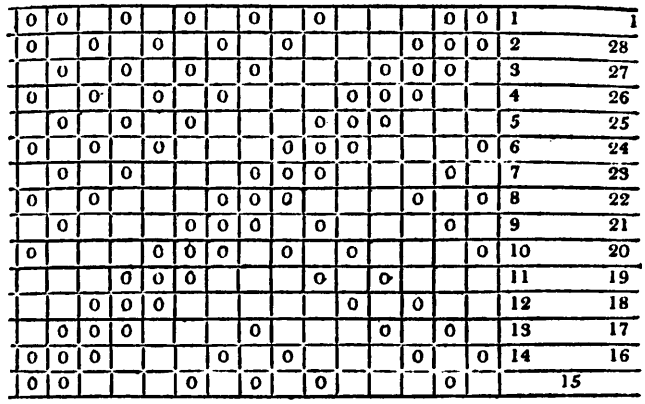

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
16 17 18 19 20 21 22 23 24 25 26 27 28

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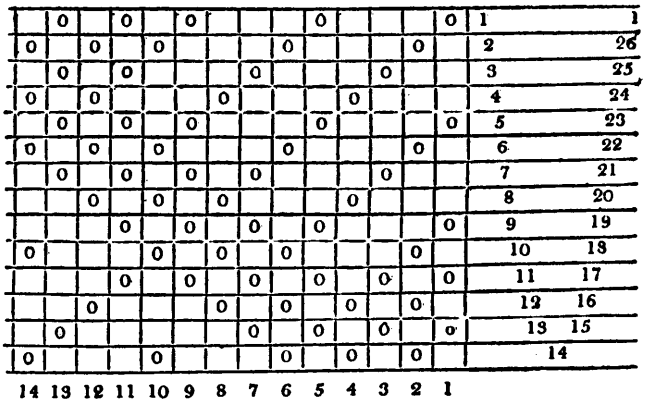
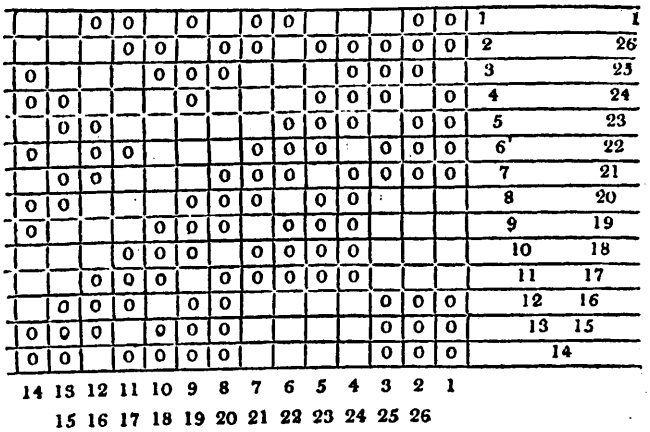
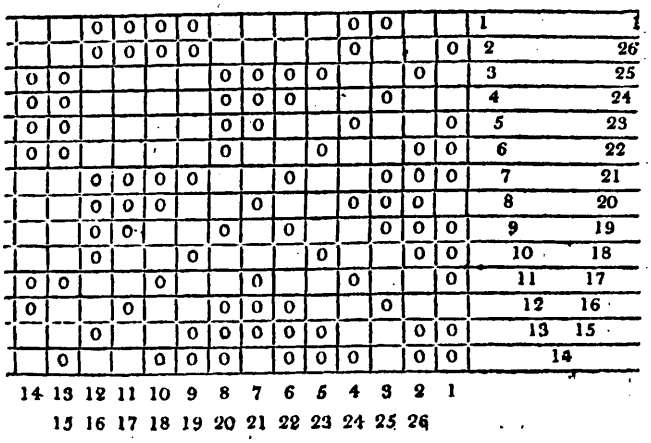


14 13 12 11 10 9 8 7 6 5 4 3 2 1
15 16 17 18 19 20 21 22 23 24 25 26

No. 15.


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


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

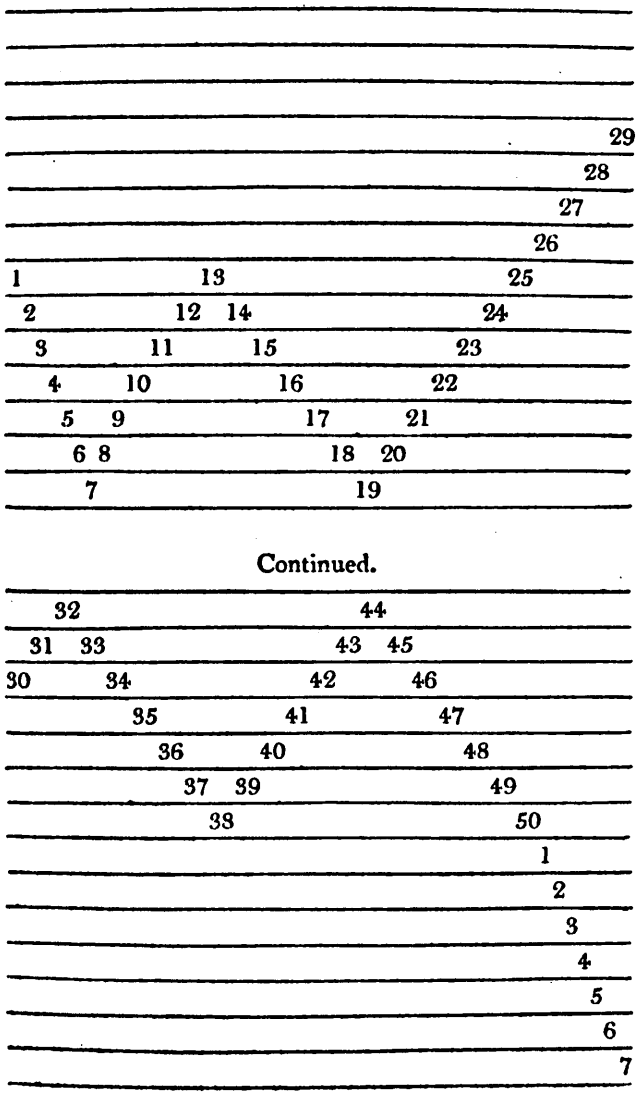
No. 2. is a plan containing sixteen leaves and sixteen treddles. Fig. 11. Plate 4. shows its effect upon the design paper. The description given of No. 1. applies equally to this and to all the others.

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.



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