WEAVER, in *Manufactures*, one who practiſes the art of weaving.

Perſons uſing the trade of a weaver, ſhall not keep a tucking or fulling-mill, or uſe dyeing, &c. or have above two looms in a houſe in any corporation or market-town, on pain of forfeiting 20*s*. a week: and ſhall ſerve an apprenticeſhip for ſeven years to a weaver or clothier, or ſhall ſhall forfeit 20*l*. &c. 2 & 3 Ph. & M.

WEAVER'*s Alarm*. This contrivance is only a weight faſtened to a packthread, which is placed horizontally, ſo that in a certain time a candle may burn down to it. Then the flame of the candle ſetting fire to the thread, the weight falls, and awakens the ſleeping perſon. See Phil. Tranſ. No. 477. ſect. 14, where we have a figure to explain the invention, which has got its name from being in frequent uſe among the weavers.

WEAVER'*s Lake*, in *Geography*, a lake of New York; 3 miles N.W. of Otſego lake.

WEAVING, in *Manufactures*, is the art of combining and uniting threads together, to form cloth. Stocking-knitting or weaving is a diſtinct art from cloth-weaving, the manner of combining the thread, being eſſentially different in the two. In the ſtocking fabric, the whole piece conſiſts of one continuous thread, which is formed into a ſeries of loops in ſucceſſive rows; and the loops of each row are drawn through the loops of a former row. See STOCKING-*Frame*.

Woven cloth is always compoſed of two diſtinct ſyſtems of threads, called the warp and the weft: theſe traverſe the piece of cloth in oppoſite directions, and are uſually at right angles to each other. Thoſe threads, (or, as the weavers call them, yarns,) which run in the direction of the length of the web or piece of cloth, are called the warp, and they extend entirely from one end of the piece to the other. The croſs thread, or yarn, runs acroſs the cloth, and is called the woof or weft. This is in fact one continued thread through the whole piece of cloth, being woven alternately over and under each yarn of the warp, which it croſſes, until it arrives at the outſide one. It then paſſes round that yarn, and returns back over and under each thread, as before; but in ſuch a manner, that it now goes over thoſe yarns which it paſſed under before, and *vice verſâ*; thus firmly knitting or weaving the warp together. The outſide yarn of the warp, round which the woof is doubled, is called the ſelvage, and cannot be unravelled without breaking the weft. The ſtrength of the cloth, in the direction of the length, muſt depend on the threads of the warp; but its ſtrength in the oppoſite direction will depend upon the weft; and the ſtrength of theſe two threads ſhould be always properly proportioned to each other.

The combined arts of ſpinning and weaving are among the firſt eſſentials of civilized ſociety, and we find both to be of very ancient origin. The fabulous ſtory of Penelope's web, and, ſtill more, the frequent alluſions to this art in the ſacred writings, tend to ſhew, that the fabrication of cloth from threads, hair, &c. is a very ancient invention. It has, however, like other uſeful arts, undergone a vaſt ſucceſſion of improvements, both as to the preparation of the materials of which cloth is made, and the apparatus neceſſary in its conſtruction, as well as in the particular modes of operation by the artiſt. Weaving, when reduced to its original principle, is nothing more than the interlacing of the weft or croſs threads into the parallel threads of the warp, ſo as to tie them together, and form a web or piece of cloth. This art is doubtleſs more ancient than that of ſpinning, and the firſt cloth was what we now call matting, *i. e.* made by weaving together the ſhreds of the bark, or fibrous parts of plants, or the ſtalks, ſuch as ruſhes and ſtraws.

This is ſtill the ſubſtitute for cloth amongſt moſt rude and ſavage nations. When they have advanced a ſtep farther in civilization than the ſtate of hunters, the ſkins of animals become ſcarce, and they require ſome more artificial ſubſtance for clothing, and which they can procure in greater quantities. Nevertheleſs, ſome people are ſtill ignorant of the art of weaving; for the cloth made in the iſlands of the South ſea appears to be made by cementing or glueing the ſhreds together, rather than by weaving. From the deſcription given by captain Cook, and other circumnavigators, and from the ſpecimens which have been brought to Europe, their cloth, or rather matting, is in general produced by coheſion of the parts, rather than texture. This aſſimilates it more to the ideas which we attach to paper, or paſteboard, than to thoſe which we form of cloth.

When it was diſcovered that the delicate and ſhort fibres, which animals and vegetables afford, could be ſo firmly united together by twiſting, as to form threads of any required length and ſtrength, the weaving art was placed on a permanent foundation. By the proceſs of ſpinning, which was very ſimple in the origin, the weaver is furniſhed with threads far ſuperior to any natural vegetable fibres in lightneſs, ſtrength, and flexibility; and he has only to combine them together in the moſt advantageous manner.

The art of weaving cloth has been ſo extenſively applied

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in almoſt every civilized country, and the knowledge of its various branches has been derived from ſuch a variety of ſources, that no one perſon can ever be practically employed in all its branches; and though every part bears a ſtrong analogy to the reſt, yet a minute knowledge of each of theſe parts can only be acquired by experience and reflection. We will endeavour to give the reader as comprehenſive an idea of the hiſtory and progreſs of this ancient and invaluable art as the nature of the thing, and the limits to which we are neceſſarily confined, will permit.

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.

The art of making linen, which was probably the firſt ſpecies of cloth invented, was communicated by the Egyptians, the inhabitants of Paleſtine, and other eaſtern nations, to the Europeans. By ſlow degrees it found its way into Italy; and it afterwards prevailed in Spain, Gaul, Germany, and Britain. The Belgæ manufactured linen on the continent; and when they afterwards ſettled in this iſland, it is probable they continued the practice, and taught it to the people among whom they reſided.

When it is conſidered that the wants of mankind are nearly the ſame in all countries, it is not improbable that the ſame arts, however varied in their operations, may have been ſeparately invented in different countries. It is not, however, certain that the art of making cloth is one which the Britons invented for themſelves.

It is moſt probable that the Gauls learned it from the Greeks, and communicated the knowledge of it to the people of Britain. It is very certain that the inhabitants of the ſouthern parts of Britain were well acquainted with the arts of dreſſing, ſpinning, and weaving, both flax and wool, when they were invaded by the Romans. Nevertheleſs, we have the authority of Julius Cæſar, that when he invaded Britain, the art of weaving was totally unknown to the Britons.

Whatever knowledge the Britons might poſſeſs of the clothing arts, prior to the invaſion, it is very certain that theſe arts were much improved amongſt them after that event. It appears from the Notitia Imperii, that there was an imperial manufactory of woollen and linen cloth, for the uſe of the Roman army then in Britain, eſtabliſhed at Venta Belgarum, now called Winchester.

Many public acts relative to the woollen manufacture, in the earlier period of Engliſh hiſtory, evidently prove that the greater part of our wool was, for a very long ſeries of years, exported in a raw ſtate, and manufactured upon the continent.

In biſhop Aldhelm's book concerning "Virginity," written about A.D. 680, it is remarked, "that chaſtity alone forms not a perfect character, but requires to be accompanied and beautified by other virtues." This obſervation is illuſtrated by the following ſimile, borrowed from the art of figure-weaving: "It is not a web of one uniform colour and texture, without any variety of figures, that pleaſeth the eye, and appeareth beautiful; but one that is woven by ſhuttles, filled with threads of purple, and many other colours, flying from ſide to ſide, and forming a variety of figures and images, in different compartments, with admirable art."

Perhaps the moſt curious ſpecimen of this ancient figure-weaving and embroidery, now to be found, is that preſerved in the cathedral of Bayeaux. It is a piece of linen, about 19 inches in breadth, and 67 yards in length, and contains the hiſtory of the Conqueſt of England by William of Normandy; beginning with Harold's embaſſy, A.D. 1065, and ending with his death at the battle of Haſtings, A.D. 1066. This curious work is ſuppoſed to have been executed by Matilda, wife to William, duke of Normandy, afterwards king of England, and the ladies of her court. Although it is certain that the art of figure-weaving was then known in Britain, it muſt be owned, that the piece of tapeſtry juſt mentioned owes moſt of its beauty to the exquiſite needle-work with which it is adorned.

The ſilk manufacture was firſt practiſed in China, and the cotton in India. Both the woollen and linen were borrowed by the Engliſh from the continent of Europe; and for many ages, all the improvements in them in this country were firſt introduced into this country by foreign artificers, who ſettled amongſt us.

About the cloſe of the eleventh century, the clothing arts had acquired a conſiderable degree of improvement in this iſland. About that time, the weavers in all the great towns were formed into guilds or corporations, and had various privileges beſtowed upon them by royal charters.

In the reign of Richard I., the woollen manufacture became the ſubject of legiſlation; and a law was made, A.D. 1197, for regulating the fabrication and ſale of cloth.

The number of weavers, however, was comparatively ſmall, until the policy of the wiſe and liberal Edward III. encouraged the art, by the moſt advantageous offers of reward and encouragement to foreign cloth-workers and weavers, who would come and ſettle in England. In the year 1331, two weavers came from Brabant, and ſettled at York.

The ſuperior ſkill and dexterity of theſe men, who communicated their knowledge to others, ſoon manifeſted itſelf in the improvement and ſpread of the art of weaving in this iſland.

Many Flemiſh weavers were driven from their native country, by the cruel perſecutions of the duke d'Alva, in the year 1567. They ſettled in different parts of England, and introduced or promoted the manufacture of baizes, ſerges, crapes, and other woollen ſtuffs.

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. Theſe improvements chiefly related to ſilk-weaving.

The arts of ſpinning, throwing, and weaving ſilk, were brought into England about the middle of the 15th century, and were practiſed by a company of women in London, called ſilk-women. About A. D. 1480, men began to engage in the ſilk manufacture, and the art of ſilk-weaving in England ſoon arrived at very great perfection. See SILK.

The civil diſſentions which followed this period, retarded the progreſs of theſe arts; but afterwards, when the nation was at reſt, the arts of peace, and among others that of weaving, made rapid advances in almoſt every part of the kingdom.

In the latter part of the laſt century, the invaluable inventions of ſir Richard Arkwright, introduced the very extenſive manufacture of cotton, and added a lucrative and elegant branch of traffic to the commerce of Britain. The light and fanciful department of the cotton manufacture has become, in ſome meaſure, the ſtaple manufacture of Scotland, whilſt the more ſubſtantial and durable cotton fabrics have given to England a manufacture inferior, in importance and extent, only to the woollen trade.

At the preſent day, our ſuperiority in point of quality

is univerſally acknowledged in the cotton manufacture; but in thoſe of ſilk, linen, and woollen, it is ſtill diſputed by other countries.

Loom.—Weaving is performed by the aid of a machine called a loom. The common loom for plain cloth is a very ſimple machine; but ſome of the varieties which are uſed for weaving ornamental and figured cloth are very curious: ſtill there are parts common to all. The principal of theſe are as follows.

1. The yarn-beam, which is a round wooden roller, on which is wound or rolled the warp, or yarns that are to form the length of the piece of cloth. 2. The cloth-beam is a ſimilar roller, on which the cloth is rolled up when woven. The yarns of the warp are extended in parallel lines, between the yarn-roll and the cloth-roll, ſo as to form a horizontal plane, or ſheet, and are combined together by the croſs-threads, or weft. 3. The ſhuttle, which has a hollow to contain a bobbin or pirn of the weft. 4. The heddles, which are threads with loops or eyes, through which the yarns of the warp paſs: the heddles are connected with the treadles, upon which the weaver places his feet, to draw down one ſet of heddles and raiſe up another, ſo as to open and ſeparate the warp into two diviſions, and allow a paſſage, called the ſhed, for the ſhuttle between them. 5. The reed, which is a frame containing a row of parallel ſhreds of reeds or cane, and the yarns of the warp paſs between them, as it were between the teeth of a comb. 6. The reed is fixed in a frame, called the lay or lathe, which ſwings upon centres of motion. The uſe of the reed and lay is to comb or puſh the threads of the weft cloſe to each other, and make the cloth cloſe and denſe.

The operation of weaving or working the loom for plain cloth conſiſts of three very ſimple movements, *viz.* 1. Openning the ſhed in the warp alternately, by preſſing the two treadles with his feet in oppoſite directions. 2. Driving or throwing the ſhuttle through the ſhed when opened. This is performed by the right-hand, when the fly-ſhuttle is uſed, and by the right and left alternately, in the common operation, wherein the ſhuttle is thrown from one hand and caught in the other. 3. Pulling forward the lay or batten to ſtrike home the woof, and again puſhing it back nearly to the heddles. This is done by the left-hand with the fly-ſhuttle, or by each hand ſucceſſively in the old way.

There are ſeveral different ways of ſetting up a loom for weaving plain cloth; but the principal parts are always made the ſame. We ſhall firſt deſcribe that which is uſed for weaving plain ſilks: it is ſhewn in perſpective in *Plate* II. *Weaving*. In this A is the yarn-roll or beam, on which the thread to form the warp is regularly wound; B, the cloth-beam, or breaſt-roll, on which the finiſhed cloth is wound up; D E, the treadles, on which the weaver preſſes his feet; *d d*, *e e*, are the heddles, or harneſs. Theſe are each compoſed of two ſmall rods *d d* and *e e*, connected together by ſeveral threads, forming a ſyſtem of threads, which is called a heddle; *e e* is another heddle, behind the former. In the middle of each thread of the heddle is a loop, through which a yarn of the warp is paſſed, every other yarn going through the loops of the heddle *e e*, and the intermediate yarns paſſing between the threads of that heddle, and afterwards through the eyes or loops of the other heddle *d d*.

The two heddles, *d d* and *e e*, are connected together by two ſmall cords going over pulleys, ſuſpended from the top of the loom, ſo that when one heddle is drawn down, the other will be raiſed up. The heddles receive their motion from the levers or treadles D E, moved by the weaver's feet. The yarns of the warp being paſſed alternately through the loops of the two heddles, by preſſing down one treadle, as E, all the yarns belonging to the heddle *e e* are drawn down; and by means of the cords and pulleys, the other heddle *d d*, with all the yarns belonging to it, are raiſed up; leaving a ſpace, called the ſhed, of about two inches between the yarns, for the paſſage of the ſhuttle.

F, G G, H, (*fig.* 2.) is a frame, called the batten or lay, ſuſpended by the bar F, from the upper rails of the loom, ſo that it can ſwing backwards and forwards, as on a centre of motion; the bottom bar H is much broader than the rails G G, and projects before the plane about an inch and a half, forming a ſhelf, called the ſhuttle-race. The ends of the ſhuttle-race H have boards nailed on each ſide, to form two ſhort troughs or boxes I I, in which pieces of wood or thick leather *k k*, called peckers or drivers, traverſe. The peckers are guided by two ſmall wires, fixed at one end to the uprights G G, and at the other to the end-pieces of the troughs I I. Each pecker has a ſtring faſtened to it, tied to the handle *y*, which the weaver holds in his right-hand when at work, and with which he pulls, or rather ſnatches, each pecker either to the right or left alternately.

R is the reed: it is a ſmall frame, fixed upon a ſhuttle-race H, containing a number of ſmall pieces of ſplit reeds or canes; or elſe of pieces of flat wire, of ſteel or braſs; but the cane is moſt common, although the frame is called the reed. When *fig.* 2. is in its place in the loom, the yarns of the warp paſs between the canes or dents of the reed. In *fig.* 2. the reed is repreſented without the top or piece which covers it, and which is called the lay-cap. It is a rail of wood with a longitudinal groove along its lowermoſt ſide, for the purpoſe of ſuſtaining the upper edge of the reed. The lay-cap is that part of the machine on the middle of which the weaver lays hold with his left-hand when in the act of weaving.

The ſhuttle (ſee *Plate* I.) is a ſmall piece of wood pointed at each end, from three to ſix inches long. It has an oblong mortiſe in it, containing a ſmall bobbin or pirn, on which is wound the yarn which is to form the weft; and the end of this yarn runs through a ſmall hole in the ſhuttle, called the eye. The ſhuttle has two little wheels on the under ſide, by which it runs eaſily upon the ſhuttle-race H.

Operation.—The weaver ſits on the ſeat M, (*fig.* 1.) which hangs by pivots at its ends, that it may adapt itſelf to the eaſe of the weaver when he ſits upon it. It is lifted out when the weaver gets into the loom, and he puts it in again after him. He leans lightly againſt the cloth-roll B, and places his feet upon the treadles D E. In his right-hand he holds the handle *y* (*fig.* 2.), and by his left he lays hold of the rail, called the lay-cap, which croſſes the batten or lay G G, and ſerves to ſupport the upper edge of the reed R. He commences the operations by preſſing down one of the treadles with his foot: this depreſſes one-half of the yarns of the warp, and raiſes the other, as before-deſcribed. The ſhuttle is previouſly placed in one of the troughs I, againſt the pecker K, belonging to that trough. By the handle of the pecker, with a ſudden jerk, he drives the pecker againſt the ſhuttle, ſo as to throw it acroſs the warp upon the ſhuttle-race, into the other trough I, leaving the yarn of the weft, which was wound on the bobbin after it, in the ſpace between the divided yarns. With his left-hand he pulls the lay towards him; and, by means of the reed, the yarn of the weft, which before was lying looſe between the warp, is driven up towards the

the cloth-roll: the weaver now preſſes down his other foot, which reverſes the operation, pulling down the heddle which was up before, and raiſing that which before was depreſſed. By the other pecker he then throws the ſhuttle back again, leaving the woof after it between the yarns of the warp; and, by drawing up the batten, beats it cloſe up to the thread before thrown.

In this manner the operation is continued until a few inches are woven; it is then wound upon the cloth-roll, by putting a ſhort lever into a hole made in the roll, and turning it round, a click acting in the teeth of a ſerrated wheel, prevents the return of the roll. At each end of the yarn-roll A, (*fig.* 1.) a cord is tied to the frame of the loom; the other ends of the cords have weights hanging to them. The rope cauſes a friction, which prevents the roll from turning (unleſs the yarn is drawn by the cloth-beam), and always preſerves a proper degree of tenſion in the yarn.

T T (*fig.* 1.) are two ſmooth ſticks (cotton-weavers have uſually three) put between the yarns, to preſerve the leaſe, and keep the threads or yarns from entangling.

In cotton-weaving theſe ſticks or 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 hang over the yarn-beam.

The cloth is kept extended during the operation of weaving, by means of two hard pieces of wood, called a templet, with ſmall ſharp points in their ends, which lay hold of the edges, or ſelvages, of the cloth.

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 fixed in one of the pieces of wood. This ſtretcher is called the templet. Silk-weavers uſually ſtretch their cloth by means of two ſmall ſharp-pointed hooks faſtened to the ends of two ſtrings, with little weights at the other ends; and the ſtrings are made to paſs over little pulleys in each ſide of the loom, at a ſuitable diſtance from the ſelvages of the cloth.

The perfection of the work depends very much upon the previous operations which the yarn muſt undergo. It is obvious that the yarns of the warp muſt be ſtretched with great parallelism and equality of tenſion, ſo that when the cloth is finiſhed, every individual yarn may bear an equal ſhare of any ſtrain which tends to tear the cloth; hence great care muſt be taken to ſtretch the yarns of the warp to an equal length, and roll them with great regularity upon the yarn-roll. Theſe operations are called warping and beaming. Previous to warping, the yarn muſt be prepared by ſizing or ſtarching, in order to cement all the looſe fibres, and render the yarn ſmooth.

The ſpinners of yarn, whether they employ machinery or not, uſually reel the yarn into ſkeins and hanks of a determinate length; and the weight of theſe hanks, or the number which will weigh one pound, is the denomination for the fineneſs of the yarn. (See *Manufacture of* COTTON.) In this ſtate the yarn is bought by the weaver. The hanks of yarn are firſt boiled in water; if it is linen-yarn a little ſoap and potaſh are put into the water, and for cotton-yarn a ſmall portion of flour is added, to render the thread firm. When the hanks are perfectly dry they are wound off upon bobbins, each thread having a ſeparate bobbin, and a certain length is wound upon each. This winding is performed by a very ſimple hand-wheel to turn the bobbin rapidly round, the hanks of yarn being extended upon a reel, or over two ſmall reels placed at a diſtance aſunder, which are called wiſks.

Warping.—The object of this operation is to ſtretch the whole number of parallel threads which are to form the warp of the cloth to an equal length. For this purpoſe as many of the above bobbins are taken as will furniſh the quantity of threads which is required in the warp of the piece of cloth. The bobbins are uſually one-fourth or one-ſixth of the number of threads required, and are mounted on ſpindles in a frame, ſo that the thread can draw off freely from them. All theſe threads are drawn off at once, ſo as to combine them all into one clue, which will be ready for the warp. The ancient method was to draw out the warp at full length, and ſtretch it in a field; and this is ſtill practiſed in India and China, but is ſo very uncertain in our climate that it is ſeldom uſed. The preſent mode of warping is either by the warping-frame or warping-mill.

The warping-frame is a large wooden frame, which is fixed up againſt a wall in a vertical poſition. The upright ſides of the frame are pierced with holes to receive wooden pins, which project ſufficiently to wind the clue of yarns for the warp round them.

The operator having the threads which are to compoſe the warp wound on the bobbins before-mentioned, places thoſe bobbins in a frame; then tying the ends of all the threads together, and attaching them to one of the pins at one end of the frame, he gathered all the threads in his hand into one clue; and permitting them to ſlip through his fingers, he walked to the other end, where he paſſed the yarns over the pin fixed there, and then returned to the former end of the frame and paſſed the warp over another pin, then went back again, and ſo on till he formed the required length of the warp. This being done, he ſecured the end of the warp by croſſing it round the pin, and then he worked back and returned over all the ſame ſpace again, laying the threads over the ſame pins, ſo as to double the clue; and he repeated the doubling until the number of threads neceſſary for the breadth was made up. The number of doublings would be according to the number of bobbins and threads which he took in his hand at once.

This method is uſed very much in France, particularly at Lyons: it is alſo uſed in Devonſhire. It is adapted to the weaving carried on in cottages, becauſe the frame is fixed cloſe to the wall, and takes little or no room; but the warping-mill or reel is very ſuperior, and is adopted in all improved manufactures where the warping is a ſeparate buſineſs, and is uſually done at the mill where the yarn is ſpun.

The warping-mill is a large reel of a cylindrical form, or rather of a priſmatic form, being made with twelve, eighteen, or more ſides. The reel is uſually about ſix feet diameter and ſeven feet high: it is turned round on a vertical axis by a band, paſſing from a grooved wheel which is turned by a winch, and is placed beneath the ſeat on which the warper ſits. (See a figure of the warping-machine for ſilk *Plate Silk, fig.* 6.) The bobbins which contain the yarn are placed on a vertical rack ſuſpended from the ceiling, and the threads from them are all collected together and paſſed between two ſmall upright rollers in a clue, which is wound up by the reel when it is turned round. To guide the clue and diſtribute it equally on the length of the reel, the above rollers are fixed on a piece of wood, which ſlides perpendicularly on an upright bar fixed at one ſide of the reel. The ſliding-piece is ſuſpended by a ſmall cord, wrapped round a part of the perpendicular axis that riſes above the reel. The cord paſſes over a pulley at the top of the upright bar, and goes down to the ſliding-piece which carries the two rollers. When the reel turns round, the guide-rollers are ſlowly

drawn up by the coiling of this cord round the axis; and the yarn is wound in a regular ſpiral about the reel, until the length which the warp requires is wound upon it. When the full length of the yarn is wound on the reel, the clue of thread is croſſed over pins projecting from the frame of the reel, and the mill is then turned the reverſe way, ſo that the ſlider and guide-rollers deſcend, and the yarn is laid downwards along the ſame ſpiral which it before aſcended, ſo as to double the clue of thread; and this doubling is repeated until the required number of threads is collected together in one clue upon the reel.

When the warp is thus completed, it is taken off the reel and wound upon a ſtick into a ball; the croſſings which diſtinguiſh the different returns or doublings of the ſimple clue being firſt properly ſecured, as a means of dividing the warp into as many equal portions as is neceſſary for the convenience of the weaver, in counting the threads in the ſucceeding operation of beaming.

There is likewiſe another kind of diviſion of the threads of the warp; this is called the leaſe, and ſerves to ſeparate all the threads which are to go through one of the heddles of the loom, from thoſe which are to go through the other heddle. To effect this ſeparation, the bobbins from which the threads are drawn are arranged in two rows, and a thread is alternately drawn from the upper row and from the lower row. Then at the beginning and end of every doubling of the warp, the threads of one row of bobbins are croſſed over the threads of the other row, and two pins are put into the croſſings to retain them. Theſe pins are put into holes made in pieces of board fixed to the warping-reel. One of theſe boards at the top of the reel is fixed faſt, but the other is moveable, and can be fixed at any part of the reel, according to the length of the warp.

In the moſt improved warping-machines, the ſeparation is made by an apparatus called in Scotland the heck. It conſiſts of a row of ſteel pins with eyes through one end of each for the threads to paſs through like large needles. Theſe are ſtuck into two pieces of wood, by which they are ſupported in a row near to the warping-reel. Every alternate pin in the row is faſtened in one piece of wood, and the intermediate pins are faſtened in the other piece, ſo that by lifting up one piece of wood the pins and threads belonging to it will be raiſed up, whilſt the intermediate pins and threads are held down. This occaſions the diviſion of the threads, and a pin is put in to keep them ſo divided. The other piece of wood is then lifted up, which occaſions all the threads to be croſſed; that is, every thread forms a croſs over that which is adjacent to it. A ſecond pin is then put in, and before the warp is taken off from the reel, this croſſing is ſecured by a ſtring.

Beaming.—When the weaver receives his warp in a large ball or bundle, he proceeds to roll it up regularly upon the yarn-roller of his loom: this is called beaming. For this purpoſe he employs an inſtrument called a ſeparator, or ravel, which conſiſts of a number of ſhreds of cane, faſtened together, and fixed to a rail of wood, like the teeth of a long comb; the threads are intended to be put into the ſpaces between theſe teeth, ſo as to ſtretch the warp to its proper breadth.

Ravels are ſomewhat like reeds, but much coarſer, and are alſo of different dimenſions. One proper for the purpoſe being found, one of the ſmall diviſions of the warp is placed in every interval between two of the teeth. The upper part of the ravel, called the cape, is then put on, to ſecure the threads from getting out between the teeth, and the operation of winding the warp upon the beam commences. In broad works, two perſons are employed to hold the ravel, which ſerves to guide the threads of the warp, and to ſpread them regularly upon the beam; one or two other perſons keep the threads at a proper degree of tenſion, and one more turns the beam upon its centre.

The knottings which ſecure the croſſings or doublings made in warping, are very uſeful to the weaver in beaming, to aſcertain the number of threads, and to diſtribute them with regularity. He cuts the knotting before he can put the warp in the ravel, but he ſtill keeps them diſtinct by a ſmall cord.

The French weavers uſe a ſmall reel, upon which they wind the warp from the ball, and then from this reel they draw off the warp through the ravel, by winding up the beam. The reel is loaded with a weight, to make a regular friction, and draw the warp with a regular tenſion.

Drawing.—The warp being regularly wound upon the beam, the weaver muſt paſs every yarn through its appropriate eye or loop in the heddles: this operation is called drawing. Two rods are firſt inſerted into the leaſe formed by the pins in the warping-mill, and the ends of theſe rods are tied together; the twine by which the leaſe was ſecured is then cut away, and the warp ſtretched to its proper breadth. The yarn-beam is ſuſpended by cords behind the heddles, ſomewhat higher, ſo that the warp hangs down perpendicularly. The weaver places himſelf in front of the heddles, and opens the eye of each heddle in ſucceſſion; and it is the buſineſs of another perſon, placed behind, to ſelect every thread in its order, and deliver it to be drawn through the open eyes of the heddles. The ſucceſſion in which the threads are to be delivered is eaſily aſcertained by the leaſe-rods, as every thread croſſes that next to it. The warp, after paſſing through the heddles, is drawn through the reed by an inſtrument called a ſley, or reed-hook, and two threads are taken through every interval in the reed.

The leaſe-rods being paſſed through the intervals which form the leaſe, every thread will be found to paſs over the firſt rod, and under the ſecond; the next thread 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. There is likewiſe a third rod, which 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.

Theſe operations being finiſhed, the cords or mounting which move the heddles are applied; the reed is placed in the lay, or batten, and the warp is knotted together into ſmall portions, which are tied to a ſhaft, and connected by cords to the cloth-beam, and the yarns are ſtretched ready to begin the weaving.

Manner of Weaving.—The operations of weaving are ſimple, and ſoon learned, but require much practice to perform them with dexterity.

In preſſing down the treadles of a loom, moſt beginners are apt to apply the weight or force of the foot much too ſuddenly. The bad conſequences of this are particularly felt in weaving fine or weak cotton-yarn; for the body of the warp muſt ſuſtain a ſtreſs nearly equal to the force with which the weaver's foot is applied to the treadle. The art of ſpinning has not yet been brought to ſuch perfection as to make every thread capable of bearing its fair proportion of this ſtreſs. 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

which they are generally in contraſt when riſing and ſinking. A ſudden preſſure of the foot on the treadle muſt cauſe a proportional increaſe of the ſtreſs upon the warp, and alſo of the friction. 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, and are broken very frequently. 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.

If the weaver, from inattention, continues the operation after one or more warp-threads are broken, the conſequence is ſtill worſe. The broken thread cannot retain 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: it frequently does both.

In every kind of weaving, and eſpecially in thin wiry fabrics, much of the beauty of the cloths depends upon the weft being well ſtretched. If the motion given to 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 or bobbin of the ſhuttle in doubles, which, if not picked out, would deſtroy the regularity of the fabric. The weft 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 cotton ſmooth and parallel, and its effect is ſimilar to that of dreſſing of the warp.

The perſon who winds the weft upon the pirn ought to be very careful that it be well formed, 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 round the cone, in the form of a ſpiral, or ſcrew, during the operation of winding.

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

The reeds are formed of a number of ſhort pieces of reed or cane, or of braſs wire, faſtened parallel to each other between two ſticks, and cemented with pitch. This frame is encloſed between two pieces of the frame of the lay, one of which is made wide, to form the ſhuttle-race; the other piece, which is the lay-cap, extends acroſs the frame, but is fitted ſo that it can be eaſily removed to take away the reeds, and ſubſtitute a finer or coarſer ſort, as the nature of the goods to be woven require. The manufacture of reeds, both of cane and of ſteel, is a ſeparate trade. Theſe are fully deſcribed in Les Arts et Metiers, vols. 9 and 15.

To render the fabric of the cloth uniform in thickneſs, the lay or batten muſt be brought forward with the ſame force every time.

In weaving ſome kinds of ſoft or light goods, the reed is not fixed faſt to the lay-cap, but is held in its place by a long thin piece of wood, which is elaſtic, and yields or ſprings when the weft is beaten up. In ſome caſes the reed is ſuſtained by a double woollen cord, ſtretched acroſs the lay, juſt beneath the lay-cap, and twiſted; this bears the reed, and is very elaſtic, but can be rendered more ſtiff by twiſting the two cords tighter.

In the common operation of weaving, a regular force of the ſtroke for beating up the weft muſt be acquired by practice. It is, however, of conſequence to the weaver to mount or prepare his loom in ſuch a manner, that the range or ſwing of the lay may be in proportion to the thickneſs of his cloth. As the lay ſwings backwards and forwards, 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 the fabric of cloth will be, as far as that depends upon the cloſeneſs of the weft. For this reaſon, in weaving coarſe and heavy goods, the heddles ought to be hung at a greater diſtance from the place where the weft is ſtruck up, and conſequently where the cloth begins to be formed, than would be proper in light work. The line of the laſt wrought ſhot of weft is called by the weavers the fell. The pivots upon which the lay vibrates ought, in general, to be ſo placed, that the reed will be exactly in the middle, between the fell and the heddles, when the lay hangs perpendicularly. As the fell is conſtantly varying in its ſituation during the operation, it will be proper to take its medium; that is, the place where the fell will be when half as much is woven as can be done without taking it up on the cloth-roll, and drawing freſh yarn from the yarn-roll.

The periods for taking up the cloth ought always to be ſhort in weaving light goods; for the leſs that the extremes of the fell vary from the medium, the more regular will be the arc or ſwing of the lay. Mr. James Hall had a patent, in 1803, for a method of perpetually winding up the cloth-beam, ſo as to take away the cloth as faſt as it was woven, or ſhoot by ſhoot. This was effected in a ſimple manner by a ratchet-wheel fixed on the end of the cloth-beam, and a proper catch to move it round one tooth at a time: the catch was actuated by the motion of the lay. A ſimilar method is uſed in ribband-weaving.

The variations in the ſtructure of looms from that which we have deſcribed, are not material. The framing is varied in almoſt every different kind of loom, and ought always to be ſuitable in ſtrength to the kind of cloth which is to be woven. The loom uſed for ſilk is very ſlight in all its parts; but for carpet and ſail-cloth it muſt be very ſtrong.

In looms for heavy goods, the cloth-beam is not placed at the breaſt of the weaver, as it is ſo large that it would impede his working; the cloth is therefore paſſed over a fixed bar in the place of the cloth-beam repreſented, and the beam is placed lower down, and near the weaver's feet, out of the way of his knees. The heddles are connected by levers, in ſome looms, inſtead of pulleys; but the effect is always the ſame; *viz.* to make one heddle aſcend when the other deſcends. For weaving fine goods, the heddles would be inconveniently cloſe together, if all the yarns went through two heddles; hence they uſe four heddles inſtead of two; but their action is juſt the ſame, becauſe they are connected together in pairs, and when one pair riſes the other pair ſinks. Many looms are ſtill made without the fly-ſhuttle; and in that caſe the ſhuttle is merely thrown from one hand to the other, and then thrown back again: this obliges the weaver to change his hands continually, and the operation is more complicated. For wide cloths, which are more than a man can reach acroſs, two perſons were always employed before the fly-ſhuttle was introduced, which is only within a few years; but by its aſſiſtance one perſon can weave the greateſt breadths. The fly-ſhuttle is the beſt for all kinds of work, and its conſtruction is ſo ſimple that no other ought to be uſed.

Treatment of different Kinds of Yarns. — The manner of weaving all kinds of plain cloth is much the ſame, whether it is wool, ſilk, flax, or cotton; except that the two latter

require what is called dreſſing. Silk and woollen warps require little preparation after being put into the loom, except to clear the yarn occaſionally with a comb, to remove knots or lumps which might catch in paſſing through the reed; the comb detects ſuch lumps, and they are removed with the aſſiſtance of a pair of ſciſſors. Flax and cotton, but particularly the latter, require the warp to be dreſſed with ſome glutinous matter, to cement the fibres, and lay them cloſe. This is applied in a fluid ſtate, and as the weaving does not proceed well after it is ſuffered to dry, the warp is dreſſed with a bruſh when in the loom, a ſmall quantity at a time, immediately before it is woven.

Dreſſing.—The uſe of dreſſing is to give to yarn ſufficient ſtrength or tenacity, to enable it to bear the operation of weaving into cloth. By laying ſmooth all the ends of the fibres of the raw materials, from which the yarn is ſpun, it tends both to diminiſh the friction during the proceſs, and to render the cloth ſmooth and gloſſy when finiſhed. The dreſſing in common uſe is ſimply a mucilage of vegetable matter boiled to a conſiſtency in water. Wheat-flour, boiled to a paſte like that uſed by book-binders, or ſometimes potatoes, are 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 affected by the action of the atmoſphere. When dreſſed yarn is allowed to ſtand expoſed to the air for any conſiderable time, before being woven into cloth, it becomes hard, brittle, and comparatively inflexible. It is then tedious and troubleſome to weave, and the cloth is rough, wiry, and uneven. This is chiefly remarked in dry weather, when the weavers of fine cloth find it neceſſary to work up their yarn as ſpeedily as poſſible, after it is dreſſed. To counteract this inconveniency, herring or beef brine, and other ſaline ſubſtances which attract moiſture, are ſometimes mixed in ſmall quantities with the dreſſing: but this has not been completely and generally ſucceſsful; probably, becauſe the proportions have not been ſufficiently attended to; for a ſuperabundance of moiſture is equally prejudicial with a deficiency. The variations of the moiſture of the air are ſo great and frequent, that it is impoſſible to fix any univerſal rule for the quantity of ſalt to be mixed. Some weavers put butter-milk in the paſte.

To apply the dreſſing, the weaver muſt ſuſpend the operation of weaving, whenever he has worked up that quantity of warp which he has dreſſed, or within two or three inches; he then quits his ſeat, and applies the comb to clear away knots and burs; next puſhes back the leaſe-rods towards the yarn-roll, one at a time, and if they ſlide freely between the yarns, it ſhews they are clear from knots; he then bruſhes the yarn with the paſte by two bruſhes, holding one in each hand. The ſuperfluous humidity is afterwards dried by fanning the yarns with a large fan, and then a ſmall quantity of greaſe is bruſhed over the yarn; the leaſe-rods are returned to their proper poſition, and the weaving is reſumed.

Dreſſing is of the firſt importance in 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 ſame practice, when uſed upon ſilk, has a very deſtructive tendency: it injures the colours of the ſilk when uſed, as it is ſometimes very improperly, by the weavers of white ſatin. The injury done to the work is irreparable. In cotton, the operation of dreſſing is indiſpenſable; but in ſilk, this is by no means the caſe.

The preparation of paſte or ſize for warp, has been the ſubject of ſeveral patents. Mr. Foden, in 1799, recommends a quantity of calcined gypſum, or plaſter of Paris, to be reduced to a very fine powder, and then mixed with alum, ſugar, and the farina or ſtarch of potatoes, or any other vegetable farina. This powder, when mixed well with cold water, forms a ſoft paſte, to which boiling water is to be added, and the mixture thoroughly ſtirred till it becomes ſufficiently gelatinous for uſe.

Another ſize, for which Mr. Wilks had a patent in 1801, is prepared as follows:—The ſtarch or flour is to be extracted from any kind of potatoes which are mealy when boiled, by grating them while raw (but waſhed clean) into a tub of water. The water, thus impregnated with the grated potatoes, is run through a ſieve or ſtrainer, which will retain the coarſer and fibrous parts of the potatoes, but admit the finer particles, conſtituting the ſtarch or flour, to paſs with the water into a veſſel beneath the ſieve or ſtrainer. This water muſt remain in the veſſel ſeveral hours undiſturbed, to permit the ſtarch to ſubſide to the bottom; then the water is poured off, and the ſtarch ſo obtained is put into freſh water, and paſſed through a finer ſieve into another tub, where the ſtarch is left to ſubſide to the bottom as before, and the water is again poured off.

About two-thirds the quantity of potatoes, which furniſhed the ſtarch, are alſo to be boiled without peeling, ſo as to make them mealy when boiled; they are then maſhed, and diluted with water, ſo that they will paſs through a ſieve into a boiler. In this the maſhed potatoes are heated till they almoſt boil; and the ſtarch from the grated potatoes is then to be added, and the whole boiled and ſtirred for 20 minutes, when it will become paſte proper for uſe. It ſhould be ſpread in a flat open veſſel to cool.

Improved Syſtem of Weaving by Machinery.—In our article COTTON we mentioned that weaving-looms, worked by mechanical power, were then coming into uſe: ſince the time that article was printed theſe have made great advances; but to uſe them with advantage, the preparatory proceſſes of warping and dreſſing muſt be conducted in a particular manner. Many attempts have been made to diminiſh the number of operations through which the yarn muſt paſs by combining ſeveral together. Mr. Stuart had a patent in 1800 for ſizing or ſtarching cotton-yarn whilſt in the cop, ſo that it would be ready to warp at once. Mr. Marſland had a patent in 1805 for the ſame object: his plan was to expoſe the cops of cotton to the action of the hot ſtarch in an exhauſted receiver; the preſſure of the atmoſphere being thus removed, the ſize penetrated readily to the centre. It was found difficult to dry the cop perfectly, and the threads were ſometimes ſo glued together as to render the winding off difficult.

Another plan has therefore been introduced both for flax and cotton: this is to wind off the yarn from the cop or bobbin in which it is ſpun, and gather it upon the bobbins ready for the warping; by this manner the reeling is ſaved. A ſmall quantity of ſtarch is applied to the yarn during the operation, by cauſing it to paſs over a horizontal wooden cylinder, which revolves on its axis in a trough filled with fluid ſtarch. The threads, in paſſing from the cop to the bobbin, are drawn over the upper ſurface of the cylinder, and receive the ſtarch with which it is covered. The winding machine for this actuated a great number of bobbins at once; the warping is then conducted, as we have before deſcribed, and the dreſſing is performed in the loom whilſt weaving, that is, if woven by hand; but for the power-loom it is dreſſed previouſly to placing it in the loom.

Dreſſing Machines.—Mr. Johnſon, of Stockport, had a patent, in 1804, for a method of dreſſing whole webs of warp at once,

once, by a machine. The yarns were wound off from the bobbins or cops of the ſpinning machines upon beams or rollers. Several of theſe rollers were placed parallel to each other, in an horizontal direction, at the oppoſite ends of the machine, from three to ſix at each end; and the yarns from them were all combined together in one web, which was received and rolled up on the yarn-beam of the loom placed in the middle of the machine, and raiſed up conſiderably above the other rollers, ſo that the yarns proceeded from both ends of the machine towards the middle. In their paſſage they paſſed through ſeveral reeds to keep them ſeparate, and were ſupplied with the paſte by paſſing over two cylinders revolving in a trough of fluid paſte. This paſte was dreſſed or worked into the yarn by means of two bruſhes, of a length equal to the breadth of the web; one of the bruſhes acted upon the upper ſide of the yarns, and the other on the lower ſide. A ſimilar pair of bruſhes were applied at both ends; each bruſh had a motion given to it by means of cranks, exactly ſimilar to the movement with which the weaver bruſhes the yarn in the loom. Near the yarn-roller a fan was placed, like that uſed in a winnowing machine, which blew a current of air through the yarns of the warp to dry them before they were rolled up by the beam. To preſerve the leaſe, the yarns were conducted through a pair of heddles, ſimilar to thoſe of the loom, but they remained ſlack to avoid friction. The machine was moved by the mill with a conſtant and regular movement.

When a warp is thus warped, beamed, and dreſſed, the yarn-beam is carried to a loom, on which the yarn is juſt exhauſted, and is made to replace the empty yarn-roll. The ends of the yarn are joined to the old yarns by twiſting, and are thus drawn through the heddles and reed, ſo that the weaving can be reſumed with very little loſs of time, and the weaver can proceed with his work without any interruption for dreſſing. The principal objection to the above machine is the friction which the yarns muſt undergo in bruſhing, and in paſſing through ſo many reeds: it was, however, practiſed in a large work at Stockport; but the weaving was performed by hand.

Another dreſſing machine was invented by Mr. M'Adam, and he obtained a patent in 1806: it is practiſed by Mr. Monteith, at Pollockſhaws near Glaſgow. This machine is very much like the former in its manner of action. Inſtead of uſing three, four, or ſix beams at each end of the machine, there are only two beams, each containing one half the number of yarns for the intended warp. The ſtarch is ſupplied in the ſame manner as the former, or ſometimes by making the two yarn-beams themſelves turn in a trough of ſtarch without employing a ſeparate cylinder. The bruſhing is performed in a more ſimple and effectual manner by uſing cylindrical bruſhes, which revolve with a regular motion, two of them are applied on the upper ſide of the warp, and two on the lower ſide; alſo four fanners are applied to dry the warp inſtead of one. The yarns were conducted between reeds and through heddles, like the firſt machine; and hence the ſame objection of friction applies to both.

Mr. Duncan, in his Eſſays on Weaving, deſcribes another method of dreſſing warps, which is practiſed by Mr. Dunlop at Barrowfield. In this the yarn is warped and beamed in the uſual manner, upon a yarn-roll: from this the yarn is unwound, and taken up upon another beam; and in its paſſage from one to the other it is extended, ſo that the picking and clearing can be performed in the uſual way by hand with a comb and ſciſſors, and the dreſſing is applied with bruſhes in the uſual way: beneath the warp a fan is placed, to blow a current of air up through the yarns and dry them. In this machine all the operations, except the fanning, are performed by hand; the advantage, therefore, conſiſts only in the diviſion of labour, by making the dreſſing and weaving diſtinct operations.

Power-Looms.—In the article COTTON we have mentioned Mr. Dolignon's claim to the invention of weaving by mechanical power.

The original project, we believe, was by M. De Gennes, and is publiſhed in the Philoſophical Tranſactions for 1768, N° 140. See alſo Lowthorp's Abridgment, vol. i. p. 499. This is a very ingenious invention. The fly-ſhuttle was not then invented, and he ſupplied the want of it by a contrivance which held the ſhuttle as it were in a hand by fingers; this carried it half way through the cloth, and then it was transferred to another ſimilar hand, which drew it through the remainder. By this means there was a greater certainty than in throwing the ſhuttle from one ſide to the other, becauſe the ſhuttle always continued engaged with the mechaniſm: the whole machine is ingenious and worthy of notice.

M. Vaucanſon, the celebrated French mechaniſt, made a machine for weaving ten ribbands at a time, which was worked by a circular motion given by the workman; and it might, therefore, have been worked by mechanical power. This is deſcribed in the Encyclopede Methodique in great detail, with ten folding plates, and is an ingenious machine.

We believe both theſe inventions were prior to that of Mr. Dolignon; and alſo that the merit of inventing the machine, and firſt reducing it to practice, is due to Mr. Auſtin, of Glaſgow. In this gentleman's memoir to the Society of Arts, he ſtates, that his firſt attempt was made in the year 1789, when he entered a caveat for a patent, but did not apply for it further; ſince that time he made many improvements upon the original plan. In 1796 a report in its favour was made by the Chamber of Commerce and Manufactures at Glaſgow; and in 1798, a loom was ſet at work at Mr. J. Monteith's ſpinning works, at Pollockſhaws near Glaſgow, which anſwered the purpoſe ſo well, that a building was erected by Mr. Monteith for containing thirty looms, and afterwards another to hold about two hundred.

Mr. Auſtin's Power-Loom.—The model from which our drawing (*Plate* I. *Weaving*) was made, is depoſited in the Society of Arts: it is an improvement upon the looms conſtructed for Mr. Monteith.

The drawing *Plate* I. is a perſpective view, exhibiting the whole loom at one glance: it is viewed from the back rather than from the front.

A is a ſquare iron axis extending through the whole length of the machine; to this the power of the firſt mover is applied by a cog-wheel B, of thirty-ſix teeth, turned by a pinion of twelve leaves fixed to the axis of the fly-wheel D. A handle is fixed to one of the arms of the wheel to give motion to the model; but in the large machine a live and dead pulley are adapted to the axis of the fly-wheel; and by means of an endleſs ſtrap, the power is communicated from any convenient part of the mill in which a great number of looms are placed together.

The axis A has ſeveral eccentric wheels or camms fixed upon it; as theſe revolve they give motion to a number of levers or treadles, by which all the uſual operations of the loom are performed at the proper intervals: theſe are,

Firſt, To ſeparate the two parts of the yarns of the warp, as ſhewn at G, and admit of the paſſage of the ſhuttle.

Secondly, To throw the ſhuttle, in order to lay the weft or croſs-threads of the cloth.

Thirdly, To move the lay 7.8, and return it; ſo that the reed *g* will beat up the weft cloſe to the fell, or pre-

ceding

ceding ſhoot of the weft: this renders the cloth of uniform texture.

Fourthly, To wind up the cloth upon the cloth-roll, as faſt as it is formed by the preceding operations.

The yarns, which are to form the warp of the cloth, are warped in the manner before deſcribed upon the yarn-roll F; and from thence they are extended horizontally to the cloth-roll E, of which only a ſmall part can be ſeen at the oppoſite ſide of the loom: in their way the yarns paſs through the eyes of the heddles G H, which effect the firſt operation above-mentioned. Each heddle is compoſed of a number of perpendicular threads equal to half the number of yarns in the warp; theſe are ſtretched between two ſmall rods *a a* and *b b*, and in the middle of each thread is a ſmall eye, through which a yarn of the warp is paſſed; thus, the firſt yarn of the warp is paſſed through the eye of the heddle G, but has no connection with the heddle H, becauſe it paſſes between its threads. The ſecond yarn is put through the eye of the heddle H, but has no connection with G; the third yarn is attached to H; the fourth to G, and ſo on alternately throughout the whole number. By this means if one heddle is raiſed up, and the other at the ſame time depreſſed, a ſeparation of the yarns will take place as ſhewn at G, every other yarn being raiſed up, whilſt the intermediate ones are drawn down, ſo as to admit the paſſage of the ſhuttle and weft between them.

The two heddles are moved by camms upon the main axis A; and they are ſo connected by ſhort levers I I, which are ſuſpended from the upper part of the loom, that when one heddle is pulled down, the other will be drawn up at the ſame time, becauſe they are ſuſpended from the oppoſite ends of the levers I.

The camms on the main axis for the heddles are marked L; the two are exactly ſimilar, but are reverſed upon the axis; that is, the ſhorteſt radius of one is placed on the ſame ſide with the longeſt of the other. They act upon two levers, which are the ſame as the treadles in a common loom; only one of theſe treadles or levers (*viz.* that which belongs to the camm L) can be ſeen at M, the other lever being concealed from the view; both levers move on centres at *n* between the ſmall uprights *d d*; the other ends ſlide freely up and down between ſimilar uprights at the oppoſite ſide of the frame, which cannot be ſeen in the figure; the levers are connected with the heddles, which being ſuſpended from the levers I as before mentioned, the levers will therefore move in contrary directions, the one riſing when the other is preſſed down by the action of the camm on the axis A.

The connection between the levers or treadles M and the heddles G H, is made by cords communicating with two counter-levers O P, which are centered in uprights ſupported by the frame at the ends of the machine. The counter-levers O P are connected with rods *h* and *k*, and theſe by a double cord are attached to the heddle-rods *a a* and *b b*.

This machinery which we have now deſcribed effects the ſeparation of the warp thus: when the axis A turns round, every revolution of its camms L will cauſe two ſeparations of the warp, and each one in a different manner, for thoſe yarns which are raiſed up at one time are drawn down the next.

The ſecond operation, *viz.* throwing the ſhuttle, is performed by two camms R S, which are reverſed to each other upon the axis A. They act upon two levers, only one of which can be ſeen at T; they are placed beneath the camms. The ſhuttle requires to be projected with a ſudden jerk; theſe levers are therefore centered at *d* on the ſame pin as the levers M and N, but the other ends preſs down ſmaller levers W, which are centered at the oppoſite end of the frame, and lie beneath the long levers. The extreme ends of theſe ſmaller levers are connected by a ſtrap *f* with a ſegment of a wheel, which has a long ſtem of whalebone Y faſtened to it; and by means of two ſtrings, one of which is ſhewn at *q* 4, it moves the peckers or drivers *z* upon the wires 3, 3, and throws the ſhuttle. The ſhuttle, which is ſhewn in a ſeparate figure, is pointed at each end, and ſhod with iron: it contains two ſmall rollers 31 31 upon which it runs; and as they project through both ſurfaces, it will run either way upwards, or either end firſt. In the centre of the ſhuttle is an oblong mortiſe, containing the pirn or bobbin 33, on which the thread for the weft of the cloth is wound; and the end of the weft marked 34, is brought through a ſmall glaſs tube, called the eye of the ſhuttle.

The action of the mechaniſm for throwing the ſhuttle is as follows:—By the revolution of the camm R, the long lever beneath it is depreſſed, and at the ſame time the extremity of the ſhorter lever W deſcends, but with an increaſed velocity; this by means of the ſtrap *f* turns the ſegment of a wheel on its centre, and its tail Y ſnatches the ſtring *q* 4 of the pecker *z*, and makes it ſtrike againſt the ſhuttle with ſuch a velocity, as to drive the ſhuttle out of the trough Q, acroſs the ſhuttle-race, into the oppoſite trough, where it will puſh back the pecker, and remain at reſt in the trough ready for the next ſtroke: by this ſtroke it will be returned back again with an action ſimilar to the laſt, but occaſioned by the other camm S, and its correſponding levers.

The threads of the warp, which are loweſt when the ſeparation takes place, are drawn down by their heddle G or H, ſo as to lie cloſe upon the ſhuttle-race, and cauſe no obſtruction to the paſſage of the ſhuttle. To facilitate this, the ſhuttle muſt be very ſmooth on the ſurface, that it may not catch the threads and be ſtopped. The ſhuttle-race is inclined towards the reed, both that the yarn may lie flat upon it, and that the ſhuttle may not be liable to run off its race; for as it leaves the weft, which is drawn off from its bobbin, in the ſpace between the divided yarns of the warp, it might be drawn off its race ſideways, without this precaution. In this manner the ſecond operation is performed.

The third motion is that of the reed *g*: this is fixed cloſe behind the ſhuttle-race, and is a frame containing a great number of parallel ſlips of reed or cane; between theſe the yarns of the warp paſs, and when the whole frame of reeds is moved towards the cloth-roll E, they will act in the manner of a comb, to beat up the thread of the weft, which is left by the ſhuttle lying looſely between the yarns of the warp.

For this purpoſe, the ſhuttle-race, reeds, peckers, &c. and their ſtem Y, with its ſegment of a wheel, are all placed on a framer which moves on hinges at the lower ends, 8, of the two upright ſides 7 8. This frame, which is termed the lay, is drawn backwards by means of ſtraps 10, 10, rolled upon pulleys 11, faſtened upon the axis 12; upon this ſame axis are two other ſmaller pulleys, upon which two ſtraps, 13, are rolled, to connect with the long levers 14, which are moved by the camms 15, upon the axis A.

The long levers, 14, are centered at one end of the frame, and the pulleys on the axis, 12, being of different diameters, the motion of the reeds will be performed very quickly. To move the lay in a contrary direction, and give the ſtroke to beat up the weft, two large weights, like *m*, are ſuſpended by ſtraps from pulleys on an horizontal axis, which carries two larger wheels *x*; on theſe, ſtraps are wound, to commu-

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nicate with the upright ſides, 7 8, of the lay, and draw it forwards.

When the loom is acting very quickly, theſe weights would not act with ſufficient ſharpneſs to throw the reeds againſt the threads of the weft with the proper force.

The weights are therefore connected by ſpiral wire-ſprings, with long levers 16, which are preſſed down by a camm or rather tappet 17, fixed on the main axis. Theſe levers act before the lay is at liberty to move, and by preſſing down the levers extend the ſprings; conſequently, as ſoon as the camm 15 ſuffers the lever 14 to riſe, the ſprings act inſtantaneouſly, to throw the lay and the reeds forwards to beat up the weft.

The inſtant after the blow has been given, the lay is drawn back again by the camm 15, and returned into the vertical poſition, in which ſituation the lay muſt continue whilſt the ſhuttle is thrown; for this purpoſe, the outſides of the camms 15 are portions of circles. This completes the third motion.

As faſt as the cloth is fabricated by the foregoing movements, it is gathered upon the cloth-roll E. This is turned ſlowly round by a ſmall crank 19, on the extreme end of the main axis A; the crank moves a ſmall rod 20 up and down, in order to turn a ſmall ratchet-wheel round one tooth each revolution of the main axis; the return of the ratchet is prevented by a click. On the axis 21 of the ratchet-wheel is an endleſs ſcrew, to engage the teeth of a cog-wheel upon the end of the cloth-roll, and give it a ſlow motion.

The yarn is kept to a proper degree of tenſion by the friction occaſioned by a line 28 paſſed twice round the yarn-roll, one end being faſtened to the frame, and the other to a lever 30, loaded with a weight.

The framing of the loom is too evident to need deſcription. In the conſtruction of the machine, the principal circumſtance to be attended to, is the figure of the different camms; alſo that they are placed upon the axis A in the proper poſitions relative to each other. Theſe cautions will enſure the accurate performance of the machine.

The camm R or S, for throwing the ſhuttle, is formed with a ſudden beak or projection, that it may ſtrike the levers T down inſtantaneouſly, and throw the ſhuttle; from this beak the curve continues circular for ſome diſtance, that the lever may be held ſtationary; the remainder of the camm gradually diminiſhes its radius like a ſpiral, and quits the lever, in order to leave it at liberty to riſe up when its correſponding lever is forced down by the beak of the other ſimilar camm S.

The camm L for the heddles is made circular where it is to come in contact with the lever, and which is all the time it is in action. This occaſions the levers and heddles to be ſtationary whilſt the ſhuttle is thrown.

The inventor ſtates that, by the addition of ſome ſimple improvements, his looms have the following advantages; *viz.* 300 or 400 of them may be worked by one water-wheel, or ſteam-engine, all of which will weave cloth in a ſuperior manner to what can be done in the common way. They will go at the rate of 60 ſhoots in a minute, making two yards height of what is called a nine hundred web in an hour. They will keep regular time in working, ſtop and begin again, as quick as a ſtop-watch. They will keep conſtantly going, except at the time of ſhifting two ſhuttles, when the weft on the pirns is exhauſted. In general, no knots need be tied, and never more than one in place of two, which are requiſite in the common way when a thread breaks. In caſe the ſhuttle ſtops in the ſhed, the lay will not come forwards, and the loom will inſtantly ſtop working. They will weave proportionally ſlower or quicker, according to the breadth and quality of the web, which may be the broadeſt now made. They may be mounted with a harneſs or ſpot-heddles, to weave any pattern, twilled, ſtriped, &c.

There is but one cloſe ſhed, the ſame in both breadths, and the ſtrain of the working has no effect on the yarn behind the rods.

The fell and temples always keep the ſame proper diſtance. There is no time loſt in looming, or cutting out the cloth; but it is done while the loom is working, after the firſt time.

The weft is well ſtretched, and exactly even to the fabric required.

Every piece of cloth is meaſured to a ſtraw's breadth, and marked where to be cut at any given length.

The loom will work backwards in caſe of any accident, or of one or more ſhoots miſſing. Every thread is as regular on the yarn-beam as in the cloth, having no more than two threads in the runner. If a thread ſhould appear too coarſe or fine in the web, it can be changed, or any ſtripe altered at pleaſure. They will weave the fineſt yarn more tenderly and regularly than any weaver can do with his hands and feet.

When a thread, either of warp or weft, breaks in it, the loom will inſtantly ſtop, without ſtopping any other loom, and will give warning by the ringing of a bell. A loom of this kind occupies only the ſame ſpace as a common loom; the expence of it will be about half more; but this additional expence is more than compenſated by the various additional machinery employed for preparing the yarn for the common loom, and which this loom renders entirely unneceſſary.

The preparatory proceſſes of reeling, winding, warping, beaming, and looming, and the interruptions occaſioned by combing, dreſſing, fanning, greaſing, drawing bores, ſhifting heddles, rods, and temples, which is nearly one-half of the weaver's work, do not happen in theſe looms. The general waſte accompanying the above operations is ſtated at about ſix *per cent.* of the value of the yarn, all which occur in the operations of the common loom. The power-loom, without further trouble, performs every operation after the ſpinning, till the making of the cloth is accompliſhed, by which a ſaving is effected of about 20 *per cent.* of the yarn.

The heddles, reed, and bruſhes, will wear longer than uſual, from the regularity of their motion. More than one-half of workmanſhip will be ſaved; one weaver and a boy being quite ſufficient to manage five looms of coarſe work, and three or four in fine work.

Mr. Miller's Power-Loom.—A patent was taken out for this in 1796. It is ſo much like Mr. Auſtin's in its general principle, that it is unneceſſary to enter into the deſcription. The motions are all produced by camms fixed on a horizontal axis, and operate upon a number of horizontal levers, diſpoſed beneath the loom, in the ſituation of treadles: in other reſpects the arrangement of the parts is very different. This is ſometimes called the wiper-loom, wiper being a different name for a camm.

Crank Loom by Power.—In this the treadles are actuated by cranks, inſtead of camms or wipers. The reciprocating motion produced by a crank is not uniform, but accelerated at one time, and retarded at another. This is an advantage in ſome of the operations of a loom. It is true, that, by means of wipers, any required law of acceleration may be produced; but in a crank, the acceleration muſt proceed according to one law. The ſuperiority of cranks ariſes from

from the circumſtance, that they will communicate motion in both directions; whereas a camm will only puſh a lever in one direction, and the return of the motion muſt be made by a ſpring or counterweight. Now, if this counterweight is too large, it makes unneceſſary loſs of power and friction; and if it is too ſmall, there is ſome uncertainty in the return of the lever.

Mr. Todd of Boulton had a patent, in 1803, for improvements in power-looms.

Mr. Horrocks of Stockport had three ſucceſſive patents for this kind of machinery, in 1803, 1805, and 1813. The machine deſcribed in the latter is a crank-loom; that is, the lay is actuated by a crank to beat up the weft. The principal improvement conſiſts in a ſyſtem of levers, which tranſmit the action of this crank to the lay, and ſo modify it, that the lay will advance quickly, and give an effective ſtroke to the weft, and then withdraw quickly to a ſtationary poſition, in which it will remain whilſt the ſhuttle is thrown. The advantages which are ſtated are, that a large ſhuttle may be uſed, ſufficient to hold a full-ſized cop of weft: the waſte and loſs of time by renewing the cop will, therefore, be leſs. From the ſmartneſs of the ſtroke, leſs weight will be required on the yarn-beam, and this will occaſion the heddles to work more lightly, ſo as to break fewer threads. From the ſame cauſe, more threads of the weft may be laid in an inch, and make cloſer work.

Mr. Johnſon of Preſton had a patent in 1805, and another in 1807, for a power-loom, in which the warp is ſtretched on a vertical plane, inſtead of horizontal, as in former machines. The advantages of this are ſtated to be, 1ſt, that it takes leſs ſpace; 2d, the reed ſerves for the ſhuttle-race, becauſe the ſhuttle runs upon the reed itſelf, and, therefore, makes no friction upon the yarns; 3d, alſo in dreſſing, picking, and clearing the warp, the attendant always remains in front of the machine, and can continue to watch the machine; whereas, in the other looms, he muſt quit his poſt in front, and go round behind the looms for theſe operations. When the dreſſing is to be applied to the warp, whilſt it is in the loom, that part of the warp is conducted horizontally for that purpoſe, and a fan is applied to dry the warp.

The lateſt inventions of power-looms are Mr. Peter Ewart's patent, 1813; and Mr. Duncan's loom, which he calls a vibrating loom.

The Indian Loom.—This is a ſtriking contraſt to our power-looms; it conſiſts merely of two bamboo rollers, one for the warp, and the other for the finiſhed cloth; and a pair of heddles. The ſhuttle performs the double office of ſhuttle and reed: for this purpoſe, it is made like a large netting-needle, and of a length ſomewhat exceeding the breadth of the piece of cloth which is to be woven.

This apparatus the weaver carries to any tree which affords a ſhade moſt grateful to him: under this he digs a hole large enough to contain his legs, and the lower part of the geer or heddles; he then ſtretches his warp, by faſtening his bamboo rollers at a due diſtance from each other on the turf, by wooden pins; the balances of the geer or heddles he faſtens to ſome convenient branch of the tree over his head; and two loops underneath the geer, in which he inſerts his great toes, ſerve inſtead of treadles; his long ſhuttle, which performs alſo the office of a batten, draws the weft, throws the warp, and afterwards ſtrikes it up cloſe to the web. In ſuch looms as this are made thoſe admirable muſlins, whoſe delicate texture the Europeans can never equal, with all their complicated machinery.

The weaving, even of their fineſt muſlins, is thus conducted in the open air, expoſed to all the intenſe heat of their climate. We know well that this would be impracticable with fine work in this country, even in an ordinary ſummer day, on account of the ſudden drying of the dreſſing. It is not known what is the ſubſtance which the Indian weavers employ for dreſſing their warps. It might be of uſe to our manufacturers, were this inveſtigated in a ſatisfactory manner. It is ſaid to be a decoction of rice, formed by boiling the rice in a ſmall quantity of water, and expreſſing the juice: when this is cool, it forms a thick glutinous ſubſtance, which undergoes ſome kind of fermentation before it is uſed.

Figure-weaving.—Having given an account of the nature and proceſs of plain weaving, we muſt notice the fanciful and ornamental parts of the buſineſs. The extent to which this ſpecies of manufacture is carried renders it an object of very great national importance, and deſerving a more minute deſcription than our limits will admit.

Figures or patterns are produced in cloth, by employing threads of different colours, or of different appearance, in the warp, or in the weft. By the weaving, the threads muſt be ſo diſpoſed, that ſome colours will be concealed and kept at the back, whilſt others are kept in the front; and they muſt occaſionally change places, ſo as to ſhew as much of each colour, and as often as it is neceſſary, to make out the figure or pattern.

The weaver has three means of effecting ſuch changes of colour: Firſt, by uſing different coloured threads in the warp, or threads of different ſizes and ſubſtances; theſe are arranged in the warping, and require no change in the manner of weaving. This is confined to ſtriped patterns, the ſtripes being in the direction of the length of the piece.

Secondly, by employing ſeveral ſhuttles charged with threads of different colours or ſubſtances, and changing one for another every time a change of colour is required. This makes ſtripes acroſs the breadth of the piece; or, when it is combined with a coloured warp, it makes chequered and ſpotted patterns of great variety.

Thirdly, by employing a variety of heddles, inſtead of two, as we have hitherto deſcribed; each heddle having a certain portion of the warp allotted to it, and provided with a treadle. When this treadle is depreſſed, only a certain portion of yarns which belong to that heddle will be drawn up, and the reſt will be depreſſed; conſequently, when the weft is thrown, all thoſe yarns which are drawn up will appear on the front or top of the cloth; but in the intervals between them, the weft muſt appear over thoſe threads which are depreſſed. The number of threads which are thus brought up may be varied as often as the weaver chooſes to preſs his foot upon a different treadle, and by this he produces his pattern.

All theſe means may be combined together, and give the weaver the means of repreſenting the moſt complicated patterns.

The principal varieties of woven cloth, including only thoſe which require a different proceſs for their fabrication, are the following:

Stripes are formed upon the cloth either by the warp or by the woof. When the former of theſe ways is practiſed, the variation of the proceſs is chiefly the buſineſs of the warper; but in the latter caſe, it is that of the weaver, as he muſt continually change his ſhuttle.

By unravelling any ſhred of ſtriped cloth, it may eaſily be diſcovered whether the ſtripes have been produced by the operation of the warper or thoſe of the weaver.

When the fly-ſhuttle is uſed, the changing of the ſhuttle is very readily effected by a ſimple contrivance. One of the ſhuttle-boxes or troughs, as we have before called them,

(*Plate* II. *Weaving, fig.* 2.) is made in two parts, ſo that a part of the trough I near the pecker, where the ſhuttle lies during the time it is at reſt, can be removed, and another trough ſubſtituted, which contains a different ſhuttle. For the purpoſe of making the change with facility, a moveable ſhuttle-box *n* is ſuſpended by two perpendicular ſtems *o* from a wire or centre of motion *m* attached to the lay, as is ſhewn by the dotted lines. The moveable box is juſt on the ſame level with the ſhuttle-trough I, and is divided by partitions into two or three ſeparate troughs, each exactly the width of the regular trough, and as long as is neceſſary to contain a ſhuttle. The pecker *k*, and the wire upon which it ſlides, remain exactly as before deſcribed; but by ſwinging the moveable box *n* on its centre any one of its compartments may be brought to line with the real place for the ſhuttle-trough in which the pecker runs. The moveable box muſt have proper catches to hold it exactly in its true poſitions.

In working with this contrivance a ſhuttle of a different colour muſt be placed in each cell or diviſion of the moveable box *n*; and when the weaver deſires to change the ſhuttle he pulls the connecting ſtring. This moves the ſhuttle-troughs either backwards or forwards, ſo as to carry away that ſhuttle which had been juſt before in uſe, and place another before the pecker. Then if he pulls the pecker-handle *y* the new ſhuttle will be thrown acroſs the ſhuttle-race, juſt as the old one was in the former inſtance. If only one moveable ſhuttle-box is uſed there will be ſome limitation in the pattern, becauſe the ſtripes of different colour muſt always conſiſt of an even number of the ſame coloured thread, as two, four, ſix, &c. This may be obviated, and a greater change of ſhuttles may be introduced, by uſing two moveable ſhuttle-boxes, one at each end of the ſhuttle-race: in that caſe the two moveable boxes are provided with cranks and ſtrings, ſo that the weaver can reach either of them with eaſe.

Checks are produced by the combined operations of the warper and the weaver.

Tweeled cloths are ſo various in their textures, and ſo complicated in their formation, that it is difficult to convey an adequate idea of the mode of conſtructing them without the aid of ſeveral drawings.

In examining any piece of plain cloth, it will be obſerved that every thread of the weft croſſes alternately over and then under every thread of the warp which it comes to; and the ſame may be ſaid of the warp: in ſhort, the threads of the warp and weft are thus interwoven at every point where they croſs each other, and are therefore tacked alternately.

Tweeled cloth is rather different, for only the third, fourth, fifth, ſixth, &c. threads croſs each other, to form the texture.

Hence two, three, four, or more, of the ſucceſſive threads or ſhoots of the weft will be found to paſs under or over the ſame thread of the warp; or, in other words, by tracing any thread of the warp it will be found to paſs over two, three, four, or more threads of the woof at once, without any interweaving the warp. Then it croſſes and paſſes between the threads of the weft, and proceeds beneath two, three, four, or more threads, before it makes another paſſage between the threads of the weft.

Tweeled cloths are of various deſcriptions, and produce different kinds of patterns; becauſe at all the interſecting points where the threads actually croſs or interweave both threads of warp and weft are ſeen together, and theſe points are therefore more marked to the eye, even if the warp and weft are of the ſame colour. Theſe points in plain tweels form parallel lines extending diagonally acroſs the breadth of the cloth, with a different degree of obliquity, according to the number of weft-threads over or under which the warp-threads paſs before an interſection takes place. In the coarſeſt kinds every third thread is croſſed: in finer fabrics they croſs each other at intervals of four, five, ſix, ſeven, or eight threads; and in ſome very fine tweeled ſilks the croſſing does not take place until the ſixteenth interval.

Tweeling is produced by multiplying and varying the number of heddles, or, as the weavers expreſs it, the number of leaſes in the harneſs, which is the name given to the whole number of heddles employed in a loom; by the uſe of a back-harneſs or double-harneſs, by increaſing the number of threads which paſs through each ſplit of the reed, and by an endleſs variety of modes in drawing the yarns through the heddles; alſo by increaſing the number of treadles, and changing the manner of treading them.

The number of treadles requiſite to raiſe all the heddles which muſt be uſed to produce very extenſive patterns, would be more than one man could manage; for if he placed his foot by miſtake on a wrong treadle he would diſfigure his pattern. In theſe caſes, recourſe is had to a mode of mounting or preparing the loom, by the application of cords to the different heddles of the harneſs; and a ſecond perſon is employed to raiſe the heddles in the order required, by pulling the ſtrings attached to the reſpective heddles of the back-harneſs, and each heddle is returned to its firſt poſition by means of a leaden weight underneath. This is the moſt comprehenſive apparatus uſed by weavers, for all fanciful patterns of great extent, and it is called the DRAW-*Loom*. See that article.

The manner of mounting the harneſs of looms, to produce all the principal varieties of fabrics, is detailed in our articles DESIGN, DRAUGHT, and CORDING *of Looms*; alſo DAMASK, DIAPER, DIMITY, DORNOCK, FUSTIAN, and TAPESTRY. A peruſal of thoſe articles will render it unneceſſary for us to proceed farther on that ſubject in the preſent article. We ſhall however deſcribe a moſt valuable invention, which has of late years come into uſe, as a ſubſtitute for the ſecond perſon or draw-boy, who muſt be employed in the draw-loom, by which loom alone all the complicated patterns can be woven.

Machine called the Draw-Boy, becauſe it performs the Office of a Draw-Boy in Weaving.—The ſaving of labour is not the only advantage of this machine; the certainty of its operation and ſecurity from miſtake are obvious. The weaver produces the required action upon the moſt complicated harneſs by two treadles only, which he works alternately, juſt with the ſame motion as in plain cloth-weaving. The machine, when once ſet up, performs every thing elſe.

Like moſt other inventions, this was at firſt imperfect, but has been gradually improved. We do not know its hiſtory, but we have ſeen great numbers of machines, for carpet-weaving and coarſe goods, which have been ſome years in uſe. The machine is ſituated in a ſmall ſquare frame, not larger than a chair, which ſtands at the ſide of the loom, and cords from all the different heddles are conducted from the draw-loom down to this frame, where they are arranged in order. Each cord has a knot anſwering to the handle, which the boy muſt pull in the common draw-loom; and there is a piece of mechaniſm actuated by the treadles which at every ſtroke ſelects the proper cord, and draws it down ſo as to raiſe the heddles belonging to it. The next time it changes its poſition and takes another cord, and ſo on until the whole number of cords has been drawn and the pattern completed.

Theſe original machines have a great defect, *viz.* that they only proceed with regularity to raiſe up all the heddles, until all the cords have been drawn, and one ſeries of changes

has been gone through; but when this is completed, and a repetition of the pattern is wanted, the weaver muſt ſtop and reſtore the machine to its original poſition by pulling a ſtring. This appears very eaſy, but it diverts his attention; and if he does not do it at the exact moment his pattern may be ſpoiled. This defect was remedied by Mr. Alexander Duff, who received a ſmall and inadequate premium from the Society of Arts in 1807, probably becauſe they were not aware of its value and importance; but in 1810 we find them with a liberality truly diſcouraging to real merit, giving an equal reward to another perſon, for the moſt trivial alteration of Duff's machine. The latter machine is alone deſcribed in their Tranſactions; ſee vol. xxviii.

Mr. Duff's Draw-Boy.—Fig. 4. *Plate* II. *Weaving*, is a plan of this machine, and *fig.* 2. a perſpective view. It is fixed at the ſide of a draw-loom, in the ſame place as a draw-boy would ſtand, and H ſhew the cords which are to draw the harneſs. The ſame letters are uſed in both figures. A A is a ſquare wooden axis, mounted ſo as to turn backwards and forwards in the frame B B, on points or centres of motion. At one end of it a pulley D is fixed, to receive a line *a a* faſtened to it at the higheſt point, by means of which the axis receives motion from the two treadles of the loom, one of the treadles being attached to one end of the line, and the other to the oppoſite end of it. E E are two rails of wood, fixed acroſs the frame parallel to the axis; and *e e* are two braſs plates ſcrewed to the rails, and pierced with a great number of holes to receive as many cords. Each cord is tied by one end to a central rail F of the frame beneath the axis; and after paſſing through one of the holes in the above plate *e*, and turning over a round wooden rod G, has a lead weight ſuſpended to the other end of it. Theſe weights are ſhewn at *b b*. The rods G G are ſuſpended by ſtrings at their ends from the ceiling of the room. To each of the above cords another is tied juſt before it paſſes over G. Theſe are repreſented by H, and hang looſely. The upper ends of theſe cords are tied to horizontal cords extended acroſs the ceiling of the room, and made faſt to the ceiling at one end; the other ends paſs over pulleys ſituated at the top of the loom, in a frame called the table of mullets, and the harneſs or heddles are ſuſpended by them.

By this arrangement it will be ſeen, that when any one of the cords faſtened at F is pulled down, it muſt draw one of the ſtrings H, and raiſe ſuch an arrangement of the harneſs or heddles as is proper to produce the figure which is to be woven. The weight *b* draws the cord ſo as to keep it ſtraight; all that is therefore neceſſary is to draw down the cords at F one at a time, but to take a different one each time, and thus raiſe a different ſeries of the heddles each time; this is the buſineſs of the machine, and which it accompliſhes in the following manner.

The bar, or axis, A A, has an iron ſemicircle, *d*, grooved like a pulley, and each of its ends divided, ſo as to form a cleft-hook or claw.

Each of the ſtrings made faſt at F has a large knot tied in it, juſt beneath where it paſſes through the braſs plate *e e*, and which knot ſtops the farther aſcent of the cord, in conſequence of the pull of the weight *b*. Now when the axis A vibrates backwards and forwards by the treadles of the loom, as before mentioned, the hook of the ſemicircle *d* ſeizes the knot of one of the cords F, and draws down that cord, and raiſes the heddles belonging to it. The weaver throws the ſhuttle, and then returns the treadles, and the axis A with the ſemicircle returns back again, and allows the cord F to take its original poſition. When the ſemicircle *d* inclines over to the other ſide, its oppoſite hook takes hold of the cord F, which is next to the one oppoſite to that which it juſt quitted; it draws down this cord, and the weaver again throws his ſhuttle, then returns the ſemicircle to the oppoſite ſide, and it will take the cord next to the oppoſite one, and ſo on; ſo that the ſemicircle will in ſucceſſion take every alternate cord in each of the rows *e e*, and leave every other.

This is effected by the ſemicircle ſliding along its axis A every time, by means of two wooden racks, *h* and *i*, in the plan, which are let into grooves in the axis A; theſe racks have teeth like ſaws, but inclined in contrary directions. The racks move backwards and forwards in their grooves, the extent of a tooth at each vibration of the axis, by the action of two circular inclined planes of iron faſtened to the frame at L M, againſt which the ends of the racks are thrown by ſpiral ſprings concealed beneath each rack. The ſemicircle is fixed on a box or carriage N, which ſlides upon the axis A, and has two clicks upon it; one at *l*, which falls into the teeth of the rack *h*; the other at *m* for the rack *i*: *n* is a roller fixed over the box, and connected with the two clicks *l* and *m*, by threads wound in oppoſite directions; ſo that one click is always raiſed up, and diſengaged from its rack, while the other is in action. O is a piece of wire fixed to the frame, ſo as to intercept a ſmall wire projecting from the roller when the axis is inclined, and turn the roller a ſmall quantity; P is another wire for the ſame purpoſe, but fixed to a croſs bar, Q, which is moveable, and can be faſtened at any required place, farther or nearer from the end of the axis. Suppoſe the roller *n* to be in ſuch a poſition that the click *m* is down, and *l* drawn up, the action will be as follows: the ſemicircle firſt inclines to the direction of *fig.* 2., its hook taking down one ſtring; during this motion the end of the rack *i* comes to the inclined part of the circular inclined plane M, and moves by its ſpring towards D, the ſpace of one tooth, which the click *m* falls into. On the return of the axis, the rack *i* is thruſt back, and the box N and ſemicircle with it towards L, cauſing the hook to take the next oppoſite ſtring: in this manner it proceeds, advancing a tooth each vibration, till it gets to the end of its courſe; the tail of the roller *n* then ſtrikes againſt the pin P, and turns the roller over, raiſes the click *m*, and lets down the other, *l*, into the teeth of the rack *h*; this was all the time moving in a contrary direction to *i*, by its inclined plane L, but had no action, as its click *l* was drawn up; this being let down, the ſemicircle is moved back, a tooth at a time, towards M, until it meets O, which upſets the roller *n*, and ſends the ſemicircle back again.

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

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

Double Cloth is compoſed of two webs, each of which conſiſts

conſiſts of ſeparate warps and ſeparate wefts, but the two are interwoven at intervals. The junction of the two webs is formed by paſſing each of them occaſionally through the other, ſo that any particular part of both warps will be found ſometimes above and ſometimes below.

This ſpecies of weaving is almoſt excluſively confined to the manufacture of carpets in this country. The material employed is dyed woollen, and as almoſt all carpets are decorated with fanciful ornaments, the colours of the two webs are different, and they are made to paſs through each other at ſuch intervals as will form the patterns required. Hence it happens that the patterns at each ſide of the carpet are the ſame, but the colours are reverſed. Carpets are uſually woven in the draw-loom, or with the machine called the draw-boy before deſcribed.

Marſeilles is a fabric woven of cotton, which is a double cloth. The loom for weaving Marſeilles is ſomewhat ſimilar to the diaper loom. A good idea of the manner in which it is prepared may be had, by conceiving two webs woven one under the other in the ſame loom, which are made to intermingle at all the depreſſed lines, and form the reticulations on the ſurface, in imitation of the quilting performed by hand.

When the ſpecies of Marſeilles, called Marſeilles quilting, is made, a third warp, of ſofter materials than the two others deſcribed, lies between them, and merely ſerves as a ſort of ſtuffing to the hollow ſquares formed by them.

Quilting is another ſort of cotton ſtuff, ſolely appropriated to quilts, which ſhould, in ſtrictneſs, be ſet down excluſively to the cotton manufacture, although there is nothing to prevent its being made of other materials.

The weft of thoſe quilts is of very coarſe and thick yarn, which is drawn out by a ſmall hook into little loops, as it is woven, that are ſo arranged as altogether to form a regular pattern; every third or fourth ſhoot of the ſhuttle, the weaver has to ſtop to form thoſe loops from a draft, which cauſes the weaving of thoſe quilts to take up more time than that of any other ſtuff, except tapeſtry; which accounts for the greatneſs of the price at which they are ſold, in proportion to the value of the materials of which they are principally compoſed.

Gauze differs in its formation from other cloths, by having the threads of the warp croſſed over each other, inſtead of lying parallel. They are turned to the right and left alternately, and each ſhot of weft preſerves the twine which it has received.

This effect is cauſed by a ſingular mode of producing the ſheds, which cannot eaſily be deſcribed without the aid of drawings.

Croſs, or *Net Weaving*, is a ſeparate branch of the art, and requires a loom particularly conſtructed for the purpoſe.

Spots, brocades, and lappets, are produced by a combination of the arts of plain, tweeled, and gauze weaving, and as in every other branch of the art are produced in all their varieties by different ways of forming the diviſion of the warp by the application of numerous heddles, and their connections with the treadles which move them. Indeed the great ſkill of the art conſiſts in the proper management of this part of the apparatus of a loom.

Ribband Weaving.—This was formerly performed by a ſmall common loom, weaving one ribband at a time. Ribbands are commonly ſtriped in the length by laying a ſtriped warp, and patterns are produced by changing the colour of the weft occaſionally; ſometimes an ornamented edging is formed by a ſucceſſion of open loops at the borders of the ribband. Figured ribbands are alſo woven by a great number of treadles, but as they rarely extend to a greater number than the weaver can manage by his feet, they ſeldom employ a draw-loom.

Engine-Loom for weaving Ribbands.—The weavers at Coventry, which is the principal ſeat of the ribband trade, univerſally employ what they call an engine-loom: it is worked by the hands and feet like a common loom, but weaves twelve, ſixteen, or even twenty ribbands at once. The ſhuttles are of courſe fly-ſhuttles, and are driven by what is called a ladder, becauſe it is a ſmall frame exactly like a ladder, which ſlides horizontally in a groove in the lay; and every croſs-bar of the ladder acts upon one ſhuttle in the manner of a pecker: the ladder has a handle to give it motion.

Another peculiarity of this loom is, that the ribbands are taken away as they are woven, with very few interruptions to wind up the work: for this purpoſe they conduct the warps over pulleys, and the ribbands alſo, ſo that both hang down in long loops. Theſe looped parts are conducted through pulleys, which are loaded with weights, and tend always to draw the loops down, and keep the warp tight. The weight which is thus ſuſpended by the finiſhed ribband tends to draw it forwards at every ſtroke which the lay makes; and the weight which is ſuſpended by the yarn of the warp is drawn up. When theſe weights have run through their reſpective courſes, the weaver muſt ſtop to wind up the finiſhed ribband, and unwind a freſh length of yarn. In ſome looms this is rendered unneceſſary by a ſimple mechaniſm, which continually winds up the ribband as faſt as it is woven.

In 1801 the Society of Arts rewarded Mr. Thomas Clulow, for an improved loom for weaving figured ribbands.

This loom differs from the common figured ribband-looms in the method of forming the figure, which, in the old mode, was tedious, from the work being ſtopped, whilſt the figure was drawn by hand.

In the preſent loom, the tire-cords which form the figure are drawn or worked by a cord or leather-ſtrap fixed to the centre-treadle, which ſtrap paſſes over two vertical and one horizontal pulley to the back of the loom, and has a weight hung to the end thereof. Upon this ſtrap above the weight is fixed an iron, of a bevel or ſloping form, which when the ſtrap is pulled up by preſſing with the foot upon the treadle, raiſes a wire-lever placed acroſs the main-wheel of the movements placed vertically, and allows this main-wheel to move one-fourth of its circumference, where it is ſtopped by an iron pin, placed on its rim, and prevented from returning by a clitch or catch on the edge of the wheel on its right ſide.

Within the rim of the main-wheel is a ſmall catch-ſtrap connected with the ſtrap above-mentioned; this catch-ſtrap pulls forward the main-wheel one-fourth of its circumference, until it is ſtopped by the wire-lever and one of the pins on the rim, of which there are four in number in the ground.

There are alſo four iron pins projecting from the left ſide of the main-wheel in oppoſite quarters of it: theſe act on a hanging lever, to the lower part of which a ſtring is attached, which paſſes behind the box containing the whole machinery, and raiſes four clicks or catches on four rollers, which permits any one of the four rollers to run back as the figure may require, each roller by ſuch motion drawing up the number of threads neceſſary to form the figure, by cords extending from theſe rollers over pulleys to the paſs-cords, which draw the figure.

Machine Loom for Ribbands.—We have before mentioned M. Vaucanſon's loom for weaving ten ribbands by a rotatory motion. We do not know that this is in uſe in this country.

Mr. James Birch invented an improvement on the ſwivel-loom, ſo as to weave ſatin-guard or figured laces, and received a reward from the Society of Arts in 1804.

This loom is worked by a circular motion of the hands, without treadles, or any application of the feet.

A wooden bar, to which the hands are applied, works two cranks on a large iron axle, extending the width of the loom; one crank is near each end of the above axis. A fly-wheel is attached to one of the ends of the axis, to regulate the motion of the machinery; an endleſs ſcrew is placed upon the axis, works a ſtar-wheel underneath it, which turns a barrel that has a reſemblance to that of a hand-organ, and has wooden pegs fixed in different parts around it: theſe pegs catch upon levers, which draw forward the cords that form the figure, and pull them down by a claw, which ſecures the cords thus brought within its power, and by thoſe means raiſe the upper geer connected with the cords.

In this loom fourteen pieces of ſatin-guard or bed-lace are wove at the ſame time, either one pattern and breadth, or all of different patterns and breadths, as may be required. The figure may be extended to any number of ſhoots deſired.

The loom takes up no more ſpace than a common ſwivel-loom, ſuch as is employed in plain-work. It appears to work with eaſe and expedition, to make good work, and to be eaſily managed. It does not break or chafe the ſilk during its working. The weaver can move to any part of the front of the loom to inſpect the work, and to continue the motion during that time; and the figure or pattern may be formed double the length of thoſe uſually done in the engine-loom. The loom can be ſtopped when required, at any one ſhoot of the ſhuttle; and it will anſwer to weave articles made of ſilk, wool, cotton, or linen, or mixtures of thoſe articles, or gold or ſilver lace, and performs its work in half the time of an engine-loom.

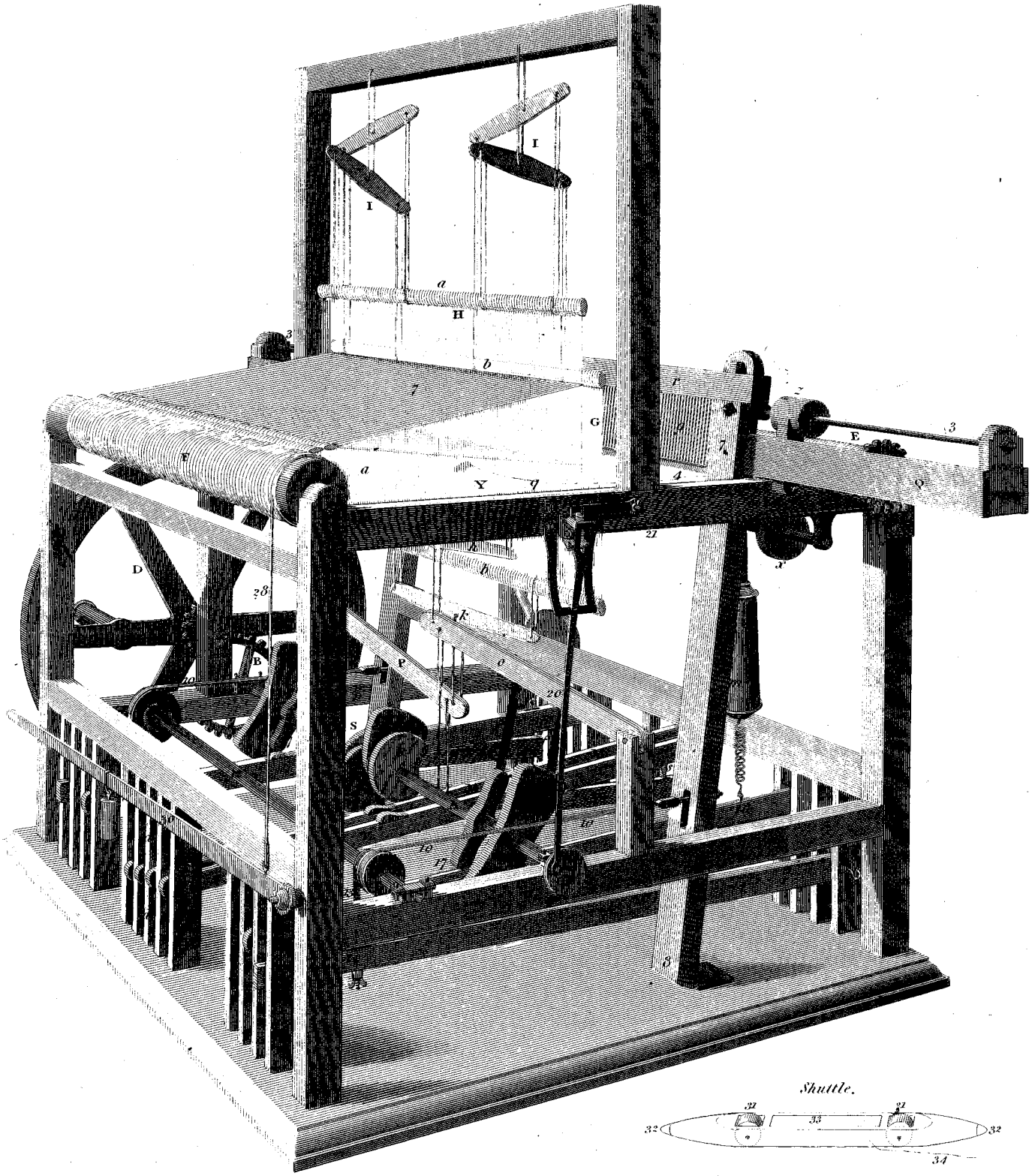
The want of uniformity in the technical phraſeology of the art of weaving, and the intricacy of the ſubject, have compelled us to render our deſcriptions far more intricate and difficult than they otherwiſe would have been.

We muſt acknowledge the aſſiſtance which we have derived from the very excellent "Eſſays on the Art of Weaving," by Mr. Duncan, 1808, in 2 vols. 8vo. It is a moſt curious and valuable publication, embracing almoſt every thing neceſſary to be known concerning the art on which it profeſſes to treat; if we except ſome of the recent improvements in machine-weaving, which are only ſlightly noticed.

The French have long excelled in the various branches of figure-weaving; but this is more from dexterity of their weavers than from their machinery. Deſcriptions and drawings of all looms uſed by them, with every detail of their ſtructure, will be found in the different articles of L'Encyclopede Methodique, and Les Arts et Metiers, D'Art de Fabriquer le Soie, &c.

WEAVING.

Mr. Austin's Engine Loom.



J. Farey del. Published as the Act directs, 1824, by Longman, Hurst, Rees, Orme & Brown, Paternoster Row, London. Lowry sculp.

Fig. 2.

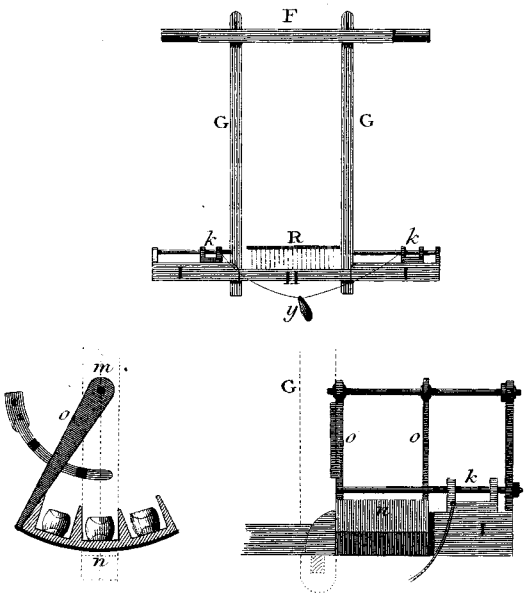
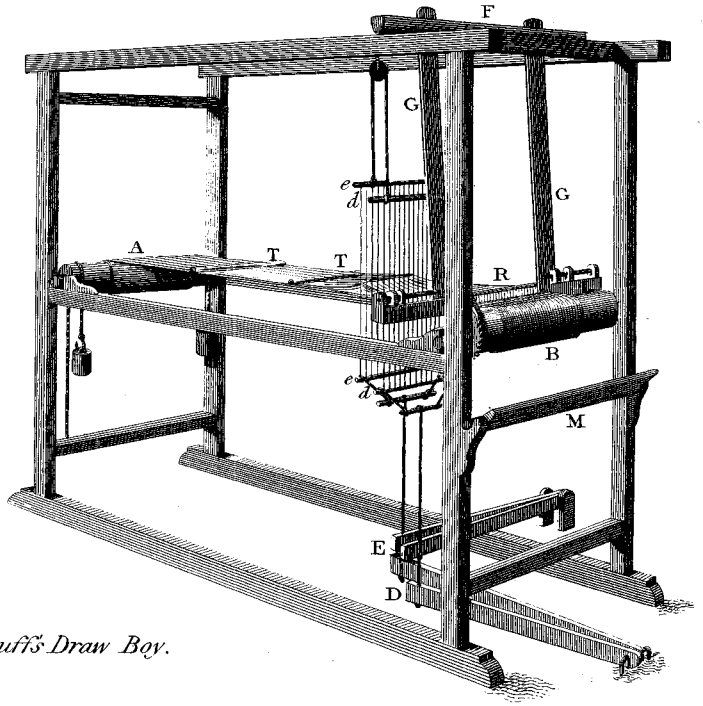


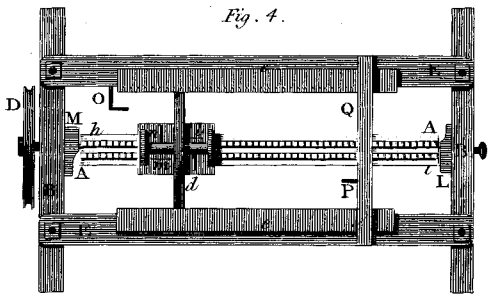
Fig. 1.

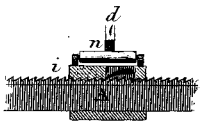


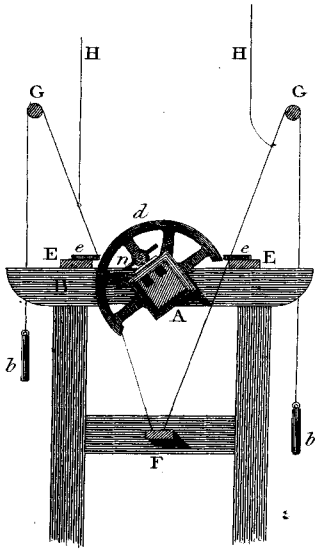
Duff's Draw Boy.

Fig. 3.

Fig. 4.







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