

be produced. The first of these contrivances is for weaving rich silk damask, and known as damask harness, and the second is generally used in weaving the richest silks now made, and is termed the split harness, or "shaft monture."

These two plans are peculiarly adapted for the work they are employed in, for when it is considered that about 400 warp threads are used in each inch in width of the warp or cloth, and only about one-fifth of that number in the weft, it follows that for the intersections to be equal in the warp and weft, five threads of the warp may be raised together in order to accomplish that effect. But the richness or fineness of the face of the cloth would be lost thereby. Now it is the object of the manufacturer to keep on the surface of the cloth the fine threads, and to do so he must be able to intersect the threads separately, and not in numbers of two or upwards. Therefore he requires that the machine shall be able to raise every alternate thread if desired, or the power to intersect every third, fourth, or eighth thread as may be desired for the formation of the ground or body of the cloth. But in weaving or forming the figure it is evident that as the weft threads are so much thicker than the warp that if each hook of the Jacquard raised two, or even four threads of the warp, the outline of the figure would still be as fine in the intersections of the warp as in the intersections of the weft. In fact, intersecting the threads to form the figure, by raising two at once, renders the outline sufficiently exact for the purposes. In the case where 400 threads per inch are used any deviation to the extent of $\frac{1}{200}$ in. can be made, besides having the advantage of the split leashes, which would cause the deviation to be $\frac{1}{400}$ in., where the split touched the outline of the figure. This part of the subject however is the especial business of the manufacturer and designer, rather than of the loom or the weaver, although the loom must be made capable of producing every effect desired by the designer, upon whose ability the beauty and soundness of the work greatly depends.

The adaptation of headles to the Jacquard loom for the production of damasks, although it is the same in principle to the headles when applied to the draw-loom, is very different in other respects, as will be seen by comparing the two systems. Figs. 155, 156, and 157 represent a front elevation, a side elevation, and a plan of one row of hooks only of a Jacquard applied to a damask harness. The same letters and numbers refer to the same parts in each of the figures. The warp W is divided into ten portions of four threads each, and each of these portions are passed through the ten mails or eyes M^1 to M^{10} , Fig. 157. After they leave the mails they are passed through eyes of the four headles $H^1 H^2 H^3 H^4$ in consecutive order, as shown in the same figure. These headles are raised by the hooks h^1 of the Jacquard, as shown in Fig. 156, and it is in this portion of the harness where the difference between the two looms above mentioned exists, and it displays an amount of ingenuity, when combined with the Jacquard, not easily to be surpassed.

Each headle is attached to two of the hooks h^1 by means of a cord passing under a pulley, as shown at $p^1 p^2 p^3 p^4$. If both the hooks attached to one of the headles be raised they will lift the headle to the full extent, but if only one of the hooks be raised, then the headle will be raised only half the distance as will be evident on referring to the headles H^2 and H^4 , in which case H^2 is raised half the distance that H^4 is raised. The eyes in the headles are made much longer than usual, and of sufficient length that when any of the headles are raised half way it does not raise the warp thread which passes through it. But if the headle be raised to the full height then it lifts the warp thread and forms the shed, as shown at S^1 , which has been formed by the thread raised by the eye in the headle H^4 .

Now it will be seen that when all the headles are at their lowest position, none of the warp threads can be raised, so as to form a shed, by the mails M^{1-10} . On the other hand, when all the headles are raised to their full height, the mails M^{1-10} have still no effect upon the warp threads. But if all the headles be raised half high, as shown at H^2 Fig. 156, then the mails M^1 may raise the warp threads in any required order.

The effect of the separate and combined operation of the two harnesses may be traced to the design, or cloth, shown at $A B C D E F$. At A the alternate threads have been raised by means of the headles 1 3 and 2 4 and from "tabby" or plain weaving. At B the headles are raised in a different

order as denoted by the numbers at the edge of the cloth. At D the headles have been raised and held stationary, and the effect of raising the mails alone is shown. At E the same arrangement is shown, but in this case the headles have been depressed, singly, and in consecutive order, thus forming a twill on the surface of the figure formed by the raising of the threads by the mails M . At F the same order is not only continued as at E , but the headles have been raised to their full height in consecutive order as well as being lowered. Thus the outline of the figure is formed by the mails M and the minor intersections, forming the ground of the cloth, are made by the headles, and whatever outline or figure so formed is made, the headles have the same effect. In this manner, according to the number of headles, any kind of twill, satin, or other ground can be made, and one design may be woven with an endless variety of effect by simply altering the order or working of the headles to form the ground either on the surface of the figure or the plain portion or ground of the cloth.

The "shaft monture" is an ingenious modification of the damask harness and entirely dispenses with the headles. By its means a 400-needle Jacquard operates upon 800 leashes with almost the same effect as though 800 needles were employed.

It appears to have been the invention of Mr. W. Rooke, of Hope Town, Bethnal Green, for he received a reward of 5*l.* from the Society of Arts in 1835 upon the occasion of his sending a model of the monture to the society. It is very probable that the society, at the time, were not aware of the value of the invention, for the reward given was very inadequate for the services rendered to the silk manufacture by this contrivance.

Rooke also received another reward of 5*l.* for an invention to apply "swivels" to the broad loom, which being in common use we shall hereafter describe; and on another occasion he appears to have sent to the society a model of an improvement in horse-hair weaving. The poor encouragement Rooke received contrasts very curiously with the reward of 30 guineas given by the society in 1810 for cutting away the capes of the loom so as to save timber and to give more light to the weaver! Such an invention needs no comment, for the stability of the loom was not only at once destroyed, but the only substantial means of support for the harness of the loom was taken away!

The split harness is an important modification upon Rooke's invention, and it is ascribed to Mr. James Gough, also of Bethnal Green. Fig. 158 represents a front elevation of the split harness. Fig. 159 shows a side elevation, and Fig. 160 is a plan of the same. In each figure the same letters and numbers refer to the same parts.

The hooks of the Jacquard are divided into two divisions in the same way as in the damask harness, as shown at h and $h^1 h^2 h^3 h^4$. Each leash is passed through the comber board c in the usual way, but it is at this point where the alteration takes place. Figs. 161 and 162 give an enlarged plan of the leashes and the way the split is formed. It will be seen that the leashes t connected to the Jacquard are here attached to two separate leashes which pass through the comber board, and each of these leashes is looped through another leash s which has a mail and weight attached, as shown at $m m$ and $l l$. It follows that whenever any of the leashes t are raised two warp threads are also raised, viz., the two adjoining threads. Through the loops of the leashes s a "shaft" or flat enamelled hoop iron bar is placed, so that when the bar is raised it lifts with it all the leashes upon it and the corresponding warp threads. In Fig. 159 four only of these bars are represented, but in practice 24 are generally used. Each bar is connected to a hook by the strong cords T , shown also in Figs. 159 and 143.

In Fig. 160 the pairs of leashes are still more clearly shown at 1, 2, 3 to 20, and the shafts $a b c d$ to which they are looped.

Now whenever any of the hooks h are raised to form the pattern the cloth will be woven with double threads at each intersection, and the figure can be varied to a distance of $\frac{1}{200}$ in. at each step, i.e., when 400 threads per inch are used in the warp. At the same time those threads which are not raised to form the figure by the hooks h can be raised by the shafts by means of the hooks $h^1 1, 2, 3, 4$, and by raising these shafts in any desired order so the ground of the cloth will be woven. In other words, the pattern can be woven to a fineness of two warp threads at each intersection without being affected by the shafts, and the remainder of the cloth can

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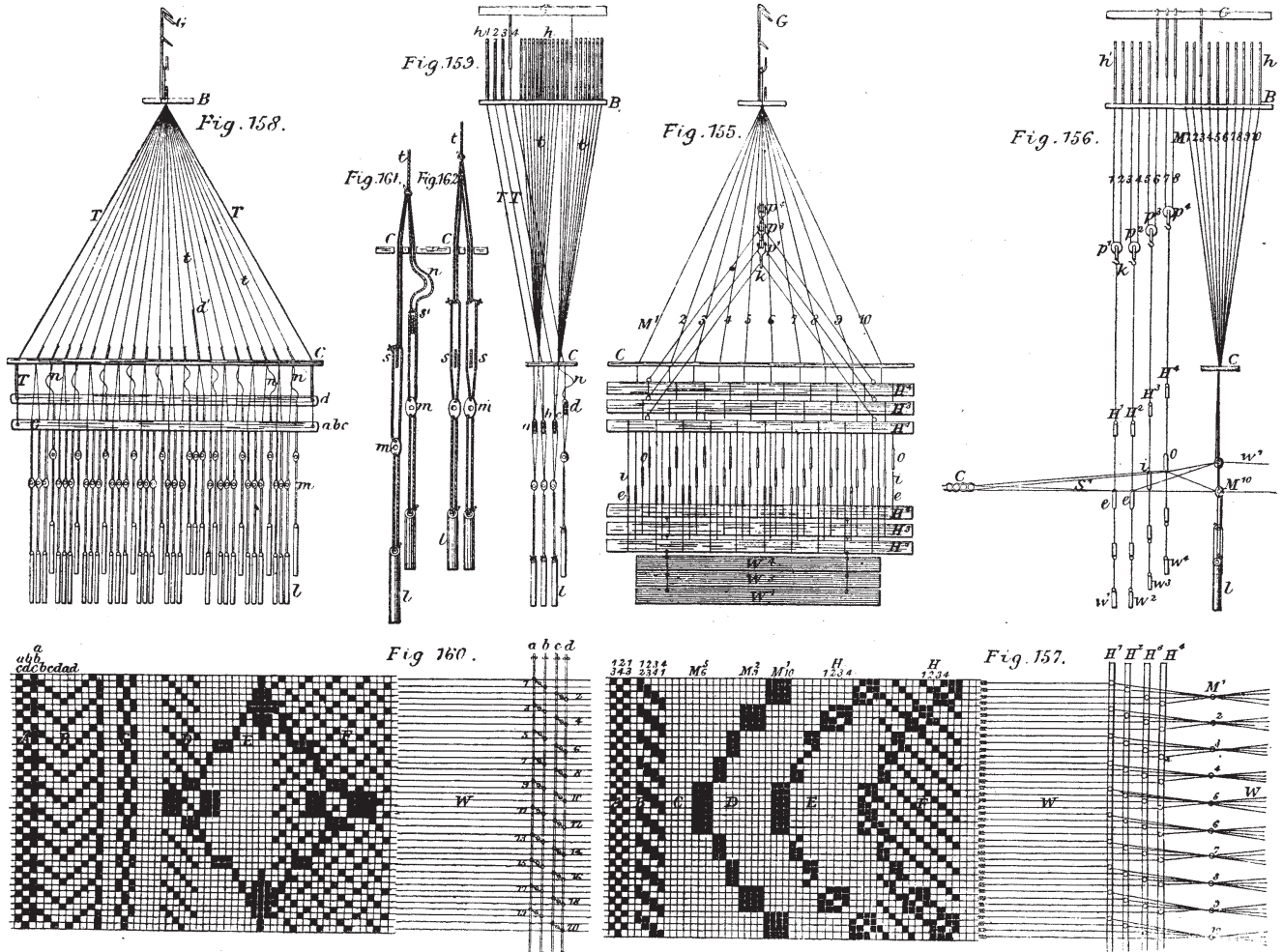
THE JACQUARD LOOM.—COMPOUND HARNESSES.

In the last article the method of applying the Jacquard apparatus in its most simple form was shown, and it was evident that each hook having but one thread to raise in each figure woven that the extent of the pattern or figure was confined to the number of hooks in the machine, except in using the point harness, where an apparent but not a real advantage was obtained.

In Fig. 112 (see page 337 of our last volume) the principle upon which a compound harness is formed is shown, as applied to the draw loom for the weaving of damasks. In that instance the effect produced was that five threads were raised by each leash or cord instead of one, consequently five times the width of pattern, or twenty-five times the area, was produced. But if eight headles had been used instead of five, then sixty-four times the area could be woven. This system suited very well for the production of table-cloths and curtains, and whenever large designs were required, but for smaller and more exact figures it was not so well adapted. The Jacquard machine is often used in exactly the same way as the draw loom, above alluded to, and instead of the draw boy (as shown in Fig. 126, page 374 of our last volume) holding the raised threads while the weaver worked the headles, the griffe is raised with the required hooks, and held in that position until the headles are worked over. In power looms this raising of the griffe at every fifth or eighth pick, or whatever number of headles were in use, gave rise to many contrivances to effect the intermittent motion with as easy and quick a change as possible.

Soon after the introduction of the Jacquard, two very valuable contrivances were applied to the harness based upon the principle of the draw loom as before mentioned. But they have this difference, in the draw loom the drawing of the cords was done every fifth, eighth, or whatever number of picks were desired, but in the new contrivances the cords are drawn at every pick, and from two to eight times the effect of the Jacquard machine may

COMPOUND HARNESSES FOR THE JACQUARD LOOM.



be woven as plain cloth with every alternate thread intersected, or in twills, satins, or other required ground, according to the number of shafts that may be employed.

With four shafts and twenty pairs of leashes, as shown in Fig. 160, the effect that may be produced will be noticed at A B C D E and F. At A "tabby" is woven by raising the shafts *a c* and *b d* as shown. At B a zig-zag is woven by raising the shafts in the order denoted by the letters. At E the pattern is formed by raising the leashes only. At D the leashes are raised and the shafts also, in this case the ground is woven as a single-thread four-leaf twill. At F the ground is a four-leaf satin or broken twill.

When the leashes are raised by the shafts the upper part of the split leash is slackened, as shown at *n* Fig. 161, but it in no way causes any inconvenience in working. In Fig. 158 one of the leashes is shown raised at *d'* by the hook *h*, shown on the griffe bar *G* Fig. 159, and one of the shafts *d* is also shown raised in Figs. 158 and 159.

The various descriptions of harness shown in this and the last article, form the basis upon which all compound harness are constructed for figure weaving, and in endeavouring to show the principles clearly it was necessary to arrange the diagrams in the most simple form possible, for to attempt a description of full mounted looms would require a mass of complicated drawings in which the oper-

ations of weaving would be lost sight of, rather than explained in their general principles, which is the object we have at present in view.