

Jacquard Mechanism

AND

Harness Mounting

BY

Fred Bradbury.

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JACQUARD MECHANISM AND HARNESS MOUNTING.

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Jacquard Mechanism

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AND

Harness Mounting

BY

FRED BRADBURY.

PROFESSOR TEXTILE INDUSTRIES, MUNICIPAL TECHNICAL INSTITUTE, BELFAST.
FORMERLY, HEAD OF THE DEPT. TEXTILE INDUSTRIES,
MUNICIPAL TECHNICAL COLLEGE, HALIFAX.

AUTHOR OF

"CARPET MANUFACTURE," "CALCULATIONS IN YARNS AND FABRICS,"
"WORSTED SPINNING," ETC.

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PREFACE.

FOLLOWING my usual plan, this work, as the title suggests, treats of only one, but that an important section of Textile manufacture. It is only by adhering tenaciously to this idea that it is possible to deal comprehensively and exhaustively with any of the vital departments of spinning or weaving.

The Jacquard machine is the prime factor in the manufacture of woven figured goods of every description, whether made from cotton, wool, silk, linen or other textile material, singly or in combination, including dress goods, damasks, tapestries, carpets, etc. In this treatise all the chief types and varieties of modern Jacquards used for the above purposes have received some consideration and treatment. No effort has been spared to first obtain a clear conception of the evolutionary developments in figure weaving and in turn to place before the reader in a progressive manner, a clear delineation of the main features of the fundamental and epochal changes in mechanism employed in figure weaving, and subsequently to build on such foundation structure as complete and up-to-date a description of mechanism and mounting as shall be, not only interesting but useful and instructive.

In describing the numerous mechanical details, consideration has first been devoted to the relation and function of each part before attempting any description of its action in combination with its conterminous and remote connections, a plan which, no doubt, the student and reader alike will find advantageous.

Anon. - 4/15/52 - P.M.

The subject is divided into four parts. In Part I., which deals with the evolution of figure and Jacquard weaving the object has been, not so much to describe ancient methods as to draw upon the past to introduce the present ; it is much easier to write on present methods in comparison with past systems since a study of the latter always involves unlimited research and much verification from contemporary sources. Much time has necessarily been spent poring over the pages of the patent specifications and dating as far back as the records in the files of the patent office, but a more certain method of procuring correct and adequate information cannot be conceived. Inventors and inventions, which have laid the foundation of our successes should never be forgotten apart from the fact that past masters in Textile invention cannot be ignored any more than past masters and masterpieces in art ; most things that are good and lasting have their roots reaching far into the past.

No chronological order of invention has been strictly followed since it is more often fatal than helpful to a clear conception and concise explanation of the growth of ideas ; on the contrary, the safer plan of treating the subject according to current order of simplicity has been adopted.

The vital section of the book is in Part II. which embraces the mechanism and fundamental principles of Jacquard weaving, including descriptions with illustrations of all the best standard and special types of Jacquards employed in modern practice. The special and exhaustive treatment of Twilling, Cross border and Index Jacquards it is hoped will merit appreciation.

Typical examples have been selected to illustrate fundamental principles and where more than one example has been supplied, the

object has been to demonstrate the diverse methods of clothing the same principle—comparisons being always helpful.

The drawings are chiefly in outline or line diagrams, a mode of elucidation which is necessary in order to show the internal construction of the various machines which the actual framing and supports ordinarily conceal and which in no way affects the principle of the mechanism.

The diagrams have been designed to present as many as possible of the mechanical details and so simplify the subsequent description. They are all original in conception and depiction and have been specially prepared directly from machines of the most recent construction and approved types in modern practice.

Technical trade terms with a local significance and limited expression, while not excluded, have been supplemented by the most general and universal terms.

All the general and fundamental principles of Harness Mounting together with a description of the preparatory processes relating thereto, are fully dealt with in Part III. together with some consideration and treatment of a variety of complex ties, each of which is designed to demonstrate a special feature of mounting and suggest some specific line of thought upon which other "ties" may be conceived and by the aid of which an indefinite number of figured patterns may be produced. The possibilities in harness mounting are so extensive as to leave no room for repetition or multiplication of examples.

The illustrations and treatment of Part IV., which embraces Card Cutting, Repeating and Lacing, have been dealt with upon the

same principle as Part II. since it is also largely a description of mechanism and an exposition of how it works.

This treatise will be found to abound in detail, explained largely by the fact that for several years the writer has recorded any thought, observation and result of conversation and discussion and retained his many copious lecture notes, specially prepared for various Textile classes ; hence much of the subject matter has been accumulated over a period of years, most of it valuable for the time and specific purpose, but at this juncture requiring “squaring” and fitting to its place.

In a work of such magnitude embracing as it does innumerable technical details and problems the writer anticipates some slight omissions and may be mistakes, but generally speaking the reader or critic is to be feared least whose knowledge is most extensive.

Comment on the work done by the printers, Messrs. F. King & Sons Ltd., Halifax and the block makers, Messrs. Gilchrist Bros., Leeds, would be superfluous—it speaks highly for itself.

F. B.

September, 1912.

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7. Quantities and weight of warp and weft in plain and fancy fabrics.
8. Weight and cost of woven fabrics.
9. Calculations involved in the analysis and reproduction of woven fabrics.
10. Conditioning or the standard allowances of moisture in textile materials.
11. The construction of woven fabrics (A).
12. The construction of woven fabrics (B).
13. The construction of woven fabrics—angle of curvature considered (c).
14. The construction of woven fabrics—compression considered (r).

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A REPRODUCTION OF A WOVEN FABRIC.

The fabric contains 3600 threads in the repeat, and involves the use of an equal number of individual figuring hooks to produce it.

PART I.

THE EVOLUTION OF FIGURE AND JACQUARD WEAVING.

CHAPTER I.

Origin and Growth of Pattern Design.

IN the earliest days it was considered ample to produce woven structures which were useful and durable. These conditions were, to a considerable extent, satisfied by the production of *plain cloth*; subsequently twilled cloth was manufactured, but with the advance of time, increase of knowledge and the development of 'taste,' the desire was created and evolved for the supply of *figure woven textures*. This made it imperative that a shedding mechanism should be introduced which would produce ornamental as well as serviceable fabrics.

Methods of Ornamenting Textiles.

A textile fabric may be ornamented after the cloth is manufactured, or simultaneously with its production. In the former case, the plain cloth is subsequently embroidered (by hand or machine), embossed, printed or painted, whilst in the latter case the principle of ornamentation or figure weaving may be accomplished by one of the following methods.

1. The introduction of variously coloured threads of warp or weft, or both.
2. The arrangement of yarns differing either in quality of material or thickness of thread.

3. The constant variation in the number of warp threads elevated and depressed on each successive shed and shot, so as to alter the order of interlacing the two sets in such a manner as to reveal or conceal and contrast each other, in large or small masses to suit any predetermined effect of pattern.

The Jacquard machine and its predecessor—the draw loom, were invented to produce woven figure effects of pattern of the last type. But while the Jacquard is of comparatively modern conception, the draw loom, with its cumbrous details, dates from remote antiquity, as does also figure weaving. Herodotus* speaks of a curious breast-plate or cuirass, covered with linen, which was sent by King Amasis to the Lacedemonians, and which was highly *ornamented* with numerous figures of animals *woven* into its texture.

Before entering into the details of figure weaving and the mechanical contrivances employed in the modern Jacquard machine for producing the same, it is proposed to explain generally and trace progressively the production of the simpler varieties of structural woven patterns, the fundamental principles of weaving, especially with respect to warp shedding, and finally to indicate the salient features of epochal developments of figure producing machinery.

Fundamental Types of Woven Fabrics.

All woven fabrics are composed of two sets of threads, one of which is denominated warp and the other weft; the former is arranged longitudinally and the latter transversely, by interlacing them at right angles in the process of manufacture.

A few examples representative of the chief and standard types of interlacing adopted in the manufacture of the simpler kinds of woven textures are illustrated at Figs. 1 to 30, where plan views, transverse sections and point paper designs are given. These will serve to illustrate the probable line of original development of pattern variety, prior to figure weaving. They are also intended to demonstrate that each warp thread which works differently on any given shot of weft from any other thread of warp in one com-

* Lib. iii., c. 47.

plete repeat of pattern, must of necessity be so drawn through the heddles that it can be controlled independently of the others. *This is a factor of vital importance* which in sympathy with the demand for an increased size of pattern, eventually involved the introduction of the draw loom and the Jacquard machine.

Fig. 1. Fig. 3. Fig. 2. Fig. 4. Fig. 6. Fig. 5.

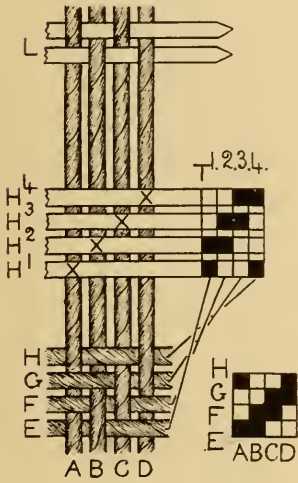
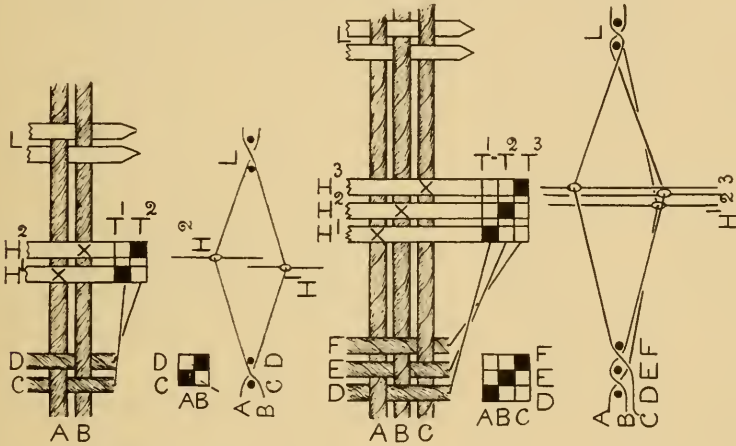


Fig. 7.



Fig. 9.

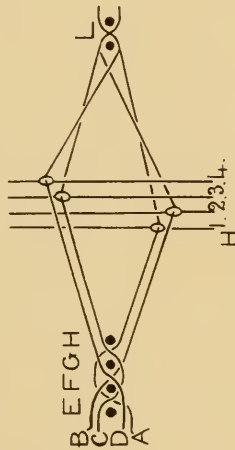


Fig. 8.

In all the illustrations from Figs. 1 to 30, the following indications are common.

L = The lease rods.

H¹ etc. = the heddles.

x = The order of drafting the warp threads through the heddles.

T = The order of lifting the heddles, denominated 'tramp,' 'pegging plan' or 'shedding.'

■ = The heddle or heddles for the given shed to be raised.

τ^1 = The first 'tread.'

τ^2 = The second 'tread,' and so on to the end of the pattern.

FIG. 1 is a plan view of plain cloth, showing its relation to the smallest number of heddles on which it can be produced. A and B represent the warp, C and D the weft threads, and H^1 and H^2 the heddles required.

FIG. 2 is a transverse section through the weft, heddles and lease rods.

FIG. 3 is the point paper design for Fig. 1.

FIG. 4 is a plan view of a three end twill or 'drill.' ABC and DEF indicate the warp and weft threads respectively in one complete repeat of pattern, and heddles, H^1 H^2 and H^3 are requisite.

FIG. 5 is a transverse section through the weft heddles and lease rods. The last two figures demonstrate that three heddles or shedding factors are necessary to produce this pattern, as compared with only two for plain cloth as in Figs 1 and 2.

FIG. 6 is the point paper design for Fig. 4.

FIGS. 7, 8, 9 are plan, transverse section and the point paper design respectively, of a four leaf common twill. ABCD and EFGH indicate the warp and weft threads. Heddles, H^1 H^2 H^3 and H^4 are required.

FIGS. 10, 11, 12 are similar views of a five leaf weft, sateen or satin. ABCDE indicate the warp threads, and FGH IJ the weft threads. Heddles H^1 H^2 H^3 H^4 and H^5 are required. For the successive sheds it will be observed that the heddles 1, 3, 5, 2 and 4 are respectively raised, which is the order for the sateen pattern.

FIGS. 13, 14 and 15 similarly illustrate the eight end sateen.

FIGS. 16, 17 and 18 represent a plan, transverse section and point paper design of the heddles, draft and tramp requisite for the production of a 'herring bone' pattern, which, though complete on eight threads of warp and four shots of weft, requires only four heddles, because there are only four *different* threads of warp in the complete pattern repeat. It is representative of an example of

Fig. 10.

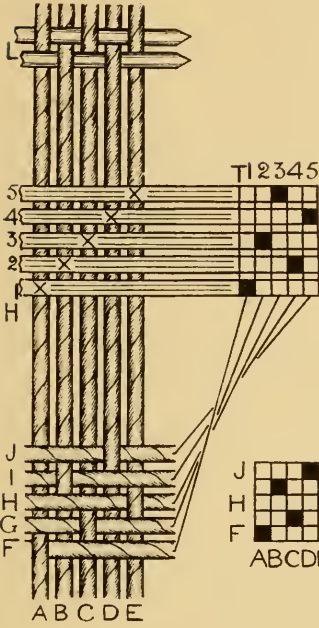


Fig. 12.

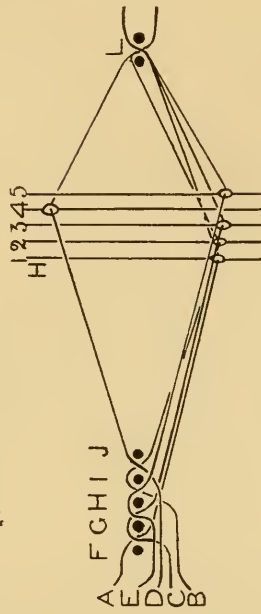


Fig. 11.

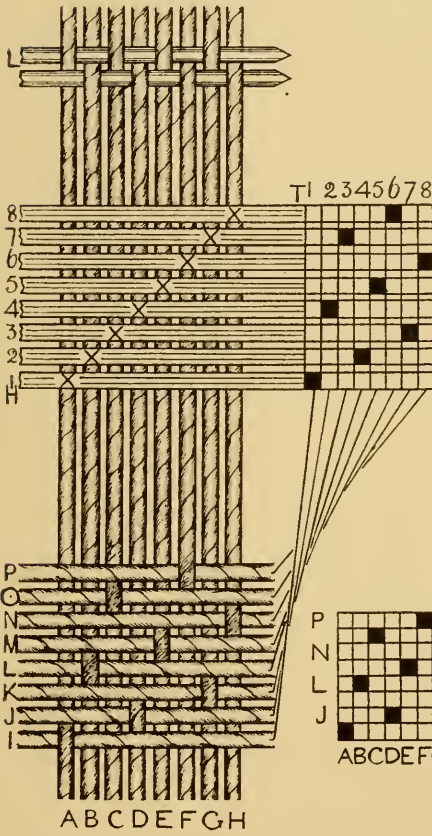
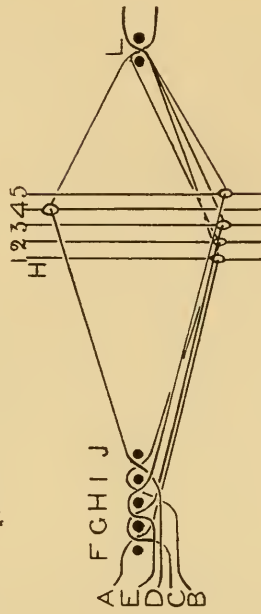


Fig. 13.

Fig. 15.

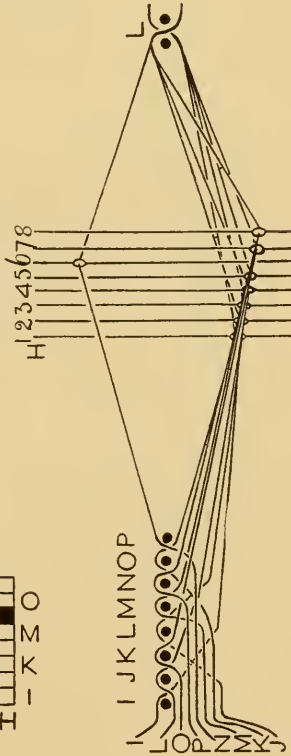
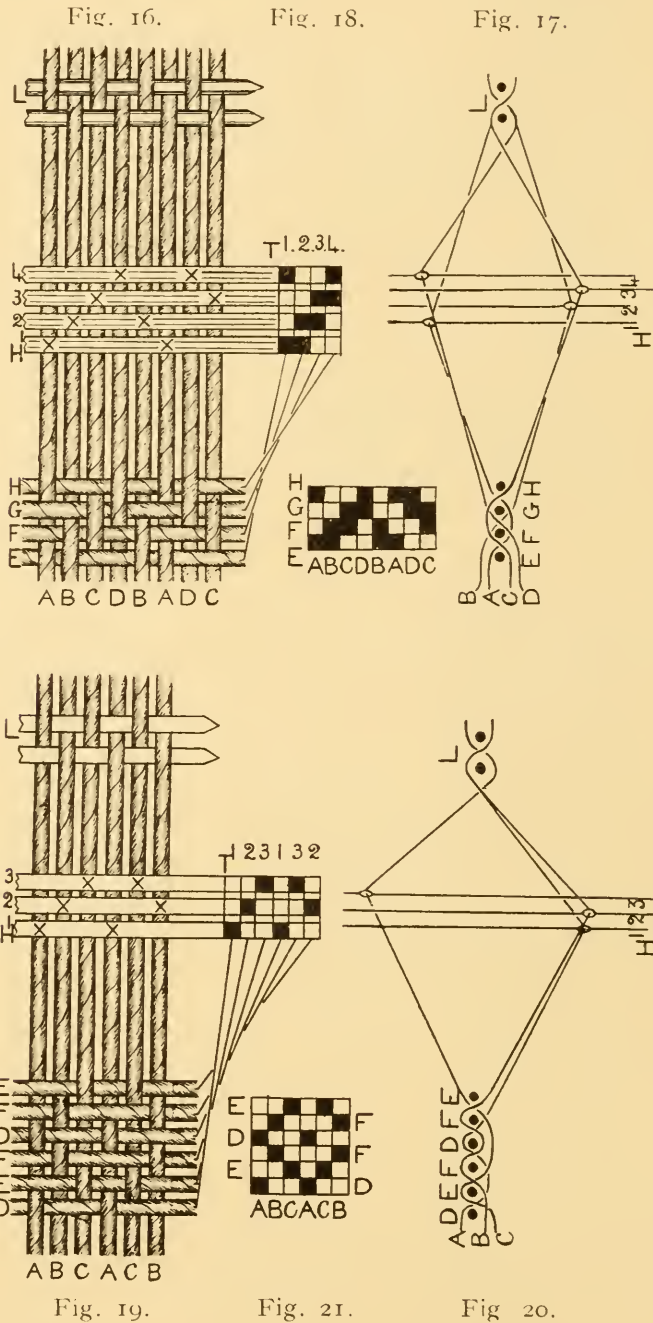


Fig. 14.

probably the first effort to produce variety of effect in the woven texture with limited shedding mechanism.



FIGS. 19, 20 and 21 correspondingly indicate the factors for the standard 'three end diaper;' this type of pattern also belongs to

the earliest attempts at *figure* production by means of varying a common weave.

Fig. 22.

Fig. 24.

Fig. 23.

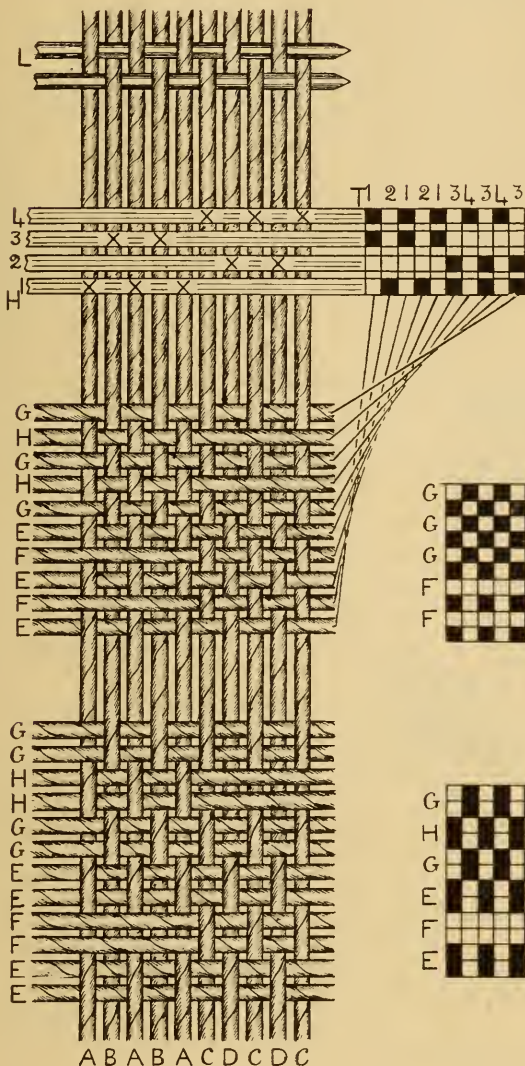


Fig. 25.

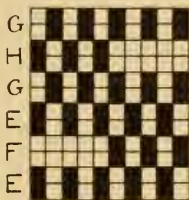
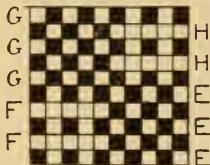


Fig. 27.

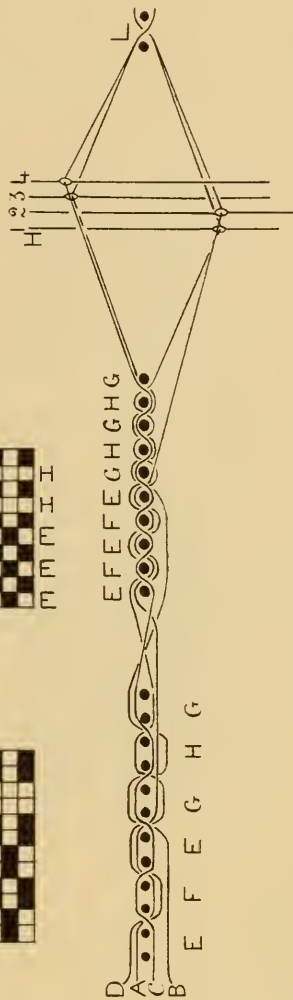


Fig. 26.

FIGS. 22, 23 and 24 indicate similar details for the 'ordinary huck' pattern; this weave, which is of ancient practice, is also characterised by its departure from the regular twill or sateen type; when finished it possesses a rough or raised surface, which feature makes it very suitable for towelling and toilet purposes. It should be observed that this pattern is made with one shot of weft in each shed.

FIGS. 25, 26 and 27 are respectively a plan, section and point paper design, showing a modification of the foregoing structure where the pattern is produced with the same heddles and draft, but tramped to give two shots of weft in each shed. This modified effect is of more recent origin and termed the 'Devon huck.' The draft for both the huck patterns is the same, but the tramp for Fig. 22 is only given.

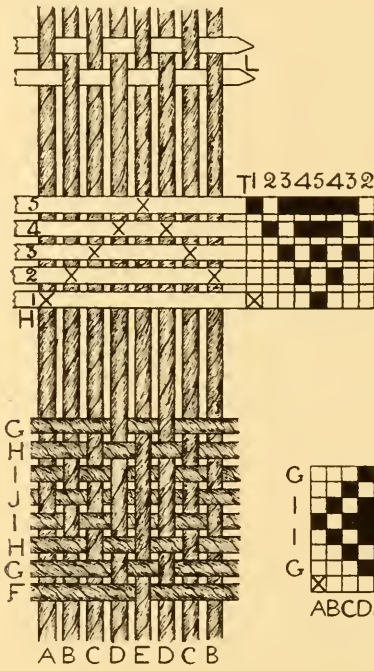


Fig. 28.

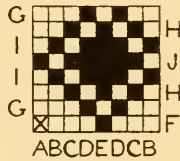


Fig. 30.

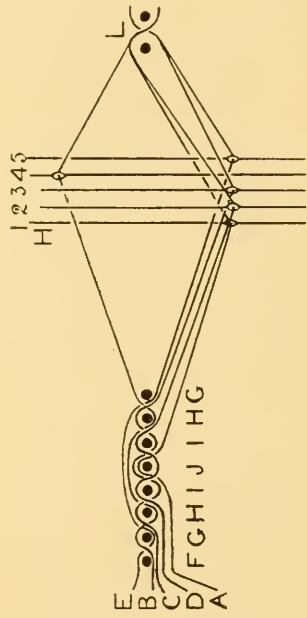


Fig. 29.

FIGS. 28, 29 and 30 show the plan, section and point paper design respectively of another type of modification, composed of tight and loose interlacings, which the predetermined design combines to produce an effect corresponding to the 'honey-comb,' from which the pattern is so designated. The additional rising mark, thus x, on the first end and pick (Fig. 30) is sometimes added to this pattern.

The point paper method of representing the order of interlacing the warp and weft threads is modern, comparatively speaking. It is economical in time and space, and is therefore the only system that can be commercially adopted, but the textile student in the

initial stages should not fail to make plan views and sections of cloth on the same basis as hitherto demonstrated, as this plan will be found most exhaustive and instructive in obtaining a knowledge of first principles in cloth structure.

From the foregoing praiseworthy attempts at figure weaving with limited warp shedding mechanism, it is the purpose of this treatise to demonstrate not only the principle and development of figure shedding details, but eventually also to show how the most elaborate designs and almost unlimited variety of effect can be produced at the present time with the aid of the most approved types of modern Jacquards—the frontispiece is a fine example to wit.



CHAPTER II.

Fundamental Principles of Weaving.

THERE are three essential mechanical principles involved in the actual weaving of a piece of cloth, viz.:—(1) warp shedding, (2) picking, and (3) beating up the weft to the ‘fell’ of the cloth. Two other necessary but supplementary motions must be added, viz.:—taking-up the cloth simultaneously with its production, and letting-off the warp in sympathy, or to correspond with the amount of web woven or taken-up.

This treatise is chiefly concerned with the first and most important of these mechanical principles—*Warp Shedding*—and more especially with the manufacture of the class of goods which involves the use of a Jacquard machine to produce the requisite variety of warp sheds.

Warp Shedding.

The object of warp shedding is to divide the warp threads into two portions, producing an upper and lower line of threads; this division is technically known as the “shed.” The weft which is contained in a shuttle has to be propelled through this shed from side to side of the loom, so as to interlace and lay the weft threads transversely to those of the warp. The shed must be of sufficient depth to allow the shuttle to travel through it with the least possible amount of friction.

For the purpose of shedding, ‘healds’ or ‘harness’ are employed, both of which are free to move in a vertical plane. An important feature in both the healds and harness is a small eyelet, technically called a ‘mail’, through which the warp thread is drawn. The number of warp threads corresponds with the number of eyelets in the healds or harness. The warp threads normally lie longitudinally and in a horizontal plane, but when the healds or harness are operated by suitable mechanism, they are elevated, depressed or

remain stationary according to the requirements of the pattern and type or principle of the actuating mechanism.

Any movement which is imparted to the warp threads should be eccentric, since any sudden or undue strain upon them would result in many breakages. The most satisfactory movement which can be imparted to the shedding mechanism is a slow motion at the commencement, with a gradual increase in velocity until the centre of the traverse is reached, then a decrease in the same velocity ratio. Further it is necessary that the shed should remain open for as long a period as is possible during the passage of the shuttle through it.

There are several fundamental principles of warp shedding, the clothing of which has involved the introduction of numerous mechanical contrivances.

Chief Principles of Warp Shedding.

There are two chief principles of warp shedding, viz. :—‘*Closed*’ and ‘*Open* ;’ the former may be sub-divided into ‘centre’ and ‘bottom’ and the latter into ‘open’ and ‘semi-open.’

CLOSED SHEDDING is so called because all the warp threads are placed in the same plane at the completion of each shot of weft, irrespective of the position which they must occupy on the succeeding shots.

OPEN SHEDDING is so termed because the warp threads remain in their highest or lowest position in the shed for as many shots as the pattern indicates.

Centre Shedding.

In centre shedding the normal position of all the warp threads is a straight line drawn from the surface of the breast beam to that of the warp rail; the shed is formed by an elevation of all the warp threads required to form the upper division of warp and a corresponding depression of those threads which must form the lower. After the insertion of each pick of weft these two sets of threads again meet in the centre preparatory to the next division. This principle is illustrated at Figs. 31 and 32. The former shows the shed, in its normal state, *closed*, and the latter, when the machine is in action or *open*.

A indicates the normal line, where all the warp threads meet, before and after the insertion of each shot of weft; B and C show the temporary positions of the upper and lower lines of warp respectively, during the insertion of weft; Y, the yarn beam; BR, back rail; L, lease rods; H, bealds or harness; M, mails; W, plan of web; S, transverse section through the weft; FR, front rail; PR, perforated roller; CR, cloth roller. In this example the shed is formed by causing the upper division B and the lower division C to travel half the distance of the shed in opposite directions, during the period of the pick allowed for the change of *heddles*. This method economises time and power and reduces tension, but it generates a constant vibration among all the warp threads, which constitutes its most objectionable feature.

**Bottom
Shedding.**

In bottom shedding, the mails of the harness, when in their normal position, coincide with the lower divisional line of the warp threads, *i.e.* slightly below a straight line drawn from the front to the back rail. The production of the shed therefore simply involves the elevation of all those warp threads which are required to form the upper division. After the insertion of each shot of weft, they are lowered to the bottom preparatory to each new division. Fig. 33 indicates the normal or stationary position of the warp threads when the shed is closed. Fig. 34 shows the same warp threads when the shed is formed.

A indicates the normal or lower division and B the upper division of the shed; the remaining letters refer to similar parts as shown in Figs. 31 and 32. This type of shedding is not suitable for high speeds; it requires double time to form the shed, increases the *strain* upon the warp threads, and consumes the maximum amount of power. The factors which modify the relative *strain* upon the warp threads during the formation of the shed are:—(1) the size of the shed or distance moved through by the warp, and (2) the time occupied. It is a well known mechanical law that the strain put upon any material will vary in the ratio of the square of the distance moved through, by the body under tension, in a given time.

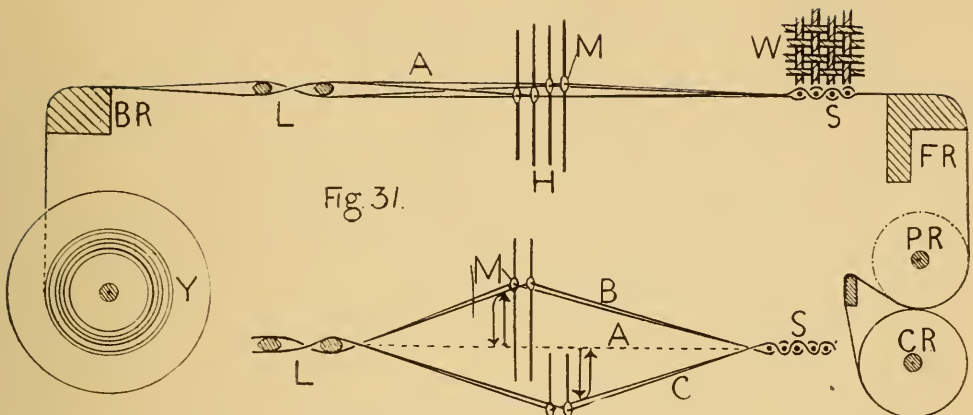


Fig. 33

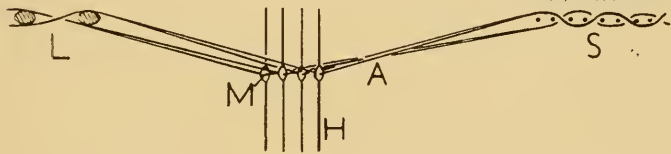


Fig. 34

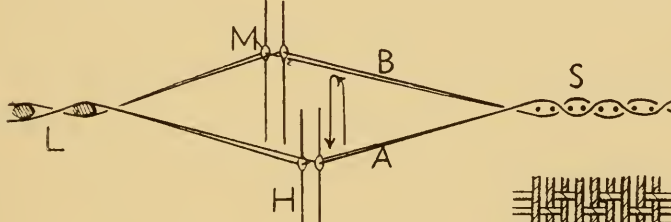


Fig. 35

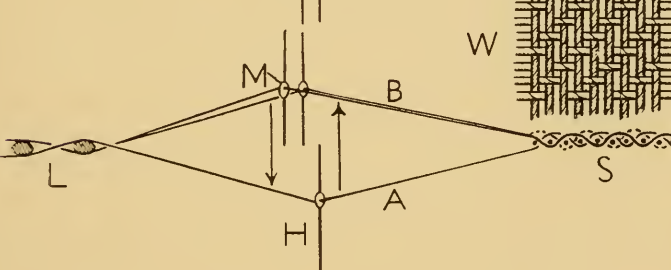
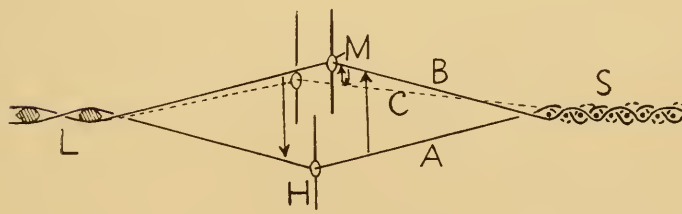


Fig. 36.



Open Shedding.

Normally, in open shedding, the shed is always open. The threads required to change from the upper line are depressed, while those required from the lower set are elevated and *vice versa* for every new shot of weft (see Fig. 35). A is the lower fixed line and B the upper; the remaining letters correspond to similar parts described in Figs. 31 and 32. This method of shedding economises time, and being of the counterpoise type, also effects a saving of power. It is an ideal system.

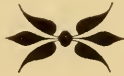
Semi-open Shedding.

Strictly speaking, this principle of shedding might be correctly described as *imperfect* open shedding. Normally, the shed is always open and the bottom line of warp is permanently maintained, whereas part of those threads which form the top shed, and which should remain stationary in their highest position for as many picks as the pattern requires, descend about $\frac{1}{7}$ of their normal traverse and have subsequently to be raised to their highest and former position, but those threads which are required to change for a new shot pass directly from the bottom to the top and *vice versa*. This, as intimated, is not a principle but rather a defect of mechanism to which further reference will subsequently be made. Fig. 36 illustrates this method of shedding, A indicates the permanent bottom line, B the upper, and C the position to which the upper line of threads B descends, even though these same threads are required to be up on the next pick. The remaining letters refer to similar parts as before.

Warp Shedding Mechanisms.

There are four mechanical systems of warp shedding, viz. :—Treadle, Tappet, Dobby and Jacquard. All warp shedding mechanisms are either negative or positive. The *negative* arrangement produces movement in the heddles or harness in one direction only, the reverse motion being accomplished by the addition of external mechanism involving the use of springs, weights, pulleys and levers, and springs and levers. The *positive* arrangement controls the shedding apparatus in both directions, without the aid of any external mechanism.

Treadle, tappet and dobby systems are designed for either the negative or positive. All Jacquard machines are necessarily negative in their action upon the warp threads. Single lift Jacquards are constructed so as to produce motion in the upper division of the warp threads only, *i.e.* they produce a 'warp shed' on the closed principle of the 'bottom' type. The depression of the lower division is accomplished by the use of weights or 'lingoes' suspended from the harness cords. Double lift Jacquards clothe the bottom, centre and semi open principles. The ideal open shed is still a desideratum in Jacquard weaving. The mechanical contrivances adopted in practice to clothe the foregoing mechanical principles are legion; to treat them technically and exhaustively would require many volumes. In this treatise attention will be devoted chiefly to warp-shedding mechanisms as employed for figuring purposes, which machines, combined with harness mounting, represent the most complex of all mechanical devices extant for producing woven figured effects.



CHAPTER III.

Hand Loom Weaving—Treadle Shedding.

BEFORE detailing the principle of figure weaving as practised in the *draw loom*, it is necessary and perhaps more advantageous to consider the salient features of the *hand 'treadle' loom* system of weaving, noting its possibilities, limitations and modifications, which eventually led up to the introduction of the draw loom and development of *figure weaving*. In the earlier types of hand looms, when shedding was chiefly produced by the aid of treadles designed to actuate the heddles through suitable connections, the extent of pattern production during the process of weaving was necessarily very limited.

Hand loom weaving of the treadle order, as a commercial enterprise, has undoubtedly passed the zenith of its days. It will, however, always be used for specific purposes, such as weaving very fine and light cambrics and figured goods of silk and linen material. It should also be given a place in the weaving section of all technical institutions. Students who desire to obtain a thorough knowledge of the process of weaving and the production of cloth will find it of considerable advantage to first study the constructional details of the original hand 'treadle' loom, and where possible, produce their first patterns on this type of loom, since every movement requisite in the manufacture of a piece of cloth, thus having to be performed actually by the students' own efforts, must of necessity be conceived, considered and allowed to dwell in the mind a sufficient time to make it their own, which could not obtain in the case of the power loom where so many of the motions are automatic and repeated in rapid succession.

Fig. 37 is an illustration of a hand 'treadle' loom mounted with four heddles complete for weaving, with treadles on the *centre* princi-

ple of the *closed* shed type. It was upon this type of loom that all the subsequent improvements for figure weaving were made, from simple and complex treadle shedding to the draw loom and Jacquard machine. The letters A, C, E, G, H and K in this sketch refer to corresponding parts, illustrated and described in the detailed sketch Fig. 38, which represents in elevation and partly in perspective the essential features of a treadle loom containing 8 heddles and 8 treadles, and while it further demonstrates the whole principle of

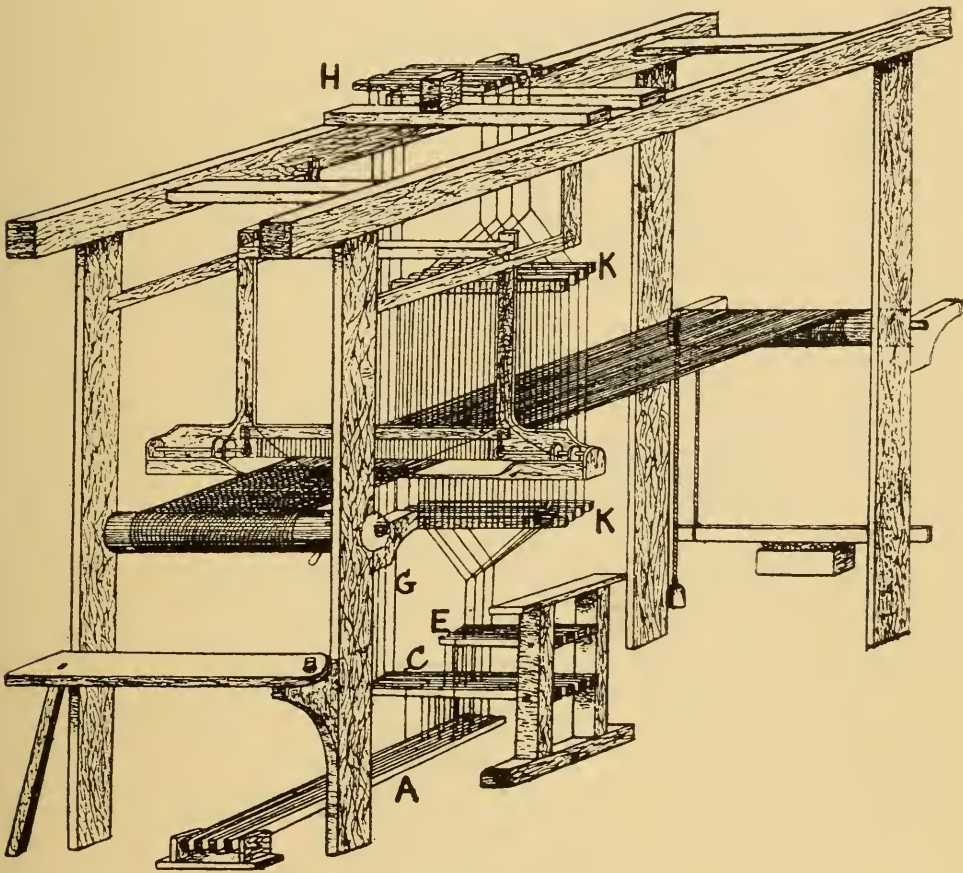


Fig. 37.

this system of weaving, it also forcibly illustrates its limitations. A^1 to A^8 indicate the treadles, each of which is free to oscillate about the fulcrum pin B. C^1 to C^8 are long levers fulcrumed at D; these were commonly called 'marches.' E^1 to E^8 are short marches free to move about the point F. G indicates connecting cords between the levers C and H. H^1 to H^8 are known as 'jack' levers, sometimes called

'coupers'; they are pivoted and free to oscillate about the stud I. J^1 to J^6 are denominated 'bow' bands; they connect the jack levers to

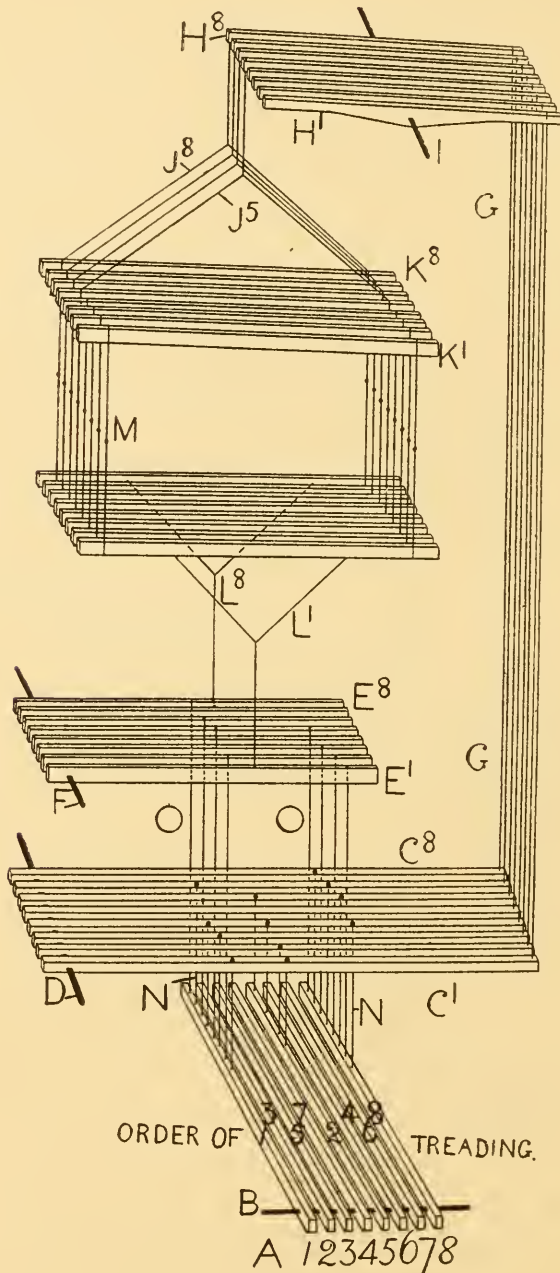


Fig. 38.

the heddles, K^1 , K^8 as shown. The lower staves of the heddles are similarly connected by bow bands L to the short levers E in corres-

ponding arithmetical order. The heddle, harness and mails are shown at M.

Each treadle must be so connected that it can, independently of all the rest, control and operate *all* the heddles to form the required shed. Consequently there must be as many treadles in the loom as there are different shots in one given repeat of pattern.

The point paper design of the required pattern is shown at 39. The order of drafting is straight, as shown, together with the tie-up at Fig. 40. The manner of connecting the treadles to elevate or depress the heddles is termed 'tieing-up' or 'cording'; the first and last shots or treads only of this pattern, are shown tied-up to both the long and short levers C and E (Fig. 38). This is to simplify the illustration. Referring to the first shot of the pattern it will be observed that the warp threads 1, 3, 4, 7 are required to be raised, and since these are drawn respectively on to the corresponding heddles, separate cords are connected between No. 1 treadle and the long levers C 1, 3, 4 and 7, which through their connections are free to elevate the corresponding heddles whenever the weaver presses this treadle down. The same treadle is also shown connected to the short levers E 2, 5, 6, 8, and through their attachments to the under-side of the corresponding and respective heddles, it is free to operate and depress them in sympathy with the elevation of heddles $\kappa^1 \kappa^3 \kappa^4 \kappa^7$. Passing over to the eighth shot, the method of connecting the cords with the eighth treadle is as follows. The eighth pick or shot on the point paper design indicates that warp threads Nos. 4, 6, 7 and 8 require to be lifted, and since these have been drafted on to the corresponding heddles it is first necessary to connect the long levers C 4, 6, 7, 8 to the given treadle A⁸, by which means the corresponding heddles can be elevated. The remaining four heddles 1, 2, 3, 5 have to be depressed, and they are therefore shown connected to the short levers E 1, 2, 3, 5, which in turn are corded to the same treadle A⁸. For the second shot of this pattern the treadle is only shown connected to the long levers C 1, 2, 4 and 6, which require to be operated to lift the corresponding and respective heddles and warp threads. It will now be evident that when a *long* lever is *not* connected with any given treadle, the corresponding *short* lever must be

corded to it, so that it can be depressed to form the bottom shed ; hence when the order of tying-up or cording requires to be indicated to suit any specific draft and pattern it is only necessary to mark the connections between each respective treadle and *long* lever.

This plan is illustrated at Fig. 40, where the heddles are shown at κ^1 to κ^8 . The order in which the warp threads are drawn through these heddles is indicated on the left hand side of the sketch, and the 'tie up' and order of treading at the right hand side. The treadles are shown at A. The x's denote that the particular heddles are connected to the *long* levers (c Fig. 38) of corresponding numbers. These long levers in turn are tied up to the treadles in order of *picking* or treading, through the action of which they operate on the jack levers (H Fig. 38) to lift the requisite heddles on each pick.

No marks are put on the remaining heddles, since it will be understood that they must of necessity be depressed and therefore linked with the corresponding *short* levers.

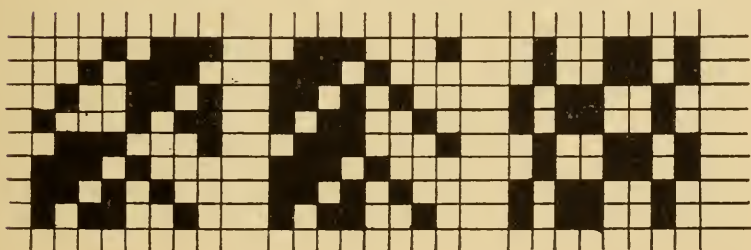
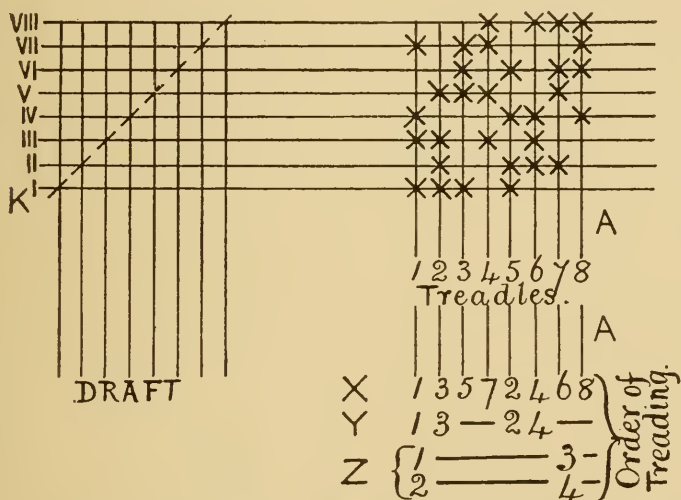
It is not essential that the treadles be connected in arithmetical order ; they may be connected to the 'marches' to suit any desired plan which will facilitate convenience of treading and production and variety of pattern, *e.g.* at Fig. 40 the order of tying-up for pattern, Fig. 39 has been arranged so that the weaver can work the treadles with the left and right foot alternately ; all the odd treads are on the left, and the even on the right hand side of the weaver.

An important feature in treadle weaving is that when once the 'tie-up' has been completed, several different effects of pattern can be produced without any further alteration of the loom mechanism or the tie-up—the weaver simply changes the order of operating the treadles. By working the treadles as at X Fig. 40 the pattern at Fig. 39 is produced ; when the order of treading is changed as indicated at Y Fig. 40 the pattern produced is a perfect stripe composed of the $\frac{3}{1}$ and $\frac{1}{3}$ twills, as pattern Fig. 41 (which it should be observed consists only of the first four shots of the original pattern Fig. 39), four treadles out of the eight only being used. When the order is further changed to the scheme shown at Z Fig. 40, a mat

effect is the result, and two out of the eight treadles are only necessary. This pattern is supplied at Z (Fig. 42).

It has now been fully demonstrated that the simplest kind of cloth, such as 'plain' and its modifications, required the use of only two mechanical units or factors, the construction and operation of such

Fig. 40.



X
Fig. 39.

Y
Fig. 41.

Z
Fig. 42.

apparatus being fundamentally simple. For purposes of increased strength and effect of surface, the interlacing of the warp and weft yarns took a different form, involving an increase in the number of warp controlling unit factors, e.g., when the repeat of pattern contained 3, 4, 5, 6, 7 and 8 threads of warp, its production involved the use of respective and corresponding numbers of mechanical parts, which had to be free to permit of their being independently controlled.

Factors in Pattern production in Treadle Weaving. The possibilities of pattern production with the foregoing mechanical aids, simply consist of mechanical repetition of all patterns, whether simple or complex in design.

All patterns in which the repeat is small can be woven by the aid of heddles controlled by treadles or 'witches' in the hand loom, and tappets or dobbies in the power loom. The possibility of pattern production by the use of heddles in some respects is considerable, especially when combined with special *drafting* and *tramping* which in former times was carried to a fine art—the warp threads being so drafted, arranged and repeated, and the treadles so corded and worked, as to produce the best fancy effects with the least number of heddles and treadles. Even after the draw loom and harness mounting had been long in practice, many fancy patterns were preferably woven with heddle and treadle mounting. The importance of tying-up was so considerable that all the complex woven patterns depended principally upon the arrangement of the ties, and the better the weaver was skilled in the art and intricacies of drafting, the further he increased the possibilities of pattern production. The increase in heddles and treadles, and especially when grouped in two or more tiers for diapers and drafted patterns generally, involved the use of more treadles than could be conveniently worked, and since the number which could be so manipulated was necessarily limited, and rarely exceeded eight, it soon became evident that other contrivances must be adopted if the weaver were to successfully cope with the growing demand for variety of pattern. The number of heddles and treadles required to accomplish the production of patterns where variety was extensive, would be so great that one man could not possibly manage to work the treadles with his feet, and the number of heddles could not possibly exceed the space limits of the loom, and at the same time produce the depth of shed necessary to allow the passage of the shuttle through it. Various methods were adopted to work as large a number of heddles as possible—as many as ninety, involving the use of external mechanical aid, were not uncommon for weaving some of the finer silks and old diapers in the early part of the 19th century. The shafts for

this purpose were about $\frac{1}{8}$ inch thick and arranged in three tiers of different depths to prevent the staves touching each other, when the sheds were opened.

Fig. 43.

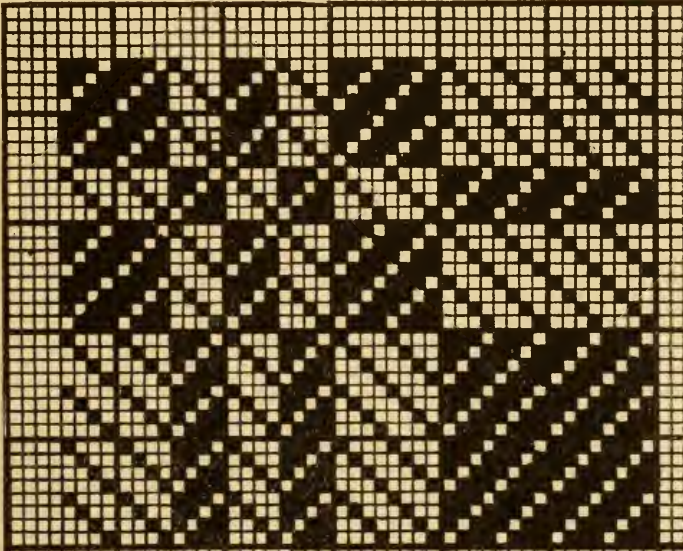


Fig. 45.

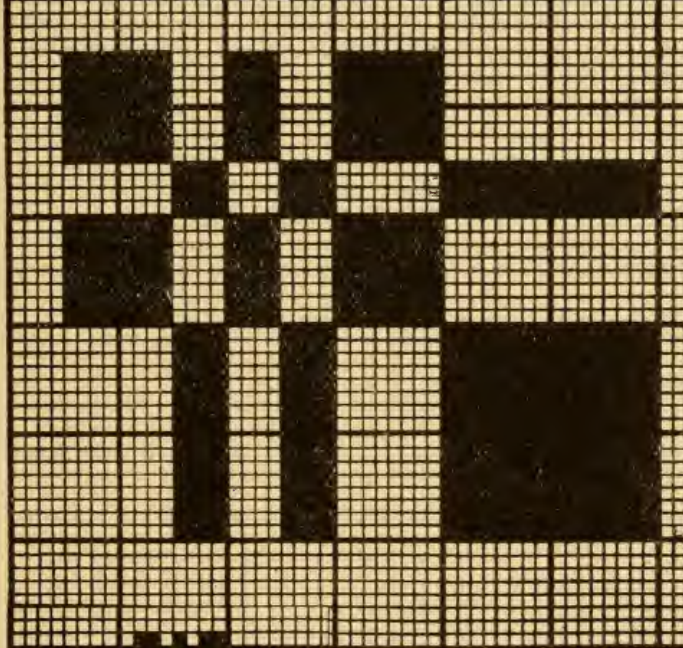
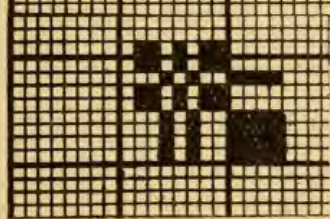


Fig. 44.



Old Diaper Patterns.

Fig. 43 supplies a point paper design of a class of patterns known as the old diaper type. This style is in reality an attempt at figure weaving by mechanical expansion, repetition and re-arrangement of elementary weave effects. It is representative of a system which was once extensively employed, especially prior to the introduction of the Jacquard machine. The pattern under consideration is developed from the small fancy mat weave, Fig. 44, which is used as a base; each square of warp and weft is then made to represent four threads of warp and weft. The block plan pattern as enlarged is shown at Fig. 45. There is no limit to the number of threads of either warp or weft which each square in the base design may be made to represent; it is only determined by the size of pattern required. When the base weave is thus enlarged and blocked out, the contrasting masses of warp and weft are too large to intersect with each other and at the same time produce a firm texture. The floating masses of warp and weft must be bound down in some regular twill or satin order. It is probable that this old block plan of weave development was the first cause which led to the introduction and practice of passing the warp threads in groups of 2, 3, 4, 5 or 8 through the mails of the back harness, and then separating them and passing them individually through the mails in a set of front heddles called pressure heddles, which had to be worked once over as binders to each separate lift of the back harness. It will therefore be apparent that this plan increases the figuring capacity of any shedding mechanism, a number of times equal to the number of threads drawn through each mail on the back set of heddles or harness.

It is important to note that the pattern supplied at Fig. 43 can, by special drafting, be woven on eight heald shafts. The student might with advantage work out the draft and tramp or pegging plan to weave this pattern on the reduced number of heddles.

Combined Treadle and Twilling Mechanism.

The following method of duplex warp shedding was designed with the object of reducing the number of treadles to a minimum

when weaving old diaper and similar varieties of patterns, where the warp threads are first lifted in blocks of *three, four, or five*, with only *one* out of each group left down for binding purposes and conversely one out of each group of threads, lifted in the remaining parts of the pattern.

Fig. 46 shows a front elevation of the shedding and twilling mechanisms, employed to weave a pattern on twenty heddles but involving the use of only five treadles.

Fig. 47 is a side elevation of the twilling details.

The same letters and numerals in each diagram refer to corresponding parts.

A represents the top front rail which supports the principal parts of the shedding apparatus. B and C are supports for the principal and secondary jack levers (coupers) respectively; the usual series of jack levers are indicated at D^1 and pivoted to the support B as shown. The secondary series of jack levers E^1 are similarly supported and pivoted to the supports C. From the ends of D^1 and E^1 cords F and G respectively and successively connect the jack levers to the heddles H, by which means the heddles are supported and elevated as desired. Weights I are suspended to the heddles to normally depress them after they have been raised, thus obviating the use of short "marches."

The five treadles are indicated at J^1 to J^5 . A corresponding number of cords K^1 to K^5 , connects each respective treadle and then passes through a perforated guide board L, and through the warp and heddles to an upper set of levers M^1 to M^5 , which correspond to the ordinary "long marches," but are placed above instead of below as in the ordinary treadle loom.

The five levers M^1 to M^5 , are pivoted at X. The march lever M^1 is shown directly connected by tight cords N^1 N^2 N^3 N^4 to the *first* of each respective series of jack levers, D^1 to D^4 . Three slack cords O^1 and duplicate groups O^2 , O^3 and O^4 , are suspended from the *second, third and fourth* jack levers respectively of each series, D^1 to D^4 . Each group of three slack cords is looped to respective small rings P^1 to P^4 , from which a corresponding number of cords

y^1 to y^4 , passes down through the lever M^1 . The *fifth* jack lever of each series is unattached in any way with the march lever M^1 .

Similarly the march lever M^2 is connected with the *second* jack lever in each series from D^1 to D^4 , the march lever M^3 with the *third* jack lever in the series D^1 to D^4 , and so on with march levers M^4 and M^5 .

There are four distinct groups of *slack* cords for o^1 , o^2 , o^3 and o^4 , combined with each of the march levers M^2 , M^3 , M^4 and M^5 , e.g., the third, fourth and fifth jacks in each series D^1 to D^4 are combined with M^2 ; the fourth, fifth and first in each series D^1 to D^4 with M^3 ; the fifth, first and second in each series D^1 to D^4 with M^4 , and the first, second and third in each series D^1 to D^4 with M^5 . The remaining jack levers unattached to march levers are the first jacks in each of the series and M^2 ; the second jacks and M^3 ; the third jacks and M^4 , and the fourth jacks and M^5 .

For the complete order of tying-up, see diagrammatic representation (Fig. 50).

The four cords, y^1 to y^4 , after emerging from the underside of the march lever M^1 are passed up through a grid box Q of which a plan is supplied at Fig. 48. They are next combined with intermediary and adjustment levers R which are in turn connected to the levers s which are virtually the *twilling* levers, and are pivoted as shown to the fixed support T .

Suspended from the opposite ends of levers s are knotted cords u , with handles v fixed at their lower extremity.

The parts o to v , inclusive, are repeated in duplicate for each march lever M^2 to M^5 .

The cords u pass through a special perforated trap board w , a plan of which is shown at Fig. 49.

**Action of
the Combined
Treadle and
Twilling
Mechanism.**

The weaver begins by pulling down the cords u , as required by the pattern, until the knots are below the underside of the board w , when he places them under the narrow slits. In the given Fig. 47, the cord u^4 and the left arm of lever s^4 are depressed so as to draw tight the cords y^4 and o^4 as shown. The treadles J^1 to J^5 are then worked once over, and these in turn depress the

levers M, which through the medium of the cords N, depress one out of each group of the series of jack levers $D^1 D^2 D^3 D^4$ and through these elevate the heddles.

In group D^4 , where cords o are tightened as already described, the march lever M^1 as it descends pulls in sympathy the first four jack levers in D^4 . The shed thus formed gives one warp and four weft for the first fifteen shafts, and four warp and one weft for the last five shafts. By working over the remaining four treadles in twill or sateen order, a like warp and weft twill stripe will be produced, which can be repeated as often as desired.

Fig. 46.

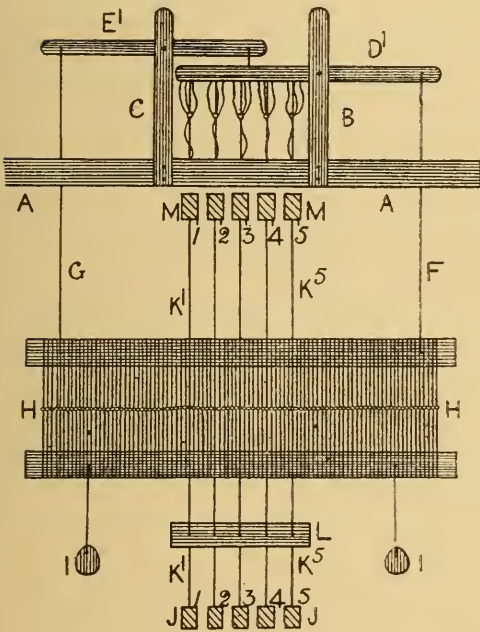


Fig. 46.

Fig. 47.

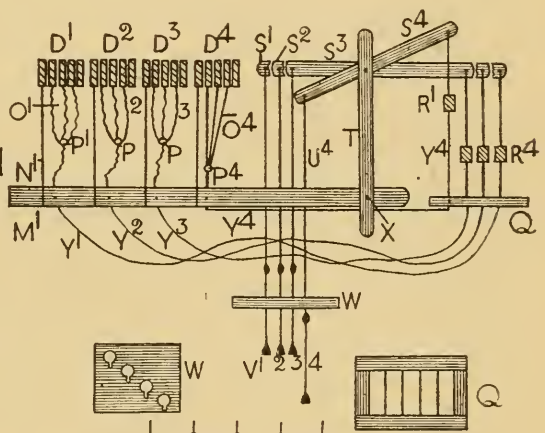


Fig. 49.

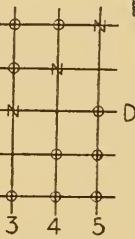


Fig. 50.



Fig. 48.

If now it be assumed that *all* the cords u are depressed and the knots placed in the narrow slits of the board w, where they may remain for as many repeats of the twilling weave as desired by the predetermined pattern, then through the connections described above, the slack cords o will be drawn down tightly to correspond with those of n, so that when any one of the treadles j is depressed it will operate through its connections described to depress the lever

M¹ together with four out of every five of the jack levers D, and thereby elevate this series of heddles and produce a pattern of four warp and one weft on the surface of the cloth.

If however all the cords U are released, the cords o will be normally slack, so that if any one of the treadles J is depressed it will through its connections draw down march lever M and the tight cords N (the slack cords o being unaffected), and one jack lever D out of each group, thereby elevating only one heddle out of every five to produce a pattern of one warp and four weft. Between these two extremes, any variety of pattern can be produced.

It must of course be understood that the order of connecting the treadles E with the marches M is designed to depress the latter, in simple order, one at a time, whereas for the block figure pattern the tight and slack cords will vary in their arrangement of attachment to jack lever D according to pattern, so that a different selection of heddles may be raised on each of the five successive shots of weft. The cording plan of this arrangement is illustrated at Fig. 50. The *first group* of jack levers is represented by the horizontal lines D, the tight cords N and the slack cords o; the march levers M by the vertical lines 1, 2, 3, 4, 5. The remaining three groups of jack levers are corded in exactly the same order and hence not repeated.

It will now be manifest that by increasing the groups of heddles, or number in each group, the figuring capacity for diaper and like patterns can be extended in multiples according to the number of jacks in each group.

This invention, which was the prototype of 'pressure harness' or 'shaft mounting,' is an example of an indefinite number of attempts, many of them successful and full of ingenuity, to overcome difficulties presented by the ever increasing desire for variety of pattern.

CHAPTER IV.

The Draw Loom.

THE 'draw loom' represents the first real attempt at 'figure weaving,' beyond the reach of treadles and eventually of heddles. It had its origin in the East in prehistoric ages, and was introduced into the West so long ago that even the date is uncertain. There is no authentic record of its introduction into England; tradition fixes the period at or about the middle of the 16th Century, when, through the persecutions of the Duke of Alva, the Dutch and Flemish weavers fled from their homes and found refuge in England.

The working of the draw loom *originally* required the constant attention of two persons, one of whom—the 'draw-boy,' raised the heddles, or their equivalent, in the requisite order of succession, by pulling cords connected to the various heddles in the order of succession as required by the tramping of the pattern, while the other performed the usual operation of weaving.

The 'draw boy' was used both for heddle and harness weaving; it would be difficult to determine with which type of mounting he was first employed, though very probably he was originally used with heddles when they so increased in number as to be uncontrollable by the weaver. The first English patent record which I have been able to trace bears the date 3rd October, 1687. The following is an exact copy from the file of patent specifications No. 257 bearing the above date:—

“Joseph Mason of our citty of Norwich invented An Engine By the Help of which a weaver may pforme the whole worke of Weaveing such stuffe as the greatest Weaveing Trade of Norwich doth now depend upon without the help of a draught boy which engine have beene tryed and found to be of Great Vse to the said weaveing trade.”

In the year 1727, June 1st, James Christopher Le Blon obtained a patent No. 492 in which he claimed to have discovered, "The art of weaving Tapestry in the loom, a secret never practised beforeand which will be extremely beneficial to this our kingdom if carried on with effect."

**Details of
the
Draw Loom.**

The essential features of the draw loom combined with harness mounting are illustrated at Fig. 51, which is a sectional elevation showing one front row of the harness cords together with its connections. These cords were gathered into groups to correspond with the number of warp threads which required to be woven the same way according to the pattern, each group being equivalent to an ordinary heddle with its complement of mails and cords.

A represents the cords, denominated 'harness,' B the necks or leashes by which each group (as above) is free to be supported and operated, C is a perforated board, four or five inches in depth, and slightly longer than the required width of the web—technically termed the comber-board; the perforations in the board must equal at least the number of warp threads and harness cords; they are equidistant for the subsequent purpose of distributing the warp threads evenly in the web. At D the harness cord is double, being looped through the mail F and then taken upwards through the board and knotted above it as at E; suspended from mail F through the medium of a cord G called the lower coupling is a tension lead weight H called the 'lingoe,' the purpose of which is to keep the harness cords and warp threads normally in their lowest position when not required to be elevated. I is a crossbeam supported on the framing at the top of the loom, and combined with its duplicate, supports a box J, known as the pulley box; the pulleys are arranged on an inclined plane as shown at K; passing individually over these pulleys are a series of cords L, technically termed *tail cords*. These are attached to the necks of the harness and after passing over the pulleys in the pulley box, they are shown attached to the position at M which represents a stick, denominated the *tail stick*, which is secured to or near the ceiling, about 20 feet from the loom. A lease is formed in the tail cords at N, which are then grouped into

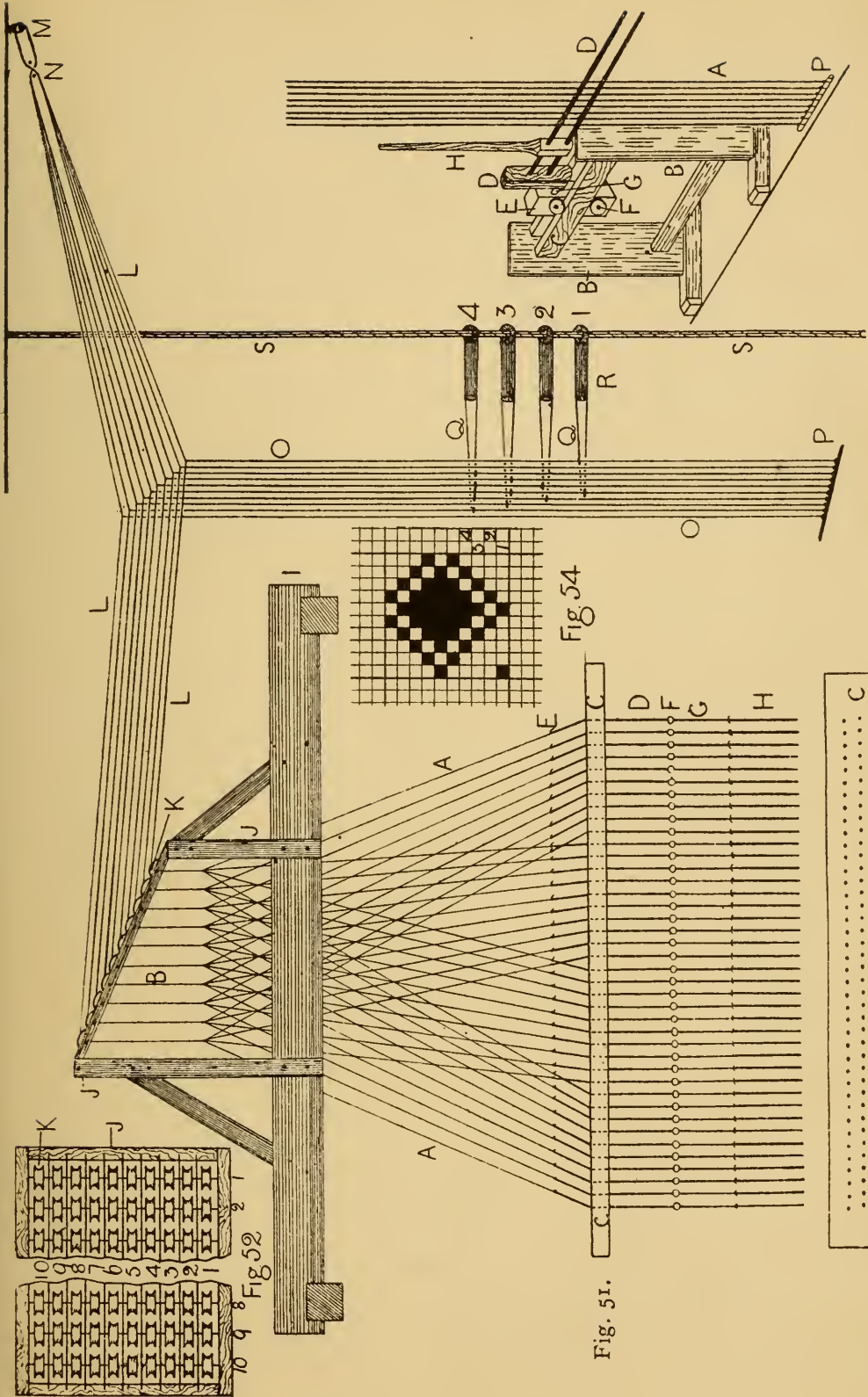


Fig. 55.

Fig. 51.

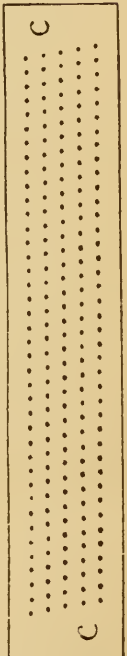


Fig. 53.

Fig. 51.

small lots of about five tails each and fastened at equal distances apart, around the tail stick M, so that they approximately occupy a space equal to that of the full complement of the tail cords.

Only one out of ten rows of pulleys and tail cords is shown which represents a figuring capacity of 100, being at that time a common number. The remaining nine rows of pulleys, etc., are duplicates of the one illustrated. To each tail cord L is suspended a cord o formerly called a 'simple' or 'symbolt'; these are arranged in parallel lines and are fastened to a stick P near the floor of the room. Similarly all the remaining harness, tail cords and simples were duplicated until the full complement of cording was completed according to the demand of the figure to be woven. In some instances for fine linen damasks, the number of harness necks and tail cords reached 1000. It will be perceived that by drawing or pulling any group of simple cords o, they in turn will draw down the tail cords L which will elevate the neck B, harness A, mails F and warp yarns to form the upper division of the warp shed, *i.e.*, a shed on the bottom and closed principle. It was therefore upon the 'simples' that the pattern was 'lashed' as it was then styled. It consisted in passing the lash twine Q (8 to 12 inches in length) round the simples o as indicated by the pattern on the point paper, for any pick or particular shed; each loop was called a 'tack', and the complete number of tacks necessary for each shed was designated a 'lash'—one lash was therefore equal to one treadle and one shot of weft. The ends of the lash cords were connected to small pieces of strong twine R called 'heads' (9" to 10" long), which were doubled and formed into loops or nooses and through each a strong, vertical 'gut' cord S passed, being suspended from the ceiling and fastened to the floor. Upon this gut cord the 'heads' with their respective lashes were arranged in consecutive order for the requisite shedding, each head being free to slide up or down the gut cord when necessary. When the pattern to be woven was small, one gut cord was ample, but for larger patterns two or more were used, in which case the heads were attached to the cords alternately when there were two, and in corresponding order when three or more.

Coloured work always required one gut cord for each separate colour. For 'covered' colour work, each colour required a separate lash and these were linked together, for every given line of weft, by a small cord called a 'bridle.' Each lash therefore represented one colour and *one* tread, but the bridle represented all the colours and requisite treads in one line of weft.

Plan views of the pulley box and comber-board are shown at Figs. 52 and 53 respectively.

**Principle of
Lashing the
Pattern.**

A small pattern is given at Fig. 54 by the aid of which the principle of lashing the pattern will be explained. On the first shot of weft, threads 1 and 6 require to be lifted, therefore the lash twine Q is tacked behind the corresponding simples 0 and then fastened to one of the heads R. On the second shot of weft, threads 5 and 7 require to be raised, therefore simples 5 and 7 must be lashed in a similar manner. For the third shot, simples 4, 6 and 8 require to be lashed; for the fourth shot, simples 3, 5, 6, 7 and 9 must be lashed, and for the fifth shot, simples 2, 4, 5, 6, 7, 8 and 10. The first four of these five shots are shown lashed to the simples at Q, Fig. 51. The lashing of the simples for the remaining shots is treated in the same way, and whether the pattern capacity of the machine be large or small, and the number of simples few or many, the process of manipulation is the same and requires no further demonstration. Provision was made on the lashing frame, so that when the lash cords were drawn or pulled by the draw boy, the simples to which they were looped were all depressed a like distance, so that a shed of uniform depth was formed. The work of the draw boy consisted in drawing each lash on the simple in succession. He grasped the threads of the simple and separated them from the rest, then pulled them down so as to operate on the tail cords and raise the requisite harness cords with the warp threads, to form the shed through which the shuttle was propelled.

**Mechanical
aids for the
Draw Boy.**

With frequent use it was evolved that the shedding capacity of the draw loom could easily be increased to meet the growing demand for variety of pattern, consequently when the number of 'simple cords' was increased from 100 to 200, 300, 400 and over, it became evident

that some mechanical means must be devised to assist the draw boy to control the increasing number of simples, together with the corresponding tail cords, necks, harness, warp threads and lingoës, apart from the increase of friction generated by the multiplicity of cords. The most important invention designed for this purpose was a fork and lever mechanism, constructed to travel to and fro in a lateral direction on a carriage, so that when the lash coupled with the required number of simples was drawn forward by hand, one rod or leg of the fork was made to pass behind and the other leg in front of the selected simples. The fork lever was then brought forward by hand, which caused the forks to turn about their common centre and simultaneously depress the selected simples on the given lash for one figuring shed. This invention dates from the beginning of the 17th century; it is supposed to have been designed by M. Dagon about the year 1606.

The chief features of this apparatus are illustrated at Fig. 55. A represents a few of the simples of the usual draw loom, B a fixed frame carriage, C the carriage rails. A fork D with two prongs is supported to a movable carriage E, with antifricition pulleys F as shown. The fork D is free to turn about the carriage E at the point G, and the carriage E is free to travel inwards and outwards at will along the carriage rails C. A hand lever, as shown at H, is secured to the fork D by the use of which the fork can be vibrated. The mode of operation is as follows:—The lash twine with its complement of simples is first selected by the draw boy and drawn a sufficient distance forward to allow the top prong of the fork D to pass through the opening thus formed into the simples, instead of grouping these by hand as heretofore; lever H on being depressed rotated in sympathy with the upper prong of the fork, by which means the simples were held downwards until the weaver inserted the shot of weft or until he worked over all the heddles, when they were combined with the harness for twilling the figure. The draw boy had ample time to bring the lash twine for each tread over the fork lever, preparatory to producing the figuring shed, with all those cloths where the weaver had to tramp over the treadles for the twilling details, but with full harness mounting and one shot for one

warp thread, the boy had to lose no time in the performance of his duties.

**Mechanical
Draw-Boy.**

The next important and epochal advance was the introduction of an apparatus which altogether displaced the human draw-boy. It automatically selected in successive order the required tail cords or their equivalent, which controlled each figuring shed. There were many mechanical contrivances conceived and attempted to attain the above object and relieve the weaver of much physical and mental effort in the production of special weaves and figured patterns. The most important of these was a small apparatus, placed on one side of the loom and heddles or harness, called the 'Parrot or Pecker,' which was brought into general use in the year 1807. It was afterwards denominated the 'draw-boy,' since it actually performed automatically, the work the boy had done.

It not only successfully saved the labours of one attendant, but it performed the sequence of operations with unerring certainty, and so removed all possible chance of pulling a wrong string and consequently lifting the wrong series of warp threads—a mistake of frequent occurrence so long as the work was performed exclusively by human agency.

It must not be assumed however that this was the first mechanical draw-boy introduced, nor yet the only one adopted, but inasmuch as it embodied all the best features of the several inventions of this kind it has been selected as the type to illustrate the process of evolution in mechanism used to produce the most comprehensive patterns, and though now out of date, it serves to display the ingenuity that was exercised in past days. *The most singular feature in the long series of inventions is, that most of the improvements were designated to operate on parts of mechanism considerably remote from the object to be controlled.* The essential features of this mechanism are given at Figs. 56 and 57, the former shows a sectional elevation and the latter a plan. The same letters in both illustrations refer to corresponding parts. A represents the frame supports at one end only, the duplicate is indicated at A¹, Fig. 57. B represents a square prism, free to oscillate between the frame supports A.A¹. C is a

grooved segment pulley secured to a sliding carriage placed on the square prism B, designed to oscillate with it, but free to be moved laterally from end to end. D D' are wood rails connecting the frame supports A A'; secured to these wood cross rails are perforated brass plates E E'; through each of these perforations knotted

Fig. 56.

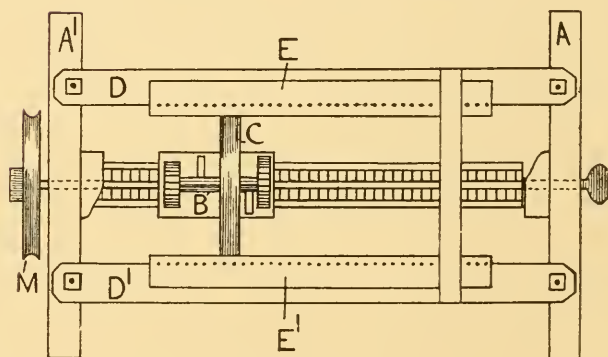
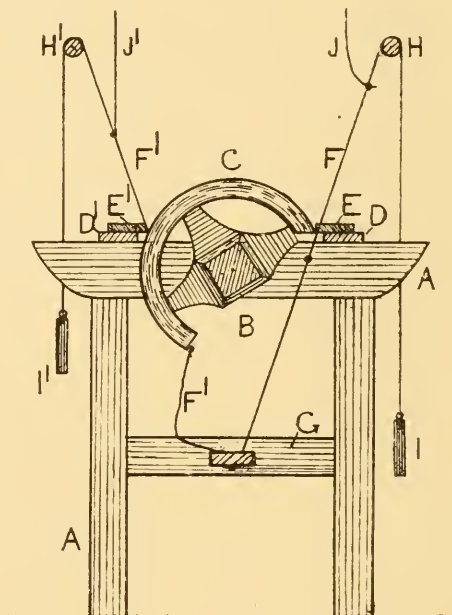


Fig. 57.

cords F F' are alternately passed, one end of each cord being secured to the cross rail G, whilst the other end after passing through the perforation is carried over a rod H and kept in tension by a weight I; the rod H is suspended by cords from the ceiling. A second cord J J' connects the cords F F' in respective order to a series of tail cords L,

Fig. 51, according to any required pattern. Near to one end of the square prism B is fixed a small rope pulley M ; two cords are fastened to it, one on each side of the wheel pulley. The cords are then individually connected to two treadle levers which can be operated alternately by the feet of the weaver. The alternate treading of these levers causes the pulley M , prism B and 'pecker' or segment wheel C to oscillate first to the right and then to the left. In each string of the series F and F^1 there are large knots immediately below the perforations of the brass plates E and E^1 . When the square prism is made to vibrate by the action of the treadles, the groove in the end of the pecker just catches the knotted cord F as the vibration is clockwise, and the cord F^1 when it turns counter-clockwise, and through their respective connections J and J^1 operate on the tail cords and harness necks to produce the requisite shed. After each complete vibration, the pecker moves laterally forward a distance of two perforations in plate E and E^1 before again vibrating to lay hold of the knots in the cords F and F^1 . These vibratory and lateral movements are continued until the pecker has travelled to the end of the machine and rack, when it automatically begins the return journey and engages with the remaining alternate cords on each side of the parrot frame, until all the different sheds in one repeat of the figured pattern have been woven over once.



CHAPTER V.

British Efforts to Supplement or Supersede the Draw Loom.

THE first authentic British record, in which pressure heddles are mentioned as being employed, was in connection with the draw loom, which was still extensively used in the latter quarter of the 18th Century, and many efforts continued to be made to improve its details, notwithstanding the numerous attempts to supersede it. The draw loom was also used long after the introduction of the Jacquard machine, or *French draw loom* as it was first denominated.

The pressure system of weaving may have been in vogue very many years previously, but it is recorded that on Nov. 23rd, 1779, Wm. Cheape secured a patent No. 1237, in which he claimed to have "Invented a new method of weaving diaper and damask linens for tableing and other purposes, also some kinds of figured silks, cottons and worsteds, where three or more woof shots are necessary betwixt each draught, without the assistance of draw boys."

**The Original
Compound
Harness and
Shaft Mounting.** At this juncture it is only proposed to briefly enumerate the fundamental principles of 'shaft mounting,' or 'pressure heddle weaving,' as it is sometimes called. A more exhaustive treatment, with illustrations, of this important branch of figure weaving is given in Chapter XII, where this principle is embodied and used with modern Jacquard weaving machinery. The subject is referred to here because, being of ancient origin, it forms a link between the past and the present. It will be perceived to have connection with the old diaper system of figure weaving (Fig. 46, pages 40 to 44) from which method the system of compound shaft mounting and pressure weaving has possibly been evolved.

From a study of the specification and drawing of Wm. Cheape's invention, the following are the important points and essential details of difference, from the ordinary draw loom. The tail-cords, instead of passing over the side of the loom, are carried over the weaver's head and suitably secured. The simples are suspended right down in front of the weaver in a perpendicular direction, so that they are all under his immediate control without requiring the aid of a draw boy—human or mechanical. Combined with the ordinary harness are five pressure heddles. The spacing of the heddles, harness, etc., it is very important to note, was as follows:—

Centre of warp rail,	...	to centre of harness	36 inches
„ harness	...	„ pressure heddles	24	„	
„ pressure heddles	„	lay, when vertical	9	„	
„ lay, when vertical, to cloth rail	12	„

The duty of the weaver, by this method, was first to select the simples in the natural order of succession, then by suitable leverage to depress the requisite tail cords to form each successive figuring shed, and having raised such parts of the warp as were necessary for any given part of the figure pattern, provision was made to keep up the said parts of the warp yarn until all the five heddles were woven once over, after which the operation was repeated for the next and successive figuring sheds.

The chief characteristics of this compound pressure system of weaving were as follows:—The warp was first drawn through the harness in groups of five or eight threads, and afterwards the same threads were separated and individually passed through the mails of the heddles, which, together with the harness, operated upon the same warp threads, but performed distinctive duties. The function of the harness was to form the pattern on a large scale by lifting the warp threads for the large masses of figure in multiples of five or eight according to the number drawn through each harness mail. The heddles served to break these groups of threads into minute detail of intersection represented by either a common sateen or an ordinary twill weave.

**The Comb
Draw Loom.**

This invention was introduced about the year 1803; it represents a further attempt to supersede the draw boy. Its figuring capacity was very small. It is very probable that the single lift 'witch' machine of a subsequent date, used for dobby work, was derived from the comb draw loom. Various persons appear to have had a share in its introduction, but I have been unable to discover any authentic patent specification. It however embodied a new and fundamental principle of warp shedding. The tail cords were replaced with vertically suspended cords from a fixed board above the top of the shedding apparatus; to these suspended cords the necks of the harness twines were attached. The suspended cords were knotted immediately above a corresponding number of perforations in the free end of a single lever, under control of a single treadle lever. The perforations in the end of the lever made it appear like a *comb*, hence the designation 'comb draw loom.' The knot cords were connected and operated by simple cords which extended horizontally, immediately over the weaver's head. The simples were lashed according to each required warp shed, and each lash was placed within the weaver's reach as he sat in his weaving position; these he pulled down in regular succession to form the figuring shed, without the aid of an assistant. Whenever the lash was drawn down, the simples in turn drew the knots of the suspended cords into the teeth of the comb lever, which when operated by the treadle lever produced the requisite figuring shed. Each lash when drawn downwards could be 'notched' into a recess and held in position until the weaver worked over all the ground or pressure heddles.

**Cross's
Counterpoise
Harness.**

This invention represents perhaps the last of the most important efforts repeatedly made to replace the services of the draw boy and to perfect the draw loom. It was introduced by James Cross, of Paisley, North Britain. The fame of the French draw loom or Jacquard machine had by this time begun to spread into England. It had reached such a state of perfection as to threaten to remove for ever not only the draw boy or his mechanical substitute, but the

draw loom itself. It is perhaps important to record, however, that for many years after this period, the weavers continued to use the draw loom, declining to be torn away from old methods to which they were attached by long and familiar custom, until the force of circumstances absolutely determined otherwise. Such adherence to tried methods and well beaten paths may be considered safe by some, while others experiment with new ideas and schemes, and run risks; but in this respect as in all commercial undertakings, *to stand still invariably means to drop out*. I have heard it said of a certain manufacturing centre in Yorkshire, that every firm which stuck to the old methods went to the wall.

The Cross's Counterpoise Machine was characterised by three distinctive features: (1) a double lift arrangement or counterpoise harness; (2) a combined lashing frame, and (3) treading details. The last two parts, though very ingenious, do not essentially differ from the methods hitherto considered and designed for the same purpose; the first part, however, records a new departure and therefore merits a brief consideration. Fig. 58 shows a front elevation of the essential parts of this invention. A B C D represent four boards, all perforated with a number of holes which correspond to the number of neck twines supporting the harness. The top and bottom boards A D are permanently fixed to the two upright supports E and E¹, which are in turn fixed to a permanent cross rail F. B and C, called trap boards, are free to rise or fall at will; they are respectively supported by connecting and lifting arms G H and G¹ H¹, which are supported and free to oscillate on respective stud pins I J and I¹ J¹ fixed to the wheels K and K¹ called the rotators. These are free to oscillate on the shafts L and L¹ by connection with the treadles. M represents a flat straight bar which joins the rotators K and K¹ in such a manner that whatever motion K makes, K¹ similarly responds. They are shown in the sketch in the centre of their movement. There is *no tail*—an important departure—connected to the harness, but 'knot' cords N, as they are called, are suspended from the top board A, then passed through the perforations of B C D and connected to the necks of the harness cords. The cords N are all suitably knotted as shown in the illustration. The

perforations in the trap lifting boards *B* and *C* consist of holes and continuation slits or 'saw cuts'—the holes being large enough to permit the knots of cords *N* to pass through, but the slits are too narrow for this purpose. The suspended knot cords are connected at right angles by a corresponding number of cords *O* *O*¹, etc., called the simples, which are thus arranged in a horizontal plane instead of vertically, as in the original draw loom. Each simple is lashed at the right hand side, according to pattern, in a similar manner to the principle hitherto described. On the left hand side of the machine the simples are supported by a half heddle *P* suspended from the support *Q*. The ends are then fastened to the ceiling in the direction *R*. Weights *S* are suspended from the simples *O*, by which means they, together with the knot cords *N*, are kept steady and in their normal position, *i.e.* with their knots immediately opposite the large holes in the boards *B* and *C*.

The lashes are automatically selected in arithmetical progression and through their connection with the treadles, they are drawn down together with the simples, a distance sufficient to place the knots of cord *N*, according to the requisite shed, immediately opposite and over the narrow slits of *B* or *C* whichever is in its lowest position and ready for rising on the given lash or shed. Consequently, when the figuring treadle is depressed, the wheels *K* *K*¹ partly rotate with shafts *L* *L*¹ and elevate rods *G* *G*¹ but depress *H* *H*¹ as shown in the illustration. The top board *B* thus raises all those cords *N* where the knots were drawn into the narrow slits, and so lifts the necks and harness to produce the requisite figuring shed. For the next figuring shed the corresponding lash is drawn. The weights *S*, in the meantime, have been free to recover the normal position of the knot cords *N*. The board *C* then rises taking up with it all the knotted cords drawn into the narrow slits; simultaneously the upper board *B* descends, and with its load acts as a '*counterpoise*' and to a certain extent assists in lifting the lower board *C*. Should any of the knotted cords lifted in the previous lash be required to be raised on this, the next and subsequent lash, the particular cord will be caught by the rising board *C* when the two boards are passing their respective centres.

These operations are similarly repeated until the complete pattern is woven.

Fig. 58.

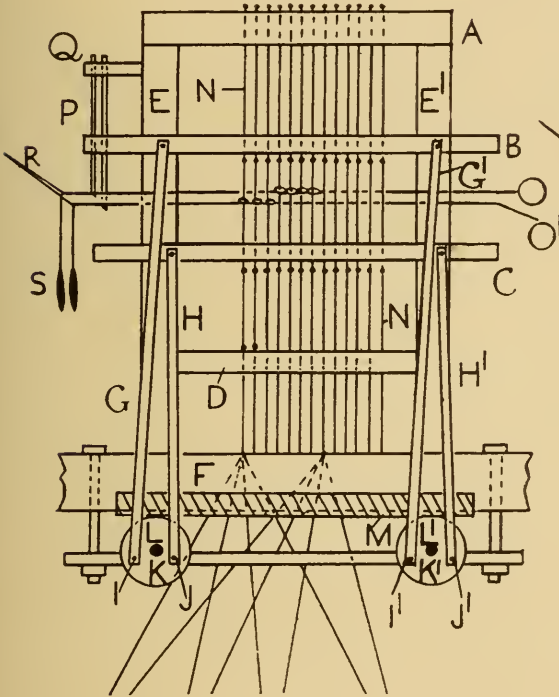


Fig. 59.

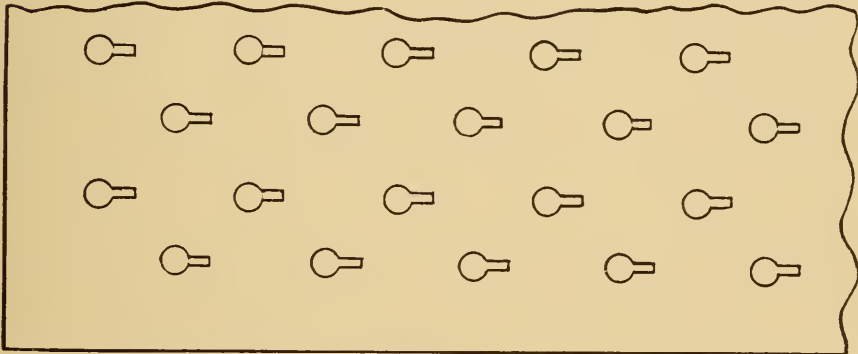
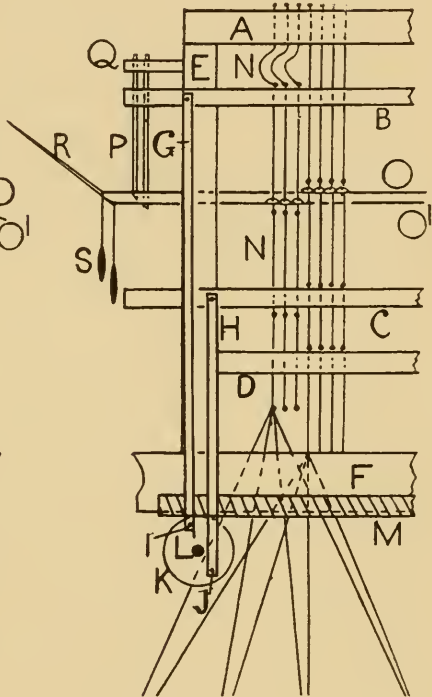


Fig. 60.

Fig. 59 shows the position of the mechanism when the figuring shed is fully open. The trap board B, together with the first three knot cords—lashed to the given simple—is shown in its highest position and the trap board C in its lowest. For the next figuring shed the two boards B and C operate as already described.

Fig. 60 shows a plan of part of the perforated board B or c.

The foregoing invention is most interesting since it is characterised by the inherent principle of the centre shed and double lift Jacquard machines of subsequent date and discovery.

**Taylor's
Double Necks.**

On 13th January, 1818, Benjamin Taylor took out a patent No. 4216, which possessed some of the characteristic features of Cross's Counterpoise Harness, and which are interesting inasmuch as they serve to demonstrate that Cross's machine was meriting favour and receiving attention from other inventors.

Taylor claimed that his "loom could be worked without a draw-boy and shift the different lashes required for the changes without stopping....." The harness had a *double neck* and as one *lash* fell the other rose, and by the falling of one, the weight assisted the rising of the other. This use of the double neck is the first record of its advent into practice; it marks an important forward step and contrasts with Cross's machine where two knots, in different positions on the same cord, were employed for lifting the same neck twines and harness cords.



CHAPTER VI.

French Efforts to Supersede the Draw Loom.

DURING the period that the British weavers were engaged in improving the shedding mechanism for producing figure effects in woven cloths, the French weavers were similarly engaged in developing and perfecting machinery for the same purpose, which efforts finally resulted in the Jacquard machine.

Bouchon's Draw Loom.

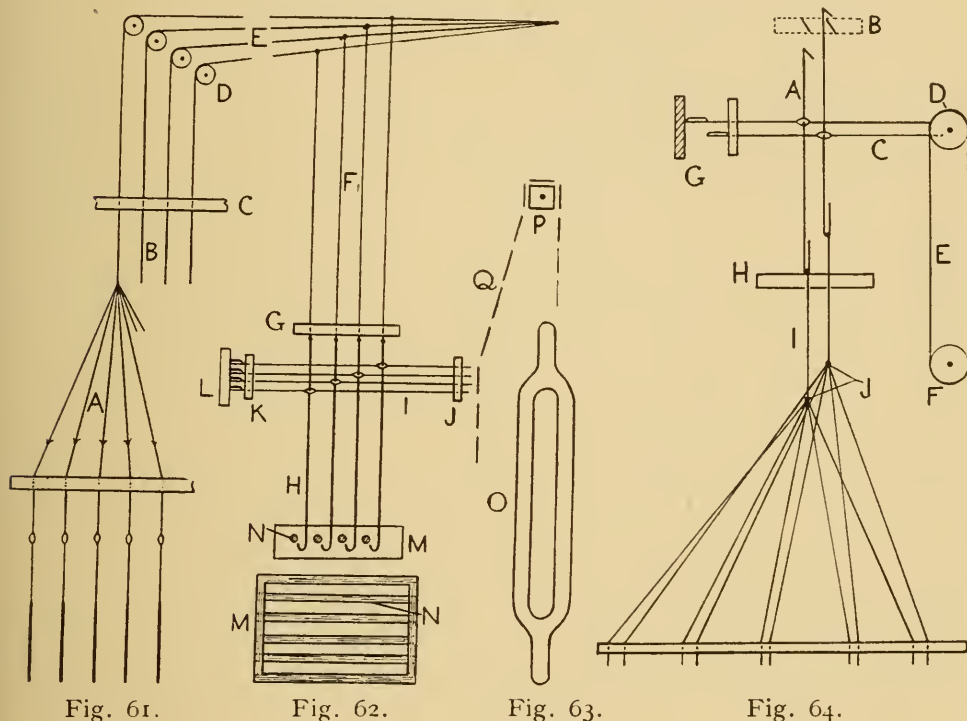
The first important improvement of the French draw loom, from which the Jacquard machine was subsequently evolved, took place in the year 1725, when M. Bouchon introduced the principal of applying a perforated band of paper, according to pattern, in lieu of 'tacking' the 'simples' with the 'lash' twine for each separate tread. A continuous roll of paper was punched by hand, in sections, each of which represented one lash or tread, and the length of the roll was determined by the number of shots in each repeat of pattern. The respective sections of paper were subsequently pressed by hand on every figuring shot against a single row of needles which were connected to and controlled the simples,—these being attached to the tail cords in the usual manner. The non-perforated portions of the paper operated to press the needles and through them the simples into a rack comb or trap board, which, when depressed by the treadles, drew down the simples together with the tail cords, and thus raised the necks, harness and warp yarns to form the shed according to pattern. Since the arrangement of the harness, tail and simples is the same as in the common draw loom no further illustration is necessary; the single row of horizontal needles connected to and free to operate the simples whenever they were pressed by the non-perforated paper into the rack comb lever referred to, represents the only point of difference. The main features of this machine are embodied with Falcon's subsequent improvements in the illustration at Fig. 61.

**M. Falcon's
Improved
Draw Loom.**

In the year 1728, M. Falcon arranged the 'simples' in four rows, and consequently used four rows of needles to operate them, instead of one, as in Bouchon's machine. This arrangement considerably increased the figuring capacity. Falcon also designed a square prism for supporting the cards, and instead of the continuous roll of perforated paper he used paste board paper cards—one for each figuring shot—equivalent to each 'lash,' and each card was perforated by hand, according to pattern; these, he strung or laced into an endless chain series.

It is important to note at this juncture that the separate cards, square prism, and plan of the needles are retained in the modern Jacquard machine. Fig. 61 illustrates these important parts. A represents the harness twine; B the neck cords; C the neck guide board; D the pulleys detached from the pulley box; E the tail cords; F the simples; G a perforated guide board for the simples; H a series of iron rods (with hooks at their base) which are individually connected to the simples at the position indicated immediately below the guide board G; I shows four horizontal wires or needles constituting one row of the series; these are supported and kept in position by the needle boards J and K. The needles at the back are looped and terminate against a flat board L which serves to keep them in position but recedes whenever any pressure is applied to the front of them, but immediately the pressure is released the board L is clamped, through the medium of suitably adjusted springs, against the looped terminals of the needles, and thereby replaces them in their normal position as shown. M represents a wooden frame containing four iron rods N, a plan of which is shown at Fig. 62. This frame being suitably connected with the treadles, is designed to rise and fall at will. Fig. 63 is a sketch of the hand bar. The process of operation is as follows:—The perforated cards O, being supported by and rotated over the non-perforated square prism P, are pressed in progressive order against the needles J by the aid of the hand bar O. A non-perforated card would press all the hooks of the suspended wires H immediately under the iron rods N, so that when the frame M was depressed by the treadle it

would pull down all the simples and tail cords and lift all the harness and warp. A fully perforated card would produce the opposite results. Between these two extremes any desired variety of effect of warp shedding could be obtained compatible with the capacity of the shedding apparatus.



**Vaucanson's
Epoch-making
Changes.**

The next important step embodying a change in fundamental principles, and which was destined to live, occurred in the year 1745, when M. Jacques de Vaucanson, a mechanician of considerable note, altogether dispensed with the mass of tail cords, simples, lashes and adjuncts to same.

In lieu of the tails and simples he arranged a series of hooked wires in a vertical plane and connected these with a corresponding number of cross wires; he further introduced the rising and falling griffe to lift the upright hooks, together with the suspended necks and harness twines, and controlled the correct selection of these by applying Bouchon's roller and band of perforated paper to operate

at the top of the loom in approximately the same position as now prevails in all modern Jacquard machines. Vaucanson virtually combined the apparatus of Bouchon and Falcon, and made them to operate on the top of the loom *directly above the harness necks*, instead of as heretofore, *remote* from the object, on the simples and through them on the tails and harness.

Vaucanson's invention therefore most nearly approached the machine which has revolutionised figure weaving in every kind of cloth, and which has been perfected so much in detail as to make it well nigh impossible to improve any of its main details. Fig. 64 illustrates all the chief principles of Vaucanson's machine. In the illustration there are two rows of needles and uprights, but his original conception was an arrangement with only one row of each, very similar in detail to the existing 'witch' machine as used in many modern hand looms. A indicates the upright wires with the hooks at the top; B the griffe, with two knives free to rise and fall through its connection with the treadle lever; C the cross wires which are looped to the needles in the order shown, and are therefore free to operate them whenever required; D indicates the position of the perforated roller or barrel over which the roll of perforated paper travelled; the barrel was made to rotate on its axis; E the continuous roll of paper perforated to pattern; G a striking-up or levelling board for the needles; H a board for supporting the uprights A and a guide for the neck twines I; the harness is shown connected to the necks at J.

Vaucanson's discovery, though facilitated by the inventions of Bouchon and Falcon, was no accident, but rather the result of continuous study and close application.

Joseph M. Jacquard. Jacquard, a native of Lyons, France, was born 7th July, 1752, of humble parents, and died 7th August, 1834, near to his native city. M. Jacquard first directed his attention to the machine which bears his name in 1790. It was not until 1801 that he completed his first model, which he exhibited at the National Exposition, Paris. For the success of his invention he received a bronze medal, an annuity of 1,500 francs,

and a royalty in cash of 50 francs for each machine sold. The machine produced was designed on the same lines as its predecessors, was simple in detail, and economical in space as compared with the common draw loom, and sufficiently practical in working arrangement to merit universal adoption.

The introduction of Jacquard's first machines into actual practice caused annoyance and was much resented by the weavers of his day, and as happened with most other important textile inventions, they were pulled down and wantonly destroyed by infuriated mobs whose knowledge was in the inverse ratio to their misguided enthusiasm.

Little did such people realise that good inventions invariably mean relatively greater cheapness in production, and hence a greater demand for the goods produced, which indirectly results in more work.

Near to the place where his first machines were burned, a statue of M. Jacquard now stands.

Speaking technically and from an analysis of what had been done by other inventors, it is very difficult to state exactly what particular part of the 'Jacquard' machine, Jacquard himself designed. He may have combined the best mechanical elements of other inventors, but at any rate the machine he made must have differed from its predecessors in arrangement and minor working details. It was similar in most general principles to Vaucanson's arrangement, except that he made use of Falcon's individual paste board paper cards and his square prism or card 'cylinder,' which he is credited with having fully perforated on each of its four sides in lieu of Vaucanson's perforated 'barrel.' Jacquard's machine also contained eight rows of needles and uprights as compared with Vaucanson's double row, which modification enabled him to increase the figuring capacity of the machine. In his first machine he supported the harness by knotted cords, which he elevated by a single trap board on the principle still used in a Brussels Carpet Jacquard. (Bradbury's *Carpet Manufacture*, p. 86).

The advent of Jacquard machines into the British Isles was between the years 1816 and 1820, when Stephen Wilson, an English silk manufacturer, employed them in his own works. One of the chief advantages which he claimed for this machine was that, whereas in weaving damasks the figuring shed was usually drawn once for every four shots, with the new apparatus it could be drawn on every shot, thus producing a fabric with greater definition of outline, which, he stated, was obviously a more difficult operation.

In the succeeding years 1822-1823, it was introduced into Coventry, and in 1827 into Halifax, in Yorkshire, after which the machines were rapidly distributed into every manufacturing centre, and in the course of a very few years the Jacquard almost entirely replaced every other method of figure weaving. It has certainly been the chief instrument in bringing the important and beautiful art of ornamenting textile fabrics, simultaneously with their production, to its present state of perfection, see frontispiece.



PART II.

MODERN JACQUARD MECHANISMS.

CHAPTER VII.

The Single Lift Jacquard Machine.

THE modern Jacquard machine is the product of many minds. It is an accessory to the hand and power looms, designed to control, and independently operate a large number of warp threads, and produce the maximum variety of warp sheds, for ornamenting purposes, with the minimum amount of mechanism, mounting and space.

Jacquard weaving is characterised by two distinctive features. (1) The shedding mechanism and (2) the harness mounting or parts which supply the place of heddles exclusive of its appendages. Harness mounting, though inseparably combined with the Jacquard of the present day, was in use hundreds of years before Jacquard himself was born—a fact made demonstrably clear in Chapter IV.

Jacquard machines, as used in modern practice, are numerous and varied, ranging from the ordinary single lift to the more complex automatic cross border, leno, twilling, index and double-cloth Jacquards.

The single lift of to-day is still representative of the original invention and unchanged in all its main features, though many important improvements have been and are constantly being made and details added.

It is simple in construction and therefore the only type of machine adopted for figure weaving in the hand and smallware looms. Being built upon the 'bottom' and 'closed shed' principle of warp shedding it is not suitable for high speeds—about 120 picks per minute being a fair average for $5/4$ looms. For this reason it is used in power looms for the manufacture of silk brocades and all woven figured goods where the character of the material precludes fast running. A further factor which sometimes contributes to the adoption of single lift Jacquards with power looms, is the desire to imitate—as near as possible—the 'kind' or 'soft handle' of the hand loom woven products.

**Details of the
Single Lift
Jacquard.**

The essential features of the single lift Jacquard for either hand or power looms are fully illustrated at Figs. 65, 66 and 67. Fig. 65 is a perspective sketch of a standard single lift Jacquard combined with harness mounting but showing only one harness cord for each upright hook in the machine to avoid confusion and simplify demonstration. Fig. 66 is a perspective sketch illustrating the chief features which operate and control the 'swing batten' lever, card cylinder and pattern cards. Fig. 67 shows in elevation one row of 'uprights,' 'crosswires' or needles, needle board, spring box, tug cords, tug and grate boards.

Corresponding numerals in each diagram refer to similar parts. 1 indicates the upright wires turned over at the top to form a hook, for which reason they are usually designated the 'hooks.' The wires of these upright hooks are doubled at the base and turned upwards for about one third of their length until they reach and pass between the cross wires of a fixed grate 2. This double wire combined with the cross wires in the grate 2 neutralises any tendency on the part of the hooks to twist round. The double wire at the bottom is also turned up to form a double hook which normally rests in a perforation of the board 3, called the 'tug' or 'resting' board for the uprights 1. Upon each of the double wired hooks, short and strong cords of twine, 4, are looped and afterwards passed through the perforations in the tug board 3; these short

cords are technically called 'tug cords' and in some localities 'neck cords.' In many machines the upright wires 1 are simply bent and turned upwards without forming the double loop, shown at the base, in which case the tug cord has to be looped on to the single wire with the result that it is much sooner worn or cut. To each of the tug cords 4, any required number of harness cords 5 may be tied—one only is shown in Fig. 65. There are twenty-eight rows with eight hooks in each row, but only twenty-five rows are shown to be in use, making 200 hooks in all; the first and last two rows are reserved for selvages and other special purposes. The harness cords 5 are all passed through the perforated board 6, usually termed the 'comber board.' 7 indicates the knots which connect the harness cords *below* the board to the cords 8 called the *upper* couplings. These are double and pass through and support the eyelets or mails 9 and double cords 10 designated the *lower* couplings which connect the mails 9 to the iron weights or 'lingoes' indicated at 11, which weight the harness cords and draw down the warp threads. The parts 8, 9 and 10 are usually and collectively called the couplings. The warp threads 13 pass through the mails 9 as indicated and a portion of the woven fabric is shown at 14. A series of cross wires 15, corresponding in number to the uprights are linked to the upright hooks in the order as shown by the thick markings, where the hooks and wires cross each other. These wires or needles pass through a perforated board 16 called the needle board. At the opposite end the needles are turned back to form a loop and supported and kept in position by a series of springs contained in the box 17, Fig. 67. The needles serve to press the hooks of the uprights 1 normally over a set of horizontal knives 18 which are contained in the iron frame 19 (part of which only is shown) and variously called the 'head,' 'griffe' or 'brander.' The head or griffe with the knives is free to rise and fall in a vertical plane; a threaded bolt 20, connects the head 19 by a swivel link and nut 21 to a simple lever 22, which is pivoted at 23 on a fixed upright 24. When the Jacquard is placed above a hand loom, a cord 25 connects the head lever 22 with the foot lever, but when used on a power loom, the lever 22 is pivoted near the top of the

in the centre of each ; the whole must be absolutely true. The card cylinder is placed into and supported between the free ends of the arms of the swing lever 27 ; the arm on the right hand side has been omitted so as to give a clearer view of the cylinder end. The cylinder is adjusted by means of the set screw and lock nut 33, duplicated on the opposite side. It is perforated to correspond with the number of needles. Resting square on the iron part at each end side of the card cylinder is an inverted T shaped 'hammer' 34, the spindle or shaft (35) of which passes through the lower and upper cross bars of the swing frame 27. A spiral spring 36 circumscribes the spindle 35 between a shoulder on the spindle shaft, near to its base, and the underside of the top cross bar 27, by which means the hammer 34 is kept in close contact with the iron part of the card cylinder. Secured to the top cross rail of the swing frame 27 at the point 37, is a grooved casting 38 known as the 'Swan neck.' Adjusted and free to move between the two sides of the swan neck is an antifriction bowl 39 which is free to rotate around a stud pin 40 fixed to the end of a connecting arm 41 ; this arm is fixed and projects from the lifting head of the Jacquard and therefore rises or falls with it.

A special hooked catch 42 is pivoted to the stud 43 which projects from the fixed frame of the Jacquard machine. The free end of the catch rests passively on the lantern end of the card cylinder with the hook projecting just clear of one of the shoulders. A similar catch 44, but inverted, is shown on the underside of the card cylinder. This catch is pivoted to the stud 45 fixed in the machine framing. The arm of this catch projects beyond the stud pin, and a cord 46 is attached to it and suspended to within reach of the weaver. This 'bottom' catch, as it is usually called, normally rests with its hook just clear of the card cylinder. A vertical iron pin 47 rests upon the face of the bottom catch and its head just touches the under side of the top catch 42. The pin 47 is kept in its vertical position by passing it through the perforation of a bracket 48 secured to the machine. A small lever catch 49, called the cylinder protecting catch is pivoted on the common stud 45 ; a spiral spring 50 fastened to the machine keeps the short arm of the

lever catch down; the upward movement of the long arm is regulated by a fixed stop. It will thus be evident that by pulling down

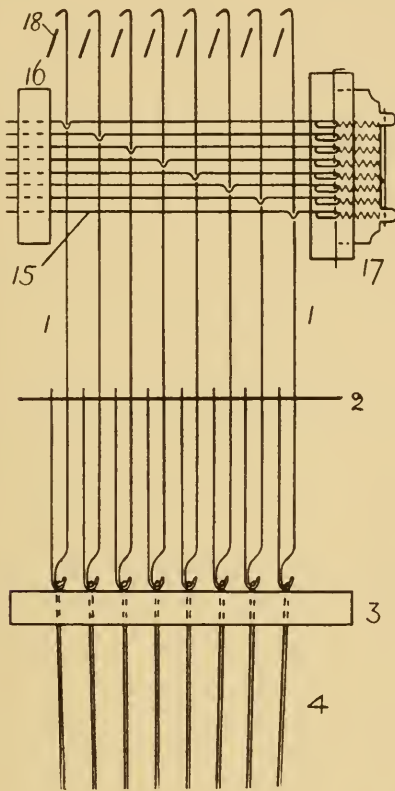


Fig. 67.

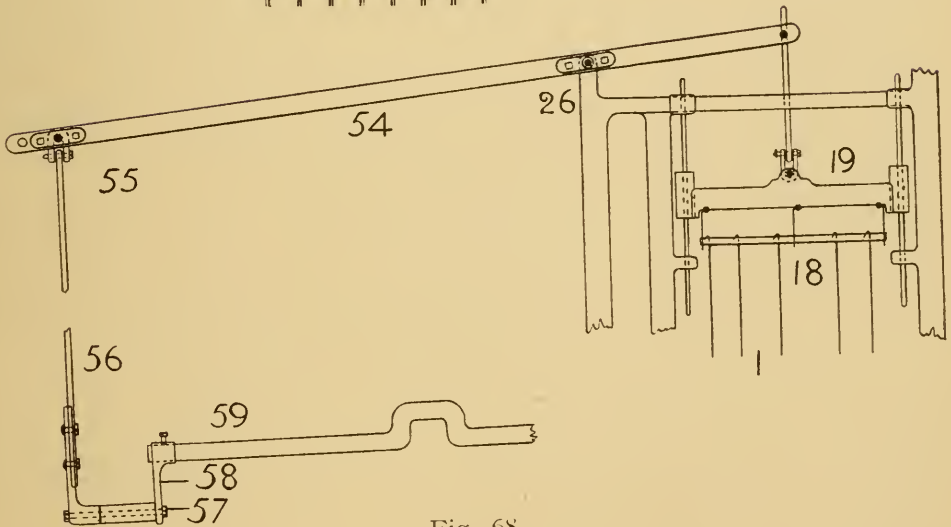


Fig. 68.

the string 46, the catch lever 44 will turn about the stud 45 until it is in contact with the underside of the cylinder, and also lift through

the pin 47, the catch lever 42 until the hook of the top catch is above and perfectly clear of the shoulders of the card cylinder. A series of perforated cards 49*a* are placed over the card cylinder and kept in their true position by means of pins 51 or cylinder pegs. Two iron springs 52 are fastened to the top of the swing frame, the lower ends being turned up and free to press against the card which is on the back square of the prism and so help to keep it in contact with the cylinder 32.

**Reciprocation
of the
'head lever.'**

In the hand loom, Fig. 65, the head lever 22 is combined through cord 25 with a simple tread lever of the second order adjusted near the weaver's foot and conveniently vibrated by the same.

Fig. 68 is a front elevation showing the method of communicating reciprocating motion to the Jacquard head. The head 19 is combined with the head lever 54, pivoted at 26. Suspended from the stud 55 a reciprocating rod 56 combines the lever 54, through stud 57, to a crank lever 58 which is set screwed to the crank or loom shaft 59.

**Action of the
combined parts
in the
Jacquard.**

In power loom weaving the constant rotation of the crank shaft 59 with crank lever 58 reciprocates the rod 56, head lever 54 and head 19. In *hand loom* weaving, when the foot lever is pressed down, the connecting cord or chain 25 (Fig. 65), draws down the free end of the lever 22 about its centre 23 and thus elevates the connecting swivel 21, link 20 and the lifting head 19 together with its full complement of knives 18.

Simultaneously with the elevation of the lifting head, the projecting arm 41 (Fig. 66) rises, carrying with it the antifriction bowl 39, which, travelling inside the groove of the swan neck lever 38 causes the card frame 27 to swivel about the centres of the two studs 28 and 29 and so to carry the cylinder 32 and pattern cards 49*a* away from the points of the needles 15. When the card cylinder has travelled outwards a given distance, the catch 42 holds against the top corner of the cylinder and resisting any further outward movement causes the cylinder 32 to rotate about its axis. The

hammer 34 keeps it from turning too far and ensures it being kept perfectly square with the points of the needles when brought into contact with them. With the descent of the head 19, the bowl 39 falls to the bottom of the swan neck lever and draws it, together with the card cylinder, into close contact with the needles 15, so that if a *fully* perforated card, as shown at the top of the cylinder, is brought into contact with the needles, they enter the perforations in the card and cylinder but in *no* way exercise any influence over the normal position of the uprights which are over the lifting knives 18, so that as the knives ascend they lift *all* the uprights, harness and warp. The second card is shown *blank*, *i.e.*, without any perforations, so that on the succeeding lift when it is brought into contact with the needles, it forces *all* the hooks *clear* of the ascending knives 18 and consequently the uprights, harness and warp all remain down. The third card is shown to be *partly* perforated, so that it combines the factors of a non and a fully perforated card. Then as the griffe ascends, the uprights left in their normal position are caught and lifted together with the harness and warp to form the *top* division of the warp shed, but the remaining uprights which have been forced *clear* of the knives together with their harness and warp are left down to form the *bottom* division of the warp shed. Thus by varying the perforations in the card any number of uprights may be lifted or left down and so any variety of warp shedding may be produced.

Rotating the Card Cylinders.

There are two chief systems in use for operating the Jacquard card cylinders, viz. :—The swing lever and the slide or horizontal. Either system may be compounded with that of the lifting ‘head’ or operated by an independent drive.

Principle of the Swing Lever Card Cylinder. Figs. 69, 70 and 71 show elevations of this type of card cylinder mechanism together with the principle of operation. The numerals in these diagrams refer to corresponding details given in Fig. 66. Fig. 69 shows the position of the mechanical parts when the card cylinder is *normally* in close contact with the face of the needles.

Fig. 70 shows the card cylinder at a point midway between the needles and the limit of its traverse. It will be perceived that the top catch has operated on one corner of the lantern to make the card cylinder rotate through an angle of 45° and in the process has caused the hammer 34 and hammer shaft 35 to overcome the resistance of the spiral spring 36, as the swing lever 27 continues to travel outwards until the card cylinder gradually passes through an angle of 90° . During the whole of this period the action of the spiral spring 36, has been to keep the movement of the card cylinder steady and also to prevent it from rotating too rapidly or too far, so that on its return it will strike 'square' with the face of the needles. A further factor which contributes towards this object is the small protecting 'catch' lever 49. Immediately the lantern corner of the card cylinder passes the free end of this lever, the spring 50 operates to depress the opposite arm of lever 49 until the free end of the cylinder protecting lever is raised to its maximum height—a position, such, that if the card cylinder has not rotated through 90° it will assist it to complete the right angle and also prevent its tendency to exceed this limit, thus ensuring that the face is presented squarely to the needles.

Fig. 71 indicates the position of the swing lever 27 at the extreme end of its traverse. The spiral spring 36 has also assumed its normal position and caused the hammer 34 to rest on the square of the card cylinder so that the latter is in position ready to return and strike against the face of the needles with the next pattern card as in Fig. 69.

The chief advantages of the swing lever system are:—It is easy to operate and the amount of friction generated is small. It is well adapted for reversing the Jacquard cards, whether for finding the broken pick and pattern, or for reversing the pattern cards when weaving bordered goods and similar designs. The chief defects are:—The oscillating motion of the card frame has a tendency to divert the pattern cards from the cylinder. The arc described by the card cylinder also alters the relative position of the centres of the holes in it with the points of their respective needles, which makes

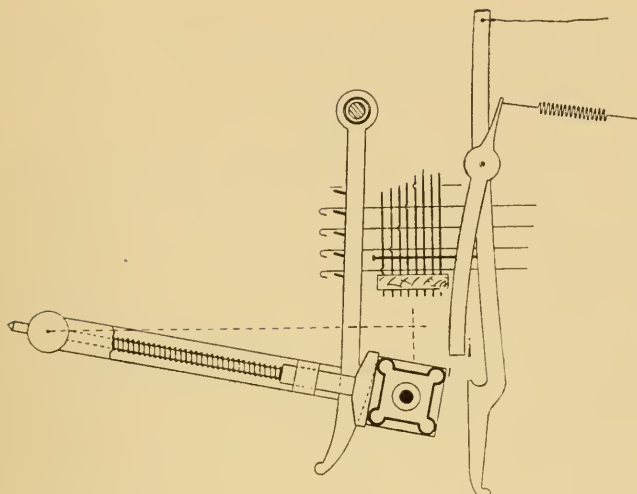


Fig. 71.

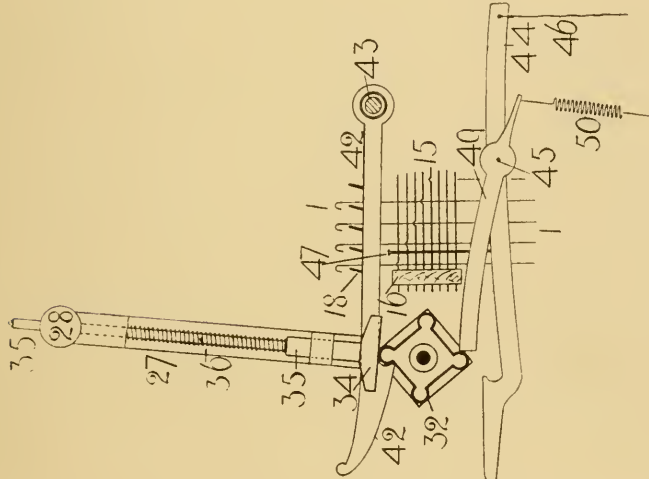


Fig. 70.

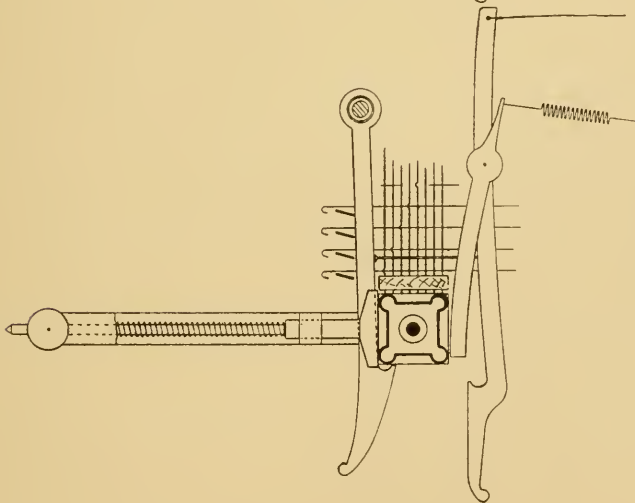


Fig. 69.

it difficult for the cylinder to strike "square." A higher frame is also required with this system, which is an objection, especially where the ceiling is low.

**Rotating the
Card Cylinder
on
Slide Principle
with
"Swan Neck."**

Fig. 72 illustrates the detached parts of the Jacquard mechanisms which actuate the card cylinder on the slide principle, combined with the lifting head and a swan neck attachment to the slide. A is the antifriction bowl and stud which are secured to the lifting head of the Jacquard. B is the "swan neck" casting with a slotted groove, up which the bowl A is free to move. The casting B is secured by the bolt and nut C to the slide bar D which, in turn, is supported and free to move laterally in two fixed slide brackets E and F. The gudgeon spindle of the card cylinder G is adjusted and supported in the end of the slide bar D. A right-angled hammer H is kept in close contact with the 'lantern' part of the card cylinder, by means of the constant action of a spiral spring I which is connected to a fixed part of the machine frame and to the horizontal arm of the hammer H in the position shown. J is the top catch, fulcrumed at K, for turning the cylinder G; L is the bottom catch with its fulcrum at M. The two catches are joined together by a rigid upright wire N. A cord O, under control of the weaver, is suspended from the catch lever L.

**Action of
the
Mechanism.**

It is evident that with the ascent of the head and bowl A, no movement will take place in the swan neck B nor slide D, until the bowl A reaches the angle formed in the swan neck. This affords sufficient time for the knives to reach and catch under the hooks of the uprights, before the cylinder begins its outward movement. Immediately the bowl A begins to slide up the incline of the swan neck casting, the latter moves out laterally carrying with it the slide bar D and the card cylinder G. The pressure of the card cylinder against the upper catch J is sufficient to cause the former to rotate a quarter of its revolution, which action is facilitated by fixing the position of the fulcrum for the catch J above the point of contact of the catch with the shoulder of the 'lantern.' When the string O is

pulled down, the lower catch *L* is raised into close contact with the underside of the card cylinder, so that whenever the latter travels outwards, it is made to rotate in the reverse direction. Because the position of the pivot for this catch is *above* the *centre* of the axis of the card cylinder, the rotation of the latter is more difficult than if it were pivoted *below* the centre. The combined action of the hammer *H* and spiral spring *I* results in keeping the card cylinder steady during rotation. When the bowl *A* is travelling up or down or at rest, in the vertical groove at the *top* of the swan neck *B*, the card cylinder dwells in a position *remote* from the needles, and in a similar way it dwells in *contact* with the needles when the bowl *A* is in the *bottom* vertical groove.

**Rotating the
Card Cylinder
on
'Spindle Slide'
and Bell Crank
lever principle.**

Fig. 73 represents the essential features of this principle of operating and controlling the card cylinder on a Devogé single lift Jacquard. *A* is an antifriction bowl combined with a fixed stud to the lifting head of the machine. *B* is a connecting link between the bowl and stud and the bell crank lever *C*. A loose stud *D* passes through the link *B* and the lower arm of lever *C* in the position shown. The lever *C* is pivoted and free to oscillate about the fixed stud *E*. The horizontal arm of the lever is joined by a stud *F* to a connecting and pushing rod *G*, which is in front of the lever *C*. The stud *F* is bolted to rod *G* but passes freely through the arm of lever *C*. The opposite end of the rod *G* is connected to a bracket casting *H* through the medium of the stud *I*. The casting *H*, of which a portion is indicated by the dotted lines, supports the card cylinder *L*. A round spindle *J* is bolted to the machine at *K*. Upon this spindle the bracket or casting *H* is placed and free to slide alternately forwards and backwards. The spindle shaft of the hammer *M* passes through and is free to slide between two projections on the remote side of the upright part of the bracket *H*. A spiral spring *N* circumscribes this spindle shaft and combines with the hammer to keep the cylinder steady during rotation. The catches *O* and *P* for rotating the card cylinder either forwards or backwards are compounded and oscillate about a common centre *Q*. The projecting arm *R* and the string *S* provide

the means for lifting the upper catch *o* clear and the lower catch *p* into position for reversing the rotation of the card cylinder.

Action of the Mechanism. With each ascent of the griffe and bowl *A* in the direction of the arrow τ , the centre of the loose stud *D* describes an arc of a circle *U* by which means the lower arm of lever *c* is gradually elevated but the upper is simultaneously depressed. The centre of the stud *F* describes an arc of a circle *F V*. This same end of the pushing rod *G* also follows the same arc *F V* by which means it pushes outwards to the left, bracket *H* combined with the hammer *M*, spring *N* and the card cylinder *L*. The *normal* position of the rod *G* when the card cylinder is in close contact with the needles is indicated by the dotted line which joins the two centres *F I*. The *relative* position of this rod *G* with the horizontal, gradually changes until it assumes its final inclined position indicated by the dotted lines *v w*, which represent the respective positions of the centres *F I*, when the card cylinder is at the extreme end of its traverse outwards. Conversely, the falling 'head' brings all the described operating parts into their original and normal position, the card cylinder bringing the next pattern card against the needles for the next warp shed.

At first sight this arrangement appears to suggest undue friction in the various working details, but if the connection with the head is detached and the catches lifted, it will be found that the weight of the horizontal arm of lever *c* is sufficiently counterpoised to push out, by gravity, the bracket *H*, card cylinder *L* etc., their full distance, consequently when the 'head' ascends, it has only to rotate the card cylinder a quarter of a revolution, by overcoming the resistance of the catches, hence the friction is very small when the parts are properly adjusted.

Timing the various movements in Single Lift Jacquards.

The following actual particulars were ascertained from a single lift Jacquard, mounted on a $5/4$ single shuttle loom running at the rate of 120 picks per minute. The griffe or lifting head of the Jacquard was driven by a rotating crank, set screwed to the extreme

Fig. 72.

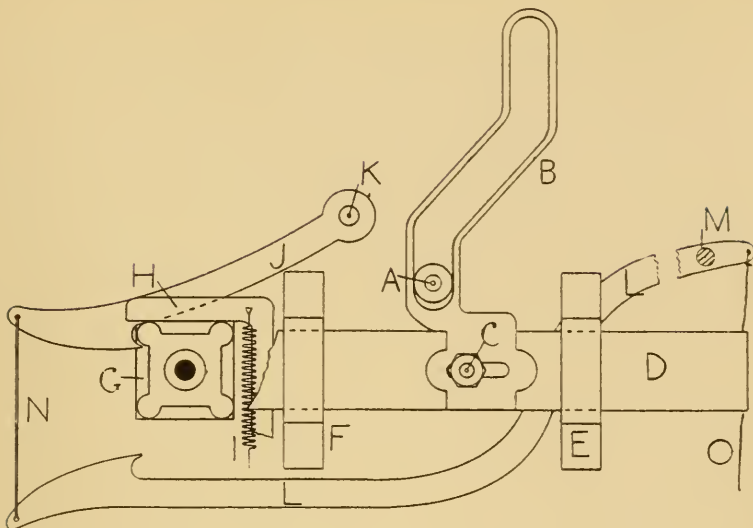


Fig. 73.

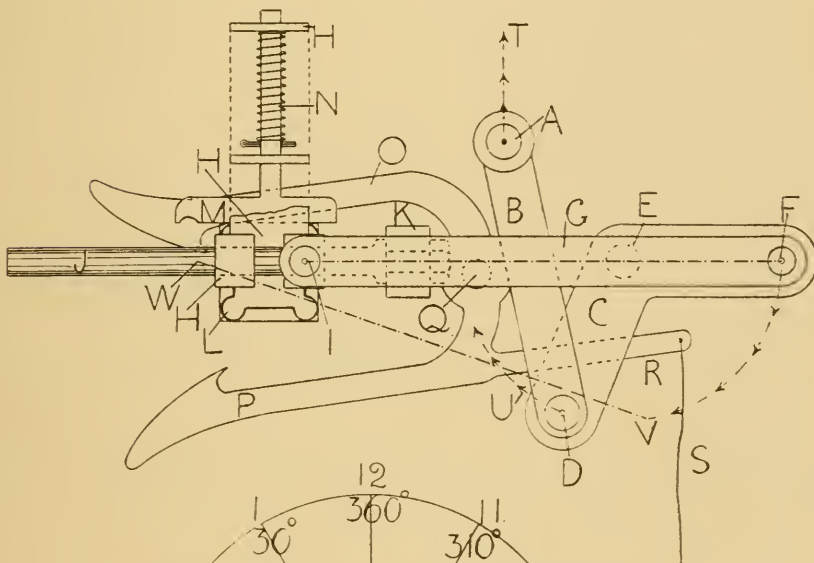
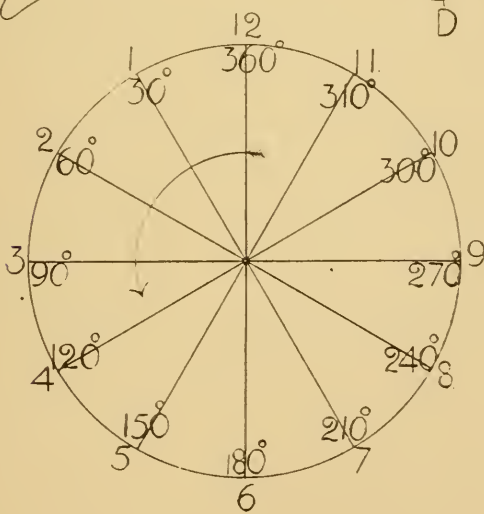


Fig. 74.



end of the top or crank shaft as in Fig. 68. The card cylinder was driven independently by an eccentric also secured to the crank shaft.

Assume the circle described by the crank shaft to be divided into 12 equal parts, each part being equal to 30° (Fig. 74). The *rotating lever* 58 (Fig. 68) is adjusted 35° *i.e.*, approximately one part behind the crank of the top shaft. Commencing with the loom at rest, the warp shed absolutely closed, the *lifting lever* on the crank shaft at the top centre and the griffe at the bottom. The card cylinder is in initial acting contact with the needles, pressing on or leaving clear such uprights as are necessary for the next shed Fig. 69. The loom crank is then at 1 Fig. 74, *i.e.*, 30° past its top centre. The full details are summarised as follows:—

Positions of Card Cylinder.		Time	Positions of Loom Crank	
				Divisions
1.	Initial acting contact of c c with needles -		30°	1
2.	Dwell of c c in contact with needles - -	40°	70°	2-3
3.	Initial contact of c c with turning catch - -	40°	110°	3-4
4.	c c in centre of rotation thus \diamond Fig. 70 -	60°	170°	5-6
5.	When c c reaches the limit of its outward traverse	40°	210°	7
6.	Dwell of c c at the limit of its outward traverse -	25°	235°	7-8
7.	Traverse of c c into initial contact with needles -	155°	30°	1

The griffe commences to rise when the circle described by the crank shaft is 55° past the top centre, approximately division 2. The shed is fully open at 210° —division 7 where it ‘dwells’ to 230° midway between divisions 7 and 8. From this point the griffe begins to descend and reaches rest at 40° immediately past division 1 where the closed shed ‘dwells’ preparatory to a repetition of its cycle of movements.

Figuring Capacity of Jacquards.

The figuring capacity of a Jacquard is represented by the number of warp threads which it can independently operate and control. In single acting Jacquards where each lifting hook is controlled by a separate needle, the figuring capacity is always equal

to either the number of uprights or needles which the machine contains. These are usually made with 208, 304, 408, 608 or 612 uprights and needles, and respectively designated for convenience of expression, 200, 300, 400 or 600 machines. Larger figuring capacities are obtained by combining and working together, two or more of any of the foregoing, or by using a fine pitch Jacquard, either on the English or French system.



CHAPTER VIII.

Double Lift Jacquard Machines.

THIS type of machine is designed with the object of facilitating a greater relative speed of the power loom, and at the same time reducing the relative excessive speed of the operating parts of the Jacquard, *e.g.* a single shuttle power loom, mounted with a single lift Jacquard and making 120 shots per minute could be increased to 180 shots per minute by the substitution of a double lift Jacquard, while all the working details of the Jacquard could be reduced to half the speed of the loom as will be demonstrated shortly.

The double lift Jacquard is further designed to produce a warp shed on the semi-open shed principle, as illustrated at Fig. 36, Chapter II, and it therefore possesses all the advantages of the semi-open shed, as compared with the closed shed principle, *e.g.* The rising shed acts as a counterpoise to a falling shed and *vice versa*; the distance travelled by the warp is only equal to one and a half times the depth of the shed, whilst in the single lift machines, the warp must travel twice the full distance for each shot of weft. Further, with the double lift machine more shots of weft can be relatively driven into the cloth than is possible with the single lift, because with the former the weft is driven into a 'crossed' shed, which after having once been 'beaten up' cannot recede from the fell of the cloth, whereas, with the latter type of machine, the weft being driven into a 'closed' shed, has a tendency to slip back from the 'fell' as the reed recedes. The beating up of the weft in the crossed shed produces a better 'cover' or distribution of warp threads in the web, than obtains when beating up on the closed shed principle.

The introduction and perfecting of the double acting Jacquard machine combine to make a very *great advance* in *figure* weaving and have proved to be of inestimable benefit to this branch of the textile industry.

**Double Lift
Single Cylinder
Jacquard.**

This type of machine is representative of the simplest class of the double acting series of Jacquards. The chief details of the system will be illustrated and described under this heading, the remaining varieties will only be considered in so far as they differ from the main and essential features. Fig. 75 shows in elevation

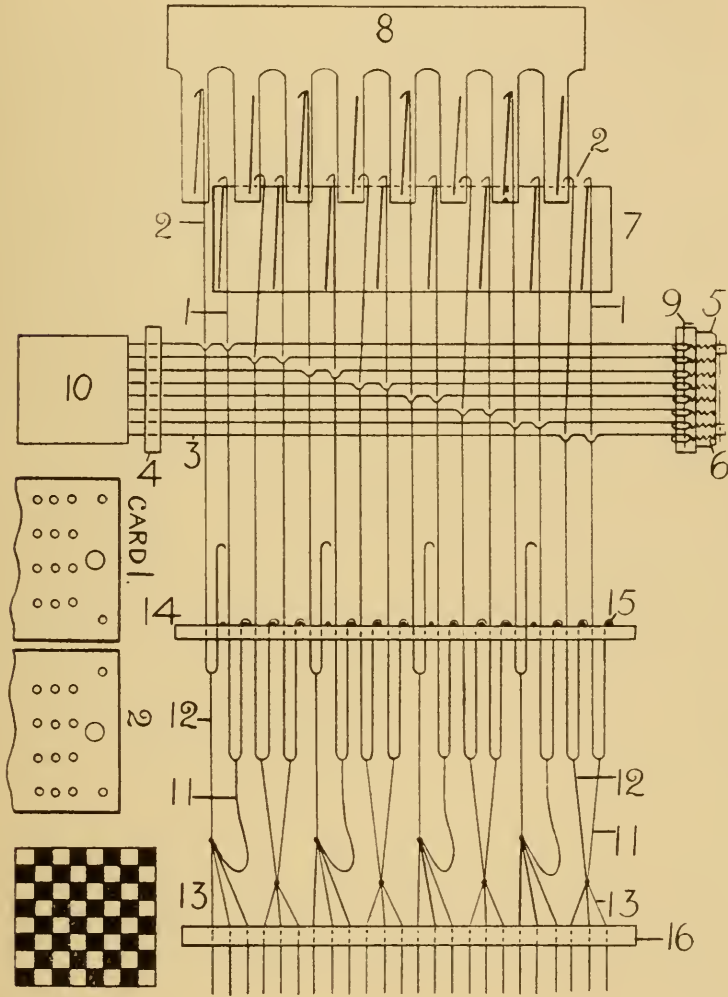


Fig. 76.

Fig. 75.

one row of needles, uprights, tug cords and harness, together with the lifting knives of a '400' machine as seen from the left side of a right hand loom. Altogether the machine contains 51 rows of needles and uprights, each of which is a duplicate of the one illus-

trated in the figure. All Jacquard machines are usually provided with one or two extra rows of uprights for working the selvages, controlling the shuttle boxes, cross-borders and any other specific purpose which may arise when conducting experiments or weaving specialities. There are two sets of uprights, indicated at 1 and 2, and one set of needles, 3; each needle is looped round and controls two uprights.

The needles are shown supported in the needle board 4 and the spring box 5; spiral springs 6, consistently press against the returned ends of the needles in the box 5 so as to keep the uprights normally in a true vertical plane, with their hooks immediately over the two sets of lifting *deep* knives or griffe blades 7 and 8. A fixed vertical pin 9 passes through the loops at the returned ends of the needles for the purpose of limiting their lateral traverse in either direction. The card cylinder is indicated at 10, the neck cords at 11 and 12 looped respectively to the uprights 1 and 2. The cords are fastened *direct* to the same series of harness twines, 13. Sometimes they are secured to a single strong *tug* cord, which acts as an intermediary between the neck cords and the harness twines, which adjunct possesses no apparent advantage. 14 is a grate which serves as a guide for the uprights, which being double near their base are thus prevented from turning on their axis. The grate contains fixed cross bars, 15, which act as resting places for the uprights when in their lowest position, and also determine the limit of their fall; 16 is a guide grate for the harness, technically termed the 'heck.'

Each series of griffe blades, 7 and 8, is supported in an iron frame compounded with two vertical spindles 17 and 18, and their duplicates 17¹ and 18¹, as shown in Fig. 77, which is a side elevation in perspective of the parts variously denominated the 'head,' 'griffe,' and 'brander.'

The spindles 17 and 18 pass through sockets in the fixed bracket 20, through which they are free to slide up or down; iron cross heads 21 and its duplicate, compound the respective pairs of spindles 17, 17¹ and 18, 18¹, see also plan Fig. 79. The spindles 17 and 17¹ are compounded with the top griffe 8 in the position 22, and its

duplicate at the opposite side, whilst 18 and 18¹ are similarly compounded with the bottom griffe 7. This arrangement is common for all double acting Jacquards, whether for single or double cylinder machines.

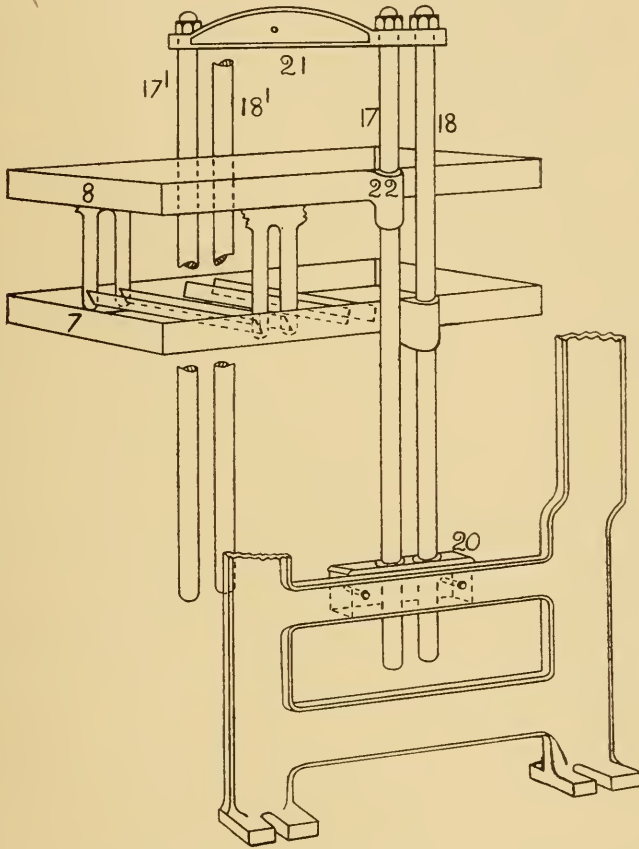


Fig. 77.

**Driving the
'Head Levers,'
ordinary
method.**

Fig. 78 is a front elevation and Fig. 79 a plan, of the common method of communicating the requisite motion to the cross heads and lifting knives. 23 represents the bottom or picking shaft which rotates at half the speed of the crank shaft; 24 is a double throw crank, set screwed or otherwise adjusted to the shaft 23. An adjustable link 25 fits loosely on the outer stud of the double crank. A steel 'steam' rod 26 is welded on to a solid end, threaded and bolted to the link 25. The rod is joined by the stud

27 to a swivel link 28. Stud 29 combines the swivel link 28 to the 'head' lifting lever 30.

Parts 25 to 30 inclusive and 35 are in duplicate.

The head levers 30 and 30¹ are pivoted on the common fulcrum stud pin 31 in the bracket chair 32 which is secured to the top cross rail 33 of the Jacquard machine. The free ends of the lifting levers 30 and 30¹ are connected through the stud 34 to the cross head 21 by swivel links and short connecting rods 35 as shown.

Fig. 78.

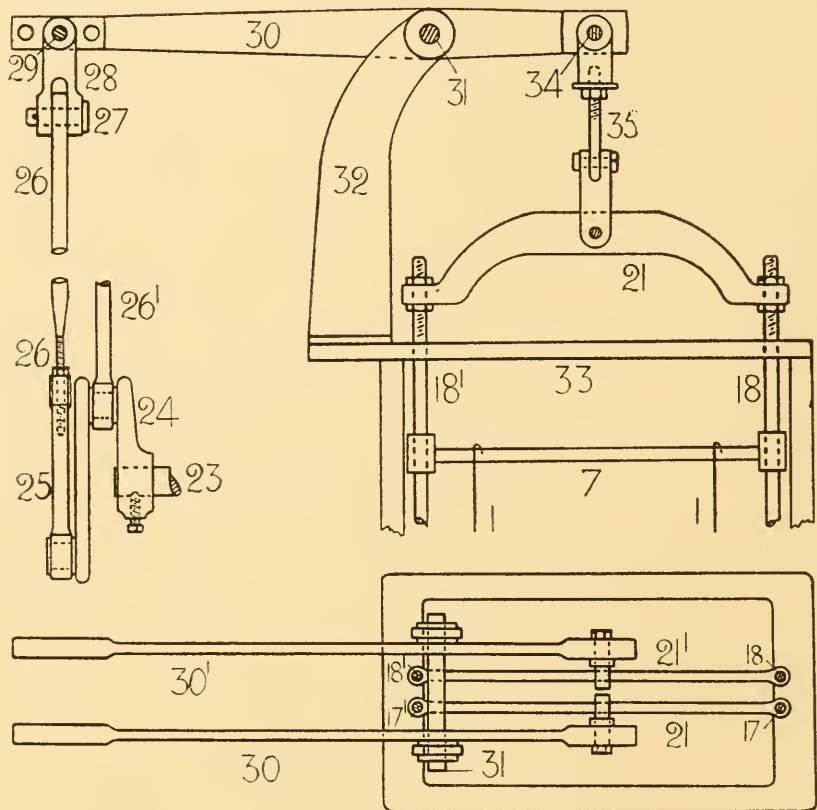


Fig. 79.

**Action of the
Combined
Mechanism.**

The bottom shaft 23 rotates at a constant rate and with it the double crank 24 produces a reciprocating motion in the connecting rods 26 and 26¹ and head levers 30 and 30¹, thus causing the two heads 21 and 21¹ to rise and fall on alternate and opposite picks to each other, by which means the griffe blades 7 and 8 are similarly

reciprocated. Then, if the card cylinder 10 Fig. 75, is pressed with a fully perforated card, against the needles 3, when, for example, the griffe 7 is about to ascend, the whole of its set of hooks (being normally over the blades) will be lifted together with the whole of the harness and warp. For the next pick, the griffe 8 will be at the bottom. Assume the card cylinder with a blank card to be pressed against the needles, the action will cause all the upright hooks 2 to be moved clear of the lifting knives 8. The same action will *tend* to *push off* the uprights 1 from the top blades, but the upright wires are made sufficiently long to permit of a slight bend which counter balances this tendency. The griffe 8 therefore ascends without any hooks whilst the griffe 7 descends with its load of uprights, harness and lingoos, allowing all the warp to fall to the bottom. As in the case with the single lift, any variety of warp sheds may be produced up to the limit of the capacity of the machine by perforating the cards according to the required pattern. In the illustration Fig. 76, the card has been perforated for plain weave and consequently alternate uprights 1 Fig. 75, are shown elevated with griffe 8. The chief defect of the single cylinder is the high speed at which it must run which somewhat neutralises any advantage gained by the double acting Jacquard.

The value of all *independent* driving of the cylinder is apparent when it is considered that it can be timed to strike the needles at any convenient moment with the rising griffe, whereas, when the mechanism is combined with the 'head' such variation in the time of striking is impossible.

Fig. 80 shows the main mechanical features of the single acting card cylinder. A gives the position of the crank or loom shaft. B is a split eccentric secured to the crank shaft A. The periphery of the eccentric B is sunk between two side projections, indicated by the dotted line. An iron collar strap c is adjusted between these side projections on to the periphery of the eccentric which is free to rotate inside the collar and freely reciprocate it, together with the connecting rod D which joins the collar to an adjustable swivel link E and the simple lever F, which is secured to a short shaft G,

**Independent
drive, for
Single Cylinder,
double lift
Jacquard.**

supported and free to oscillate in the bearing of two small brackets or chairs H. These rest upon the fixed gantry I, which carries the

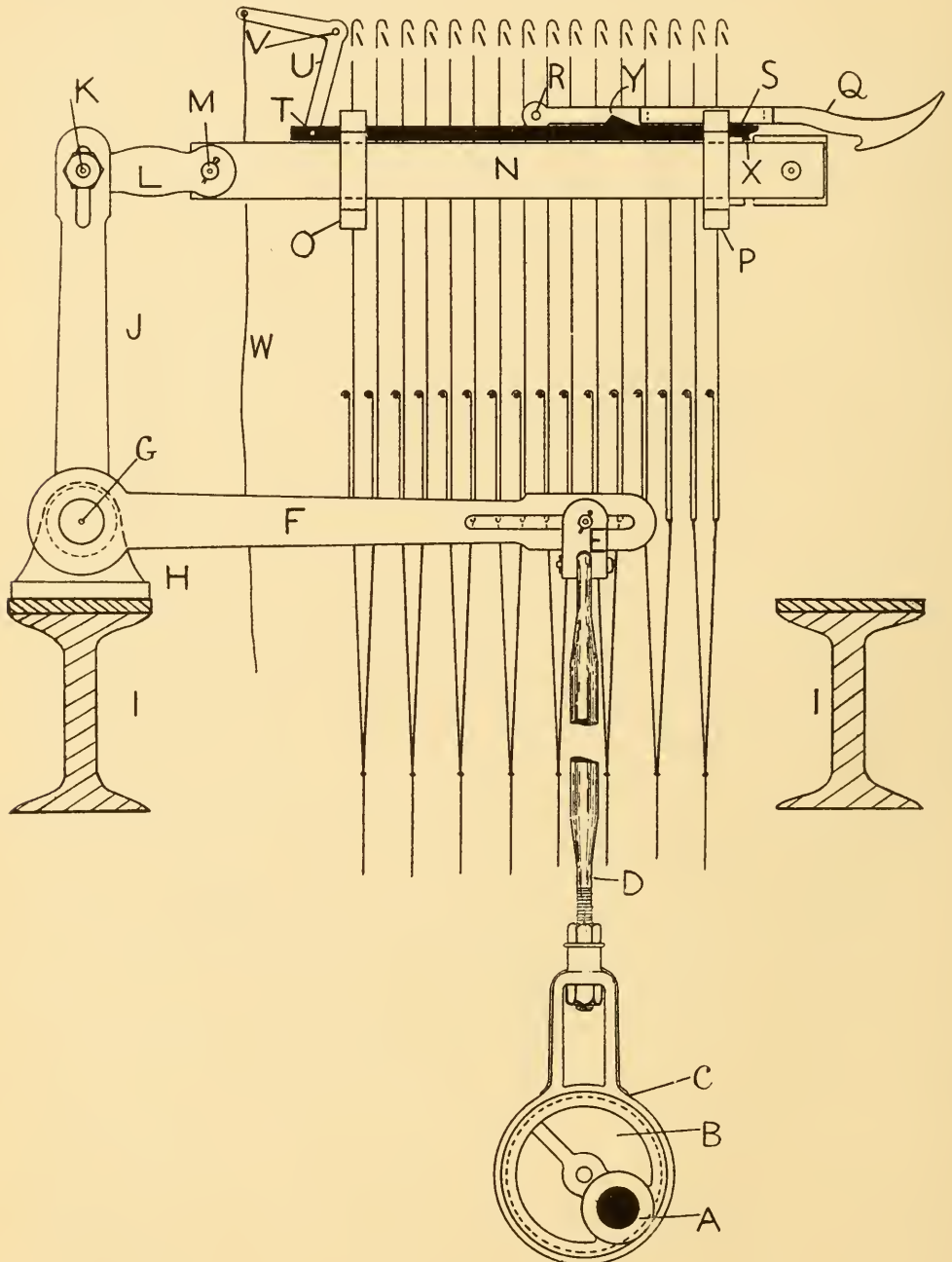


Fig. 80.

Jacquard machines independently of any direct support from the loom. A second lever J is also secured to the shaft G, but at right

angles to the lever *F*. An adjustable stud *K* combines the lever *J* and a short connecting link *L*. A second and loose stud *M* joins the link *L* to the slide bar *N* which supports the card cylinder at the opposite end in the position shown. The slide bar is supported and free to slide between the two brackets *O* and *P*, which form part of the Jacquard fixture. The top catch for rotating the card cylinder is shown at *Q*. It is pivoted on the stud *R* fixed to the machine. A second and 'pushing' catch for reversing the direction of the card cylinder is shown at *S*, one end of which is secured by the stud *T* to the vertical arm of the bell crank lever *U*, pivoted at *V*. A string *W* is suspended from the horizontal arm of the lever *U* to within control of the weaver. The free end of the pushing catch *S* rests loosely over the top of the needle board on the inside of the machine framing. The small hooked projection *X* is directly opposite the top corner of the 'lantern' on the end of the card cylinder. A shoulder *Y*, on the top of the pushing catch *S*, is provided to simultaneously lift the top catch out of action, whenever the catch *S* is made to travel towards the card cylinder for the purpose of reversing its motion. The combined action of the various foregoing parts for turning the card cylinder is as follows:—With the constant rotation of the crank shaft *A*, the eccentric *B* operates to reciprocate the collar strap *C*, lifting lever *F* and oscillating the shaft *G*, which in turn reciprocates the lever *J*, link *L*, slide *N* and the card cylinder. With each outward traverse the last is brought into contact with the hook of the catch *Q* and rotated a quarter of a revolution, thus bringing up the next pattern card. To reverse the motion, the weaver pulls down the cord *W*, reciprocates the bell crank lever *U* and the pushing catch *S* which through *Y* lifts the catch *Q* clear of the cylinder and through the projection *X* rotates the card cylinder clockwise.

**The Bradford
Card Cylinder
Motion with
Escapement
Apparatus.**

This accessory is designed to drive the card cylinder *independently* of the 'head' and it can be rotated *by hand* forwards and backwards, while the loom itself is not in motion. Hence, if it is necessary to turn over any number of cards to find a broken pick or pattern, the operation can be readily accomplished.

If the *loom* were 'turned over' with the rotation of the cylinder for each card, the web would be carried forward out of reach of the forward movement of the 'lay' unless the finger connected with the taking-up catch' were *lifted clear* of the ratchet wheel for each turn of the loom. Therefore with the adoption of the above mechanism, the necessity of letting back the web, drawing the warp back on to the yarn beams and adjusting the reed to the fell of the cloth, is obviated.

This mechanism is used with single or double lift Jacquard machines, but the apparatus reaches the limit of its application where two or more heavy double lift Jacquards are mounted over the same loom, since they involve more labour than can be performed by hand.

Fig. 81 is a side elevation of the main features of the escapement apparatus, and Fig. 82 a sectional elevation of the parts immediately behind those of Fig. 81.

Fig. 83 shows a plan of these combined parts. The same letters in each diagram refer to corresponding details. A is a shaft suitably supported on chair brackets, immediately above the top rail at the back of the loom and behind the Jacquard harness. B is a double or bell crank lever made fast to the shaft A by two set screws c c. One arm of the lever B is straight and below the shaft A; the other arm forms a quadrant and is in a horizontal plane. A second lever D carries a sleeve E which fits loosely on the shaft A. The lever D is provided with two slot holes F and G as shown. An iron slide H is placed into close contact with the face of the lever D and is held in sliding position by means of a bolt and nut I. The shank of the bolt, which is square in section, passes through and just fits the slotted hole F. The slide has also cast with it a small spindle J, which passes through a hole of similar diameter in a bracket projection K cast with the lever D. A small rectangular stud L is cast upon the slide H at the point where the slide and spindle meet. Normally the stud L fits closely into the recess M formed in the centre of the arc circle in the quadrant lever B. Two other studs N and O are also cast on the face of the slide H. A special shaped or 'finger'

lever P is pivoted to the stud pin Q, which passes through the centre of the lower arm of the lever B. The upper arm of the lever P

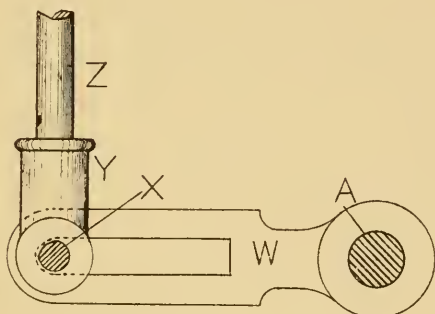


Fig. 82.

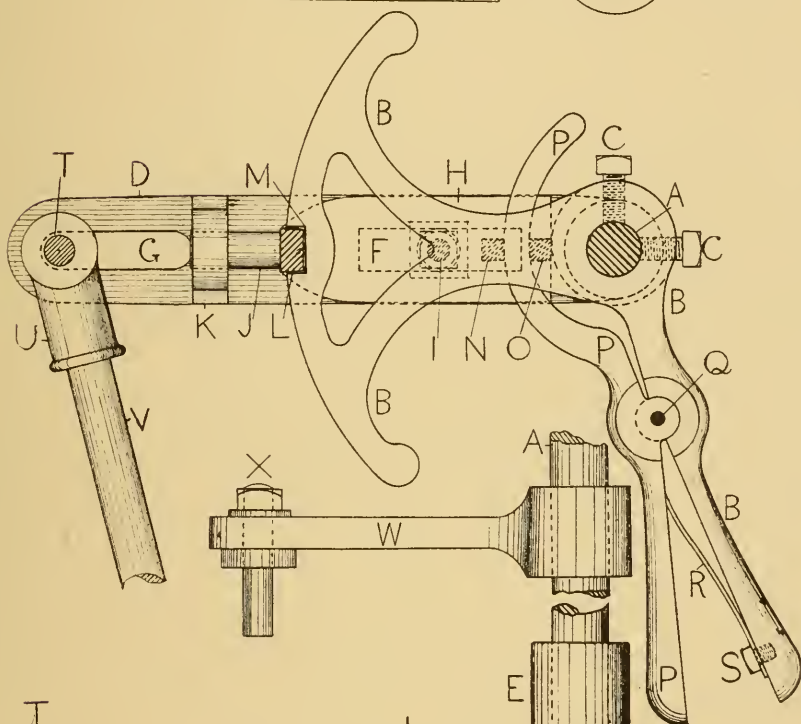


Fig. 81.

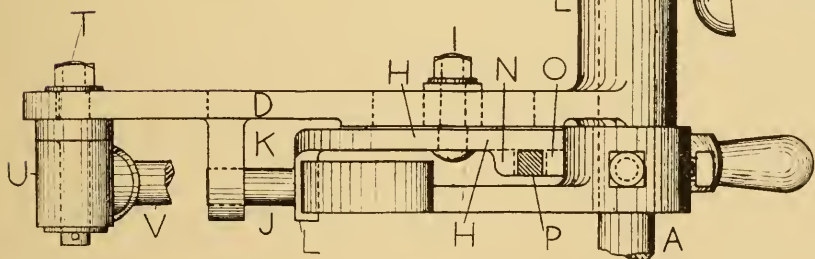


Fig. 83.

which forms an arc of a circle, fits closely but is free to slide between the two studs N and O. A strong steel spring R is set screwed at s

to the lower arm of lever B. The free end of the spring R presses with its maximum energy against the lower arm of the lever P, and thus normally keeps B and P apart. The upper arm of lever P then, turning clockwise, presses against the stud O, and thereby keeps the slide H and its respective parts normally in the position illustrated. Adjusted to the lever D in the slot G is a stud T which supports the sleeve connection U. A connecting rod V joins U to a 'split' eccentric operating from the crank shaft in the loom. Upon the shaft A beyond the lever B is secured a small lever W. A stud X passes through the sleeve Y and joins the latter to the free end of the lever W. A connecting rod Z passes up to the parts which actuate the card cylinder.

Action of the Mechanism.

With the continuous rotation of the crank shaft, the eccentric reciprocates the rod V and lever D with which the slide H is compounded, and since the stud L is also fitting closely into the recess M of the quadrant arm of the lever B, this lever is also reciprocated, and through its medium the shaft A is oscillated, which in turn alternates the lever W, and operates to alternately press, in and out, the card cylinders, on each pick of weft. Suppose now the loom to be stationary and the lower arms of the levers B and P pressed together by the weaver, the arc arm of lever P then operates against the stud N to move the slide H and spindle J to the left, until the stud L cast with the slide, is clear of the recess M and so long as the weaver keeps his grip upon the levers B and P, he can, by reciprocating them in unison oscillate the shaft A independently of the lever D, and so move the card cylinder, in and out at will, turning the cards forward so long as the cylinder catches remain normal; but by pulling down the string W, Fig. 80, attached to the free ends of the catches, the lower catch is elevated into contact with the card cylinder and the cards are reversed with each reciprocation of the levers B and P. Immediately the pressure on B and P is released the steel spring R operates to separate them and bring the stud L into the recess M on the quadrant arm of lever B combined with the correct adjustment of the same.

Double Acting Jacquard—Double Cylinder.

In a machine of this type there are *two* sets of needles, each being actuated by a separate card cylinder and set of cards. One needle of the upper set and one of the lower are attached to an adjoining pair of uprights which are combined by two neck cords to a single tug cord.

Fig. 84.

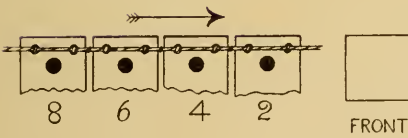
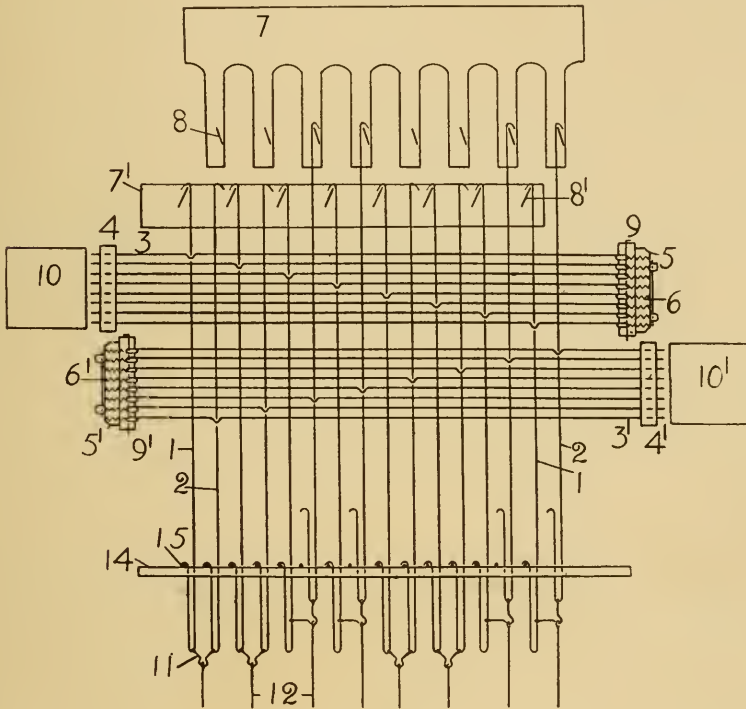


Fig. 86.

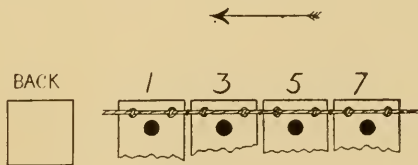


Fig. 85.

Fig. 84 is a side view of one complete row of both sets of uprights together with one row of each set of needles and transverse sections of the two card cylinders, as seen from the right hand side of a right hand loom. The hooks of the two sets of uprights are opposite to each other, for if this plan were not adopted a non-

perforated card would push the hooks on to the griffe blades at the one side and off at the opposite.

The chief details of the mechanism are indicated as follows:— 1 and 2 are the uprights, 3 the upper set of needles, 4 the needle-board, 5 the spring box, 6 the springs, 7 the griffe, 9 the needle stop pin and 10 the card cylinder for operating the uprights 1. Duplicates of these details to operate the uprights 2 are indicated from 3¹ to 10¹ respectively. A link 11 is employed instead of the double neck as in Fig. 75. Combined with the link 11 is a stout tug cord 12 to which all the harness twines 13 are knotted. 14 is the hook guide grate, 15 the resting bars.

The arrangement enables the pattern cards to operate upon the correct hooks from either side of the machine. Half the cards—all the odd numbers—are laced together for the bottom cylinder; the remainder—all the even numbers, are laced for the top cylinder. The odd numbered cards are laced forwards as at Fig. 85 and are usually arranged to work at the back of the loom. The even numbered are laced backwards and work at the front of the loom as at Fig. 86.

**Driving the two
Card Cylinders.**

Fig. 87 shows the essential details and the arrangement for operating the two card cylinders. Fig. 88 shows the left card cylinder and its details on an enlarged scale. A indicates the reciprocating rod, worked from the eccentric rotating on the bottom shaft in the loom. B is a lever connected to A and fulcrumed to the shaft C which is supported in brackets and free to oscillate near to the foot of the Jacquard. D is a second lever, set screwed to the shaft C. The free arm of D is adjusted to the stud E, fixed in one end of the connecting and reciprocating link rod F which is attached to the stud G, firmly fixed in the cylinder slide H. This slide is supported and free to move laterally in the two slide brackets I, I¹, affixed to the Jacquard framework L. At opposite ends of the slide bar H, brackets J, J¹, are securely fixed. Supported and free to rotate between the bracket J¹ and its complement at the opposite side of the machine, is the bottom card cylinder K¹. The top card cylinder K is similarly

supported and free to rotate between the bracket J and its complement. The hammers M and spiral springs N prevent the card cylinder rotating too far during action.

With the constant rotation of the bottom shaft the reciprocating rod A acts through the lever B, oscillating shaft C, lever D and link F to alternate the slide bar H supporting the brackets J and J' and the card cylinders K and K' and brings them alternately into striking contact with each respective set of needles.

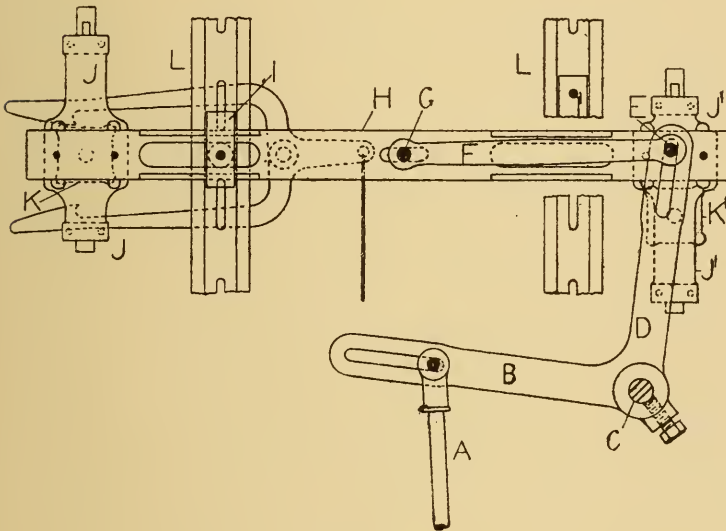


Fig. 87.

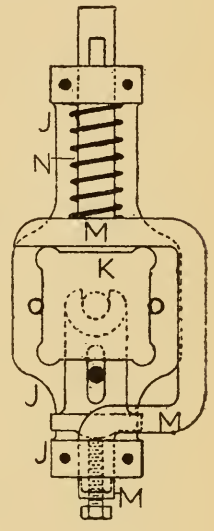


Fig. 88.

The chief advantages of this system as compared with the single cylinder are:—An increase of time is afforded for the rotation of the two card cylinders since they are required to strike only on alternate picks, which makes it possible to run the loom at a relatively higher speed. This is the principal advantage, since it involves fewer repairs and ensures a longer life to the Jacquard details and its connections. There is also less vibration among the uprights because the card cylinders only strike against the needles when the bottom knives are clear of the bottom hooks. The drag upon the pattern cards is reduced, especially where large sets are necessary and the working, generally, of the machine is easier.

The foregoing advantages will be seen to far outweigh the disadvantages of this system, the chief of which are:—The two sets of cards frequently get out of their consecutive order which increases the difficulty in finding a broken pick, or adjusting correctly both sets of cards after the pattern has been broken. Originally the uprights, for the top set of knives, were made longer than those for the bottom, but this plan interfered with repair work among the hooks, hence, they are now all made of uniform length.

The upright wires are necessarily longer than in a *single lift machine*, but the length is virtually no greater than for *one cylinder in the double lift machine*.

Devoge's 'Swivel Slide' Double Cylinder Motion. The chief feature of this arrangement is the ready adjustment of the card cylinders in the vertical and horizontal planes. Fig. 89 is an elevation in perspective of the mechanism. A is the slide shaft, freely supported in the adjustable swivel bearings B and C by the four set screws and sleeves as shown. The bracket bearings are bolted fast to the machine gable D. The brackets E and F securely fastened to opposite ends of the slide shaft A support the card cylinders G and H respectively. The reciprocating motion of A is obtained from an eccentric on the crankshaft operating through the usual links, rocking shaft and bell crank levers combined with shaft A.

Automatic Stop Motion for Double Cylinder Jacquards. One of the chief and inherent difficulties of the two cylinder system is the liability of a card to be presented to the needles out of its proper sequence. Various devices have been invented to overcome this defect and immediately detect any irregularity of order in the pattern cards. Fig. 90 is an elevation of Devoge's effective 'Jacquard Stop Motion,' as applied to and viewed from, the right hand side of a double acting double cylinder Jacquard, mounted over a right hand loom, as illustrated at Fig. 84. The mechanical parts are few and the action is simple. A and B are two special hooks added to the '25' row side. A is linked with needle H in the

second row of the top set of needles, under control of the front card cylinder. B is linked with the needle I in the second row from the bottom of the lower set of needles. A spiral spring c circumscribes this needle and exercises its influence to press the hook B *clear* of the griffe knife and to keep the end of the needle normally out of contact with the card cylinder. The hook A is normally *over* the griffe knife. A bell crank lever D made of strong wire is pivoted at E in the fixed bracket F. The horizontal arm of this lever passes through a loop w formed in the upright A and the vertical arm passes through a loop y formed in the needle I. A heavy lingoe J is suspended from the upright A to keep it normal. A cord K combines the upright B with the weft fork lever L. The remaining details are the same as the parts illustrated in Fig. 84.

The odd numbered cards rotate over the bottom and back cylinder, and the even, over the top and front cylinder.

The principle of the mechanism is as follows:—A *blank* in the card opposite needle H pushes the hook A clear of the griffe knife and no action results. A *perforation* in the card opposite needle H permits the rising griffe to lift the hook A which in turn raises the horizontal arm of lever D and moves the upper arm with the needle I to the right, until the end of it projects slightly through the needle board. 314263

A perforation in the next card presented to the same needle I permits the elevation of 'stopper' hook B, cord K and weft lever L which last operates through the weft fork to release the starting handle and automatically stop the loom in the usual manner. If however, a blank card is presented to the needle I it will press the hook B clear of the lifting knife and thus neutralise the action of the hook A. Briefly then, a perforation in an 'even' card opposite needle H followed by a perforation in an 'odd' card opposite needle I stops the loom, but followed by a blank, the loom continues to run.

It is therefore essential to design some order of stamping the cards which will *primarily* not interfere with the constant motion of the loom so long as the pattern cards are in the correct sequence, but immediately this sequence is broken, the order of stamping

Fig. 89.

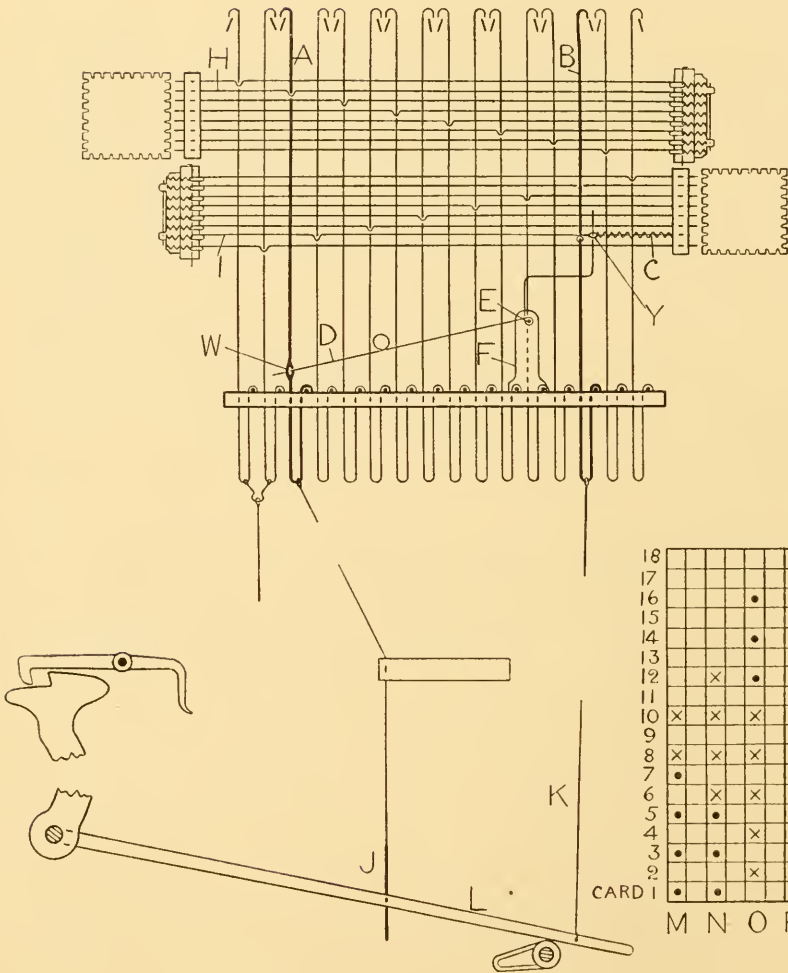
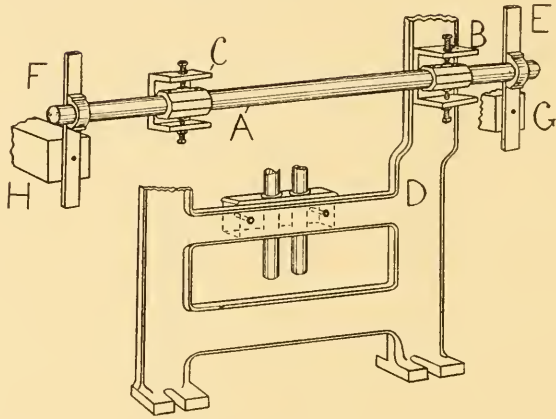


Fig. 90.

CARD 1

18				
17				
16				
15				
14				
13				
12				
11				
10	X	X	X	
9				
8	X	X	X	X
7				
6		X	X	X
5				
4			X	X
3				
2			X	X
1				
	M	N	O	P

Fig. 91.

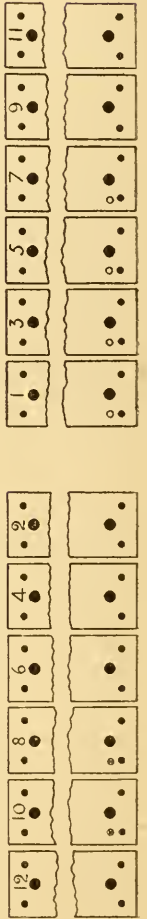




Fig. 92.

should be such that a perforation opposite needle H in any of the even cards is followed by a perforation opposite the needle I in any of the odd cards, so that the hook B is lifted and the loom is brought to a standstill.

The scheme of punching or stamping the cards must be on any number of picks which is a measure of the complete number of cards in the figure pattern. Fig. 91 supplies four such examples M N O P containing 12, 14, 16 and 18 cards respectively to the repeat—1008 cards. The marks  represent perforations in the odd cards to act opposite needle I, and  perforations in the even cards to act opposite needle H.

The 12 pattern cards for design M are shown stamped at Fig. 92 from which it will be perceived that so long as they maintain their regular sequence, this order of stamping will not interfere with the motion of the loom.

The hook A is only lifted on the even picks 8 and 10 which are followed by the blank cards 9 and 11 respectively, but if the order is broken so that any of the perforated cards, 1, 3, 5 or 7 succeeds either of the cards 8 or 9, the hook B will immediately follow the rising lead of A until it operates through the details described to immediately arrest the loom.

Double Neck Cords and Link Motion.—A Comparison.

Double Neck Cords. Fig. 93 illustrates the original style with *two* neck cords in the position where both uprights are level; they pass each other in the centre of the shed. A A¹ are the uprights, B the resting board for the uprights when in their lowest position, c c¹ the neck cords, and D the group of harness twines controlled by either of the uprights A or A¹, or the neck cords c or c¹.

Fig. 94 illustrates the same details when the upright A¹ is lifted to its highest altitude, and when its companion A is at the bottom. It will thus be seen that while the neck cord c¹, looped to the lifted upright A¹, is under tension and supporting all the weight of the group of harness twines to which it is connected, its duplicate neck

cord *c* hangs 'slack' as shown. In a full machine, especially where the figuring capacity is large the slack neck cords constitute the chief defect. The sudden pull on the cords after hanging slack, tends to cause very frequent breakages and to generally shorten their life, and further, if any of the neck cords break, they are somewhat difficult to repair and correctly adjust.

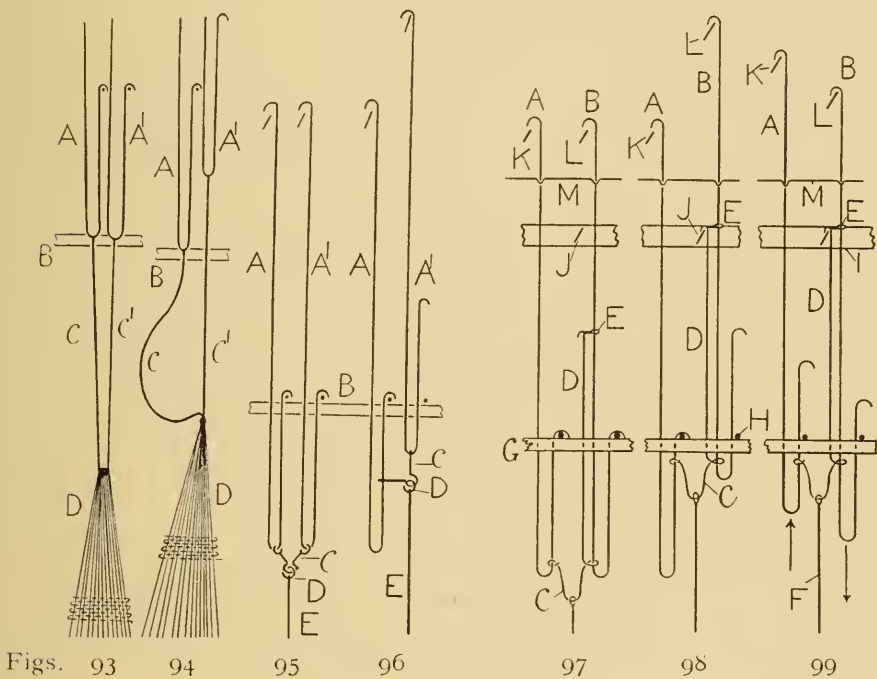
**Link
Motion.**

Fig. 95 completely represents the details and principle of the '*link*' motion, introduced in the year 1890 by Hancock, Rennie and Hudson. *A*, *A*¹ are the two uprights, and *B* is the resting plate combined with horizontal iron rods for supporting the uprights when in their lowest position. *c* is a double link which combines the uprights *A*, *A*¹ and constitutes the special feature of the invention. *D* is a single link which combines the special double link *c* with the tug cord *E*.

Fig. 96 illustrates corresponding details but shows the upright *A*¹ lifted; one arm of the double link *c* is suspended from the bottom of the raised upright *A*¹ and rises with it, but the opposite arm of link *c* slides freely up the short shank of the upright *A* which remains down; the tug cord *E* together with the harness twines and warp threads simultaneously ascend with the double link *c*. If the requirements of the pattern determine that this same group of warp threads must be lifted on the next pick of weft, the upright *A* will gradually ascend until it meets the upright *A*¹, half way, and continuing its traverse carry upwards the link *c* and its load to the top again, whilst the upright *A*¹ continues its descent to the bottom. Of course where no warp threads are required to be lifted on any given pick, both uprights remain down. The effect of this action upon the warp is less sudden and severe than that of the double neck system.

From a mechanical point of view this invention works very well whenever the pull of the harness on the links is almost perpendicular as in narrow looms, but when weaving wide fabrics, the angular pull on the links, especially from the harness nearest the sides of the Jacquard machine, is very great. The amount of friction thus generated neutralises the tendency of the links to freely

slide up or down their respective short shanks of the uprights A or A'. This difficulty is to a certain extent overcome by using the *link motion* only for the *central* parts of the machine and *double necks* at the *sides*. A better method has recently been adopted by Devoge and Co. by which the tug cords are made to pass freely through a 'cord' board before they are attached to the harness twines, which ensures that the links rise and fall in a vertical plane, and reduces to a minimum any tendency to stick during their action.



The adoption of the link motion necessarily generates a certain amount of friction and increases the wear and tear by the sliding action of the links over the surface of the uprights, but nevertheless its introduction marks a step forward in Jacquard mechanism.

**'Open Shed'
Jacquard with
Link
Attachment.**

A perfect open shed Jacquard machine is a desideratum. Numerous attempts have been made to attain this object. The following illustration from Dracup's machine is one of them. This invention produces an open shed after the double lift dobby principle. The top shed only falls slightly on every pick

to allow sufficient clearance for the hooks to be pressed clear of the knives when desired.

Fig. 97 shows two uprights A and B in their lowest positions, combined with the modified link attachment c. The special feature of this link is an extended shank D with a hook at the top and a loop E. The loop is linked to and free to slide up or down the shank of upright B. The tug cord is shown at F, the hook resting board at G with the usual cross bars at H. The board G contains *five* perforations, instead of the usual four, for each pair of uprights. An additional fixed board I contains a series of steel knives J on which the hook of shank D may be placed and continue holding up link c and tug cord F for as many picks of weft as the pattern requires. The bottom griffe and knives are shown at K, the top griffe and knives at L, and the needles at M.

Fig. 98 shows the same details but hook B lifted to the top and the hook of D immediately over knife J.

In Fig. 99 the hook B is descending; the hook of D is retained on the knife J; the hook A is rising to carry the link c up to its highest point and to permit the hook of D to be pressed clear of the knife J in sympathy with hook B of the knife L if the warp thread for the next pick is required to be down.

Springless Jacquards.

Hardaker's. This type of machine is designed to work with two card cylinders but only one row of needles, each of which controls two uprights. By this method a shorter length of upright is required and thus a saving of space is effected at the top of the loom; an ordinary *single* cylinder machine can be readily converted into a *double* cylinder; one row of needles is only required.

Fig. 100 illustrates the essential features of this principle of mechanism. A indicates the position of the uprights, arranged in pairs with their hooks facing each other and normally over the knife blades. B is the resting board. c and c¹ the griffe knives. D is a series of round rods, in pairs, one on each side of an upright;

these serve as a fulcrum against which the respective uprights can press and so be induced to assume their normal upright position after having been subjected to pressure by their controlling needles. They are easily detachable whenever it becomes necessary to remove the uprights for repairs, etc. The needles are shown at

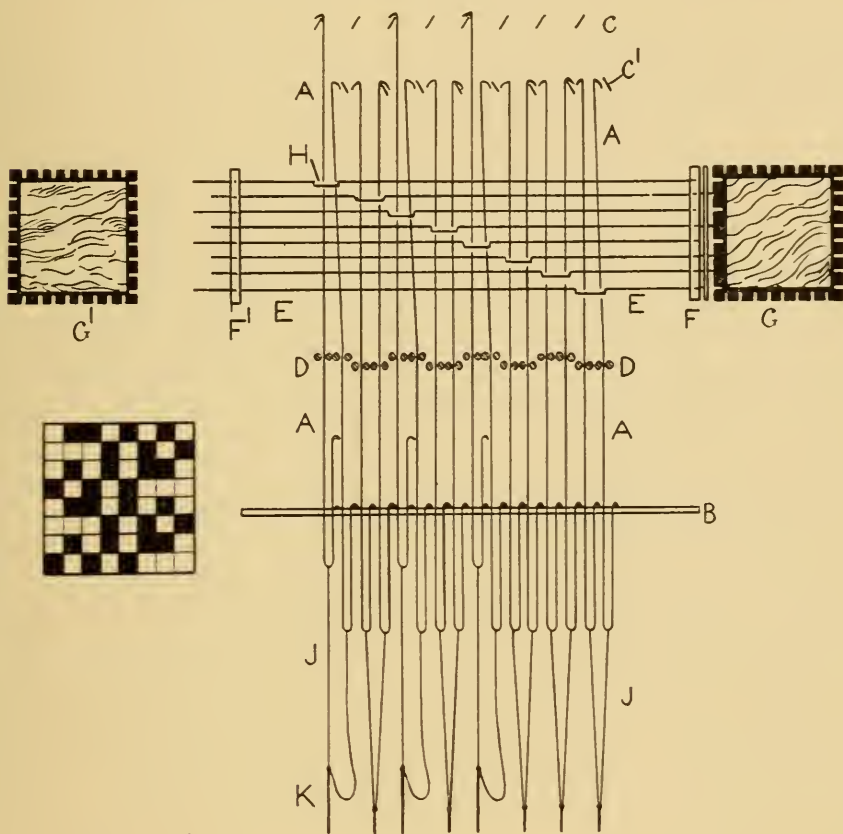


Fig. 101.

Fig. 100.

E, the needle boards at F, F¹, the card cylinders at G, G¹, the neck cords at J, and the tug cords at K. A crank H is formed in each needle of sufficient length to just enclose two uprights.

In the given illustration, to coincide with the first pick of pattern Fig. 101, griffe c is shown raised, with uprights 1, 3 and 5 left over the knives by the last pattern card. Cylinder G has just struck against the needles for the next shot. This card has left, in their normal position, uprights 2, 4, 6 and 7 to be lifted by the griffe blades immediately they commence to rise. The remaining

uprights 1, 3, 5 and 8 are shown pressed by the right shoulders of the corresponding needles *clear* of the griffe blades. In a similar manner the operation is repeated according to pattern for the whole design and length required.

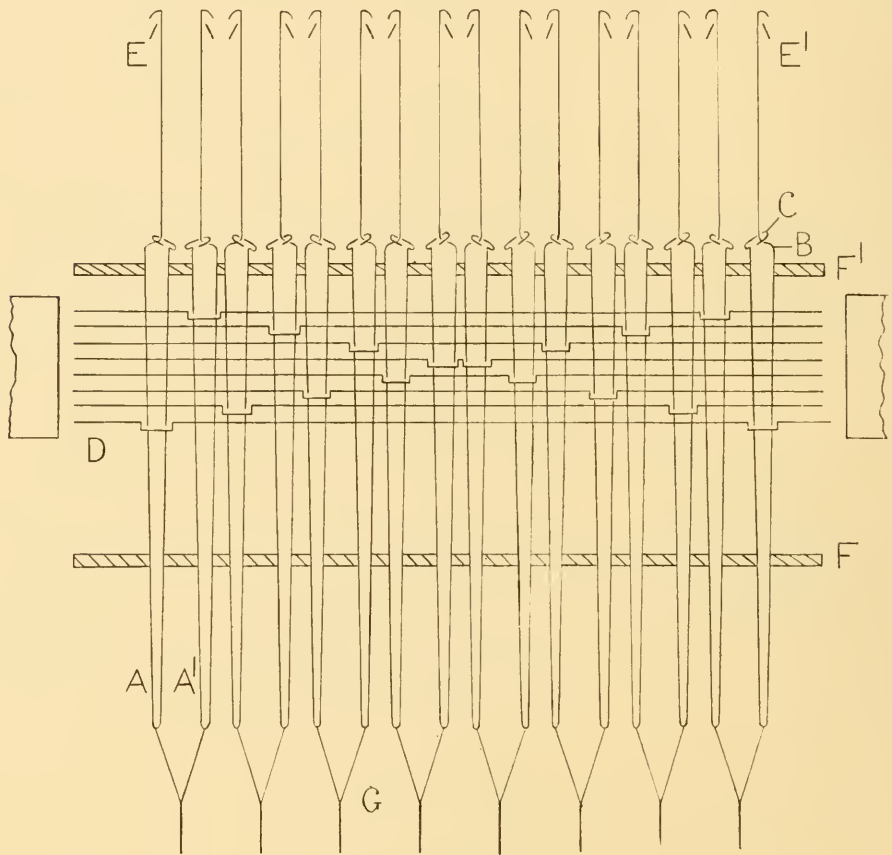


Fig. 102.

Wadsworth's Fig. 102 shows the main features and chief points of difference in this machine as compared with the former. The uprights A, A¹ are of special construction. A crank is formed at B in the long shank of A and a loop at the top of the short crank at C; through this loop the long shank passes. The cross wires or needles are shown at D, in each of which is a crank of sufficient length to just contain one pair of uprights A, A¹. E, E¹ are the two sets of knives. F, F¹ are fixed grid plates which serve as supports and act as fulcrums for the uprights, when subjected to lateral pressure by the needles. Immediately this pressure is

released the long shank assumes its normal upright position. The loop *c* regulates the extent of the lateral traverse so that the hook of each upright is just over its respective griffe knife. The neck cords connecting the same tug cords are shown at *g*.

Varieties of Jacquard Driving.

Cam Driven Jacquards.

Many reasons and advantages can be advanced in favour of using *cams* for operating the draw rods and reciprocating the 'head' levers of both single and double lift Jacquard machines. The system imparts a straight lift, and generates the minimum of friction combined with a uniform movement in the various parts of the actuating mechanism. The cam or cams can be constructed to produce any *variety* of motion and period of 'dwell' in the head levers and shed, and may be effectively employed where a steady movement among the warp threads is essential during the period of shedding and where the nature of the yarn and structure of the material preclude high speeds, as in figured leno weaving of the gauze reed and leno Jacquard types. This principle is most useful with pressure harness, double cloths, Brussels and Wilton Jacquards (see also *Carpet Manufacture*, pages 92 and 130) and similar arrangements where the head is required to *dwell* up for two or more shots of weft.

The principle details of the mechanism for producing the necessary movement in the draw rods for a double acting Jacquard machine are illustrated at Figs. 103 and 104. The former is an end and the latter a side elevation; the same letters in each, refer to similar details. *A* indicates the position of the crank shaft; *B* the low shaft running at half the speed of *A*; *C* is a cast iron support for the driving apparatus. The remaining details are chiefly in duplicate. The function of both drawing rods is consequently the same, but they operate alternately. Set screwed to the low shaft *B* are two cams or tappets *D*, *D*¹, adjusted diametrically opposite to each other. *E*, *E*¹ are two cam slides connected through the adjustable links *F*, *F*¹ to the draw rods *G*, *G*¹ respectively. *I*, *I*¹ are antifriction rollers between which the slides *E*, *E*¹ can reciprocate. Mounted and free to rotate upon studs secured to the cam slide plates *E*, *E*¹ are anti-

friction rollers J, J^1 below the cams D, D^1 and similar rollers k, k^1 above the cams respectively. The cams are kept in rolling contact with their respective top or bottom antifriction rollers.

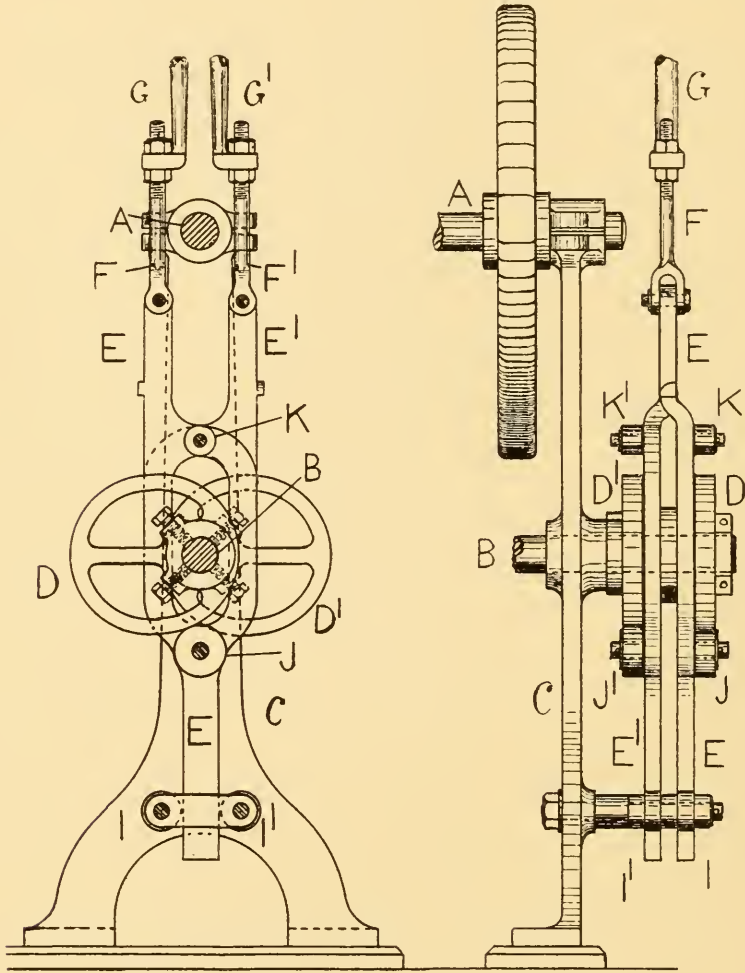


Fig. 103.

Fig. 104.

**Action of
the
Mechanism.**

The reciprocation of the draw rods G, G^1 is as follows:--With the constant rotation of the low shaft B , the cam D rotating counter clockwise, presses upon the roller J to depress the cam slide, the link F and the draw rod G to produce the upper division of the warp threads constituting the shed. Simultaneously, but conversely, the cam D^1 also rotating counter clockwise gradually releases

its pressure upon roller J^1 and approaches roller K^1 until when in rolling contact it assists in checking the falling shed, acting almost with a positive controlling force for this purpose. For the next half rotation of the shaft B the two cams D and D^1 continuing their rotation produce exactly, but conversely, the same operation.

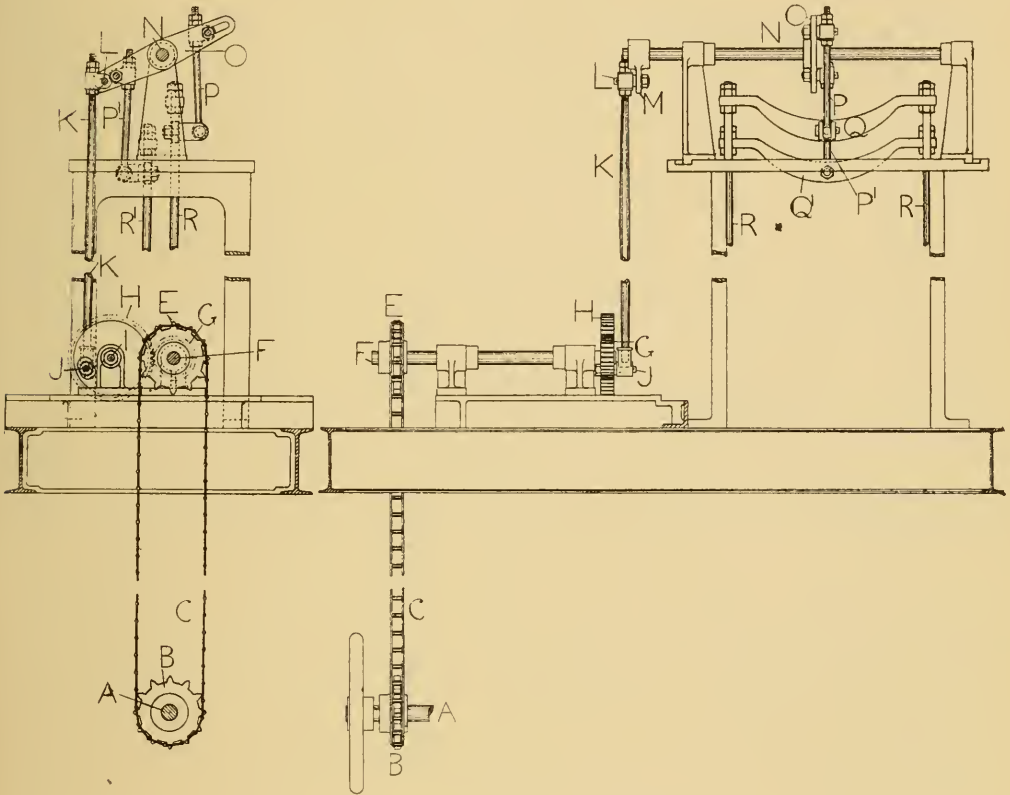


Fig. 105.

Fig. 106.

Chain Driving Motion.

This system is designed to produce a steady drive in the reciprocating parts of the head and to economise room by obviating the use of the ordinary *long* head levers.

Figs. 105 and 106 are sketches made from Hardaker's machine. The former shows an end elevation and the latter a front elevation of the operating details. The same letters in each diagram refer to corresponding parts.

A is a portion of the crank shaft, supported in the loom framing. B is a chain wheel secured to the crank shaft in the

position indicated. *c* is a link chain of the bicycle type. The chain passes upwards and over a second sprocket or chain pulley *E* secured to the shaft *F* which is mounted and free to rotate in bracket supports at the top of the Jacquard gantries as shown in the front elevation, Fig. 106. Compounded with the chain shaft *F* is a spur wheel *G* which gears into and drives a second spur wheel *H* containing double the number of teeth of *G* and, therefore, revolving at half the speed and being centred and free to rotate upon the fixed stud *I*. A pin stud *J* passes through one of the arms of the wheel *H* and rotates with it. A reciprocating and connecting rod *K* joins the stud *J* with a second stud *L* fixed in the simple lever *M* centred and free to oscillate on the shaft *N* to which a rocking lever *O* is connected. The link *P* connects lever *O* to the cross head *Q*, Fig. 106, with which is compounded the spindles *R*, in turn fixed to the griffe and knives. Duplicates of *P*, *Q*, *R* attached to the second griffe and set of knives are shown at *P*¹, *Q*¹, *R*¹.

Action of the Mechanism. With the constant rotation of the crank shaft, the sprocket chain wheel *B* and chain *c* rotate in sympathy and at the same rate as the driven chain wheel *E* and driving spur *G*, which in turn rotates the spur wheel *H* once every two shots of weft. The rotation of the stud *J* affixed in *H*, reciprocates in sympathy the rod *K* and lever *L* and oscillates the shaft *N*. The oscillation of this shaft elevates and depresses, through the medium of parts *O*, *P*, *Q*, *R* and the duplicates *P*¹, *Q*¹, *R*¹, the two griffes with their respective sets of knives on the required alternate shots of weft.

Compound Driving of Two Double Lift Jacquards.

Whenever it is found necessary to combine two or more machines to work together over the same loom it is of vital importance that they should be operated from the same source so that both heads rise and fall exactly in unison.

Oscillating Pulley. Fig. 107 shows Devoge's application of a pulley combined with a rocking shaft for alternately lifting the Jacquard heads in a double lift machine. *A*, *A*¹ are sections through the two cross heads. *B*, *B*¹ are loose bolts

which combine the heads with swivel links c and c^1 . Bolts D and D^1 combine respectively the leather straps or steel chains E and E^1 which are fastened to the periphery of the pulley F at G . This pulley is fixed on the square section H of bar I which is suitably supported and free to oscillate in fixed bearings. On the top of the Jacquard a simple lever J , set screwed to the bar I , is combined with bolt K to the reciprocating rod L which receives its vibratory motion direct from the bottom shaft. The lever J in turn oscillates the rod I and pulley F through which the two heads of the machine are alternately elevated and depressed.

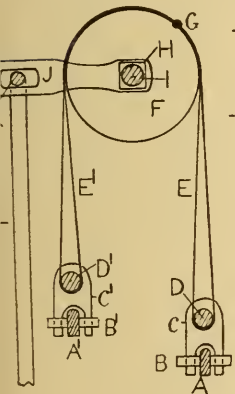


Fig. 107.

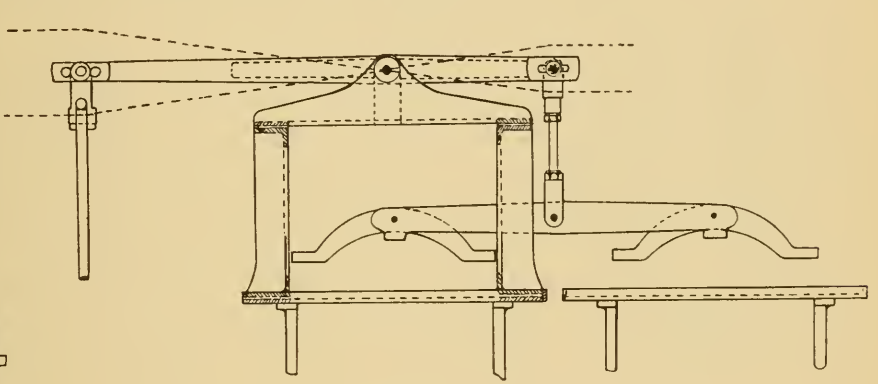


Fig. 108.

In some instances the two Jacquard heads are simply combined by a cross bar, and this is then lifted from the centre with the two heads suspended—one at either end, Fig. 108. This arrangement is not very satisfactory. A compounding of levers on one of the following methods is preferable.

Two Lever Principle.

Fig. 109 shows, in elevation, a front view of the head levers with their respective 'heads' for driving two 600 double lift machines. Fig. 110 is an end view of one of the two reciprocating rods which connect the head levers with the eccentric on the low shaft, and Fig. 111 is a plan of the essential parts and connections given in Fig. 109.

The same letters in each diagram refer to similar parts. A and A^1 represent the two head levers. B is a stud pin which serves as the common fulcrum for both lifting levers. The stud pin and the levers are supported in the bracket c fixed to the top of the Jacquard framing. A stud D is adjusted and bolted in the slot as shown,

midway between the fulcrum pin B and the right arm of lever A. This stud supports a link E and a short rod F. A short stud G joins the rod F to the swivel link H which is free to oscillate to the right or left and forwards or backwards. A third stud I at right angles to G joins the swivel link H to the cross head J, to which last, the spindles and griffe bars are attached. Adjusted near the end of the right arm of lever A, are a stud K, link L, rod M and stud N which, in turn, is adjusted to the free end of the lever O, pivoted on the fulcrum pin P in the bracket chair Q fixed to the top of the Jacquard machine as shown. In lever O, the stud R, link S, rod T, stud U, swivel V, stud W, and cross head X correspond and respectively agree with the details D, E, F, G, H, I, J, in the lever A.

Duplicates of parts shown from A¹ to W¹ refer to similar details which are connected with the back or second griffe of each Jacquard machine. It should be observed that the head lever A belongs to the first order and the head lever O to the second order of levers.

**Action of
the
Mechanism.**

With the constant operation of the low shaft in the loom or its substitute, for reciprocating the driving rods already described, the head levers A and A¹ alternately rise and fall on opposite shots of weft. Then, with the depression of the left arm of A, the right arm ascends carrying with it the free arm of lever O, which, through its connections previously detailed, elevate simultaneously the heads J and X. The reverse motion is produced by the *rising* of the left arm of lever A. The operation of the second griffe for each machine is exactly the same in principle, but the mechanism is adjusted so that the first griffe is at the top when the second is at the bottom and vice versa. The descending griffe assists the elevation of the rising griffe and thereby acts as a counterpoise.

**Problems on
Uniform Depth
of Shed with
Two or more
Machines.**

It is of first importance that the two heads J and X should be lifted exactly the same height, and start from the same level. This involves that the centres of the connections in the given levers A and O, Fig. 109, should be adjusted exactly.

The dimensions for the given parts are as follows:—The throw of the crank eccentric, reciprocating the rods

and connecting the crank with the levers A and A' is $9\frac{1}{4}$ inches; consequently the traverse of lever A at the centre of its connection with the reciprocating rods is also $9\frac{1}{4}$ inches. The distance between the fulcrum B and the lifting stud in the left arm of lever A = $23\frac{1}{2}$ inches. Between the centres of B and K, where K connects lever O in N = $23\frac{1}{2}$ inches, therefore, the traverse of lever O at the point N

Fig. 110.

Fig. 109.

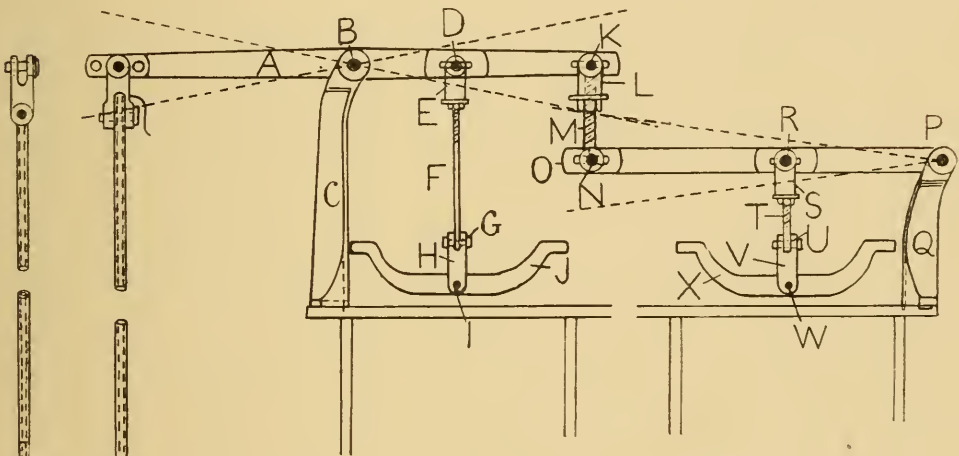


Fig. 111.

is also $9\frac{1}{4}$ inches. The distance between the centres of B and D in lever A = $10\frac{1}{8}$ inches, the distance of K and P or N and P in lever O = $33\frac{1}{2}$ inches, and that of R and P = $14\frac{3}{8}$ inches.

Then the traverse of the head in No. 1 machine equals the amount of reciprocation imparted to the lever A at the point D

$$= \frac{9\frac{1}{4}'' \times B D}{A B} = \frac{9\frac{1}{4}'' \times 10\frac{1}{8}''}{23\frac{1}{2}''} = 4 \text{ inches.}$$

and in No. 2 machine the traverse of the head equals the amount of reciprocation imparted to the lever *o* at the point *r*.

$$= \frac{9\frac{1}{4}'' \times R P}{N P} = \frac{9\frac{1}{4}'' \times 14\frac{3}{8}''}{33\frac{1}{2}''} = 4 \text{ inches.}$$

Slight adjustments can be made to equalise the lifts if necessary.

**Bradbury's
Direct Lever
Counterpoise.**

This method differs somewhat from the former in respect to its simpler mechanical details and the relatively smaller number of parts employed.

With the ordinary and former method each head lever has necessarily to lift *one* head in *each* machine; the counterpoise acts through the two opposite Jacquard heads, lever and double crank.

In the following design the *counterpoise* acts *directly* through each head lever, each of which is simultaneously an elevator and a depressor.

The result of this modification is a reduction in friction and a maximum saving of power equal to about 25%.

Fig. 112 is a front elevation of the working details of this mechanism. Fig. 113 is a plan of the same details. The same letters in each refer to similar parts. *A* indicates the reciprocating rod which joins the double eccentric on the bottom shaft to the intermediate rocking lever *E*. A stud pin *B* connects the rod *A* to the swivel link *C* which, in turn, is attached by a stud *D* to the left arm of the rocking lever *E*, pivoted on the stud *F* in the fixed bracket. This is, in turn, bolted fast as shown to the underside of the steel beam which forms part of the building structure. This arrangement produces a direct pull on the head levers and considerably reduces the amount of friction generated, whenever the horizontal distance, from the crank eccentric to a plumb line dropped from the point of contact with the head levers, is great.

G is a stud connecting the lever *E* to the reciprocating rod *H* which is adjusted into the link *I*, pivoted to the stud *J* in the head lever *K* fulcrumed on the stud *L* in the bracket fixed to the top of the two Jacquards as shown. The free end of lever *K* is connected

with the bottom griffe of No. 2 machine on the principle of the *first* order of levers. An adjustable stud *m* connects and supports a link *n* to the lever *κ*. A short, threaded bolt *o* screwed into *n* supports the stud *p* and the swivel link *q*, in turn, joined by the stud *r* to the cross head *s*.

Fig. 112.

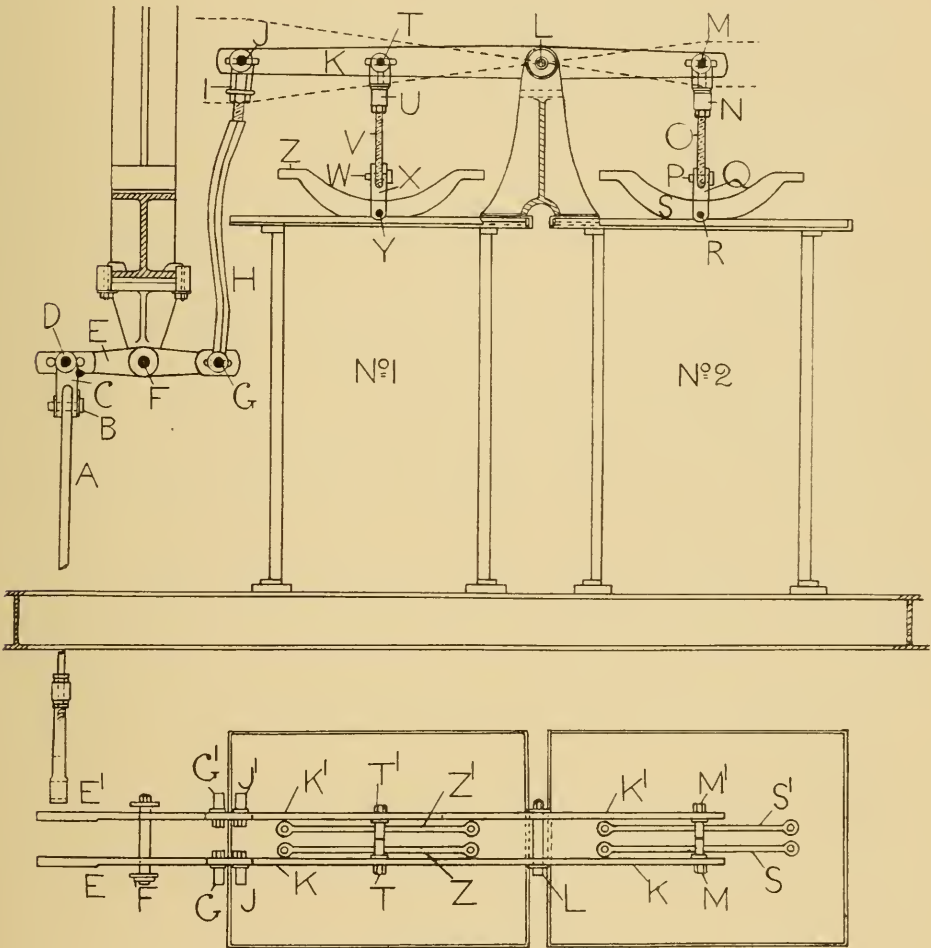


Fig. 113.

The top griffe of No. 1 machine is similarly connected to the head lever *κ*, acting at this point as a lever of the *second* order, through the stud *τ*, swivel link *u*, bolt *v*, stud *w*, swivel link *x*, stud *y* and cross head *z*. These parts are respectively duplicates of parts *m* to *s* inclusive.

In a similar manner the bottom griffe of No. 1 machine and the top griffe of No. 2 are combined by the parts *A*¹ to *Z*¹ inclusive.

**Action of
the
Mechanism.** The constant rotation of the double eccentric on the low shaft causes the rods A and A^1 to rise and fall on alternate picks; thus, when the rod A ascends, the left arm of lever κ *falls*, together with the cross head z and the top griffe knives of No. 1 machine, but the right arm *ascends* and lifts the cross head s and bottom griffe knives. Simultaneously and conversely the rod A^1 descends, thus causing the left arm of lever κ^1 to ascend and lift the *bottom* griffe of No. 1 machine, but the right arm of this lever descends with the top griffe of No. 2 machine.

On the next, and every subsequent alternate pick, these movements are reversed.

This mechanism was designed for the Textile Industries Department of the Municipal Technical Institute, Belfast, and performs its work most effectively with a considerable saving in power, especially in weaving 3 or 4-ply tapestries.

The principle is also applicable to double acting, double cylinder Jacquards.



CHAPTER IX.

Cross Border Jacquard Mechanisms.

Cross border patterns are specially adapted to the manufacture of handkerchiefs, napkins, damasks, table covers, shawls, tapestries and carpets. The arrangement of the mechanism for producing the *side* borders and the body or centre for any of these types of woven figured fabrics presents few difficulties, one portion of the upright hooks being set apart for weaving the borders and another for producing the centre. When two or more Jacquard machines are used, one is frequently reserved for the border, and the rest for the centre. The harness cords are tied up to their respective sets of hooks or machine and passed through the comber board to suit the side borders and centre.

The difficulties begin, when, having woven one or more repeats of pattern, it is necessary to produce a change, or *cross* border, which shall balance the side borders and make one complete square or oblong pattern. The manufacture of bordered fabrics involves the adoption of one or other of the following mechanical methods.

(1) Whenever the centre and side border constitute only *one* repeat of pattern, it is usual to stamp two repeats of the cross border and one repeat of the centre but to lace the second set of border cards the reverse way, making one continuous chain, so that the loom can run without interruption for change of pattern. When only a small quantity is required to be woven the cross border cards are only stamped for one repeat; these are woven forwards, before weaving the centre, and backwards, after the centre has been woven. Where a large number of webs have to be produced, the former plan is sometimes adopted even when there are two or more repeats of pattern for the centre to be woven. With very long lengths of table covers, etc., this plan becomes most expensive involving the

use of many thousands of cards—a greater number than the loom is capable of accommodating.

(2) Two sets of cards are cut, one for the centre and sides and the other for the cross border—the latter consisting of two repeats laced in opposite directions. As many repeats of the centre as may be required are woven, then by hand, the cross border cards are substituted over the card cylinder and adjusted so as to start with No. 1 card, and the whole set is woven over once when the cards are again changed, by hand, to the first set; the operations are similarly repeated until the requisite quantity of material has been woven. The slowness and inconvenience of this method have led to the introduction of several semi or wholly automatic devices.

(3) A common method consists in employing two sets of cards with two card cylinders as on the double lift principle. One set of pattern cards and card cylinder controls the centre and the other set and cylinder the cross border. The cylinders are designed to strike on every pick but are only in action one at a time, according to whether the centre or cross border is being woven. Whenever either cylinder has to be put into action, the other must be simultaneously thrown out. Numerous inventions have been designed whereby this operation may be performed by hand or automatically. The mechanism which will perform these changes automatically is a desideratum and ideal, but such motions, of necessity, involve very many mechanical details and complications for which reasons they do not readily find favour. The following represent a few of the principal inventions designed to accomplish the foregoing object.

**Devoge's
Cross Border
Jacquard.**

This machine is a double-acting, double-cylinder Jacquard, but for cross borders, is worked as a single cylinder machine, with either cylinder, at will. Fig. 114 is a diagrammatic representation of the mechanical details employed for locking and detaching either card cylinder *by hand*, to suit the requisite length or number of repeats of pattern for either set of cards.

A is the reciprocating rod operated from an eccentric on the crank shaft of the loom; B is a stud connecting the rod A with a

lever *c* screwed to the shaft *D* which extends across the length of the machine and near its base. *E* is a lever set screwed at right angles behind *c* to the same shaft *D*. An adjustable stud *F* combines the lever *E* with the link *G* which in turn is adjusted through the stud *H* to the lever *I* pivoted at *J*. *K* and *K*¹ are two studs set equidistant from the common fulcrum *J*. *L* is a connecting arm pivoted at *K*. Near the free end of the arm *L* a special socket *M* is

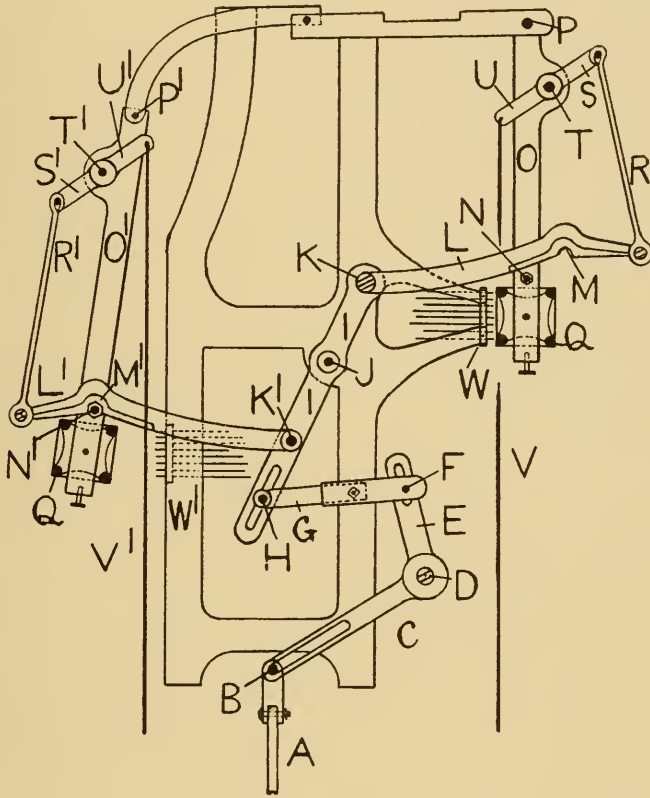


Fig. 114.

formed, which is free to lock as required with a suitably formed stud *N*, securely fixed near the base of the swing batten lever *O*, pivoted to a fixed bracket projecting from the top of the Jacquard framework at *P*. The position of the card cylinder is shown at *Q*. The extremity of the arm *L* is linked by the connection *R* to a small lever *S*, set screwed to the shaft *T* which extends and is fastened to the swing batten *O* and its duplicate for the same card cylinder. Immediately behind the lever *S* and set screwed diametrically

opposite to it, is a second lever u to which a cord v is attached. This hangs down to within the control of the weaver. Corresponding details, from k to v inclusive, are indicated from k^1 to v^1 for controlling the card cylinder on the opposite side of the Jacquard machine. Portions of the needles and needle board for the right hand cylinder are given at w , and for the left hand at w^1 .

**Action of the
Mechanism.**

In the illustration, the socket m^1 of arm L^1 is in working contact with the stud n^1 in the swing batten lever o^1 , so that the card cylinder q^1 will strike against the needles w^1 on every shot whilst this arrangement lasts. But immediately the weaver stops the loom, pulls down and makes fast the cord v^1 , he elevates through the medium of parts u^1 s^1 and r^1 the free arm of L^1 and detaches the socket m^1 from its connections n^1 and swing lever o^1 . Simultaneously the cord v is released and the arm L falls, by gravity, on to the stud n , so that by turning the loom slowly 'over,' the notch m falls over the stud n and locks itself, by which means the cylinder q is in working operation for as long as required.

**Crossley's
Cross Border
Jacquard.**

The cross border machine, commonly known as Crossley's was patented by Davenport and Crossley in the year 1883. An important feature in this invention is, that in addition to its use for cross borders it can be run as a double lift, *single* cylinder Jacquard.

The design and construction of the internal parts is ingenious, though somewhat complex, but the mechanism for producing the changes from one card cylinder to the other, which are usually performed by hand, is simple in arrangement. Fig. 115 is a line diagram which shows the internal arrangement of the needles and uprights. Fig. 116 is a plan of the special parts; corresponding numerals in each diagram and the subsequent Fig. 117 refer to similar parts. The ordinary details are:—griffe blades 1, uprights 2, guide board 3, resting rods 4, links 5, tug cords 6, needles 9, horse shoe loops 10, needle board 11, card cylinder 12, springs and spring box 13. The special details are the card cylinder 14 and a supplementary set of needles 15, supported and kept in

their horizontal plane by the boards 16 and 17; a loop is formed in the terminal of each needle. Through the loops of each vertical row of needles a fixed pin 18 passes which limits the traverse of the needles 15 whenever they are under pressure by the non-perforated portion of the pattern cards. A second loop or ring 19 is formed in the needles 15, through *each* of which a separate small vertical rod 20 is suspended and also passed through a loop 21 formed in the corresponding needles of the lower and normal set. Adjusted and fixed immediately behind each set of suspended rods 20 is a horizontal rod 22, equidistant between loops 19 and 21, which serves as a pivot about which rods 20 can turn whenever pressure is applied to the upper set of needles 15.

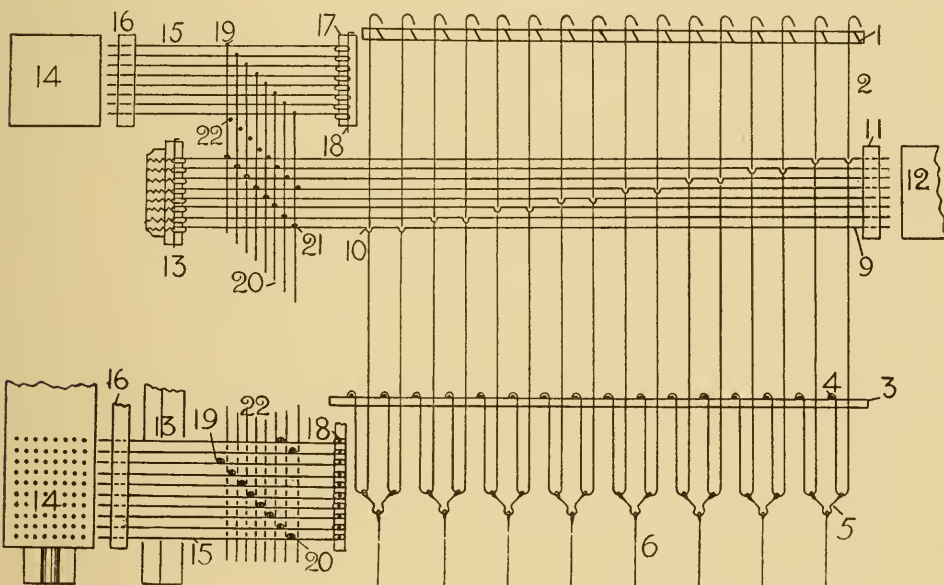


Fig. 116.

Fig. 115.

Action of the Mechanism.

The pattern cards on cylinder 12 produce the same results as obtains in an ordinary double lift single cylinder machine. The action of a non-perforated card on cylinder 14, when pressed against the needles 15, moves them to the right, together with the tops of the suspended rods 20, but the lower portion is moved to the left carrying with it the ordinary needles 9 and thus producing exactly the same result as a similar card operating on the cylinder 12.

**Card Cylinder
Changing
Mechanism.**

Fig. 117 shows a side elevation of the cross border changing mechanism. The reciprocating rod 23 receives its motion from an eccentric secured to the crank shaft; 24 is an adjustable stud connection between the rod 23 and a fixed lever 25 set screwed to a shaft 26 which extends across the Jacquard. Adjusted and fixed to the same shaft 26 is a lever 27 which combines through the stud and link 28 with a simple balk lever 29 pivoted at 30. The lower and upper arms of lever 29 carry projecting studs 31 and 32 respectively, which are free to oscillate in the slots 33 or 34 or be locked in the eccentric recesses 35 or 36. The slots 33 and 34 are compounded with the respective connecting arms 37 and 38. The arm 37 is attached to the lower cylinder 12, which is supported and free to rotate near the base of the swing lever 39, pivoted at 40 on a bracket compounded with the Jacquard machine. The arm 38 is similarly attached to the supplementary card cylinder 14 supported and free to rotate near the base of swing lever 41.

In the illustration supplied, the stud 31 is temporarily fixed in the recess 35 of connecting arm 37 while the stud 32 is clear of recess 36 and free to oscillate in the slot 34 of arm 38. Consequently whenever the rod 23 is reciprocated, the subsequent parts 25, 26, 27 and 28 correspondingly rock in sympathy with the balk lever 29 and since the stud 31 is locked and that of 32 is free, the former moves the card cylinder 12, from and to the face of the needles, but the latter simply moves to and fro in the slot 34, producing no action upon the card cylinder 14. The change, by hand, from cylinder 12 to 14 and *vice versa* is accomplished by the combination and action of the following added details. Pivoted to the fixed stud 43 is a simple lever 44 which the links 45 and 46 respectively join to the connecting slot arms 37 and 38 as shown.

A cord 47 links the free arm of lever 44 with a quadrant lever under the control of the weaver. The quadrant is secured to a bracket fixture. The quadrant lever can be fixed in different positions on the face of the quadrant. When the lever is depressed the left arm of lever 44, link 46 and cylinder arm 38 also descend, permitting the stud 32 and recess 36 to combine and place the

cylinder 14 into operative action, but the right arm of lever 44 elevates the link 45 and cylinder arm 37 until the stud 31 is clear of the recess 35, and card cylinder 12 remains stationary. When the quadrant lever is released and lifted to the top, the action of all the parts just described is reversed and the cylinder 12 is brought into operative action, while 14 remains stationary.

**Carpet
Cross-border
Jacquards.**

For the designing and weaving of cross-border patterns for Pile and Ingrain Carpets, see *Carpet Manufacture*, pages 40 to 47, 150 to 157 inclusive, and 292 and 293.

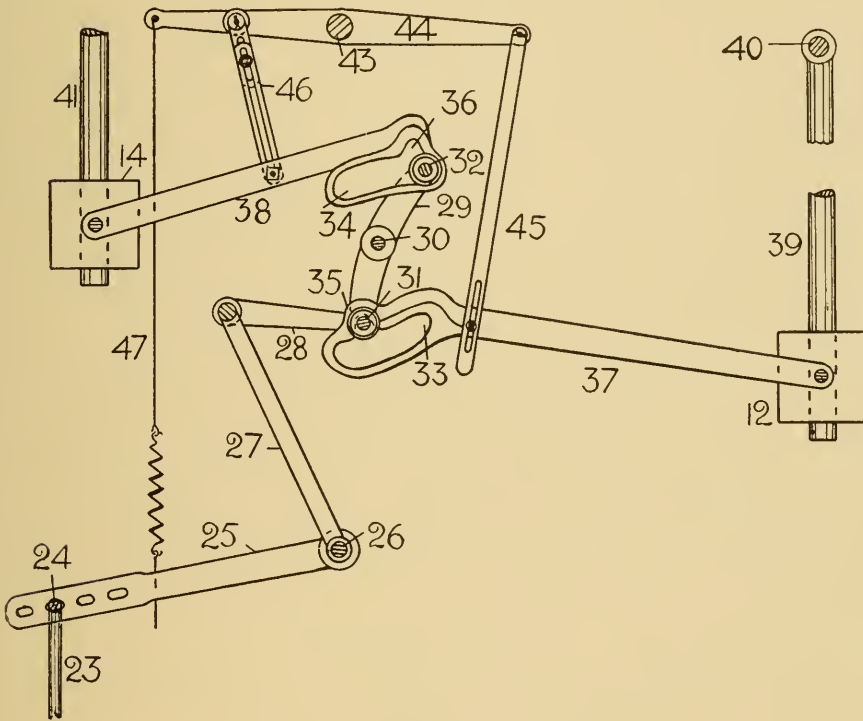


Fig. 117.

Automatic Cross Border Jacquard.

Rothwell's.

This mechanism is designed to produce the changes from one card cylinder to the other automatically, and also to reverse the pattern cards at will. Fig. 118 is a side elevation of the right hand motion, showing the various details which connect and operate the two card cylinders. 1 indicates a portion of the reciprocating rod which receives its motion from an

eccentric rotating with the crank shaft of the loom; 2 is a supplementary rod adjusted near the top of rod 1, with which it moves in sympathy. The rod 1 is adjusted by a bolt and nut to the lever arm 3, the sleeve of which is free to oscillate on, but independently of shaft 4; compounded with the same sleeve is the lever arm 5. The rod 2 is similarly adjusted to the lever 3¹—the duplicate of lever 3. The shaft 4 runs across the back, and its duplicate 4¹ across the front of the Jacquard machine near the foot. Adjusted near the top of lever 5 is a stud combined with a flanged antifriction bowl 6, free to move forwards and backwards in the space 7, or to be locked in the notched recess of this space near the top of link 8.

The link 8 is combined through a stud 9 to a second link 10, in turn combined, by the adjustable stud 11, to a simple lever 12 set screwed to the shaft 4¹. The link 10 combines the lever 12 by the studs 11 and 13 to the swing batten lever 14, pivoted to the Jacquard frame supports; the free arm of this lever supports and reciprocates the card cylinder 16 after the usual manner. The top and bottom catches 17 and 18 are compounded and pivoted on the common stud 19. A cord may be attached to the straight and free arm 20 compounded with the double catch, for reversing the rotation of the card cylinder 16 by hand, in the usual way. Duplicates of all the details from 3 to 16 for connecting the card cylinder on the left hand are respectively illustrated by the numerals 3¹ to 16¹ inclusive. The second cylinder 16¹ is designed to turn in one direction only for which purpose the single catch 22, pivoted to the machine at the point 23, is employed. One of the gantry supports for the Jacquard machine is shown at 24. If the cross border mechanism is not increased beyond the details already illustrated the apparatus may be controlled by hand to effect the changes from either cylinder to the other.

**The Automatic
Mechanism.**

The added details for this purpose consist chiefly of a set of tappets of two different heights linked together and free to rotate with a small chain cylinder, operated at will, through the medium of one Jacquard upright, a ratchet wheel and a drawing catch.

Fig. 119 shows a side elevation of the chain cylinder and tappets.

Fig. 120 is a front elevation of part of the same details.

Fig. 121 is a side view of the details for turning the ratchet wheel compounded with the tappet cylinder.

Fig. 122 is a front view of part of the same details.

Fig. 123 is an elevation of the mechanism for automatically reversing the card cylinder 16. Corresponding numerals refer to similar details. 25 is a square bracket secured to the ends of the Jacquard framing. A small chain cylinder 26 is supported, centred and free to rotate between the two sides of the bracket 25. Upon the cylinder 26 and free to rotate with it is a continuous chain of small tappets 27¹ of two different heights; resting in close contact with one or other of the tappets 27¹, is a small anti-friction bowl 28¹ supported and projecting from the underside of the simple lever 29¹, pivoted to the stud 30¹ in the upright bracket 31¹, in turn securely fixed to one of the ends of bracket 25. The free arm of the lever 29¹ is connected by a short stud 32¹ to a vertical rod 33¹ which is free to slide between two guide brackets 34¹, compounded with and on the remote side of lever arm 5¹. The head of the rod 33¹ supports the free end of the link lever 8¹. Duplicates of the parts for controlling and operating the card cylinder at the front of the machine are shown at 28 to 34 inclusive and respectively.

**Combined
action of the
Locking
and Vibratory
Mechanism.**

Whenever it is required to lock the bowl 6¹ in the recess 7¹ of link 8¹, one of the smaller tappets 27¹ is brought to the top of the chain cylinder 26, which permits the bowl 28¹, lever 29¹, rod 33¹ and link 8¹ to fall by gravity until the notched space 7¹ encloses the bowl 6¹ adjusted to lever 5¹. The unlocking of this lever is effected by rotating one of the larger tappets 27¹ into rolling contact with bowl 28¹ in lever 29¹ and lifting through these, the rod 33¹ and link 8¹ until the notched space 7¹ is clearly above the bowl 6¹, so that the last is free to reciprocate in the space 7¹. It will be observed that the stud and antifriction bowl 6¹ are enclosed in the notch of space 7¹ in the link 8¹. This combination compounds the lever 5¹ with the link 8¹, so that whenever the lever arm 5¹ recipro-

cates, the link 8¹ moves in sympathy. On the contrary the bowl 6 is shown to be clear of the notched recess in space 7 of link 8, so that whenever the lever arm 5 reciprocates, it exercises no influence on the link 8, but immediately the bowl 6¹ is released from the notch in the space 7¹, the bowl 6 is automatically pressed into the notched recess of space 7 in the link 8, and thus compounds it with the lever arm 5. When link 8 is locked, that of 8¹ is free and *vice versa*.

The continuous reciprocation of the rod 1, with its complement 2, alternates in sympathy levers 3, 3¹, 5 and 5¹ freely and independently of their respective oscillating shafts 4 and 4¹. The bowl 6¹ being locked in the notched recess 7¹, reciprocates the link 8¹. This link, acting through the stud 9¹, reciprocates the link 10¹, stud 11¹ and lever 12¹, which last oscillates the shaft 4. Simultaneously the link 10¹ reciprocates through stud 13¹ the swing lever 14¹ which carries the card cylinder 16¹ outwards and inwards, from and to the needles. If necessary, both levers 5 and 5¹ may be permanently locked with the respective links 8 and 8¹, so that the machine or machines may be used as ordinary 'double lifts.'

**Mechanism and
Rotation of the
Chain Cylinder
and Tappets.**

A ratchet wheel 36, Fig. 121, is secured to the same axis as the chain cylinder 26. 37 is a pulling catch resting immediately over the ratchet wheel, in contact at will, but normally clear; this catch is pivoted on the stud 38 fixed near the top of the simple lever 39, which is supported and free to rotate upon the stud 40 adjusted to bracket 25. A knuckle jointed link 41 combines through the studs 42 and 43 the lever 39 with that of lever 5¹. The pulling catch 37 is further supported and lifted out of contact or lowered into contact with the ratchet wheel 36, by a forked vertical rod 44, which is kept in the vertical plane by suitable guides, affixed in the cross rail of bracket 25. Near the base of this rod 44, a projecting stud 45 is adjusted at right angles and normally rests upon the right arm of the simple lever 46, pivoted on the stud 47. A spiral spring 48 links lever 46 to the bracket 49, and keeps the right arm of lever 46 in close contact with stud 45. The left arm of the lever 46 is combined through stud 50 and cord 51 with one of the upright hooks 52, the griffe blade for which is shown at 53.

**Action of
the Mechanism.**

Each vibratory movement of lever 5¹ reciprocates the pawl catch 37, but since this is normally clear of the ratchet wheel 36, through the energy in spiral spring 48 no rotation of the chain cylinder takes place. If, however, the left arm of lever 46 is lifted through the medium of cord 51, upright 52 and griffe blade 53, the right arm of lever 46 descends, permitting, through rod 44, the catch 37 to fall into acting contact with the ratchet wheel 36, and thereby turn it one eighth of a revolution, counterclockwise with each oscillation of lever 5¹. This brings forward the next successive tappet in chain 27¹ to either release link 8¹ or compound it with lever 5¹ through the connections described.

A perforation in the last or other card of either card cylinder, repeats this operation. Each *small* tappet 27 therefore represents *one* repeat of the set of pattern cards on the back cylinder 16, and each *large* tappet permits one repeat on the front cylinder 16¹. Conversely each small tappet 27¹ represents one repeat of the pattern cards on the front cylinder 16¹, and a large tappet permits one repeat on the back cylinder 16. The tappet chains 27¹ or 27 can be made any length to suit the required design.

**Automatically
Reversing the
Card Cylinder.**

The necessity for reversing the direction of the card cylinder occurs *only* when the figure design has to be woven the reverse way. Upon the chain cylinder 26, Fig. 123, a third chain of large and small tappets 27² is kept in rolling contact with an antifriction bowl 67 in the lever 68 pivoted at 69; the free end of this lever is adjusted to the double catch 17 and 18, so that whenever a large tappet lifts the lever 68, it also places the bottom catch 18 into operating contact with the back card cylinder 16. A small tappet rotated under the bowl 67, permits the lever 68 and top catch 17 to resume their normal positions when the card is turned in the usual direction.

Needles and Special Uprights for Cross Border Jacquards.

Fig. 124 shows in elevation one row of uprights and one row of each set of crosswires. The uprights 52 are constructed in two parts, but looped together as shown at 66; this special arrangement

makes it possible for all the hooks to be placed the same way. The griffe blades are also all arranged the same way. When the uprights are back to back and the griffe blades opposed to each other, the difficulty of repairing is increased. The griffe blades are shown at 53, the guide and support board at 54, the links at 55, the tug cords

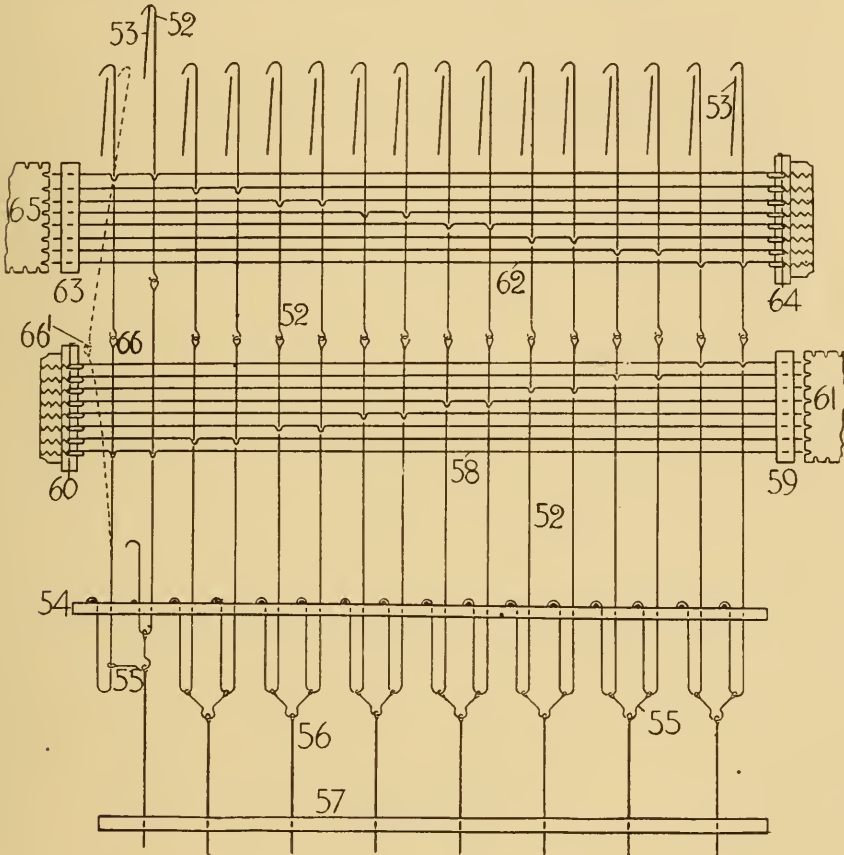


Fig. 124.

at 56, and a guide board at 57, which primarily ensures that the tugs and links rise or fall in a vertical plane. The crosswires for the bottom set are indicated at 58, the needle board at 59, the springs and spring box at 60, and the card cylinder at 61. The top set of corresponding details are indicated at 62, 63, 64 and 65 respectively.

Action of the Mechanism. Whenever a non-perforated card is presented by the card cylinder 65 to the face of the needles in the top set, it presses the upright *clear* of the rising griffe blades, but whenever a non-perforated card in cylinder 61

presses in contact with the face of the needles of the bottom set, the needles move the upright 52 near the loop joints 66 to the left—66¹, but the top portions of the uprights act as levers, and *pivot* about the point where they are in contact with the upper needles, thus causing the hooks at the top to move likewise to the right, *clear* of the rising griffe blades as indicated by the dotted lines.

Whenever a perforated card is presented to either cylinder, it exercises no influence on the needles nor through them on the uprights, consequently the latter rise with the griffe blades after the usual manner.



CHAPTER X.

Twilling Jacquards.

THE majority of woven, figured fabrics, such as damasks, napkins, dress goods, etc., belong to the class technically denominated *warp* and *weft* figures.

The figure effect on the surface of the fabric is usually produced by a combination of masses of weft predominating, contrasted with masses of warp predominating. The *weft* effect is usually denominated the 'figure' or 'flower' and the *warp* surface, the 'ground' of the pattern. The figure, in white or self colours, is visible because of the different reflecting properties which masses of warp and weft *floats* possess when viewed at right angles to each other, as they are naturally displayed on the surface of a cloth.

The balance of structure of the fabric necessitates that the *long* floats of either warp or weft must be tied down into the body of the cloth. This is commonly accomplished by employing some elementary weave, which repeats many times in each mass of figure and in the ground pattern.

It was always therefore a desideratum with the manufacturer to devise some simple shedding mechanism which would produce the binding or structural weave independently of the figuring or Jacquard apparatus and thus make it possible for each figuring unit to control two or more *adjacent* threads of warp constituting the figuring shed. It has been evident for hundreds of years that by the combination of two such shedding factors, the *normal* figuring capacity of the larger shedding apparatus would be materially and economically increased. It was the knowledge of this fundamental datum which evolved the simplex treadle and compound mounting, for weaving old diapers, Fig. 46, the pressure and split harness for producing the more elaborate figures in table covers, etc., in hand loom weaving, and finally the modern twilling Jacquard.

The twilling mechanism is designed to bind automatically, in sateen or twill order, each *group* of warp threads selected by the Jacquard machine to form the upper and lower lines of the figuring shed. The mechanism which produces the binding is combined with the Jacquard and requires no external apparatus as is the case with many inventions designed with the same object. The 'binder' weave is usually an 8 or 5 end sateen or *both*.

The chief feature of this mechanism is that each needle controls two or more uprights. Each Jacquard card has to serve for two or more shots of weft. The Jacquard machine lifts the uprights which are grouped to the needles, while the twilling motion depresses or elevates one out of every five or eight uprights, according to whether the binding must be in five or eight end sateen order.

The figuring capacity of 'single lift,' twilling Jacquards is always equal to the product of the number of needles and the average number of uprights per needle.

The number of shots in the complete repeat of the woven pattern is equivalent to the product of one repeat of the pattern cards and the average number of shots per card.

The Bessbrook or Irish Twilling Jacquard.

Generally speaking, all twilling Jacquards are called 'Bessbrooks.' There is, however, a slight difference in detail between the Irish and Scotch makes. The first series of illustrations have been drawn from the 'Brookfield' make of an Irish twilling Jacquard.

Arrangement of Needles and Hooks—
8 Leaf Twill. Fig. 125 is a side elevation of one row of needles combined with one row of ordinary hooks of a 608 machine. Each needle is linked to and controls three hooks; these are combined with, and independently controlled by an 8 leaf twilling motion.

By this compound arrangement the figuring capacity of the machine = 8 needles \times 76 rows \times 3 hooks per needle = 1824 figuring hooks.

Fig. 126 is an elevation, from the same side of the machine, of the twilling hooks.

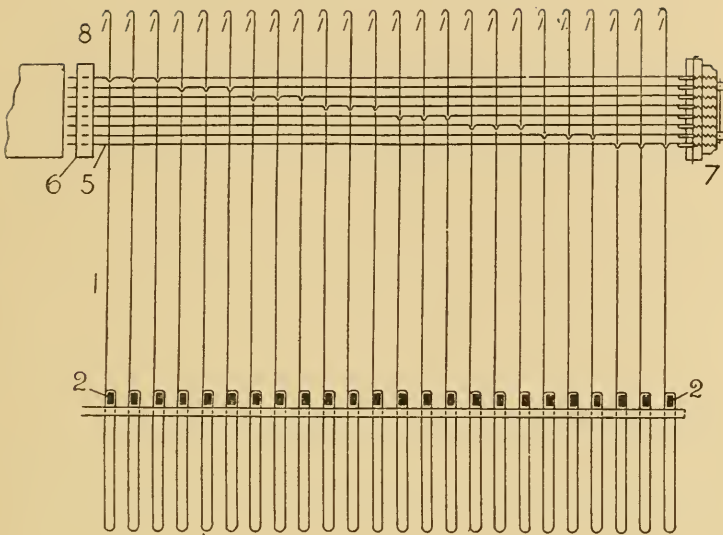


Fig. 125.

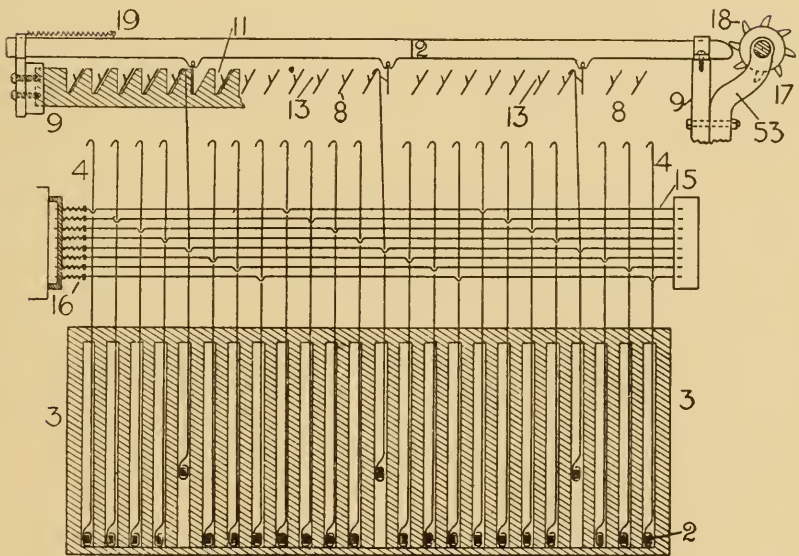


Fig. 126.

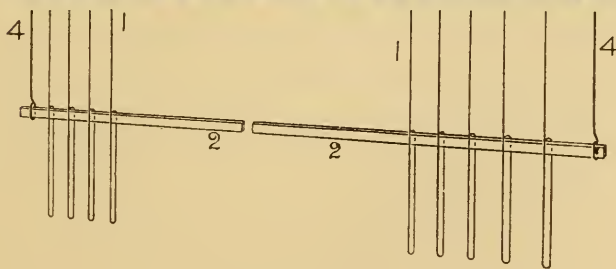


Fig. 127.

Fig. 127 shows a front elevation of the twilling hooks together with a few of the ordinary hooks. Similar numerals indicate corresponding details. The ordinary hooks 1 are doubled back from the base so as to form complete loops. The hook bars 2, made of iron, are passed severally through each row of loops. They are contained laterally, but free to reciprocate vertically, between divisions formed in two vertical 'grid' plates 3 and its duplicate. Their ends are combined with the twilling hooks 4 as shown, and they all normally rest at the bottom of the grid plates. The ordinary hooks 1 are normally at rest on the hook bars 2. The ordinary needles are shown at 5, the needle board at 6, and the spring box and springs at 7.

The griffe or lifting knives 8 are supported in the top of the head frame 9, and by a supplementary cross rail 10, Fig. 129. Portions of the supports are cut away as at 11, one side forming an incline, and the other a true vertical plane. This groove -V- permits the griffe blades 8 to be oscillated as required by means of a set of twilling bars 12. In this machine there are eight twilling bars and compounded with the underside of each are three double 'finger' projections at equal distances apart. The projections of each bar are connected in consecutive order with the griffe blades 8 for three repeats, so that each twilling bar can oscillate three griffe knives, see Fig. 129.

Normally each griffe blade lies parallel with the inclined plane of groove 11, and the ordinary hooks 1 remain stationary over the griffe blades 8, but the *twilling hooks* are then clear.

Formed near each end of the blades 8 are 'lip' projections 13, which rest in close contact with the back of the twilling hooks 4. These twilling hooks are kept in their normal position by a separate set of needles 15 and spiral springs 16. Each needle is joined to three *twilling* hooks in the same order as the twilling bars are connected with the griffe blades, Fig. 129. The twilling bars are operated by means of a small steel cylinder 17, denominated the twilling cylinder, studded with brass pegs 18, and arranged in any ordinary twill or sateen order, in this example—eight end sateen. Each peg is so arranged that as the cylinder rotates, it will be

directly opposite the end of its respective twilling bar. A spiral spring 19 fastened to the head 9 and the twilling bar 12, keeps the last in contact with the pegs 18.

Mechanism of Card and Twilling Cylinders.

Card Cylinder.

Fig. 128 is a side view of a Bessbrook *eight* leaf twilling Jacquard, and Fig. 129 a part plan of the same side of the machine, and including the twilling mechanism. Similar numerals in Figs. 125 to 129 inclusive, refer to corresponding details.

21 is the gable on the left side of the machine, and 22 a short shaft, 2in. in diameter, which oscillates to the right and left *once* for every shot of weft, see Fig. 156. It is supported in a pedestal fixed to the front of the gable 21, and duplicated on the opposite side of the machine. Adjusted and secured to the shaft 22 is a lever 23, the arm of which supports an antifricition bowl 24, on which rests the *base* rail of the lifting head 9. Fitting closely to the side of the head 9 are two *slide* brackets 25 and 25¹; these are free to rise or fall in the respective grooves 26, 26¹ in the gable 21. The bracket 25 is provided with a fixed stud and a rotating antifricition roller 27, which is free to rise and fall with the head 9, and also fits into the groove of a bracket 28 denominated the swan neck. This is set screwed to the slide spindle 29, in turn supported in a horizontal plane by three 'lugs' x. A brass bush 'sleeve' is set screwed into the bore of each lug. The spindle 29 passes through and is free to move in these sleeves with the minimum of friction. Welded to the left hand side of the slide spindle 29 is a steel bracket 30, into which is cut a vertical slot. At the base of this slot, the gudgeon pin, in the end of the card cylinder 31 rests, and is free to rotate; a lock nut and set screw 32 are adjusted through the base of the bracket 30 for raising or lowering this end of the card cylinder. A second slide spindle 33, provided with a hammer head and a spiral spring 34, is supported between the brackets 35 and 35¹, the former being fixed to the Jacquard gable 21, and the latter to the slide spindle 29. The object of the spindle and hammer 33 and spring 34 is to keep the card cylinder 'square' during the period of striking the needles.

The spindle 29 is compounded with its duplicate on the opposite side of the machine through the medium of a cross rod and coupling 36; this arrangement ensures that both ends of the card cylinder 31 shall travel outwards or inwards in perfect unison. All parts from 21 to 35¹ inclusive are duplicated on the opposite side of the machine. A fixed stud 37 in the gable 21 supports and serves as a pivot for the cylinder catches 38 and 39. 40 is a supplementary arm or wing and 41 the straight arm to which a cord and spiral spring 42 are attached for the purpose of lifting the *top* catch 38 clear, and bringing the *bottom* catch 39 into contact with the cylinder 31.

**Details of the
Intermittent
Mechanism.**

Mounted upon a stud 43, fixed in the gable 21, is a specially constructed cam or tappet 44, denominated the 'twilling tappet.' Normally, it is in rolling contact with the antifriction bowl 45, fixed into the shoulder of the bottom catch 39.

A similar bowl and stud 46 is bolted in the winged arm 40. The tappet 44 and bowl 46 are normally clear, but whenever the string 42 is held or fastened down, the catch arm 41 is also depressed in sympathy, but the top catch 38 is lifted clear and the bottom catch 39 is brought into working contact with the card cylinder. The bowl 45 is also lifted clear of the twilling tappet 44, but the bowl 46 on the winged arm 40, is moved into rolling contact with it, so that whether the card cylinder is rotating forwards or backwards, the twilling tappet operates on the catches to produce the same number of shots per card. Compounded with the tappet 44 and rotating on the same stud 43 is a ratchet wheel 47, having twelve teeth. A small lever 48 is bushed and free to oscillate about the stud 43. Pivoted and adjusted to this lever 48 is a pawl 49, the free end of which is kept in close contact with the ratchet wheel 47 through the medium of a steel spring as shown. The object of the lever 48 and pawl 49 is to rotate the ratchet wheel 47. A strong steel 'finger' spring 50 is also kept in close contact with the ratchet wheel 47, to obviate any tendency to recede when the pawl is also receding to lay hold of the next ratchet tooth. The lever 48 is linked by means of an adjustable rod 51 to the lever 52 secured to the shaft 22.

**Twilling
Cylinder.**

The twilling cylinder 17, Figs. 126 and 129, is supported and free to rotate between two wings of a bracket casting 53 secured to the head 9. One or other of the brass pegs 18 is always in pressing contact with its corresponding twilling needle. Compounded with the twilling cylinder 17 is a small octagonal shaped pulley 54, upon the periphery

Fig. 129.

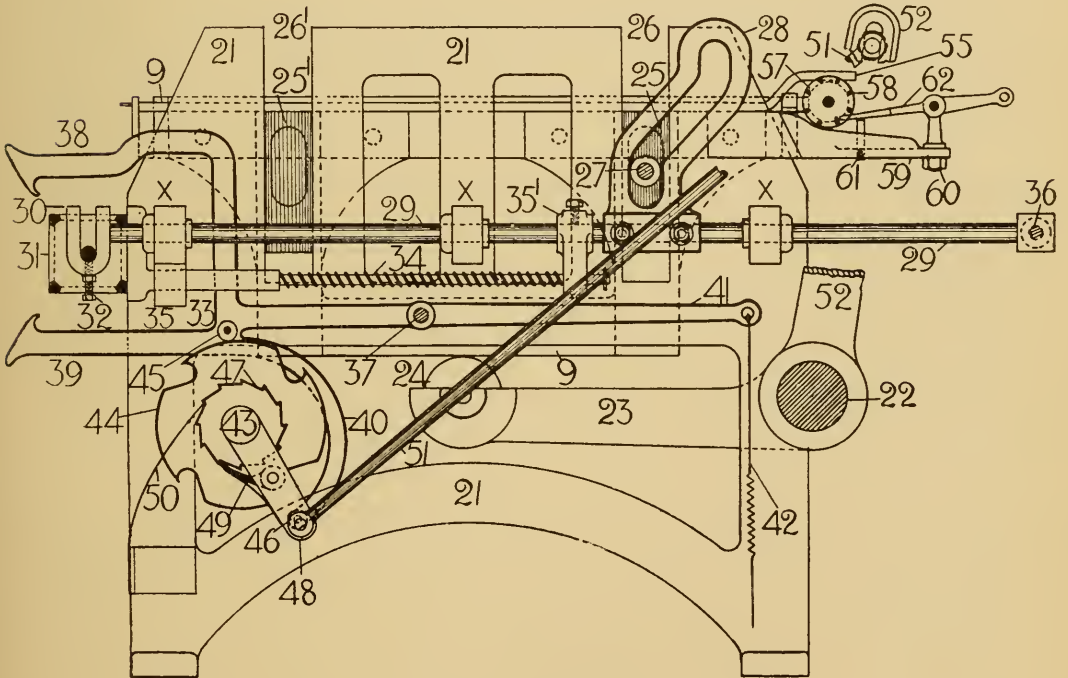
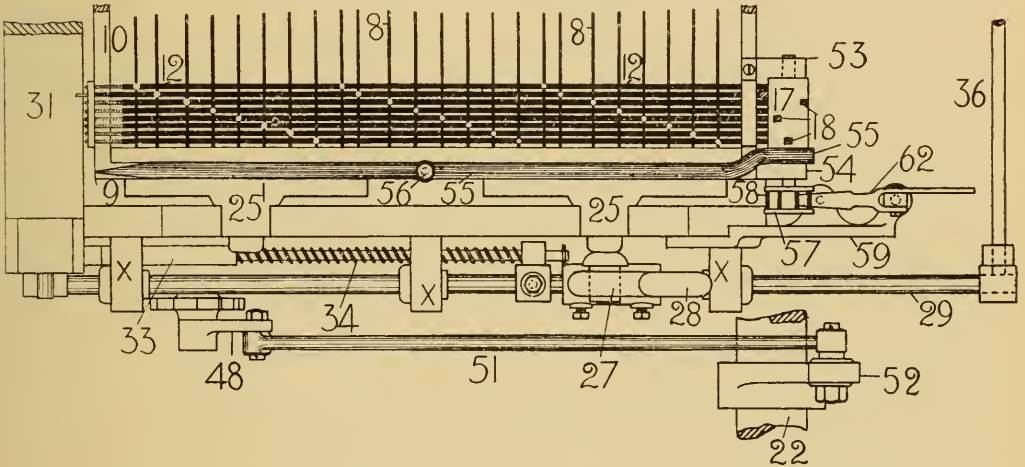


Fig. 128.

of which rests the free arm of a long flat steel spring 55, secured to the head 9 at 56. This spring is to prevent the twilling cylinder from rotating too far whenever motion is imparted to it.

Also compounded with the end of the twilling cylinder 17 is a small reel 57, the flanges of which are of brass and pierced with eight small holes at equal distances apart and near to the periphery; through the opposite holes of each flange, small steel pins 58 are inserted and welded. A bracket 59 is set screwed to the gable 21. Adjusted to this bracket are two vertical studs 60 and 61. Pivoted near the top of the former is a simple lever 62, the left arm of which normally rests upon the pins 58.

**Action of the
Card Cylinder
Mechanism.**

The head 9 rises and falls on every pick. With each *ascent* of the head, the stud and bowl 27 also rise in a vertical plane, but since they are contained in the inclined groove of the swan neck lever 28, they cause the latter together with the spindle 29, the steel bracket 30 and the card cylinder 31 to move *outwards* to the left, but *inwards* with each *descent* of the head.

Whenever the smaller radius of the twilling tappet 44 is in working contact with the bowl 45, the cylinder catches are normal and the card cylinder 31 is rotated the usual $\frac{1}{4}$ revolution, but immediately the greater radius is rotated into contact with the bowl 45 the top catch is lifted clear of the card cylinder, but not sufficiently high to bring the bottom catch into working position with the card cylinder 31. So long as these conditions prevail, the cylinder is reciprocated outwards and inwards, without *any* rotation. In a similar manner the twilling tappet operates upon the stud and bowl 46 attached to the wing lever 40, whenever the double catch lever 41 is held down by the string and spiral spring 42 for the purpose of lifting the bottom catch to reverse the card cylinder.

**Action of the
Twilling
Mechanism.**

With each ascent of the Jacquard head 9, the reel 57 rises above the left arm of lever 62, which is then free to fall until it rests upon the vertical stud 61. With each descent of the head one of the steel pins 58 is brought into forcible contact with the left arm of

lever 62, which offers resistance sufficient to cause the reel pulley 57, compounded with the twilling cylinder 17, to rotate $\frac{1}{8}$ revolution and thus bring one of the brass pegs 18 into contact with its corresponding twilling bar 12 and move it so as to overcome the resistance of the spiral spring 19, Fig. 126, and simultaneously move the *three* griffe blades, with which it is linked from the incline to the vertical plane of groove 11. These three griffe blades are then clear of all the *ordinary* hooks in each corresponding row, irrespective of whether they have been left *on*, or pushed *off* the griffe blades by the ordinary pattern cards. Simultaneously with the movement of the griffe blades into the vertical plane, the projecting lips 13 near the ends of each blade press against the back of the *twilling* hook immediately in front of them, in such a manner as to push the hook over its respective griffe blade so that with the ascent of the head on the next pick, these blades lift three of the twilling hooks, to which they are attached as indicated, Figs. 126 and 129. These, in turn pull up their respective hook bars 2, which elevate all the ordinary hooks 1 in each respective row, irrespective of whether they have been selected by the pattern cards to be lifted or left down. It should be noted that there is no griffe blade and lip projections to operate the *first* twilling hook. The lifting of this hook is dependent upon its connections with the ninth and seventeenth twilling hooks, counting from the right.

The result of the foregoing twofold action is as follows:—*First*, when any of the twilling bars 12 press the griffe blades 8, clear of the ordinary hooks 1 this ensures, that *one* row of harness and warp threads, out of every *eight* is left *down* including the same proportion of warp threads selected by the pattern cards and hooks, to form the warp portion of the figure. *Second*, the three given griffe blades when moved into the vertical plane, *lift* the twilling hooks and bars and *one* out of every *eight* rows of ordinary uprights, harness and warp threads, so that this same proportion of warp is lifted from among the mass of warp threads selected by the pattern cards and left *down* to form the *weft* figure.

The same sequence of operations is repeated on the next and each successive pick of weft. A different twilling bar is pressed

forward through the action of the next brass peg 18 rotated into position with each $\frac{1}{8}$ revolution of the twilling cylinder 17. The same pattern card may strike against the needles for one, two or more shots of weft, without in any way interfering with the twilling motion.

The twilling cylinder is usually studded with brass pegs in *sateen* order, because with this method of *binding* a greater quantity of warp and weft can be relatively crowded into a given space, and in addition a greater reflection of light is given from the solid smooth surface of a sateen, than from a twill or perhaps any other weave.

Construction of Twilling Tappets and Ratchet Wheels.

The twilling tappet is simply a steel disc, in the periphery of which notches are cut to permit the top catch to rest normally in contact with the card cylinder. The original and extreme periphery of the disc, lifts the top catch and leaves it, together with the bottom catch, *clear* of the card cylinder so that it can reciprocate, without being turned.

The twilling tappet is compounded with a ratchet wheel, in which each tooth cut corresponds to one shot of weft; the total number of teeth must be a convenient multiple of the *average* number of shots per card.

The disc must be divided into as many sections as there are teeth in the ratchet wheel. Each section also represents one shot of weft. Notches are then cut on those sections only, where the card cylinder must be rotated. In Fig. 128, the tappet 44 and ratchet wheel 47 have been designed to produce an average of *three* shots per card. The ratchet wheel contains 12 teeth, and the tappet has consequently been cut once in every three divisions, viz.—cut 1, miss 2, for four times.

The possible and standard variation of tappets and ratchet wheels for the usual number of shots per card are as follows:—

No.	Shots per card	Average	Teeth in Ratchet Wheel	Construction of Tappet.	
1	2	2	8 or 12	8 or 12 divisions	Cut 1, miss 1
2	2 3	2½	10	10	„ Cut 1, miss 1, Cut 1, miss 2
3	3	3	9 or 12	9 or 12	„ Cut 1, miss 2
4	3 4	3½	7 or 14	7 or 14	„ Cut 1, miss 2, Cut 1, miss 3
5	3 3 4	3⅓	10	10	„ Cut 1, miss 2, Cut 1, miss 2 Cut 1, miss 3
6	4	4	8 or 12	8 or 12	„ Cut 1, miss 3
7	4 5	4½	9	9	„ Cut 1, miss 3, Cut 1, miss 4
8	4 5 5	4⅔	14	14	„ Cut 1, miss 3, Cut 1, miss 4, Cut 1, miss 4

**Lags and Pegs
in lieu of
Twilling
Tappets.**

Fig. 130 shows a front elevation and Fig. 131 a side elevation of a small card cylinder with lags and pegs after the dobby pattern, designed and applied by the writer, to replace the foregoing and somewhat expensive system of twilling tappets. A is the Jacquard card cylinder, B and C the top and bottom catches respectively, compounded and pivoted on the stud D. Part of the usual extended single arm is only shown, but in its complete form it is under control of the weaver, when it is necessary to rotate the card cylinder A backwards. In the lower shoulder of the double catch a stud E is fixed, on which a small antifriction roller F is placed and free to rotate: it normally rests in contact with the lags G on card cylinder H, with which is compounded a ratchet wheel I free to rotate on the fixed stud J. Free to oscillate on this same stud is a lever K, which carries a pawl lever L, kept in constant contact with the ratchet wheel which it rotates. A strong steel spring M keeps the ratchet wheel from receding after each partial rotation. The lever K is connected to the Jacquard head through the medium of stud N and rod O. Strong wood or steel pegs P are screwed or otherwise firmly fixed in the wood lags G, according to the required number of shots per card. A peg in the lag places both catches clear of the card cylinder A, and a 'blank' permits the top catch to rest on the card

cylinder, *i.e.* the position shown in the diagram. The ratchet wheel *l* combined with the card cylinder *h* is rotated a distance equal to the pitch of the ratchet teeth and lag division, every time the Jacquard head descends as heretofore described.

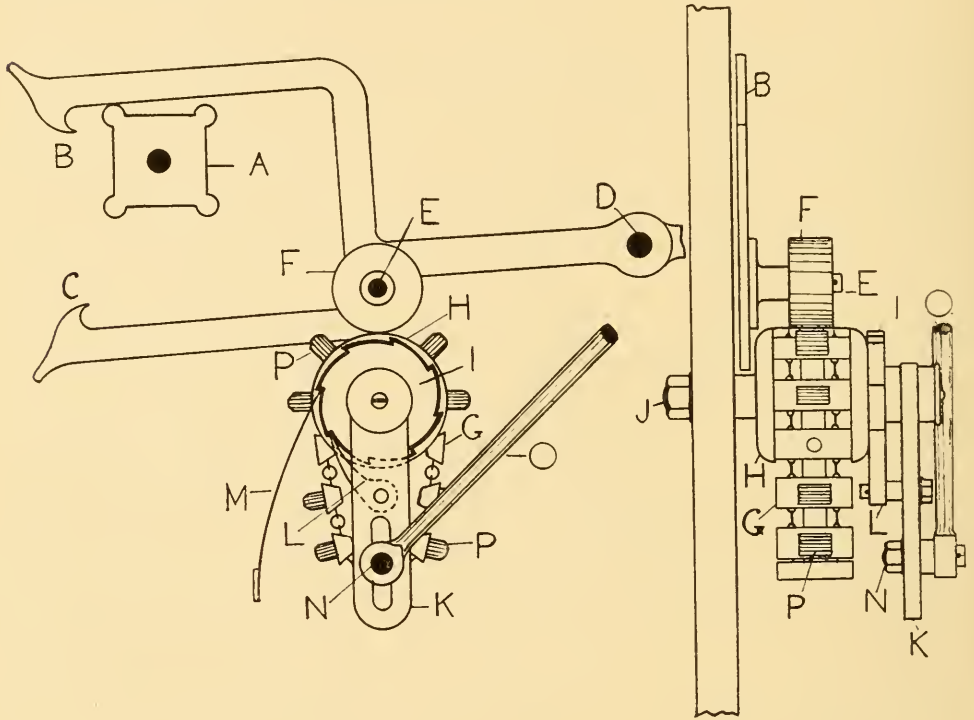


Fig. 130.

Fig. 131.

This arrangement involves no change of ratchet wheel and lag cylinder. It is only necessary to peg the lags, to suit the required number of shots per card.

The Scotch Twilling Jacquard.

The construction of this make of machine does not differ in essential principles from the Irish type already fully described.

There are, however, minor points of difference, and these are illustrated at Figs. 132 and 133, the former being an elevation of one row of ordinary figuring hooks and needles, and the latter the twilling hooks, hook bars and twilling bars, together with a transverse section of the twilling cylinder, as viewed from the left hand side of a right hand loom.

Fig. 132.

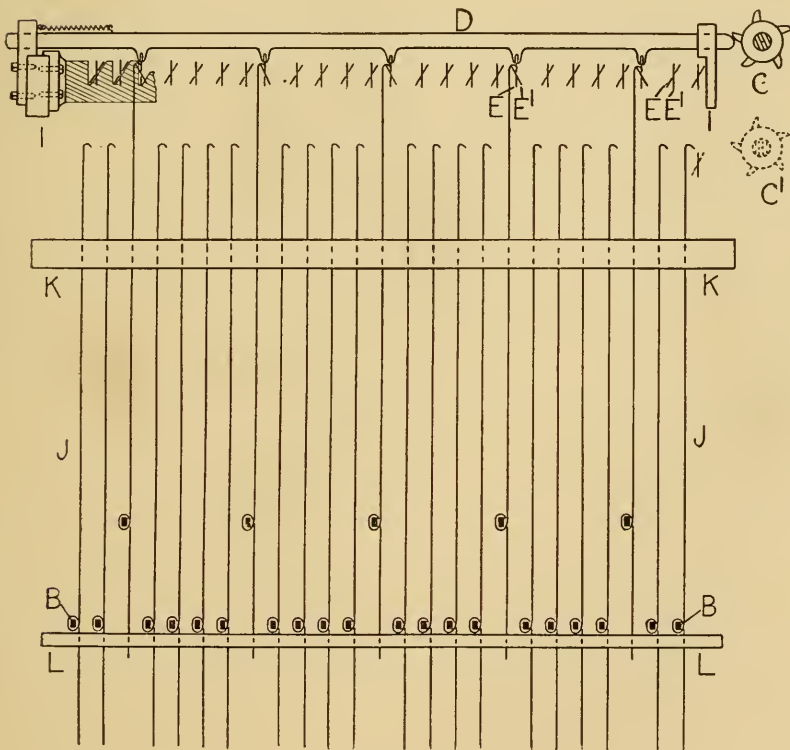
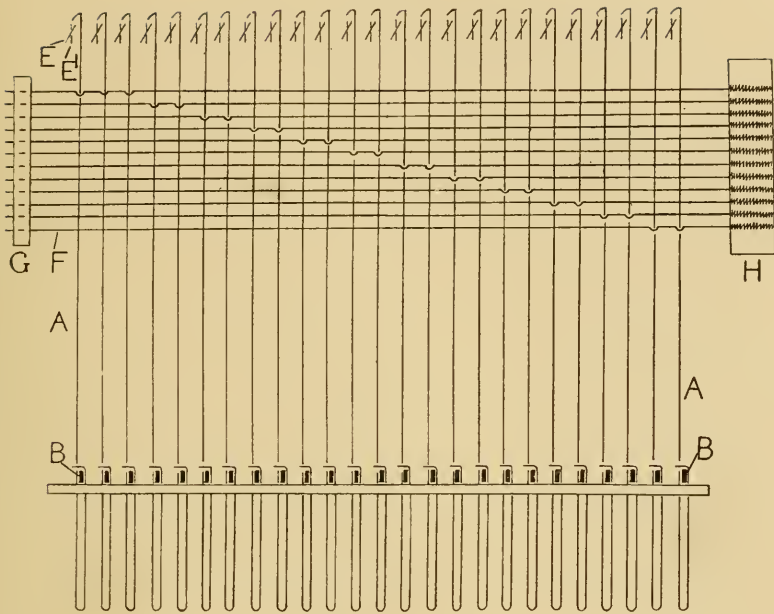


Fig. 133.

A indicates the ordinary hooks; B the hook bars; c the twilling cylinder in its highest position with the Jacquard head; c¹ the same in its lowest position; D the third twilling bar in pressure contact with the 3rd, 8th, 13th, 18th and 23rd rows of griffe blades E. These blades are normally inclined towards and immediately under the hooks A. The needles F are linked with and control the *ordinary* hooks A. The top needle combines with three hooks, but all the rest with only two hooks each. This arrangement permits the use of a *five* leaf twilling motion as in the figure; if an *eight* leaf twill binding is required, no warp is drawn through the harness controlled by the 25th row of hooks, and a new set of twilling bars is substituted. The needle board is shown at G, the spring box at H, and a portion of the Jacquard head at I. The *twilling* hooks J are looped around the ends of the hook bars B. The upper portion of each twilling hook passes freely through a perforated and fixed plate K. The extended shanks of the same hooks pass through perforations in a fixed iron plate L. The hook bars B, together with the twilling hooks, are supported in their normal positions on the iron plate L, and its duplicate at the opposite side of the machine. The *twilling* uprights in this machine are therefore only free to move in a vertical plane. They have no lateral movement whatever as was shown to be the case in the Irish twilling Jacquard. The *hooks* of the ordinary and twilling uprights are arranged to face each other. Immediately opposite each twilling hook, about *one inch* of each griffe blade E is bent from the incline to the vertical plane as indicated by the line E¹, notwithstanding which the twilling hooks are still normally clear of the griffe blades, but immediately the twilling bars oscillate any *griffe* blade E from the incline to the vertical plane (as shown in Fig. 133) so as to be clear of, and leave down its respective complete row of ordinary hooks on any given pick, the bent portion E¹ is simultaneously rocked backwards a sufficient distance to lie directly under the adjoining twilling hook and *lift* the same, together with its complement of ordinary hooks on the same given pick, irrespective of whether they have been designed to be lifted by the ordinary hooks or not.

‘Carver’s’ Combined 5 and 8 Leaf Twilling Motion.

This twilling Jacquard is designed to automatically bind the *ground* or warp figure in *five* end sateen and the flower or *west* figure in *eight* end sateen order. The pattern produced by this machine, like most other damasks, is woven face downwards.

The main features of the mechanism are identical with those of the Scotch twilling Jacquard.

The essential points of difference are as follows:—There are no *twilling* hooks, but the ordinary uprights have *two* hooks—one at the top of the ordinary long shank and one on a shorter shank, with the hooks facing opposite ways. There are also two sets of griffe knives compounded with the *head*; the upper set is arranged and free to oscillate as heretofore described, the lower set which is about 4in. below the upper, is free to move laterally, through the action of a specially constructed cam, or vertically, with the head. In each of the lower griffe blades there are projecting pockets directly opposite, and normally under, every *fifth* bottom hook and only the hooks immediately over these pockets can be lifted.

There are 25 uprights and 25 upper and lower griffe blades; the upper blades are controlled by eight twilling bars and produce the eight leaf twill; the lower blades are reserved for the five leaf twill.

Fig. 134 is a side elevation of a few of the uprights and a transverse section of the upper and lower griffe blades.

Fig. 135 is a front elevation of the combined eight and five leaf twilling mechanisms, together with the upper and lower griffes.

Fig. 136 is a plan of these same parts, but showing the bottom griffe only.

Fig. 137 is an enlarged plan (in part) of the bottom griffe and uprights.

Fig. 138 is a side elevation to demonstrate the rotation of the twilling cylinder shaft.

Corresponding details in the foregoing figures are indicated by the same letters.

A is the long shank and top hook; B the short shank and bottom hook for the same upright; a fixed guide rod passes

through the loops *c* of the uprights, and prevents any tendency on their part to rotate; *D* the top knives; *E* the twilling bars; *F* the twilling cylinder and shaft; *G* the bottom griffe knives with special projecting pockets *H*. These knives each pass through slits in the flat steel bars *I.I'*, between which they are free to move laterally, the bars in turn being supported to the head by suspended and fixed brackets *J*. The bars *I.I'* are *slightly* adjustable with the head through the medium of a lock nut, hook bolt and spiral spring. The top hooks are normally over the griffe knives, but only *one* out of every *five* of the bottom hooks, is and can be normally over the projecting pocket *H*, which is the only part of the bottom griffe designed to lift the upright. The possible lateral traverse of the bottom knives is equal to the distance of the pitch of one, two or three uprights. *K* is an octagonal wheel compounded with the twilling shaft *F*, and *L* is a strong flat steel spring, one end of which is attached to the Jacquard head, and the other free end fits in close contact with the wheel *K*. The combination of *K* and *L* prevents the twilling shaft *F* from rotating too far. *M* is a driving bevel wheel, containing 32 teeth, keyed fast to the shaft *F*. *N* is a driven bevel, containing 20 teeth, compounded with a stud shaft *O* and positive cam *P*. The stud shaft *O* is supported and free to rotate in the sleeve bracket support *Q*, in turn secured to the head. An antifriction bowl *R*, carried by the free arm of the cam lever *S* fits into the groove of the cam *P* as indicated by the dotted lines. The lever *S* is secured to a shaft *T* placed immediately over the ends and at right angles to the top griffe knives. The shaft *T* is supported to the head by suitable brackets, in which it is free to oscillate. Set screwed and adjusted to this shaft is a short lever arm *U*, which together with two duplicates, supports a round steel rod *V*, which passes through a cutting made in and near the end of each bottom griffe blade *G*. The combination and action of this mechanism reciprocates the griffe blades *G* *laterally*. A ratchet wheel *W*, Fig. 138, is compounded with the twilling shaft *F*. A horizontal pawl lever *X* for turning the same is pivoted at *Y* near the top of the fixed spindle *Z*, which is compounded with a bracket casting and firmly secured to the gable of the machine as shown.

**Action of
the Mechanism.**

The figured pattern is cut on the Jacquard cards without any binding weave as is usual for twilling machines. Then, each time the card cylinder and pattern cards are pressed into contact with the needles, the hooks A are pushed off the top griffe D by the *blank* portions, but left over the knife where the card is *perforated*. Simultaneously all the hooks A which are pushed clear of the griffe blades D press the corresponding bottom hooks B over the pockets H in griffe G, but these pockets

Fig. 135.

Fig. 134.

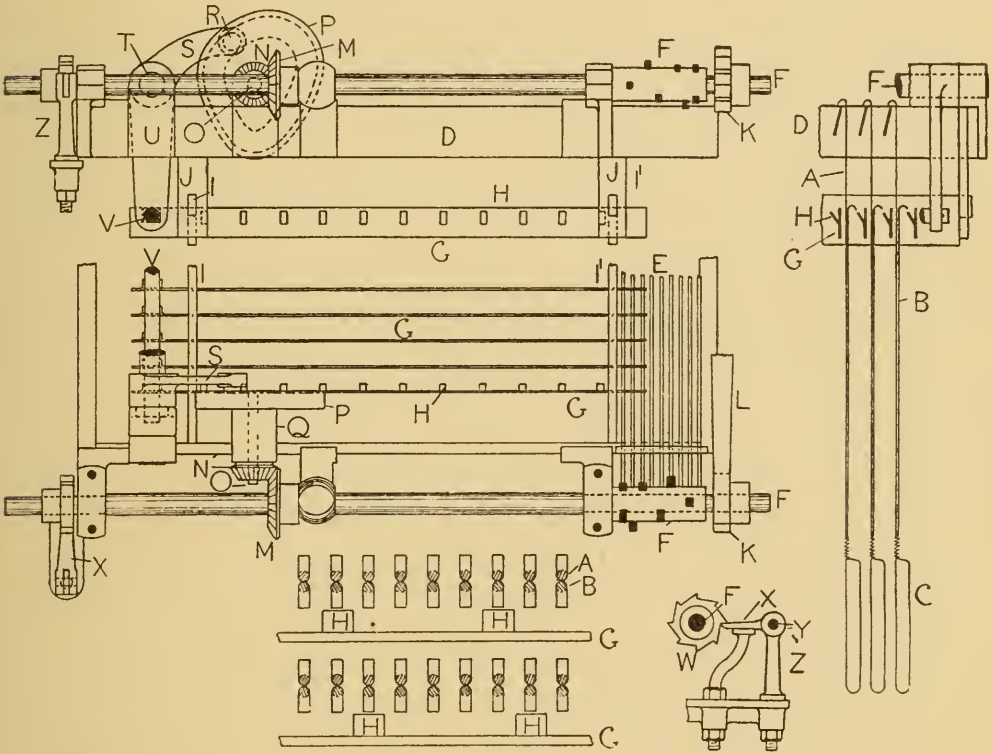


Fig. 136.

Fig. 137.

Fig. 138.

can only lift every *fifth* hook of those that have been left down by the top knife. The twilling cylinder F and twilling bars E act as already described to rock every *eighth* upper griffe blade D clear of the hooks A and leave the same *down* irrespective of their 'selection' by the pattern cards to form the upper or lower divisions of the *figuring shed*.

The twilling cylinder F is rotated $\frac{1}{8}$ of a revolution with each descent of the head by the ratchet wheel w being brought into

striking contact with the free end of the pawl lever x, and so turning it 'one tooth' = $\frac{1}{8}$ revolution.

Then since the driving bevel wheel M contains 32 teeth and the wheel N 20 teeth,

$$\text{The velocity ratio of } \frac{\text{Cam P \& Wheel N}}{\text{Twilling shaft F}} = \frac{32}{20} = \frac{8}{5}.$$

i.e. Cam P makes eight revolutions to every five of the twilling cylinder F or $\frac{8}{5} = 1\frac{3}{5}$ times as fast as F, and since F rotates $\frac{1}{8}$ revolution for each descent of the head and shot of weft, the *cam P* \therefore rotates $\frac{1}{8} \times 1\frac{3}{5} = \frac{1}{5}$ revolution for each descent of the head.

The cam P is constructed to move with each $\frac{1}{5}$ revolution, the bowl R and lever S to the right or left, and through them to oscillate the shaft T and reciprocate the lever U together with rods V and bottom griffe blades G a distance equivalent to the pitch of *two* uprights when the blades G travel to the right, and a distance of *three* uprights when they move laterally to the left, which 'moves' correspond to a five leaf sateen twill thus:—

No. 1	Pick	Each pocket H moves to the right from hook 1 to hook 3
„ 2	„	„ „ „ right „ 3 „ 5
„ 3	„	„ „ „ left „ 5 „ 2
„ 4	„	„ „ „ right „ 2 „ 4
„ 5	„	„ „ „ left „ 4 „ 1

These repeat 8 times to 5 revolutions of the twilling cylinder F.

Grouping of Needles and Hooks for 5 and 8 Leaf Twills.

As previously stated, the number of rows of hooks and griffe blades for either 5 or 8 leaf twilling machines must be some multiple of one or other, or both these binding weaves according to whichever is required. The number of twilling bars must also correspond with the twilling weave.

Therefore with a five leaf twill and five twilling bars, the number of hooks from front to back and of griffe blades must be 20, 25, 30, 35 or 40 irrespective of whether the Jacquard machine contains *eight* or *twelve* rows of ordinary needles. For an eight leaf motion the number of hooks and griffe blades must be 16, 24, 32, 40 or 48 for either eight or twelve row card cylinders. These conditions

are essential in order that the twilling pattern will repeat perfectly in the woven fabric.

The grouping of the hooks with each vertical row of needles for all the standard and normal possibilities from 20 to 48 griffe blades is fully set forth in Table I.

TABLE I.

Standard and normal number of hooks per needle and per row in twilling Jacquards.

No.	Twilling motion.	Rows of holes in card cylinder and needles in needleboard.	Number of hooks controll'd by each vertical row of needles.	Number of hooks per needle and order of distribution.	Relative figuring capacity of Jacquard with 600 needles. †
1	5 leaf	8	20	(3, 2) 4	$\frac{600 \times 20}{8} = 1500$
2	5 ..	8	25	(3 × 7) + (4 × 1)	$\frac{600 \times 25}{8} = 1875$
3	5 ..	8	30	(4, 4, 4, 3) 2	$\frac{600 \times 30}{8} = 2250$
4	5 ..	8	35	4, 5, 4, 4, 5, 4, 4, 5	$\frac{600 \times 35}{8} = 2625$
5	5 ..	12	25	(2 × 11) + (3 × 1)	$\frac{600 \times 25}{12} = 1250$
6	5 ..	12	30	(3, 2) 6	$\frac{600 \times 30}{12} = 1500$
7	5 ..	12	35	(3 × 11) + (2 × 1)	$\frac{600 \times 35}{12} = 1750$
8	5 ..	12	*40	(3, 3, 4) 4	$\frac{600 \times 40}{12} = 2000$
9	8 ..	8	16	(2) 8	$\frac{600 \times 16}{8} = 1200$
10	8 ..	8	32	(4) 8	$\frac{600 \times 32}{8} = 2400$
11	8 ..	8	*40	(5) 8	$\frac{600 \times 40}{8} = 3000$
12	8 ..	12	24	(2) 12	$\frac{600 \times 24}{12} = 1200$
13	8 ..	12	32	(3, 3, 2) 4	$\frac{600 \times 32}{12} = 1600$
14	8 ..	12	*40	(3, 3, 4) 4	$\frac{600 \times 40}{12} = 2000$
15	8 ..	12	48	(4) 12	$\frac{600 \times 48}{12} = 2400$

* Nos. 8, 11 and 14 are suitable for either 5 or 8 leaf twilling motions.

|| Nos. 2 and 5 can be adapted to serve for an 8 leaf twill by casting out one of the three rows of hooks attached to the one needle.

† Figuring capacity of twilling Jacquards = $\frac{\text{total needles} \times \text{hooks per row.}}{\text{Needles per row.}}$

Use of the same Pattern Cards for different widths and fineness of cloth.

The twilling Jacquards afford numerous facilities for satisfying the above conditions. The manufacturer usually paints his design and cuts the pattern cards to suit a given 'harness tie,' but he also frequently uses the same set of cards for various widths and fineness of fabric.

Normal Modifications. It is important to note that the same set of pattern cards, cut for No. 1 grouping of needles and uprights (Table I.) will also serve for any of the groupings 1 to 4 and 9 to 11 both inclusive or for any *eight* row machine of the same *normal* capacity. The same is true of Nos. 5 to 8 and 12 to 15 both inclusive or for any *twelve* row machine of the same normal capacity. The resultant difference in effect may be demonstrated as follows:—

Example 1.—Assume that a cloth is woven 72" wide in a 1200 set and with 20 rows of uprights in an *eight* row machine as No. 1, what change in fineness or width of cloth would be involved if the same set of cards be transferred to a loom containing 25 rows of uprights as No. 2?

One of two things would occur, either the 'set' or the width of cloth would increase.

(1) If the fineness of the web is increased and the width remains the same

$$\text{Then, } \frac{\text{Given set} \times \text{Reqd. No. of uprights}}{\text{Given No. of uprights per row.}} = \text{Reqd. set} = \frac{1200 \times 25}{20} = 1500 \text{ set.}$$

(2) If the width of web is increased and the set remains constant

$$\text{Then, } \frac{\text{Given width} \times \text{Reqd. No. of uprights}}{\text{Given No. of uprights per row.}} = \text{Reqd. width} = \frac{72 \times 25}{20} = 90 \text{ in.}$$

Example 2.—Assume that a cloth is woven in a 1200 set and 72 inches wide in the harness, with 20 rows of hooks, what change in *width* of harness would occur if the pattern cards be transferred to a Jacquard containing 25 hooks, where the harness set is 1400 (70 threads per inch)?

Then two factors must be considered—

(1) An increase in width would result through the increase in the No. of uprights from 20 to 25 in the ratio of these numbers.

(2) A decrease in width would normally result through the closer setting or tying of the harness.

The problem therefore resolves itself into one of double proportion thus :—

$$\begin{aligned} \frac{\text{Given width}}{1} \times \frac{\text{Given set}}{\text{Reqd. set}} \times \frac{\text{Reqd. No. of uprights}}{\text{Given No. of uprights}} &= \text{Reqd. width} \\ &= \frac{72}{1} \times \frac{1200}{1400} \times \frac{25}{20} = 77\frac{1}{2} \text{ inches.} \end{aligned}$$

Special Modification and Grouping of the Hooks. The manufacturer frequently requires to weave the same figured pattern in different widths and fineness of cloth, which involves a reduction in the hooks to a number which does not coincide with any of the normal groupings given in Table I. He must therefore devise some special means of grouping in order to meet these exceptional requirements.

A reduction in the fineness with retention of the same size of pattern and width of cloth can be accomplished by ‘casting out’ some of the warp threads in the harness and allowing these particular harness cords and Jacquard hooks to work empty. It is only advisable to resort to this method when the quantity of material required is small.

When the design has been painted for a given harness tie to suit different widths and fineness of cloth, and where a reasonable number of webs is required of each sort, the following plan of ‘weeding’ or ‘filleying’ out the surplus hooks is adopted.

The *average number of hooks* per row of needles is reduced pro rata to the reduced fineness or width of cloth, but they must be so weeded out, as not to interfere with the 5 or 8 leaf binding twill.

Example 3.—Assume an 8 leaf twilling Jacquard is filled with 32 hooks per 12 row needle board as No. 20, Table II., and it is required to employ the same pattern cards but to reduce the fineness of the cloth from 80 to 70 threads per inch, what average number of

hooks per row of needles would be required when refilling the machine and how should these be grouped with the 12 needles and how should the surplus hooks be left out when refilling?

(a) Then reduced No. of hooks per row of needles = $\frac{32 \times 70}{80} = 28$.

(b) The order of grouping might be as follows: (3, 2, 2) 4 times = 28.

(c) When refilling the machine, leave out the *last four hooks* on the first and alternate rows of hooks, also the *first four hooks* on the second and all the corresponding even rows of hooks.

Fig. 139

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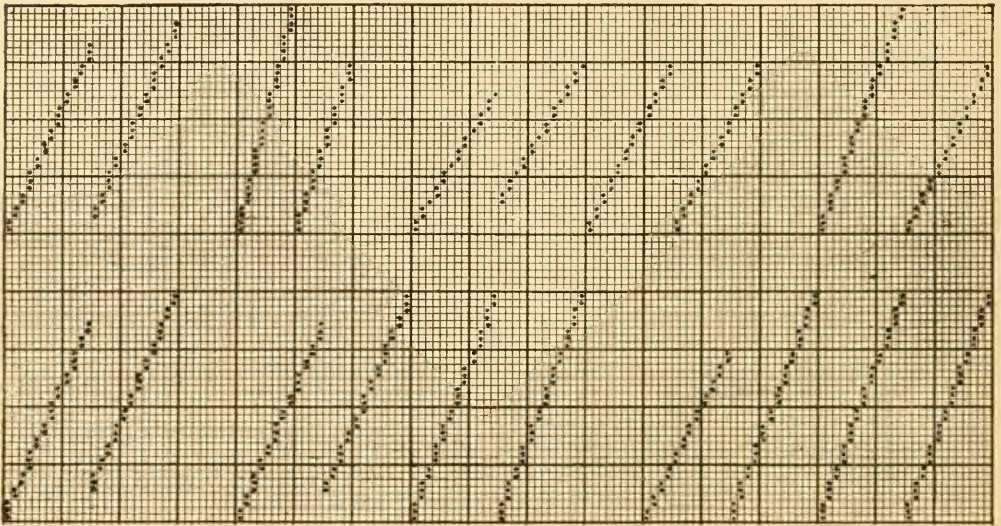


Fig. 143

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An illustration of this example is supplied at Fig. 143. The longitudinal divisions represent the needles, the transverse divisions the griffe blades, and the marks thus ■ the hooks and the number of hooks linked with each respective needle and order of distribution. This method of reducing the number of hooks per row of needles does not interfere with the continuity of the *binding* twill but it causes a *slight* 'break' in the flower details of the pattern.

TABLE II.
Special reduction of hooks per needle and per row to suit various widths and fineness of cloth.

No.	Twilling motion.	Rows of holes in card cylinder and needles in needleboard.	Normal number of hooks per needle and per row.	Required average number of hooks per row of needles.	Reduced number of hooks per needle and per row.	Number of rows of hooks in one repeat	Hooks left out on specified rows.
16	5 leaf	12	(3, 2) 6 = 30	27½ from 30	(2, 2, 2, 3) 3 } (2, 2, 3) 4 }	1 2	Last 3 hooks First 2 hooks
17	8 leaf	8	(4) 8 = 32	28 from 32	(4) 8 } (3) 8 }	1 2	Last 8 hooks
18	8 leaf	12	(2) 12 = 24	22 from 24	(2, 2, 1) 4 } (2, 2, 1) 4 } (2) 12 } (2) 12 }	1 2 3 4	Last 4 hooks First 4 hooks
19	8 leaf	12	(3, 3, 2) 4 = 32	28 from 32	(3, 3, 2) 4 } (2) 12 }	1 2	Last 8 hooks
20	8 leaf	12	(3, 3, 2) 4 = 32	28 from 32	(3, 2, 2) 4 } (3, 2, 2) 4 }	1 2	Last 4 hooks First 4 hooks
21	8 leaf	12	(3, 3, 2) 4 = 32	30 from 32	(2, 2, 3) 4 } (2, 2, 3) 4 } (3, 3, 2) 4 } (3, 3, 2) 4 }	1 2 3 4	Last 4 hooks First 4 hooks
22	8 leaf	12	(3, 3, 2) 4 = 32	30 from 32	(2) 12 } (3, 3, 2) 4 } (3, 3, 2) 4 } (3, 3, 2) 4 }	1 2 3 4	Last 8 hooks

Example 4.—Assume a 5 leaf twilling machine is filled with 30 hooks per 12 row cylinder, find the average number of hooks per row, if the width of the harness is reduced from $78\frac{1}{2}$ to 72 inches but the fineness remains the same.

$$(a) \text{ Then reduced average No. of hooks per row} = \frac{30 \times 78\frac{1}{2}}{72} = 27\frac{1}{2}$$

(b) The best order of grouping the hooks with the needles is as follows :—

Odd rows of needles and hooks	(2, 2, 2, 3)	3	=	27
Even	,, ,, ,,	(2, 2, 3)	4	= 28
				55

$$\therefore \text{Average hooks per row} = \frac{55}{2} = 27\frac{1}{2}$$

(c) When refilling the machine, leave out the last three hooks on all the odd rows and the first two hooks on all the even rows. See Fig. 139 which is modified to meet the requirements of No. 16 in Table II.

Table II. shows the normal and modified order of grouping the hooks to the needles for seven special reductions of hooks per needle and per row to suit various widths and fineness of cloth. These are graphically and respectively represented at Figs. 139 to 145 inclusive.

Figs. 146 to 150 represent an alternative method of distributing the reduced number of hooks in each row of needles and griffe blades. The hooks to be left out of the refilled machine are represented by the marks, thus \blacksquare . This plan of weeding out the surplus hooks does not interfere with the flower or ground of pattern, but it fails to stitch the binding twill wherever a hook is missing.

Fig. 146 distributes the missing hooks over *five* blades for No. 16 in Table II.

Fig. 147 distributes the missing hooks, equally over all the blades for No. 17.

Fig. 148 distributes the missing hooks over four blades for No. 18.

Fig. 149 distributes the missing hooks, equally over all the blades for Nos. 19 and 20.

Fig. 150 distributes the missing hooks over four blades for Nos. 21 and 22.

Fig. 146

147

148

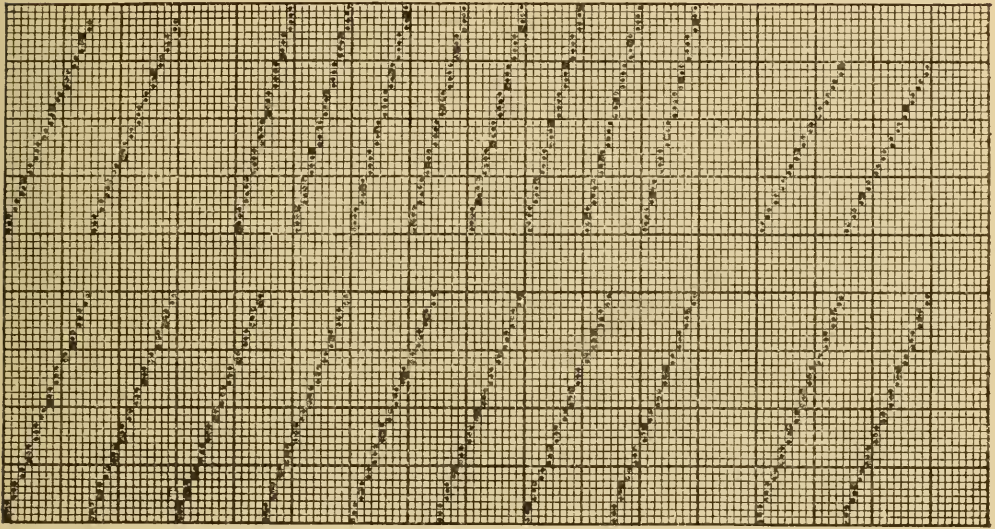


Fig. 149

Fig. 150.

Twilling and Ordinary Jacquards—A Comparison.

The designer for ordinary Jacquards and full harness mounting is not restrained in weave development of figured pattern. Any variety of structural weave, plain, twill or fancy, single, double or complex can be used with the object of increasing the variety of effect of pattern.

The *binding* intersections can be arranged to run in the same or opposite directions in the ground or figure; they can also be designed to 'cut' each other at the junctions of the figure and ground.

Fig. 151 shows a portion of a fully developed warp and weft figure design. The white portion represents the ground, and the grey portion the figure or flower. The sateen binding twill runs to the right in the ground but to the left in the outline of the figure. Some portions of the flower are bound in regular twill order, running

both to the right and to the left, other portions are shaded as shown, by increasing flushes of warp.

Advantages and Defects of the Twilling Motion. The all important advantage of the twilling Jacquard is its great figuring capacity in comparison with the ordinary machine, and the number of needles and cards required. Like most other inventions (notwithstanding its great advantages) it has its defects. These, however, are chiefly *technical*, and are seldom perceived by the uninitiated.

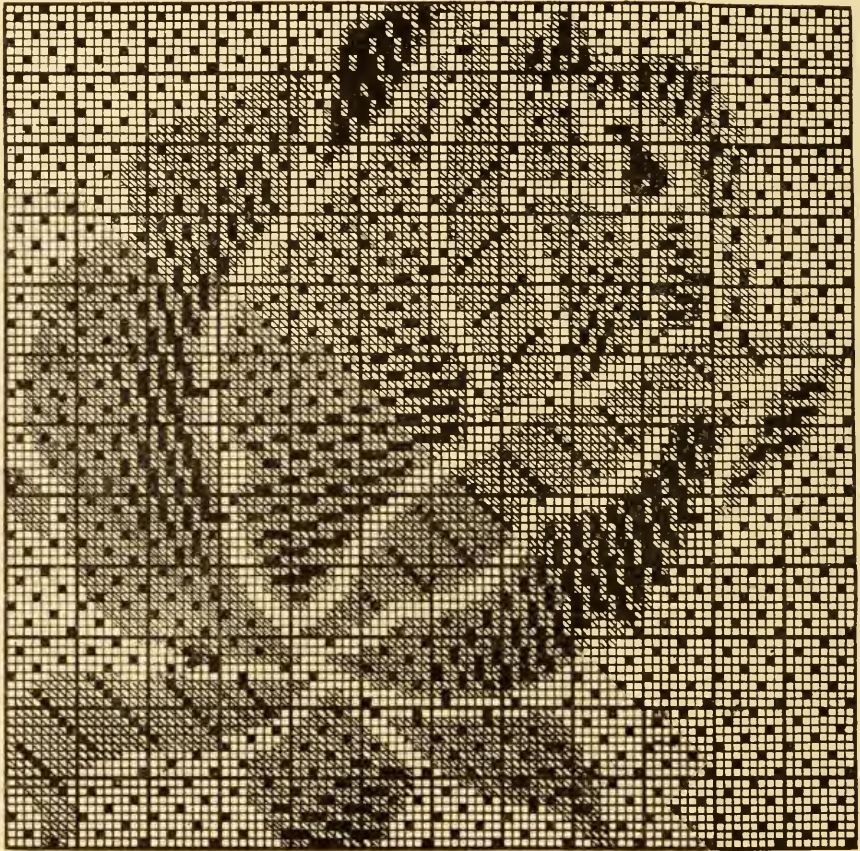


Fig. 151.

First, the binding twill produced by a twilling machine always runs in the same direction for a given direction of harness tie, both in the ground and figure. This limitation makes it impossible to obtain a perfect and minute definition of outline of ground and

figure, since the intersecting binding floats of warp and weft do not exactly meet and technically 'cut' each other. This small defect is illustrated at Fig. 152, which is a portion of a warp and weft figure

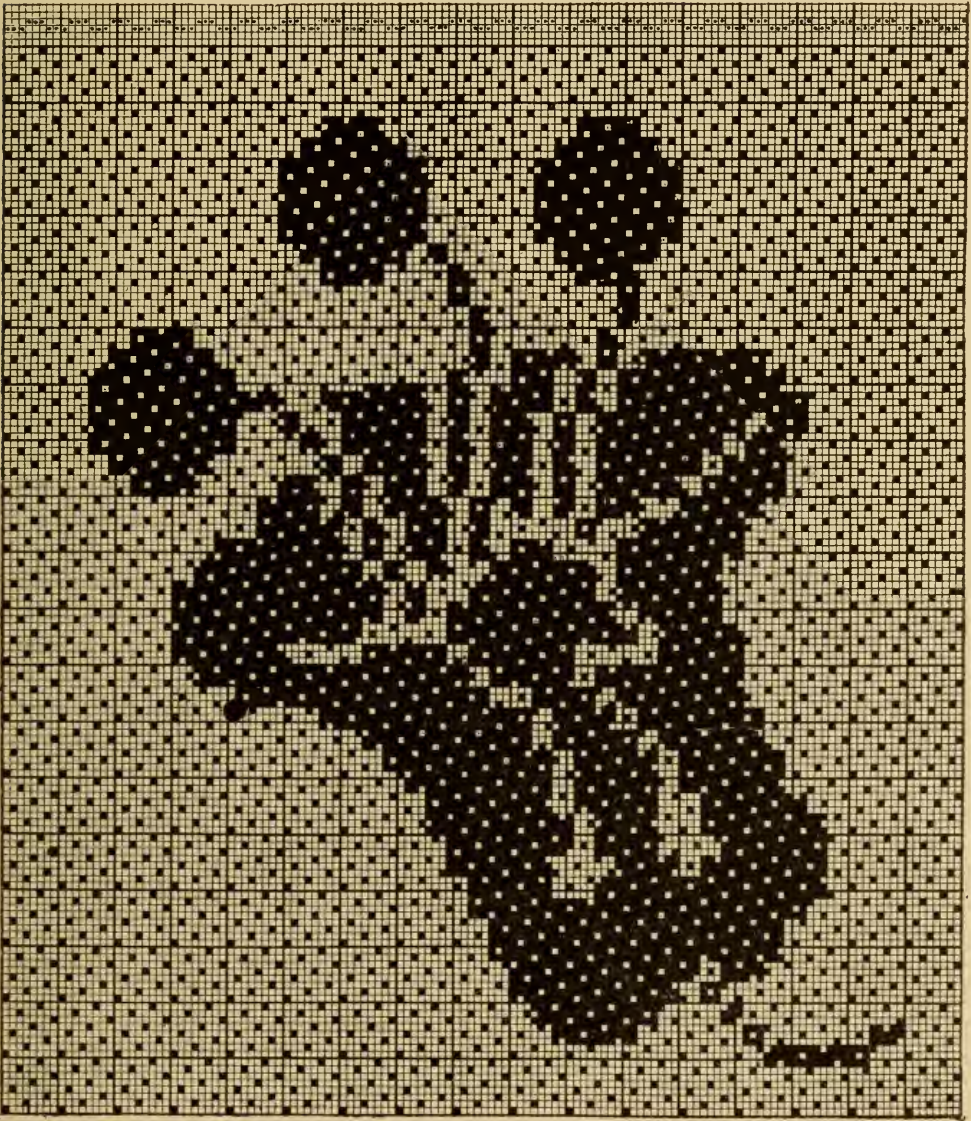


Fig. 152.

woven with three hooks to each needle, simultaneously and automatically bound by the twilling mechanism. The binding twill runs the *same* way in both the ground and figure, and at few points on the outline does the warp stitch 'cut' cleanly that of the weft.

Fig. 153.

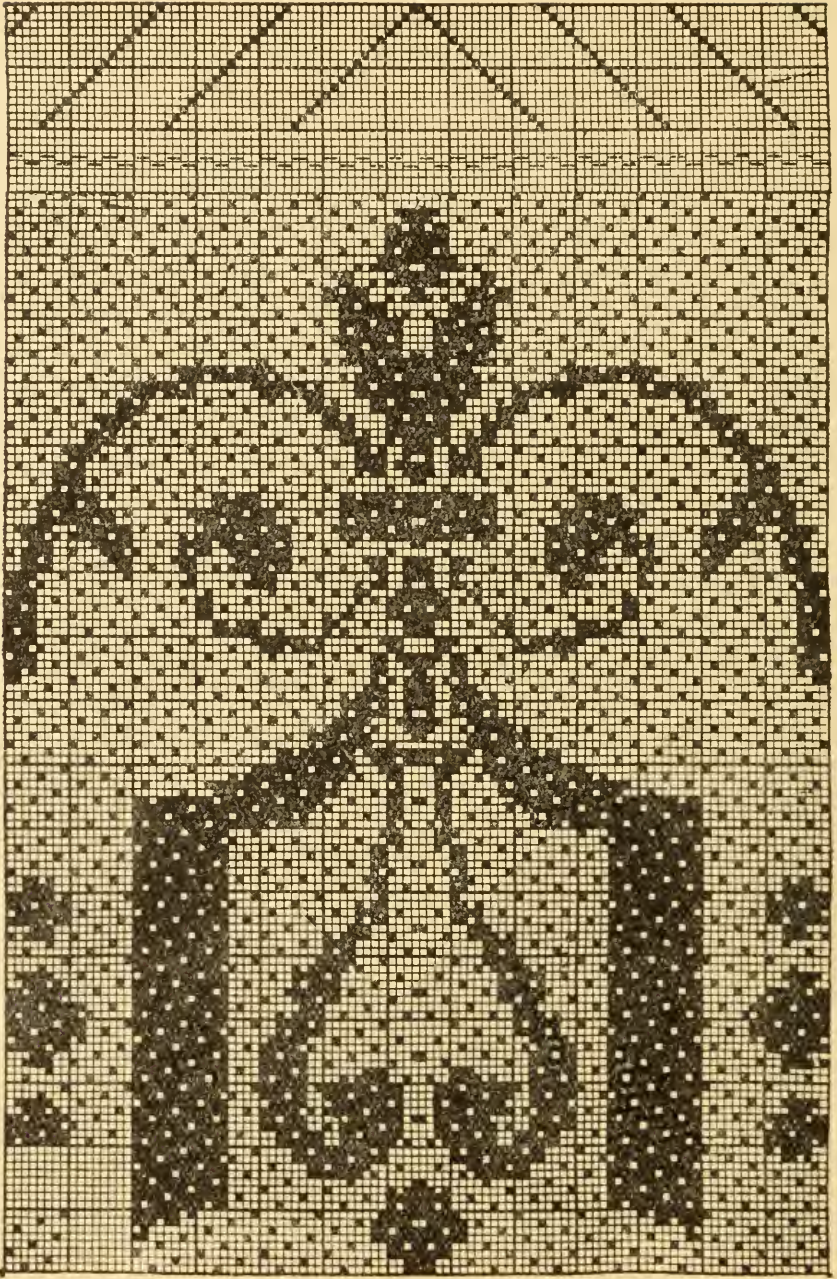


Fig. 154.

Fig. 155.

The second and chief defect of the twilling motion is the slight *breach* made in the pattern at the *junction* of every *turn* in the harness. At every point where the harness is reversed, the warp threads have necessarily to be drawn through the mails in the reverse direction, to coincide with the *turn* in the harness. Consequently,

the harness tie combined with the drafting reverses the figured pattern as desired, but it also automatically reverses, in sympathy with the turn in the harness, the direction of the binding twill, which is not desired. The resultant effect in a bordered pattern, for example, is, the binding twill runs to the right on one side of the border and the centre, where the harness and draft is in the same direction, but it twills to the left in the opposite border, where the harness and draft are necessarily reversed.

This defect is the inherent result of confining the twilling motion to produce the twilling through the medium of the figuring hooks and harness, irrespective of the harness mounting and order of drafting. An independent twilling motion, as in the case of pressure heddles, obviates this difficulty.

The foregoing defects are illustrated as follows :—

Fig. 153 indicates a portion of the tie of the harness, together with the draft of the warp threads at the turn in the pattern; the longitudinal spaces represent the warp threads and also the mails of the harness from front to back; the transverse spaces represent the rows of the harness which correspond to the number of uprights and griffe blades. The markings represent the harness cords and mails and also the warp threads drawn through them.

Fig. 154 indicates the order of arrangement of the pegs in the twilling cylinder—in this case an eight end sateen twill.

Fig. 155 shows the resultant effect of the combined action of the draft Fig. 153, and the twilling pattern Fig. 154, which demonstrates, *first*, the *turn* in the *binding twill*, and *second*, reveals the long float or stitch of weft over twelve ends on each second pick, and over fourteen on each seventh pick in the ground, as compared with a maximum float of seven in the normal twill with full harness mounting. This pattern is woven with two hooks to each needle.

It will be perceived that no shading is shown nor possible by the binding weave.

It will be observed in the portion of the foregoing reproduced figured pattern, that the two central ends are shown exactly alike. In practice it is usual to leave out one of these harness cords, or having tied it up to the hook, to leave the mail which it supports without any warp thread.

CHAPTER XI.

Compound Driving of Twilling Jacquards.

THE driving of Twilling Jacquards is necessarily complex, because each machine contains a large number of figuring hooks, and in addition two or more machines are usually combined and worked over the same loom. The power consumed is considerable, since the average load to be lifted on every pick, for two 600 machines, when weaving 72in. damask containing 70 threads per inch, is approximately 500 lbs. Further, the motion of the 'head' is variable, for it *dwells* in its highest and lowest positions, and the action is still further complicated by having to lift this great weight, and also subsequently to check its gravitation load, which involves the introduction of a counterpoise attachment.

A counterpoise on a Jacquard is an arrangement which checks the force of gravity, and stores it up until its potential energy can be utilised to assist in lifting the Jacquard head on the next succeeding pick.

There are several methods of compound driving in actual practice, with each of which is combined a counterpoise on one of the following principles: (1) the dead weight; (2) the spiral spring; (3) a combination of the dead weight and the spiral spring.

If the required motion is *accelerated* the spring arrangement is better than the dead weight principle, since the initial force required to accelerate a dead weight is relatively greater than with a spiral spring, which has comparatively *no mass*, but which is designed to offer the same amount of resistance and produce the same amount of work. If the motion is continuous, the dead weight principle is preferable, but as already stated, the driving of a Jacquard head is *not* continuous. The *initial* work in starting an accelerated load and dead weight counterpoise is equivalent to a double load.

Compound Levers with Dead Weight Counterpoise.

Fig. 156 is an elevation of the driving arrangement as seen from the right hand side of a right hand loom.

Fig. 157 is a sectional elevation of parts remote from 156.

Fig. 158 is a plan of parts shown in Figs. 156 and 157.

Details of the Mechanism.

A is the bottom loom shaft, B a spur wheel containing 56 teeth, driving a second spur wheel C with 28 teeth. C is supported and free to rotate on the fixed stud D, at the same rate as the crank shaft. A stud and swivel link E combines the spur wheel C with the drawing rod F, which is adjusted by lock nuts to the swivel link G on stud H in the lever I. This lever is pivoted on the stud J in the bracket and cross rail K, which is supported between the two gantry rails L and L¹. A stud M in the left arm of the lever I combines through the link N and stud O, the lever P which is set screwed to the shaft Q. This shaft is supported above the gantry L¹ in suitable brackets, where it is free to oscillate. A single arm lever R (Fig. 157), remote from P, is fastened to the shaft Q and carries at its free end an antifriction bowl S on which the base of the head G rests. To the right arm of lever T a stud U connects the rod V and counterpoise weight W. All the foregoing details are duplicated at the opposite and left hand side of the loom.

Action of the Mechanism.

The spur wheel C rotates uniformly counter-clockwise at the same rate as the crank shaft. Immediately the stud E, in wheel C, has passed the top centre it commences to pull down the rod F and the right arm of lever I, and conversely to lift the left arm of the same lever, together with the connecting details M N O and lever P, and to rock the shaft Q counter-clockwise. The lever R being fixed to this shaft also rises in sympathy, and bowl S, pressing in rolling contact with the base of the head G, lifts it the required distance.

This work has been assisted by the gravitation load of the counterpoise weight W, acting through the rod V and the stud U, upon the right arm of lever I. With the continued rotation of wheel C, the rod F and right arm of lever I are raised together with

the weight *w*, while the *left arm* of lever 1 descends together with the lever *p* to rock the shaft *q* clockwise. The lever *r* and bowl *s* descend in sympathy. The *weight* of the head with its complement of hooks, harness and lingoes constantly pressing upon the bowl *s*,

Fig. 156.

Fig. 157.

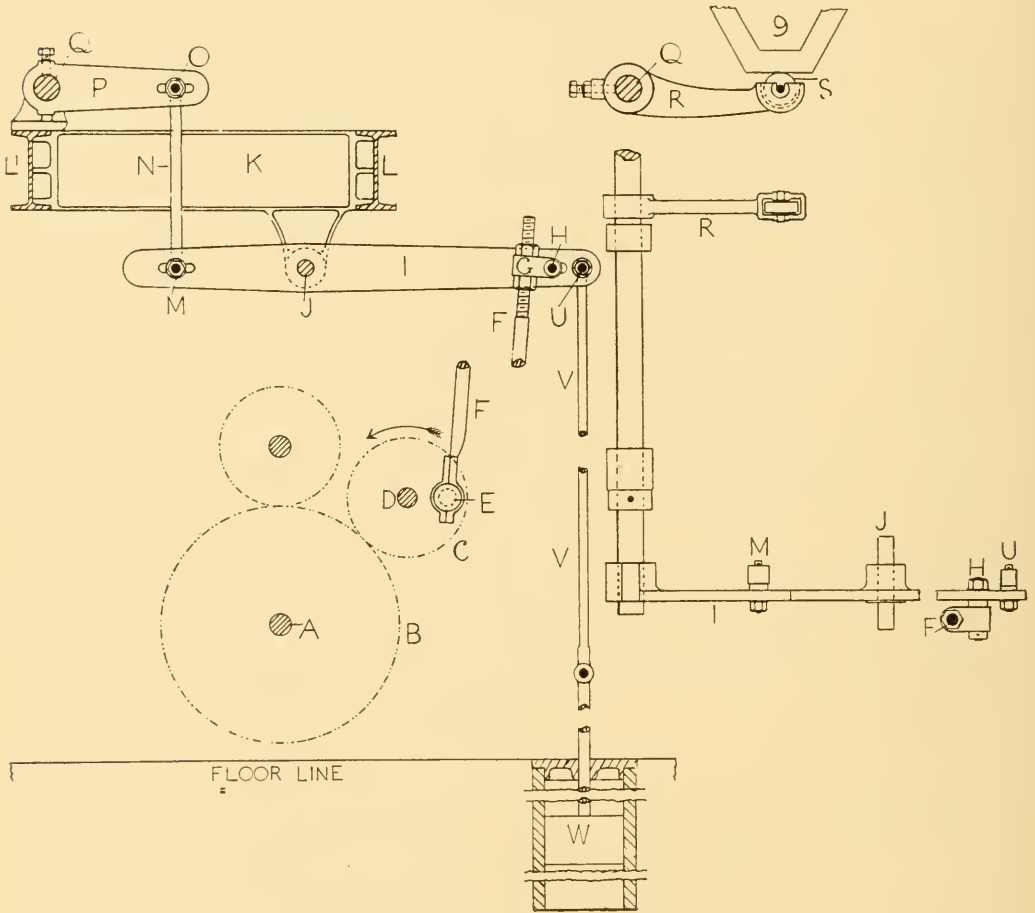


Fig. 158.

assists, through its connections to depress the lever *p* and the *left arm* of lever 1 and to elevate its right arm with which ascends the weight *w* and conversely operates to check any rapid fall on the part of the head *g*.

Single Lever with Spiral Spring Counterpoise.

This method of driving with a single eccentric is adopted when only one twilling Jacquard is employed, *e.g.*, when weaving napkins or 'table tops.'

Fig. 159 is an elevation as seen from the right hand side of a right hand loom.

Fig. 160 is a sectional elevation of parts remote from those illustrated at 159.

Fig. 161 shews parts remote from 160.

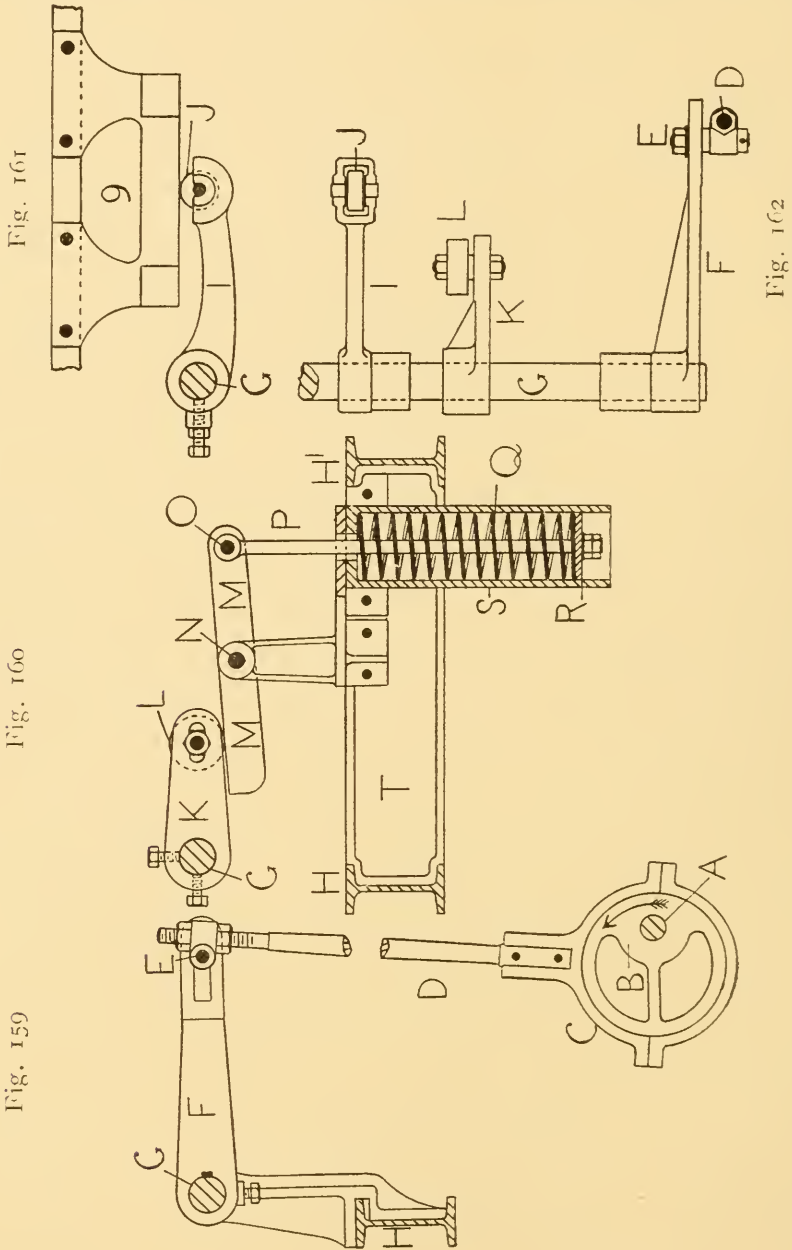
Fig. 162 is a plan of the details in Figs. 159, 160 and 161.

Similar numerals in each diagram refer to identical details.

Details of the Mechanism. A is the loom crank shaft and B an eccentric 9" diameter, 2" face and $4\frac{1}{2}$ " 'lift.' An iron collar 'strap' C circumscribes the eccentric B. A reciprocating rod D combines the collar C, through the swivel link and stud E with the lever F keyed fast to the shaft G. This shaft is supported immediately above the fixed gantry H by the bracket as shown, in which it is free to oscillate. A second single lever I is set screwed to the same shaft G but remote from F (Figs. 161 and 162). The free arm of this lever carries an antifriction roller J on which rests the base of the Jacquard head G. Upon the same shaft G and between the levers F and I a third single lever K is double set screwed (Fig. 160). This lever carries an antifriction bowl L which is kept in rolling contact with the left arm of lever M, pivoted at N. Suspended from the stud O in the right arm of lever M is a spindle rod P circumscribed by a $\frac{1}{2}$ " strong spiral spring Q, which is supported by an iron disc plate R and nuts as shown at the base of the spindle P. The spindle and spring are both enclosed in a strong iron cylinder S which is securely bolted to a strong cross rail T combined with the fixed gantries H and H¹. The bottom of the iron cylinder is open but the top is partly closed against which the spiral spring may be compressed.

Combined action of the Eccentric and the Counterpoise. The constant rotation of the crank shaft A with the eccentric B reciprocates the rod D and lever F which in turn, oscillates the shaft G. The oscillation of this shaft counter-clockwise, together with the lever arm I and the bowl J combines to lift the Jacquard head G. This is assisted by the potential energy stored in the spring Q, acting through the parts R P M and K.

The oscillation of the shaft G clockwise depresses the lever I and bowl J and permits the head 9 to descend by its own gravity; its fall is however retarded by the negative resistance offered by the



details K to S and the energy thus developed is stored up in the spiral spring Q to be afterwards expended in assisting to lift the head on the next subsequent pick.

Compound Levers, with Counterpoise of Solid Drawing Rods and Spiral Springs.

The drawing rods are made solid and about 2" in diameter, the object being to use them as a counterpoise also and thus obviate the necessity for supplementary weights. This method was introduced by the "York Street Flax Spinning and Weaving Co., Belfast."

Fig. 163 is an elevation as seen from the left hand side of a right hand loom.

Fig. 164 is a sectional elevation of details remote from those in Fig. 163.

Fig. 165 is a sectional elevation of details remote from Fig. 164.

Fig. 166 is a plan of these details.

Details of the Mechanism.

A is the crank shaft, B the spur driving wheel geared into the spur wheel C, keyed to the low shaft D. The spur wheel D gears into a spur wheel E, containing the same number of teeth as B and free to rotate on the stud F fixed in the loom gable. An adjustable stud G set out of centre and compounded with the wheel E supports a swivel link H adjustably compounded with a *solid* draw shaft I. A stud J combines the draw shaft with the lever K pivoted at L in the upright bracket compounded with the cross rail M fixed to the gantries N and N¹. The lever K is compounded through the stud O, link P and stud Q with the lever R keyed to the shaft S which is supported to and free to oscillate immediately over the gantry N¹. A simple lever T (Fig. 165) keyed to the shaft S carries an antifriction bowl U upon which the base of the head G rests. W (Fig. 164) is a third simple lever keyed and set screwed to the shaft S, having its free arm resting in close contact with a $\frac{3}{8}$ " spiral spring X on the split 'spindle' Y fixed to and supported by the cross rail M¹ in turn compounded with the gantry rails N and N¹. All the foregoing details are duplicated at the opposite and right hand side of the loom.

Action of the Mechanism.

The stud wheel E and stud G rotate clockwise with uniform velocity. Immediately the stud G passes the top centre and commences to descend, it pulls down, assisted by its own gravity, the solid drawing rod I,

the stud *J* and the left arm of the lever *K*, but the stud *O*, link *P*, stud *Q* and lever *R* rise and oscillate the shaft *S* clockwise. In

Fig. 165

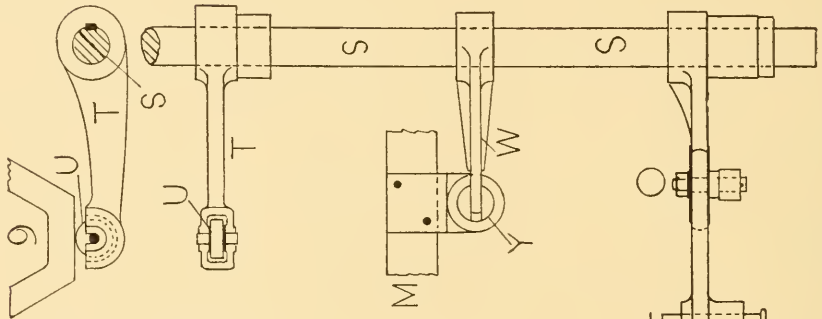


Fig. 164

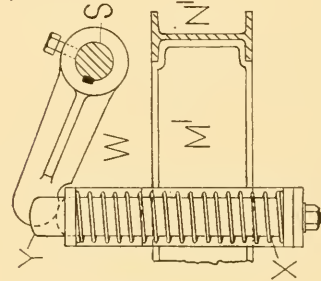


Fig. 163

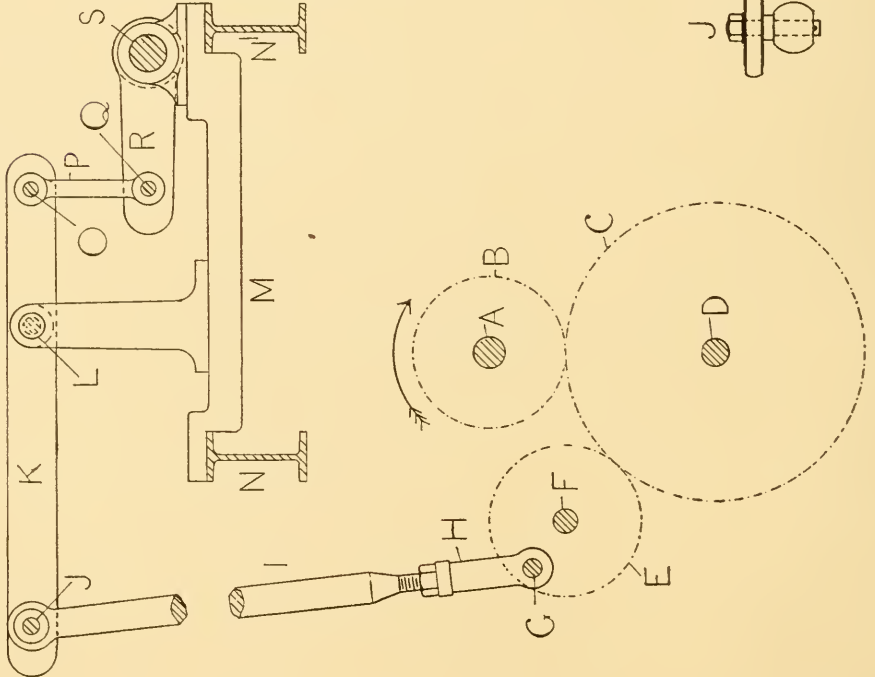


Fig. 166

sympathy with the oscillation of shaft *s*, the lever *r* and bowl *u* rise and lift the head *g*. The oscillation of the shaft *s* clockwise is

further assisted by the spiral spring x acting on the free arm of the lever w .

Immediately the stud g passes the bottom centre F all the foregoing movable parts operate in the reverse direction. The stud g rises on the left side of F and lifts the rod l , stud J and left arm of lever κ but depresses its right arm together with the details $o p q r$ to oscillate the shaft s counterclockwise and lever τ with bowl u in sympathy. This combined action releases the pressure on the head which, due to its own gravity descends and simultaneously assists to rock the shaft s counterclockwise, to lift the two solid rods and to deflect the two spiral springs. The gravitation load which the head thus exerts is stored in the two heavy rods, raised to their highest point, and the deflected spiral springs, when the head is at the bottom. This stored energy is free to be utilised in lifting the head to form the next successive shed.

Problems on Compound Driving and Value of Counterpoise.

Problem 1.—Based on the dead weight counterpoise system, described in connection with Figs. 156 to 158.

- Ascertain (a) The lift of the head and depth of shed in inches.
- (b) The work done in foot lbs., in lifting the Jacquard head on each pick.
- (c) The value of the counterpoise in foot lbs. together with its ratio value of the work done.

A foot lb. is the work done in lifting a mass of 1 lb. through a distance of 1 foot.

The average load to be lifted on each pick is 450 lbs. made up as follows :—two heads 184 lbs. plus 266 lbs. (half load of hooks, harness and lingoes).

The counterpoise load for both sides of the loom = 2 (weight of w , 60 lbs. plus 18 lbs. weight of rod v) = 156 lbs. The diameter of the circle described by the stud E = 6" The distance between the centres $H J$ = 18"; $J M$ 10"; $o q$ 10"; $q s$ 11 $\frac{1}{4}$ " and $J U$ 21".

Then (a) the lift of the head,

$$= \frac{(\text{dia. cir. described by stud } E) (J M) (q s)}{(\text{Distance } H J) (o q)} = \frac{6 \times 10 \times 11\frac{1}{4}}{18 \times 10} = 3\frac{3}{4}$$

(b) The work done by lifting the head through a distance of $3\frac{3}{4}$ "
 $= (\text{Av. load of hd. per pk.}) (\text{Lift of hd. in ft.}) = \frac{450 \times 3\frac{3}{4}}{12} = 140.6 \text{ ft. lbs.}$

(c) Value of counterpoise and ratio value of work done.

(1) Distance travelled by weights w in feet.

$$= \frac{(\text{Dia. of cir. described by stud E}) (J U)}{(H J)} = \frac{6 \times 21}{12 \times 18} = \frac{7}{12} \text{ ft.}$$

(2) Value of counterpoise.

$$= (\text{Distance travd. by } w \text{ in ft.}) (\text{load in lbs.}) = \frac{156 \times 7}{12} = 91 \text{ ft. lbs.}$$

(3) Ratio value of counterpoise.

$$= \frac{\text{Value of counterpoise}}{\text{Work done in lifting head}} = \frac{91 \times 100}{140.6} = 64.7 \%$$

Work Stored in Spiral Springs.

The deflection in a spiral spring varies directly as the load. The load value of a spiral spring acting through any given distance is equivalent to half the maximum load required to deflect the spring the given distance. If the spring is initially under deflection, then the load value of the spring will be equivalent to half the original load plus half the final load, *e.g.*

(1) If the load resistance of a spiral spring is 100 lbs. per inch of deflection in the spring, then assuming the spring to be deflected 3 inches, the mean load resistance or work stored in the spring acting through 3 inches $= \frac{100 \times 3}{2} = 150 \text{ lbs. per inch.}$

(2) If the spring is initially deflected $\frac{1}{2}$ an inch, then the mean load resistance

$$= (\frac{1}{2} \text{ load of } \frac{1}{2}'' \text{ spring deflection}) + (\frac{1}{2} \text{ load of } 3\frac{1}{2}'' \text{ deflection}) \\ = \frac{100}{2} \times \frac{1}{2} + \frac{100}{2} \times 3\frac{1}{2} = 200 \text{ lbs. per inch.}$$

The work done by the spring in giving out its stored energy over a distance of 3 inches equals

$$\text{Case 1. } \frac{150 \times 3}{12} = 37\frac{1}{2} \text{ ft. lbs.}$$

$$\text{Case 2. } \frac{200 \times 3}{12} = 50 \text{ ft. lbs.}$$

Problem 2.—Based on the spiral spring counterpoise system described in connection with Figs. 159 to 162.

Ascertain (a) The lift of the head. (b) The work done in lifting the head on each pick. (c) The net amount of deflection in the spiral spring caused by the head descending from the top to the bottom. (d) The value of the counterpoise and (e) its ratio value of the work done per pick.

The average load to be lifted on each pick is 250 lbs. made up as follows:—Weight of head = 112 lbs., plus 138 lbs. (*half* load of 1824 hooks, 2810 harness and 2810 lingoes).

The normal length of the spiral spring Q is 14.6". The initial deflection of the spring when the head g is at the top is nil. The load resistance per inch deflection of the spring is 175 lbs.

The throw of the eccentric B is $4\frac{1}{2}$ "; the distance between the centres $E G = 15$ ", $G J = 11\frac{1}{4}$ ", $G L = 7$ ", $L N = 5\frac{1}{4}$ " and $N O = 7$ ".

(a) The lift of the head,

$$= \frac{(\text{Throw of eccentric } B) (G J)}{\text{Distance between centres } E G} = \frac{4\frac{1}{2} \times 11\frac{1}{4}}{15} = 3\frac{3}{8}"$$

(b) The work done by raising the head through $3\frac{3}{8}$ "

$$= \frac{250 \times 3\frac{3}{8}}{12} = 70.3 \text{ ft. lbs.}$$

(c) The deflection in the spring due to the falling head,

$$= \frac{(\text{Throw of } B) (G L) (N O)}{\text{Distance between centres } (E G) (L N)} = \frac{4\frac{1}{2} \times 7 \times 7}{15 \times 5\frac{1}{4}} = 2.8"$$

(d) The value of the counterpoise in foot lbs.,

= (Mean active force in lbs. per inch) (deflection in feet).

$$(1) \text{ Mean active force} = \frac{175 \times 2.8}{2} = 245 \text{ lbs.}$$

$$(2) \text{ Deflection of spring in feet} = \frac{2.8}{12} = \frac{7}{30}$$

$$\text{Then work stored} = \frac{245 \times 7}{30} = 57.2 \text{ ft. lbs.}$$

(e) Ratio of work done,

$$= \frac{\text{Value of counterpoise}}{\text{Amt. of work done}} = \frac{57.2 \times 100}{70.3} = 81.3\%$$

The load resistance and deflection of the above spring is graphically represented at Fig. 167 and for the spring in problem 3 at Fig. 168.

Problem 3.--Based on the dead weight and spiral spring system described in connection with Figs. 163 to 166.

Ascertain (a) The lift of the head. (b) The average number of foot lbs. of work done in lifting the Jacquard head on each pick. (c) The value of the dead weight counterpoise. (d) The value of the spiral spring counterpoise, and (e) the ratio value of the combined counterpoise of the work done per pick.

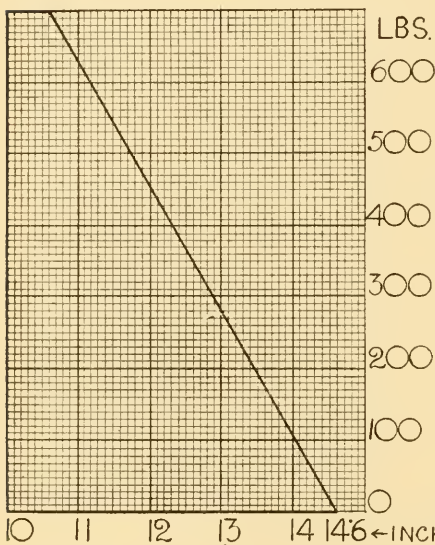


Fig. 167.

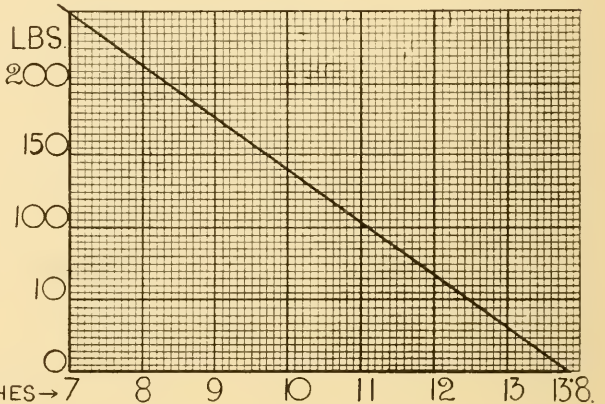


Fig. 168.

The average load to be lifted on each pick for two machines is 480 lbs. made up as follows:—Weight of two heads = 265 lbs. plus 215 lbs. (half load of 2448 hooks, 4408 harness and lingoies).

The weight of the two solid drawing shafts $1 = (104 + 104) = 208$ lbs. The normal length of the spiral spring x is $13.8''$; the initial deflection of the spring when the head is up = $0.5''$, the final deflection = $3\frac{1}{2}''$. Then $3\frac{1}{2} - \frac{1}{2} = 3''$ net. The amount of load per inch deflection = 32 lbs.

The circle described by stud $G = 6\frac{7}{8}''$. The distance between centres $JL = 18\frac{1}{2}''$; $LO = 8\frac{1}{2}''$; $QS = 9\frac{1}{4}''$; $US = 11''$; $VS = 9''$.

(a) Lift of Jacquard head,

$$= \frac{(\text{Dia. cir. described by stud G (L o) (U s)})}{\text{Centres (J L) (Q S)}} = \frac{6\frac{7}{8} \times 8\frac{1}{2} \times 11}{18\frac{1}{2} \times 9\frac{1}{4}} = 3\frac{3}{4}''$$

(b) The work done by lifting the head through $3\frac{3}{4}''$,

$$= \frac{480 \times 3\frac{3}{4}}{12} = 150 \text{ ft. lbs.}$$

(c) The value of the dead weight counterpoise,

$$= \frac{(\text{Weight of shafts I) (J L) (Q S)}}{(\text{L o) (U s)}} \times \text{Distance travelled by head.}$$

$$= \frac{208 \times 18\frac{1}{2} \times 9\frac{1}{4}}{8\frac{1}{2} \times 11} \times \frac{3\frac{3}{4}}{12} = 119 \text{ ft. lbs.}$$

(d) The value of *one* spiral spring,

= (Mean active force in lbs.) (deflection in feet).

$$(1) \text{ Mean active force} = \left(\frac{32}{2} \times \frac{1}{2}\right) + \left(\frac{32 \times 3\frac{1}{2}}{2}\right) = 64$$

$$(2) \text{ Deflection of spring} = \frac{3}{12} \text{ ft.}$$

$$\text{Then work stored in spring} = \frac{64 \times 3}{12} = 16 \text{ ft. lbs.}$$

(e) Ratio value of the duplex counterpoise,

$$= \frac{(119 + 16) \times 100}{150} = 90 \%$$

This ratio counterpoise value of 90 % of the work done is approximately as much as can be conveniently used in practice. In fact, the use of the second spring x, Fig. 164, as a counterpoise was found to be a disadvantage rather than otherwise in the given loom and problem; when weaving some goods both springs are discarded. The counterpoise values in the first problem might, with advantage, be increased to 75 % of the maximum load.

Theoretically, the weight of the head and the counterpoise should balance each other and the energy required to overcome the frictional resistance should be supplied from the driving mechanism, but practical experience demonstrates that the counterpoise load should be on the light side rather than actually balance.

CHAPTER XII.

Pressure and Split Harness Weaving and Mechanism.

Pressure Harness Weaving.

THIS system of weaving is confined chiefly to the manufacture of the finest silks and linen damasks. The fundamental principle of pressure harness mounting and weaving, ranks as the oldest system of figure weaving extant, at one period being the only system in common use, for which reason it was called '*common harness*,' a designation by which it is still known, though the system is not now common. In some districts '*twilling harness*' is also denominated common harness as distinguished from *full harness*, where only one harness cord in every repeat of pattern is connected to each Jacquard figuring hook, and where each hook is controlled by a separate needle.

Pressure harness nevertheless still merits favour with manufacturers of special classes of figured goods on both hand and power looms. With hand loom weavers, because it primarily increases the relative figuring capacity of the Jacquard machine, and facilitates the production of large repeat patterns without having recourse to the employment of two or more machines, which would necessarily entail more physical labour than could be conveniently expended. With power loom weavers, not only because large repeat patterns can be produced without the aid of Jacquards of normally large figuring capacity, but also because the binding weave, being controlled independently of the figuring harness is both uniform and perfect.

Linen damasks, woven on hand looms with pressure harness mounting, always command better prices than the same type of cloth woven on power looms with twilling Jacquards. The belief is firmly held by both manufacturers and merchants that the hand

woven product is better in stability of texture, strength and quality of material than is its contemporary power woven product. It is perhaps important to note, that only the best warps can be used in pressure harness weaving, because of the excessive *strain* which is thrown upon the threads during the process of weaving. In the hand loom woven product, single lift Jacquards are always employed and when this type of machine is used in power loom weaving with pressure harness mounting, a fabric is produced which most nearly resembles the hand woven product.

Principles of Pressure Harness and Weaving. Briefly, in pressure harness weaving, from 2 to 8 threads of warp pass through each mail of the harness, and afterwards, individually through separate mails in a set of heddles placed immediately in front of the harness. This simple arrangement is the factor which increases the figuring capacity of an ordinary Jacquard machine beyond its normal and initial capacity, and thus saves a considerable quantity of machinery, mounting and harness. The mails of the heddles are made a sufficient depth to allow (independently of them) a figuring shed to be formed by the groups of warp threads drawn through the harness. The Jacquard and harness operate the figuring sheds in groups of two or more threads, according to the number drawn through each harness mail. The griffe knives remain up with the lifted hooks for two or more shots of weft, during which time, the pressure heddles interchange to produce the binding twill in the ground and the figure.

Fig. 169 shows in elevation, as viewed from the side of the loom, one row of harness, the heddles, the figuring and binding sheds, and a transverse section of the woven cloth.

Fig. 170 is a plan view of a portion of the same woven cloth, the vertical lines of which represent the *weft*, and the transverse lines, the *warp*; the markings where the warp and weft intersect, indicate that the warp, at these points is raised to the surface.

Fig. 171 is an enlarged plan view of one row of harness mails from front to back, also five rows of mails in pressure heddles, and the warp threads.

Similar letters in each diagram refer to corresponding details. A represents the comberboard, B the harness, C the harness mails, D the lingoos, F the pressure heddles, G the heddle mails, H the warp threads, I the weft and J a transverse section of the cloth through the weft. A portion of the reed is shown at K and the shuttle at L.

Fig. 169.

Fig. 170.

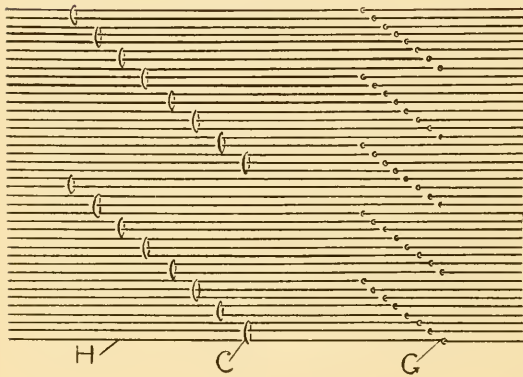
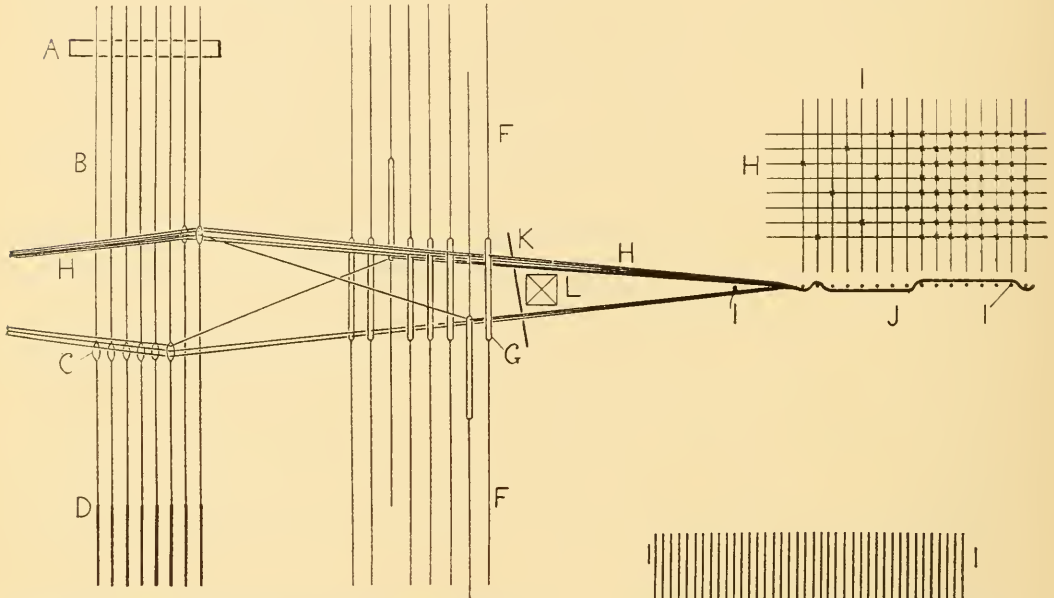


Fig. 171.

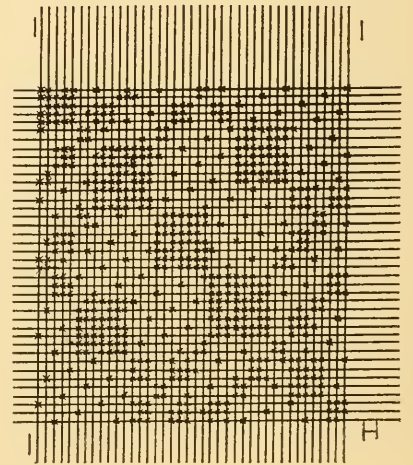


Fig. 172.

The warp threads are first drawn through the harness mails, as shown in this example (Fig. 171), in groups of 3, 2, 3, 2, 3, 2, 3, 2, *i.e.*, 20 warp threads through 8 harness mails, equal to an average of $2\frac{1}{2}$ threads per mail. The threads H are then shown to be drawn singly through separate heddle mails G.

The increased figuring capacity of the Jacquard due to this arrangement is equal to the product of the number of uprights and the average number of threads drawn through each harness mail, thus :—

No. of uprights in Jacquard mach. \times Average No. threads per mail.

Then given two 600 machines

$$\frac{600 \times 2}{1} \times \frac{3 + 2}{2} = 3000 \text{ threads, capacity.}$$

Fig. 172 is a plan view of the woven cloth.

Fig. 173 is the fully developed pattern design for same, complete on 40 ends and picks, to demonstrate the value of the foregoing mechanism. The figure effect of pattern is produced by 16 hooks and harness, and the binding weave in 8 end sateen order by 8 pressure heddles as shown in plan at Fig. 171. It should be observed that the masses of figure for the grouping of the threads given, can only be formed of 2, 3, 5 (the sum of 2 and 3), and multiples of 5 plus either 2 or 3 threads. The definition at the outline of the figure cannot be less than 2 or 3 threads, excepting where the binding weave happens to divide them. Simultaneously with the formation of the figuring shed, one of the pressure heddles (Fig. 169) *descends* and *depresses* every eighth thread of the warp that has been lifted by the harness. Similarly one pressure heddle *rises* on every pick and *lifts* every eighth thread of warp that has been left down by the harness. The harness changes to form a new figuring shed according to the required number of shots per card, but the heddles change on every shot, usually in sateen order. The depressed heddle binds the warp figure and the raised heddle, the weft figure.

Depth of Sheds.

The depth of the shed is primarily governed by the elasticity of the yarn. Linen yarn, though very strong is non-elastic in comparison with cotton or wool. If the warp is overstretched it hangs slack in the shed. The necessary formation of the two sheds—one in the harness and one in the heddles—puts considerable strain upon the warp yarn, consequently the size of the shed in the heddles and in front of the

reed is usually very small. The shuttles used are always very shallow and seldom exceed one inch in depth.

The following practical details are suitable for a loom weaving linen damask 78" wide in the reed. Depth of shuttle, $\frac{1}{16}$ " ; breadth of shuttle $1\frac{3}{4}$ ". Stroke of lay—reed in point of contact with the cloth, $7\frac{3}{4}$ ". Fell of cloth to eighth or back heddle, 13". Fell of

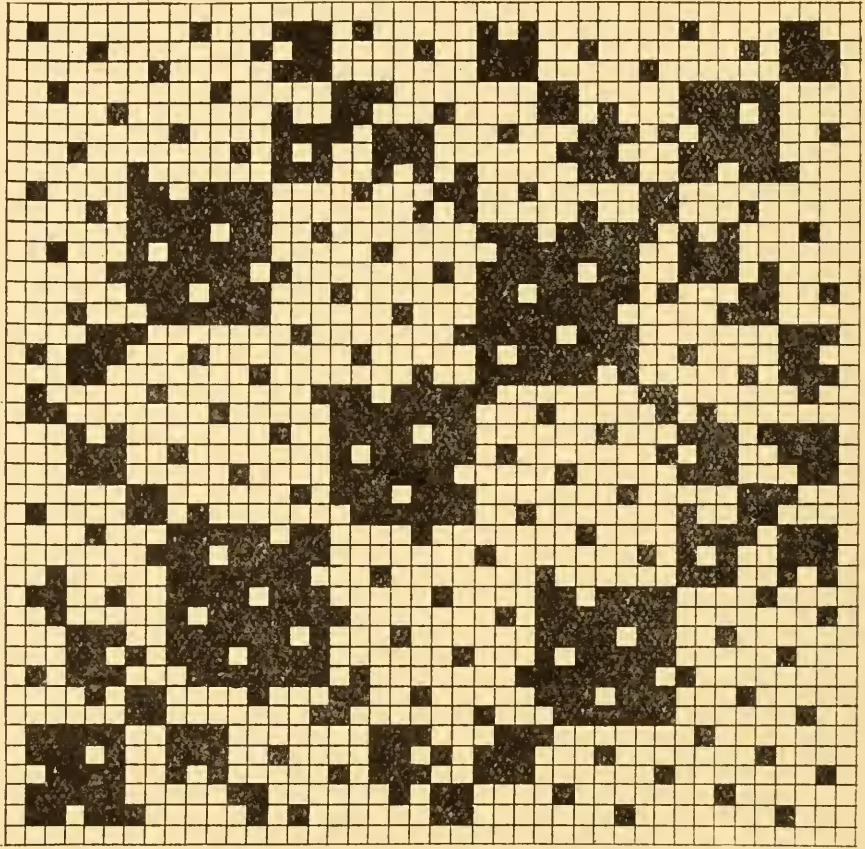


Fig. 173.

cloth to back harness mail, 28". Fell of cloth to back or warp rail, 65". Fell of cloth to point of contact with breast or cloth rail, $4\frac{1}{2}$ ". Width of cloth rail $6\frac{1}{2}$ ". From the foregoing data the following solutions may be ascertained.

(1) The depth of the shed in the heddles, or lift of the back heddle,

$$\begin{aligned}
 &= \frac{\text{Depth of shuttle} \times \text{heddle from cloth}}{\text{Stroke of lay} - \text{width of shuttle}} \\
 &= \frac{\frac{1\frac{5}{6}}{7\frac{3}{4}} \times 13}{16} = \frac{15}{16} \times \frac{13}{6} = \frac{65}{32} = 2\frac{1}{32}''
 \end{aligned}$$

(2) The depth of the shed in the harness,

$$\begin{aligned}
 &= \frac{\text{Depth of shed in the heddles} \times \text{harness from cloth}}{\text{Heddle from cloth}} \\
 &= \frac{65}{32} \times \frac{28}{13} = 4\frac{3}{8}''
 \end{aligned}$$

Experience teaches that in order to obtain a *clear* shed, of the required depth, the Jacquard head and griffe knives must traverse a distance which is slightly in excess of the actual size of the required shed. In this example the lift of the head should be about $4\frac{3}{4}''$ with a possible adjustment up to 5 inches.

Intermittent Driving of Pressure Harness Jacquards.

The Jacquard head with the griffe knives, in power loom weaving for pressure harness, is usually operated by tappets, which are constructed to lift and keep the head up for two or more picks of weft, so as to allow the insertion into the cloth, of two or more shots for each figuring card; during the dwell of the Jacquard, the pressure heddles are free to interchange twice or oftener to form the binding sheds. The manufacturer who adopts this type of Jacquard and mounting usually has to design his own method of driving, consequently there are many systems in use, most of which are similar in principle. The single lift Jacquard is most frequently employed, but a double lift machine can also be successfully adopted.

Driving Single Lift Pressure Harness Jacquards.

Fig. 174 is an elevation of a section of a single lift mechanism in actual work, designed by the writer. A is the crank shaft, keyed fast to which is a spur pinion B containing 24 teeth. A single intermediate spur wheel C on stud D combines pinion B with the large spur wheel E containing 120 teeth. This wheel is compounded with a sleeve F supported and free to rotate on the bottom shaft G at one-fifth the rate of the crank shaft A and pinion B. Set screwed to the sleeve F is a driving tappet H designed specially to lift the head for 3 and 2 shots per card alternately.

The tappet H is kept in rolling contact with an antifriction roller I which is free to rotate in the adjustable bracket K. This bracket is bolted to the treadle lever L, pivoted on the stud M in turn supported by a casting N securely fixed to the floor of the room. The free arm of the lever L combines through stud O, swivel link P and reciprocating rod Q, the head lever of the Jacquard. The constant rotation of the tappet H intermittingly reciprocates the roller I and through connections described elevates and regulates the fall of the head and griffe knives. The lower wing of the tappet H, shown in contact with bowl I gives two picks, and the upper wing, three picks per card.

**Driving
Pressure
Harness
Jacquards on
the Double Lift
Principle.**

Fig. 175 is a side elevation and Fig. 176 a front elevation of an arrangement, designed by the writer to operate the reciprocating rods combined with the head levers of two double lift Jacquards to give two or more shots of weft per card in regular or other order.

The compounding of the reciprocating rods and the head levers with the griffes, may be upon any one of the methods illustrated and detailed in Chapter VIII. The same letters in Figs. 174, 175 and 176 refer to corresponding details.

The chief points of difference in the two systems of driving are as follows:—Two single winged tappets H¹ and H² Figs. 175 and 176, are employed instead of one double winged tappet H, Fig. 174. The parts L to Q inclusive are in duplicate.

The tappet H¹ combines with and operates bowl I, treadle lever L and through the last, the reciprocating rod Q and the front head lever, to lift the head which remains up for *three* shots of weft after which it descends and dwells down alternately for *two* shots.

Conversely the tappet H² lifts, through its duplicate connections shown, the back head lever and head which then dwells up for two picks after which it descends and dwells down alternately for three picks of weft.

Amount of Dwell for Jacquard and Pressure Heddle Shedding.

Owing to the binding shed in pressure harness being very small, it is necessary to keep the warp threads tight, from the

Fig. 174.

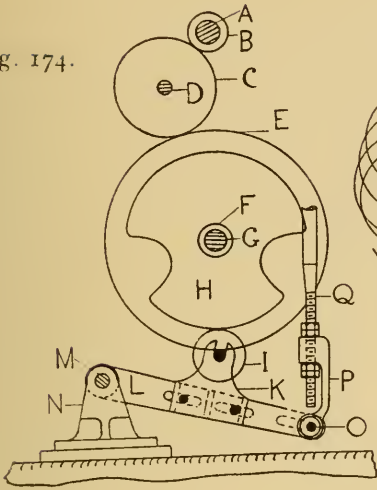


Fig. 177.

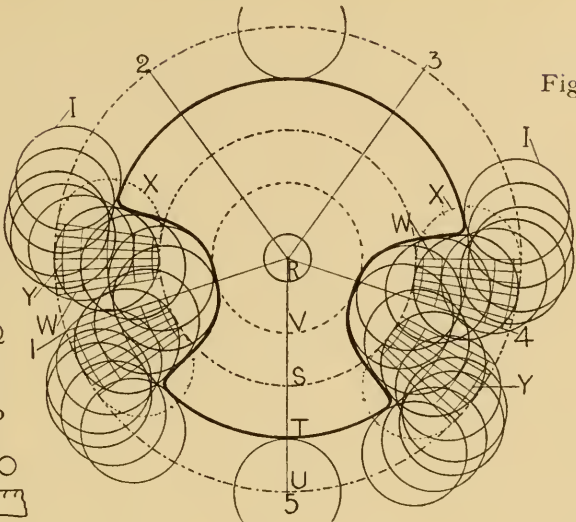


Fig. 175.

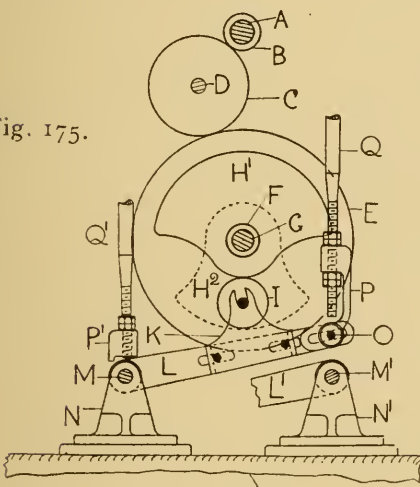


Fig. 176.

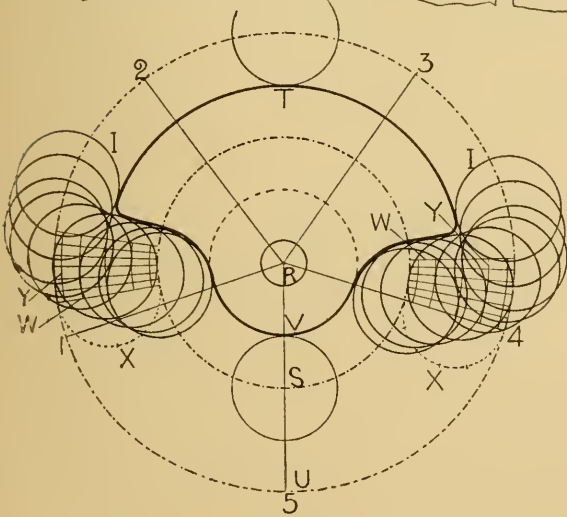
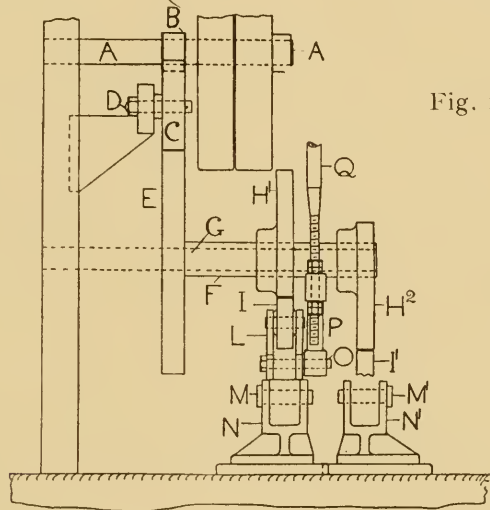


Fig. 178.

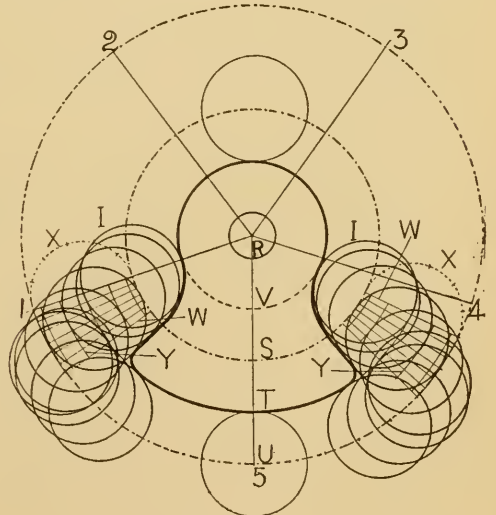


Fig. 179.

moment the shuttle enters the shed to its exit. Slack threads cause wrong stitching or interlacing of the pattern and tend to divert the shuttle from its normal straight course. Experience demonstrates that the pressure heddles require to dwell for about a half revolution of the crank shaft to allow the shuttle to pass through the shed. This is about twice the time of the normal dwell of the Jacquard head. A compromise is effected by giving $\frac{3}{8}$ of a revolution to the Jacquard shed, which, after allowing for the extra time occupied by the griffe blades in travelling from and to the hooks, combined with the increased distance travelled by the Jacquard harness mails as compared with the mails of the pressure harness, approximately neutralises the two actual differences in amount of dwell. In practice there is no appreciable difference manifest.

Problems on, and Construction of Tappets.

A tappet is a mechanical contrivance for converting circular motion into reciprocating. When the object to be alternated is to receive a series of lifts with intervals of rest, the actuating mechanism is designated a 'tappet,' but if the motion is continuous the mechanism used is termed a 'cam;' though either term is frequently used indiscriminately.

Tappets are either *negative* or *positive*. When negative, they are only capable of acting on the heddles so as either to pull them down or lift them up and external mechanism has to be introduced to impart an opposite movement. When positive they control the heddles in both directions without the aid of secondary apparatus.

The ordinary method of forming the shed by the use of tappets is negative and open.

The data requisite to construct the three tappets n n^1 n^2 Figs. 174, 175, 176, may be ascertained from the following actual details.

Problem 1.—Find the required 'stroke' of tappet to lift the Jacquard head through a distance of 5 inches when the following particulars are known:—Length of head lever, 15" on the Jacquard side of the fulcrum and 18" from the fulcrum to the reciprocating rod Q ; centres O M in treadle lever $L = 14$ "; centres I $M = 8$ ". Then stroke of tappet equals,

$$\text{Lift of head} \times \frac{18 \text{ inches}}{15 \text{ inches}} \times \frac{\text{centre } I M}{\text{centre } O M} = \frac{5 \times 18}{15} \times \frac{8}{14} = 3\frac{3}{7}.$$

Problem 2.—Construct three tappets H H¹ H² for lifting the Jacquard head as in Figs. 174, 175 and 176, to the following particulars:—Diameter of tappet bore 1½"; diameter of tappet barrel 5"; stroke of tappet 3½"; diameter of treadle bowl 3½". Allow ⅓ revolution of crank shaft for dwell of head at the bottom when the shed is closed; ⅔ dwell at the top when the shed is open; ¼ revolution for the rise and ¼ for the fall. Give five picks to the round.

The three tappets H H¹ H² are shown fully constructed at Figs. 177, 178 and 179 respectively. R represents the bore of the tappet, which fits on to the sleeve F (Fig. 174); v the periphery of the tappet barrel; τ the extreme periphery of the tappet wing; i the antifriction bowl; s the centre of traverse of the bowl i when it is in rolling contact with the tappet barrel v, and u the centre of traverse of bowl i when in rolling contact with the extreme periphery (τ) of the tappet.

The construction of tappets involves the following considerations.

- Problems on Construction.**
1. The number of picks of weft to each revolution of the tappet.
 2. The order of depressing or permitting the rise of the treadle or treadle levers, to coincide with the required shed.
 3. The required stroke of the tappet.
 4. The diameter of the tappet barrel, which should always be greater than the stroke of the tappet and increase with the number of picks to the round.
 5. The diameter of the treadle bowl, which should be as large as possible but never greater than the stroke of the tappet.
 6. The amount of dwell or period during which the shed remains open.
 7. The nature of the movement required to be imparted to the treadle lever and through its connections to the shed.

The treadle bowl should be made to vibrate exactly in the same variable ratio as is required by the shed, see page 27.

In order to attain this object the tappet must *first* be constructed on the centre of the traverse of the treadle bowl.

The correct size of the tappet is then obtained by a reduction in its radius at all points, equivalent to the radius of the treadle bowl. This ensures that the peripheries of the treadle bowl and tappet coincide at all points.

**How to
Construct a
Tappet.**

Any negative or positive tappet may be accurately constructed by observing the following directions.

(1) With R (Fig. 177) as centre and radius equal to the radius of the tappet barrel plus the radius of the treadle bowl, describe a circle s to represent the centre of the treadle bowl when it is raised (Problem 2).

$$\text{Then radius } s = (2\frac{1}{2}'' + 1\frac{3}{4}'') = 4\frac{1}{4}''.$$

(2) Add to circle s an amount equal to the lift of the tappet and describe a circle u concentric with s, to represent the centre of the traverse of the treadle bowl when it is depressed.

$$\text{Then radius } u = (4\frac{1}{4}'' + 3\frac{1}{2}'') = 7\frac{3}{4}''.$$

(3) Divide the circle u into as many equal parts as there are picks required to the round of the tappet e.g. 5.

(4) Sub-divide each division or pick on which the tappet changes into any convenient number of parts to suit the time allowed for dwell, and change for rise or fall.

(5) Sub-divide each division on which the tappet changes into six or any other convenient number of equal parts by radial lines w, the greater the number the more perfect the tappet.

(6) Describe a semi-circle x on any one of the radial lines w, between circles s and u, equal in diameter to the stroke of the tappet.

(7) Divide the semi-circle x into six or a corresponding number of equal parts, and through each point draw lines perpendicular to the diameter and the radial lines w.

(8) Through each point on the diameter line draw arcs of circles y concentric with circles R and s.

(9) Taking the points where the radial lines w and concentric arcs of circles v , cut each other (on circles s and u representing the centres of the traverse of the treadle bowl) describe circles equal in diameter to the treadle bowl.

(10) To obtain the correct form of the tappet, draw lines from v to τ touching the circumference of the bowl circles.

The intersecting points w and v represent the changing positions of the treadle bowl during its rise or fall. v represents the periphery of the tappet barrel and τ the periphery of the tappet wing.

The distances between the radial lines w being equal, represent equal times on the tappet circle. The distances between the concentric arcs of circles v , decrease from the centre in both directions. Consequently with the uniform rotation of the tappet, the centre of the treadle bowl moves a gradually *increasing* distance from the circle s to midway between s and u , and *decreases* from this point to u during equal periods of time represented on the tappet circle. The result of this causes the treadle bowl to gradually increase in speed from its position of rest to the centre, and to decrease from the centre to the end of its stroke in the same arithmetical ratio. This imparts the requisite and corresponding variable velocity to the lifting harness or heddles.

Pressure Heddle Mechanism.

The function of pressure heddles is to *bind* the ground and figure threads which have been lifted or left down by the Jacquard harness. To accomplish this, the heddles must be adjusted and operated so as to occupy one of the following three positions.

(1) A *central* or *normal* position which allows the Jacquard harness to produce a warp shed through the *mails* of the heddles of sufficient depth for the free passage of the shuttle, the eye in the heddle being made long enough to admit of this operation.

(2) A *top* position to which one of the heddles must rise on every pick and thus lift *one* out of every *five* or *eight* threads from the mass left down by the harness constituting the weft portion of the figure, the object being to bind this latter in 5 or 8 leaf sateen twill according to the number of shafts employed.

(3) A *bottom* position, where the object is to bind down one out of every 5 or 8 threads from the group of warp threads lifted by the harness and constituting, conversely, the *warp* portion of the figure.

The combined operation of forcibly lifting some warp threads from the lower to the upper division and of depressing others from the upper to the lower division of threads in the natural Jacquard shed produces an artificial and strained shed. This factor has caused the system to be denominated PRESSURE HARNESS. When any of the heddles are in their highest or lowest position, the Jacquard shed is therefore modified in proportion to the number of heddles up or down, but with those heddles in the central position, the Jacquard is free to raise the warp threads as required. The operating of the heddles, midway or at full distance, in power loom weaving, may be accomplished by employing a set of positive tappets, a small positive dobby or by setting aside a limited number of Jacquard uprights. The first of these methods is the most satisfactory and the last the most objectionable, since it involves lifting the Jacquard head on every pick.

In hand loom weaving, a separate set of treadles is employed.

**Operating the
Pressure
Heddles by
Positive
Tappets.**

Figs. 180 to 184 illustrate the essential features of the positive tappet mechanism, designed to lift or depress the heddles, midway or full distance and retain them in such position for any number of shots of weft.

Fig. 180 shows in elevation one of the eight whole plate positive tappets, including its connections with the top and bottom jack or heddle levers.

Fig. 181 is a vertical section through the given positive tappet.

Fig. 182. A front elevation showing the connection of the jack levers with the heddles.

Fig. 183. A plan of the eight treadle levers and arrangement of driving the shedding tappets.

The same letters in each refer to similar details. A is the crank shaft; B a spur pinion (containing 30 teeth) keyed to the shaft A and gearing into and driving a spur wheel C, containing 240 teeth,

denominated the 'plate wheel.' Compounded with the plate wheel c are two plates D and D¹ and eight whole plate positive tappets E. In each tappet barrel there are eight holes equidistant and concentric

Fig. 182

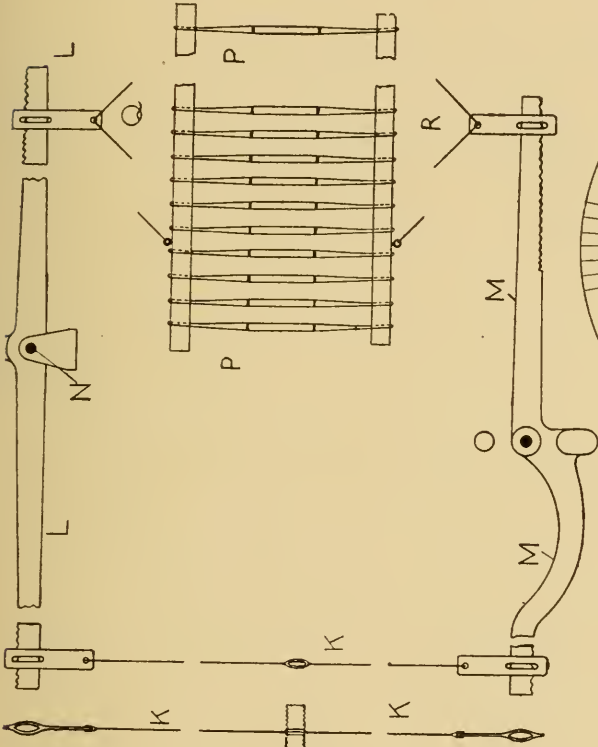


Fig. 180

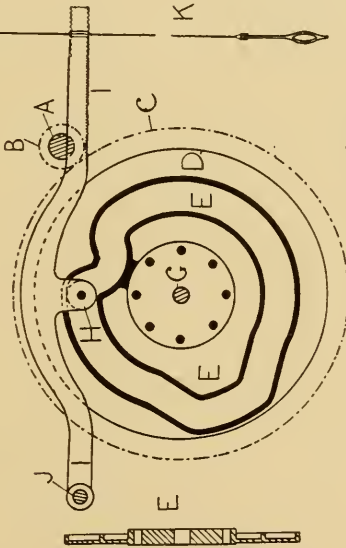


Fig. 181

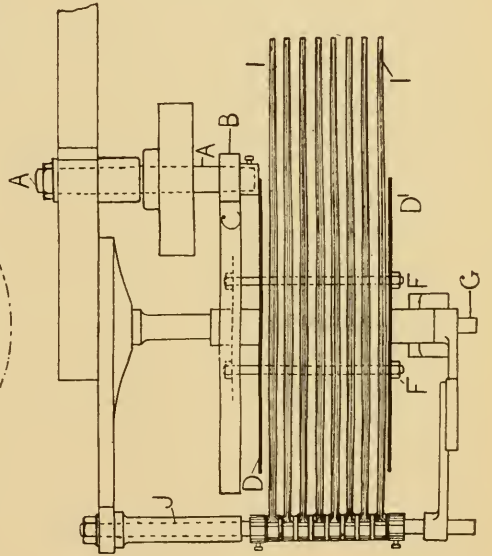


Fig. 183

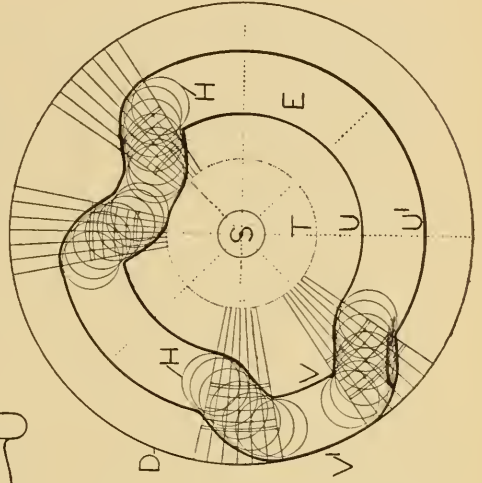


Fig. 184

with the bore of the tappet; through each of these holes and similar holes in the plates D D¹ and the plate wheel c, strong bolts F are passed which compound these several parts. The whole is placed,

supported and free to rotate on the stud shaft G fixed in the gable. Contained between the outer and inner projections of each tappet E is an antifriction roller H. These rollers are centred on the treadle levers I pivoted on the common stud J. The free arms of the treadle levers I are adjustably attached through the medium of strong cords K to the outer and left arms of a like number of jack or heddle levers L immediately *above* the heddles, and to jack levers M directly *below*. The levers L are pivoted at N and the levers M at O. The heddles P are suspended from the respective right arms of levers L by bow bands Q and connected with levers M by similar bow bands R (Fig. 182).

Fig. 184 shows the details of construction of one of the eight positive tappets E drawn to scale for eight picks to the round with the following given particulars:—Diameter of tappet bore s, $1\frac{1}{2}$ in.; radius of tappet barrel T, $2\frac{3}{8}$ in.—the position when in contact with the treadle bowl, the heddle being at its highest point. The *first* lift of the tappet = $1\frac{1}{2}$ in. Then radius U for same = Radius T + First lift of tappet = $2\frac{3}{8} + 1\frac{1}{2} = 3\frac{7}{8}$ in.—the position in contact with the treadle bowl, when the heddle is in its central position. The *second* lift of the tappet = $1\frac{1}{2}$ in. Then radius V, for same = Radius U + second lift of tappet = $3\frac{7}{8} + 1\frac{1}{2} = 5\frac{3}{8}$ in.—the position in contact with the heddle when in its lowest position. Diameter of treadle bowl H, 2in.; dwell of heddle = half revolution of the crank shaft. U^1 and V^1 represent outer projections on the tappet, concentric with and corresponding to U and V respectively.

The completed tappet consists of a disc plate, on one side of which are two raised narrow surfaces U V and $U^1 V^1$. The construction of the inner projection U is identical in principle with the ordinary negative tappet; the outer projection is concentric and parallel with the *smallest* diameter of the inner raised surface. The outer formation is therefore a duplicate in variation and construction of the inner formation. A groove is thus formed through which the treadle or antifriction bowl can travel, but the space is generally arranged to be $\frac{1}{8}$ inch greater than the diameter of the treadle bowl, so as to prevent any locking. The inner projections U and V of the tappet elevate the treadle bowl H together with the treadle lever I, and these through the connections described and shown in Figs. 180

and 182 depress the heddle *p*. The narrow projections *u*¹ and *v*¹ operate in turn upon the uppermost side of the treadle bowl *H* and so produce through the connections illustrated, an elevation of the heddle *p*.

In a similar way the remaining heddles are controlled by duplicate tappets immediately in front of *E*, which in turn operate upon the respective treadle bowls and treadle levers—these, through their respective connections, elevate and depress the heddles. Since the number of teeth in the spur wheel *B* is just one eighth of those in the spur wheel *C*, the latter makes one revolution every eight picks. Each tappet is therefore constructed to elevate and keep the heddle *p* up for one pick, in the centre for six, and down for one to each revolution.

Split Harness.

Split, sometimes called ‘scale’ harness is designed like pressure harness to weave the finest figured silks, linens and cottons. The system is chiefly used for fabrics which are ‘set’ much closer in the warp than in the weft. Some of the rich fine silks are woven with about 400 threads of warp per inch and half the number of picks of weft.

Technical Details.

The chief mechanical details of this method of mounting and weaving to increase the relative figuring capacity of the Jacquard machine are illustrated at Figs. 185 and 186. The former shows one row of Jacquard uprights, harness twines, mails and lingoes together with the transverse section of a special set of shafts introduced for binding purposes, and the latter, one row of spare uprights to which strong cords are looped which in turn support the binding shafts. The same letters in each diagram refer to similar details. The ordinary griffe blades are shown at *A*, the cross wires, etc., at *B*, the uprights at *C*; *C*¹ are the spare uprights which combine with and lift the heddles; they are placed immediately in front of the uprights *C*. The resting board and bars for the uprights are shown at *D*, the neck band at *E* and the harness twine at *F*. To each harness twine *F* at the point *G*, two harness twines *F*¹ are knotted fast. Each of

these twines is then passed through the comberboard H and threaded through the mail I and then turned upwards and knotted fast about six inches above the mails at the point J to form the loop K. Through the loops of each row of harness in the comberboard an iron or hard wood shaft L is passed, $\frac{1}{8}$ " thick, $1\frac{1}{8}$ " to $1\frac{1}{4}$ " deep. There may be 8, 12, 16 or 24 shafts according to the number of rows of harness from front to back in the comberboard or to suit the required binding weave. The lower couplings and lingoes suspended from the mails are shown at M. The strong cords N (Fig. 186) connect one row of spare hooks c^1 with the shafts L in the order shown and each upright controls two shafts to weave in eight end twill or sateen order. Sometimes a second row of spare uprights is employed and connected with the shafts 9 to 16 inclusive to bind the pattern in sixteen end sateen order. One or two rows of spare hooks on the opposite side of the machine are similarly connected to the opposite ends of the shaft L.

The Jacquard controls the figure, each upright lifting the harness and warp threads in pairs to form the warp figure, whilst the groups or masses of warp threads left down by the Jacquard in multiples of two, constitute the weft or ground portion of the figure. The binding operation in the *ground* is accomplished by lifting *one shaft* out of any number and in any order on every pick to suit the predetermined pattern. The *binding* in the warp portion of the figure is obtained by leaving down *one upright* in any order or number to suit the pattern. The shafts lift the binding threads singly in the ground, but the Jacquard uprights bind down the warp figure in two or multiples of two, according to the number of neck bands which are attached to each upright. This is a serious defect since it tends to give the fabric a coarse appearance except where *very* closely 'set.'

It is, however, possible to split the two binding threads and lift one of them by the shafts L but the order of connecting the cords N with the hooks c^1 and shaft L must be designed to coincide with the order of depressing the binding harness.

When figured patterns of large repeat have to be very closely woven, two or more neck bands, each supporting two mails and lingoes, are connected to and operated by the same upright. Each

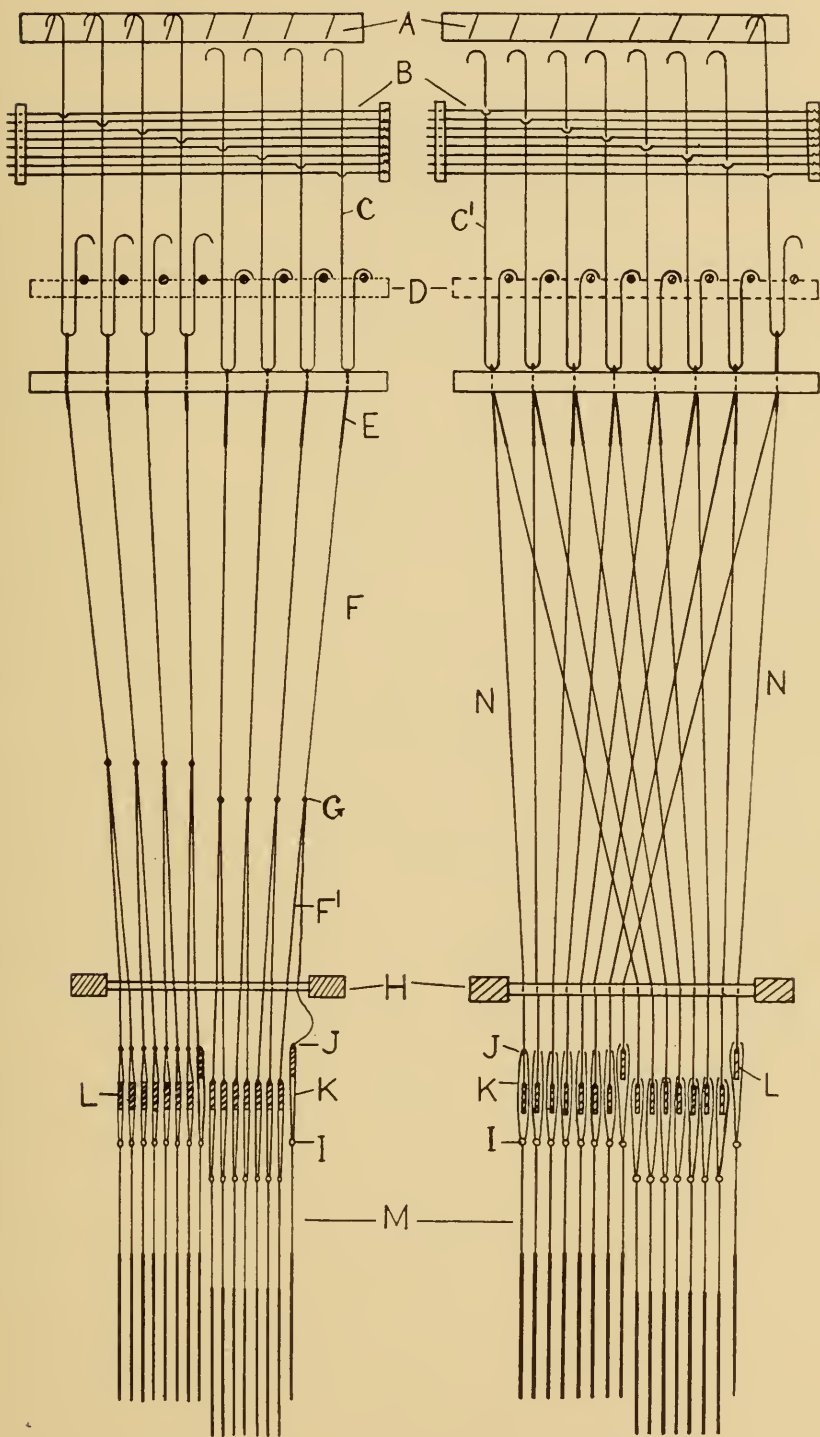


Fig. 185

Fig. 186

harness twine is, however, threaded on to a separate shaft and operated in any predetermined order by the spare uprights in the Jacquard machine. These latter, which rise on every pick with the Jacquard head may be controlled by the ordinary pattern cards or independently, if the hooks are placed near enough to the ends of the cylinder to permit short cards to operate outside those used for figuring.

If the fabric is woven *face upwards* the weft or ground portion will be bound singly and the warp portion of the figure in twos or multiples of two according to the number of neck cords connected to each upright; obviously then, these conditions will be reversed when the fabric is woven face *downwards*.

It will be seen, in Fig. 185, that one half of the uprights is lifted to form the figure and the remainder is left down for the ground portion of the pattern. In Fig. 186 only one of the binding uprights with shafts 1 and 9 is lifted on the first pick for binding the ground; the remaining uprights are selected and lifted in the usual sateen order on each subsequent pick.

The advantage of the foregoing system is that it increases the normal figuring capacity of the Jacquard machine in multiples of two for each neck band attached to every Jacquard upright.

CHAPTER XIII.

Gauze or Leno Jacquards.

THE 'Leno' Jacquard, as it is commonly called, is designed to combine with the loom to weave figured fabrics in which cross weaving (gauze or leno) is introduced as an additional means of ornament.

The gauze or leno structure is uniformly open and net-like in effect. It is this characteristic which adds value to its combination with ordinary weave and brocade interlacings.

Given a Leno Jacquard with full harness mounting and independent douping, it is possible to weave an indeterminate variety of gauze effects, separately or in combination at will, with any variety of weave interlacings, to produce figured or brocade patterns up to the limit of the figuring capacity of the Jacquard machine.

The enunciation of the fundamental principles of gauze structure, drafting, douping, easing and weaving with doups and heddles is outside the scope of this treatise. Information on these points will be found in connection with Chenille weaving, pages 250 to 258, *Carpet Manufacture*.

In these pages it is purposed to consider the manufacture of figured 'gauzes' with the aid of the Leno Jacquard or an ordinary Jacquard with one, two or more doups.

**Nomenclature
of Gauze
Mounting.**

To avoid confusion of terms, the following distinctive names are employed in gauze weaving.

(1) The half heddle or slip is called the doup.

(2) The heddle or harness which supports the doup is called the *front* or *doup standard*.

(3) The heddle or harness which forms the natural shed, and through which the crossing warp threads pass, is called the *back standard*.

(4) The heddle or harness through which the non-douped threads are drawn is called the regular heald or harness standard.

**Mechanical
Details of Gauze
Mounting.**

Fig. 187 shows in elevation one row of ordinary harness, doups, doup standards and easing harness, together with the uprights and needles which are connected to and operate these respective sections. The drawing is made from the left hand side of a right hand loom, when the *gauze* or crossed shed is being formed.

Fig. 190 shows the same details and interchange of parts when the *natural* shed is being formed. The same letters in each diagram refer to corresponding details.

The Jacquard machine contains twelve griffe or brander blades, and a like number of uprights, harness cords, mails and lingoes in each row from the front to the back of the machine. A¹ to A⁸ represent the ordinary hooks, harness, etc.; B⁹ and B¹⁰ the doup standards; C⁹ and C¹⁰ the easing standards; D¹ to D¹⁰ the needles and E a ten row card cylinder; F shows the half heald or doup, slipped through the mail of the doup standard B⁹; G is a strong cord which supports the doup to a special strong hook, or it may be securely fastened to the Jacquard head, since it must always rise on *every* pick. H is a fixed spiral spring combined with the doup F to keep it normally under tension. An enlarged and detached view of this detail is shown separately at Fig. 188.

The ordinary hooks and harness A¹ to A⁸ and the doup standards B⁹ and B¹⁰ are controlled by the same head I as shown.

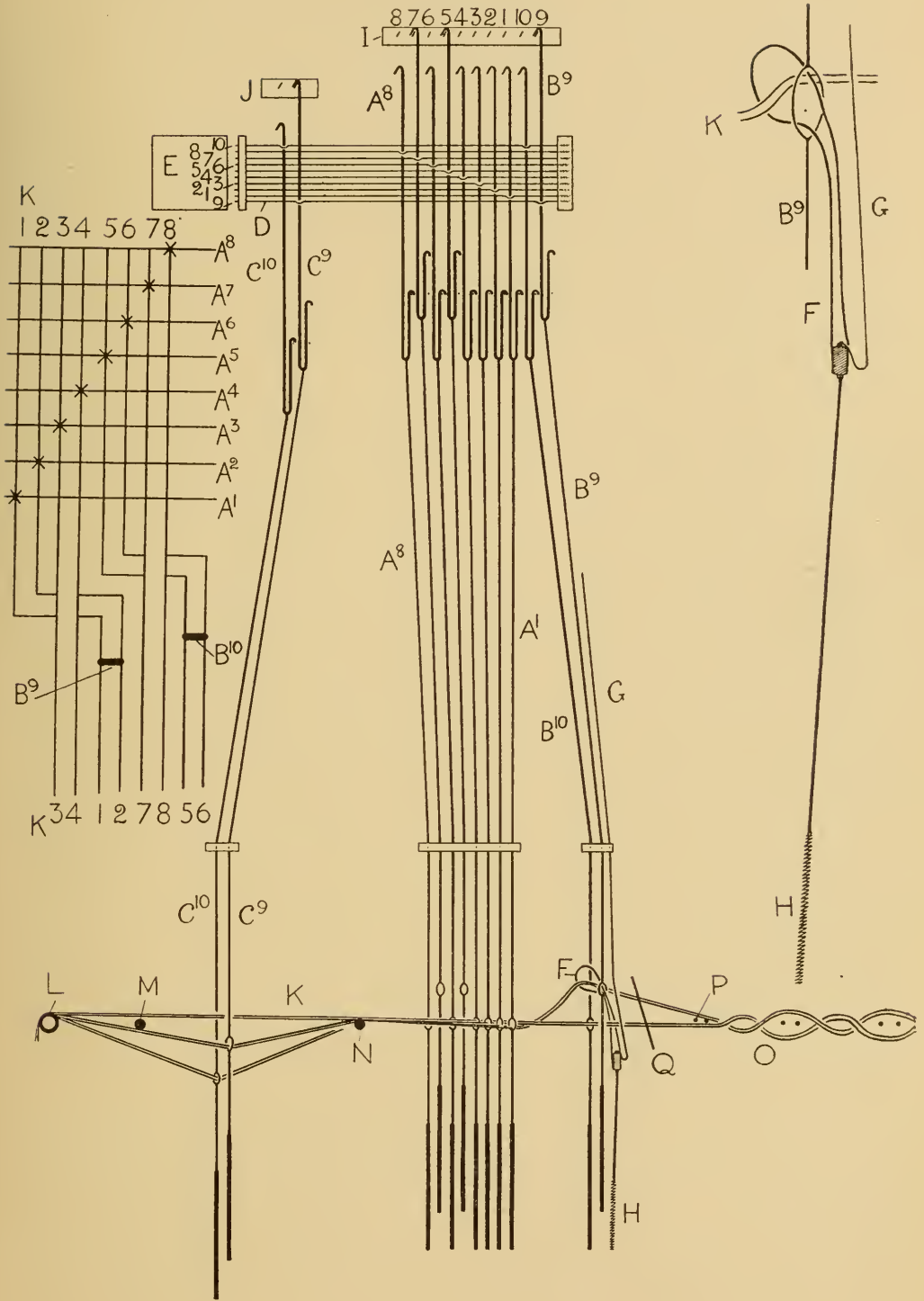
The easing hooks and harness C⁹ and C¹⁰ are under the separate control of a small and detached head J.

The warp threads κ, a few only of which are shown, run in pairs. The first pair after leaving the back rest L pass under an auxiliary easing bar M and then through the easing harness mail C⁹ and over a fixed round bar N. They are then separated, one thread being drawn through the ordinary harness mail A¹ and the other through the harness mail A². The second pair or third and fourth warp threads pass from the back rest, over M and freely between the easing harness C⁹ and C¹⁰, then over the rod N, after which the third

Fig. 189

Fig. 187

Fig. 188



thread is drawn through the ordinary harness mail A^3 and the fourth thread through the mail A^4 . Both threads then pass forward together freely between the doup standard harness B^9 and B^{10} to the fell of the cloth o which shows a transverse section through the weft p .

The first pair of threads 1 and 2 are next passed under threads 3 and 4 and then drawn *together* through the doup F on the remote side of threads 3 and 4, from which point they pass forward to the fell of the cloth o . These *four* threads form a *group* and they must therefore pass through the same split in the reed. Each *group* of *four* warp threads is similarly treated until the whole of the warp has been drawn in.

It is usual to first draw all the warp threads through the ordinary harness mails singly and afterwards to draw the crossing threads through the doups; this operation is called douping.

A diagrammatic plan of the order of drafting and manner of douping is shown at Fig. 189. Only *two groups* or eight warp threads are shown; these represent one complete row of harness from front to back. Each additional row of harness is similarly drafted. Each doup, doup standard, back standard, regular harness and easing harness is free and can be independently controlled. The parts shown in this plan are lettered to correspond with the same details in Fig. 187.

The free end of the doup, threaded through the doup standard, is only kept in position by the pair of crossing threads 1 and 2 drawn through it. If these break during the process of weaving, the slip then falls on to the single stave on which all the doups F are contained. Before proceeding to weave, the fallen slip must be threaded again through the mail of the doup standard and the crossing warp threads drawn through as before.

In Fig. 187 the gauze shed is formed by lifting the doup standard B^9 and the doup F on the remote side of the third and fourth warp threads. The hooks and harness A^5 and A^7 are shown lifted for plain weave where gauze effect is not required. In order to ease the strain on the crossing threads 1 and 2, the easing harness c^9 is also lifted as shown.

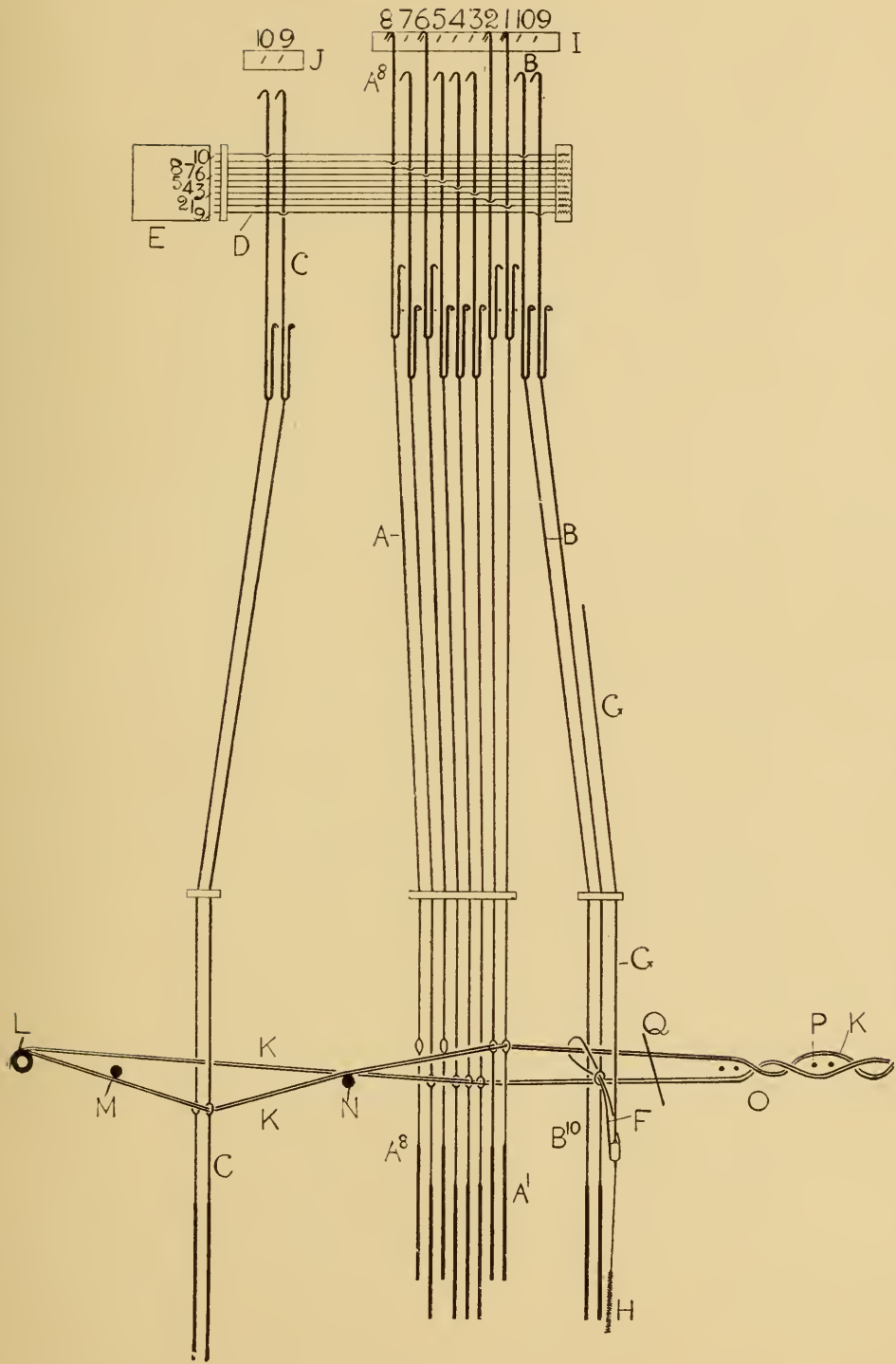


Fig. 195.

In Fig. 190 the natural shed in the gauze structure is formed by lifting the back standards A^1 and A^2 with threads 1 and 2. The doup rises in sympathy on the near or *non*-crossed side of the third and fourth threads of warp, and the easing harness c remains down as shown. Simultaneously the hooks and harness A^6 and A^8 are lifted to produce the opposite pick of plain, in the ground.

It is most important to note that each doup standard is free to be lifted or left down independently of the rest. This is the chief advantage as compared with doups and heddle weaving or of placing and working one or more doups in front of an ordinary Jacquard harness mounting. In a 400 Jacquard machine there are usually 100 doup standards with slips to suit. Each doup standard B is therefore equivalent to a separate doup. The crossing threads are usually arranged as in the illustration, with *two* threads crossing *two*, but the number of shots of weft in the gauze or natural shed is not limited.

It therefore follows that with each group of four threads of warp, it is possible to produce either gauze or ordinary cloth; then if any of the doup standards B are allowed to remain down for a series of picks of weft, the back and regular harness standards are free to form any ordinary weave effect of pattern in proportion to the number of consecutive doup standards left down for any given number of shots of weft.

The relative changes in the position of the harness and doup standards necessary to produce ordinary plain or other regular weave effects are as follows:—Leave down the doup standards for each group as required, lift the corresponding doup and then select the back and regular harness according to pattern exactly as in ordinary Jacquard weaving.

**Plan of
Gauze Harness
and Web.**

Fig. 191 shows a plan of the warp together with its controlling factors from the shell of the back rail to the web. The respective details illustrated are the warp κ , back rest L , auxiliary easing bar M , easing harness c^9 c^{10} etc., regular harness A^1 etc., doup standards B^9 etc., reed Q (where each group of four warp threads are shown

drawn through each split), web o and weft p. The web consists of a simple check pattern composed of gauze, 2 ends crossing 2 ends

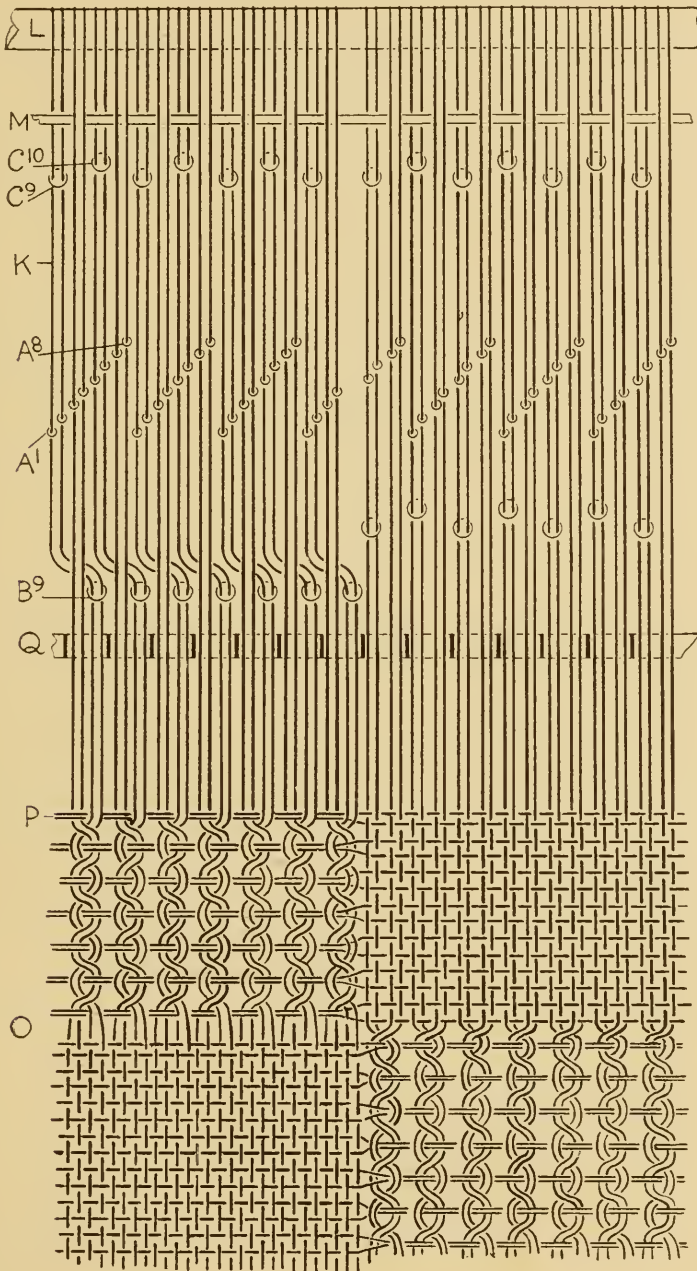


Fig. 191.

over 2 picks, and ordinary plain weave. In the top left hand corner, where the gauze is being formed, the doup standards B together

with the doups and crossing threads are shown on the right hand or *crossing* side of each respective group. In the top right hand corner of the pattern where the plain weave is being formed, the slips have been drawn by the back standard on to the left or natural side of each respective group of warp threads.

The given portion of the web *o* is illustrative of the change from gauze to plain weave and *vice versa*, but any other ordinary weave can be produced up to the full capacity of 400 ordinary hooks *A* which this machine contains.

The type of crossing represented above is usually denominated *two* threads crossing *two*. The chief reason for doubling the threads in pairs and mounting the harness to suit, is because the plain weave approximately balances the gauze structure composed of two threads of warp working together. It is for the same reason that the foregoing arrangement of harness mounting has virtually become standardised. See also page 207.

Easing Motion
Auxiliary. In the manufacture of figured gauzes composed of *linen* or other strong yarns, each group of crossing threads at the point where they pass through the easing harness *c* (Fig. 187), gradually overcomes the load resistance of the heavy lingoos and assumes a horizontal line which then becomes normal. The result of this action is to make the easing harness non-effective.

In order to obviate this inherent defect, the following auxiliary motion has been designed. Whilst it is effective, it does not interfere with the individual easing harness. The mechanism operates to bring all the crossing threads to the same *depressed initial* plane. Fig. 192 shows all the essential details in elevation.

The parts common to Figs. 187 to 191 inclusive are indicated by similar letters and the auxiliary parts by numerals.

1 is the sword of the going part pivoted on the rocking shaft 2. The crank shaft 3 is linked as shown to the sword 1. An adjustable straight rod 4 combines the sword 1 at the point 5 to the bell crank lever 6 through the medium of stud 7. The lever 6 is pivoted on the stud 8 in the bracket 9 which is compounded with the loom

by the stud 10. The upper arm of lever 6 is set screwed to a short lever arm 11 in turn compounded with a round steel bar M. The bar M passes over all the crossing warp threads and under all the non-douped threads to the opposite side of the loom, where it is similarly supported by duplicate mechanism of parts 1 to 11 inclusive. All the warp K passes over the back rail L and the fixed round bar N, towards the harness as shown.

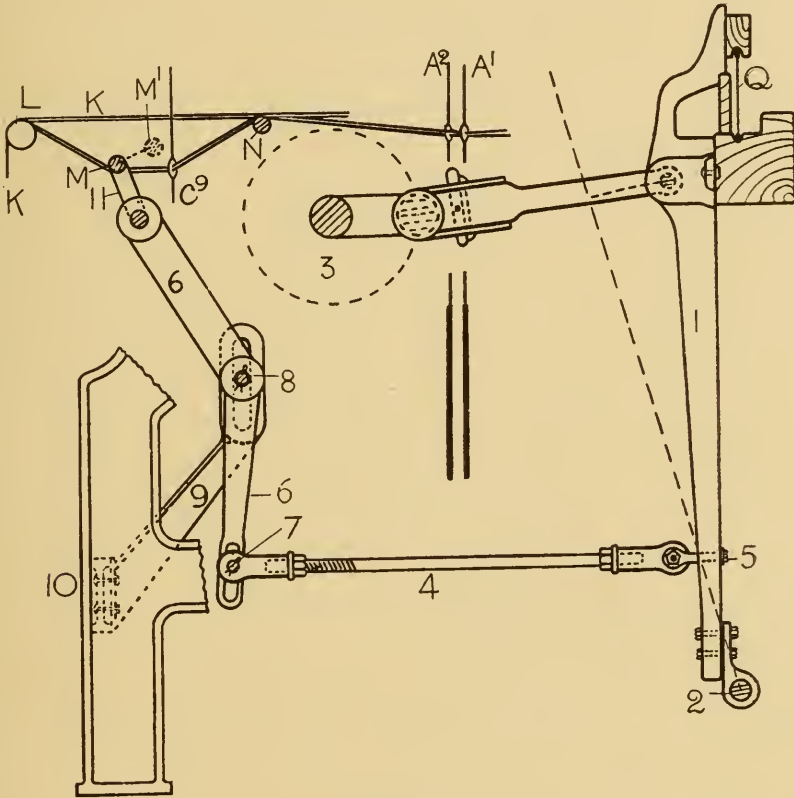


Fig. 192.

Before the operation of weaving is commenced all the crossing threads are slackened and depressed, below the normal warp line, through the medium of the lingoies, suspended from the harness c^9 and its duplicates. With each ascent of any of the doup standards B to form the gauze shed, the corresponding easing harness c is raised to ease the tension put upon the crossing warp threads, through having to form a shed between the limited distance of the back and the doup standards.

A reference to Fig. 187 shows that the same needle controls the corresponding doup standards and doup easing hooks and harness. For ordinary warps such an arrangement is ample. With very strong warps, as stated, the auxiliary mechanism must be added.

**Action of the
Auxiliary
Easing
Mechanism.**

The lingo^s suspended from the easing harness c^9 initially depress the crossing warp threads k to their lowest point and subsequently assist in maintaining this same position. The special oscillation of the steel bar m ensures the depression of *all* the crossing threads to the same uniform angle of depression immediately after the formation of each shed. With each forward movement of the lay sword 1 , the rod 4 travels in sympathy a lateral distance of $1\frac{3}{8}$ " through the points 5 and 7 . The arms of the lever 6 , then partially rotate counterclockwise, an approximately similar distance, until the steel bar m is brought into contact with the surface of the crossing warp threads and thus positively ensures their deflection to the same uniform point. But as the lay sword recedes from the 'fell' for the next gauze shed, the bell crank lever 6 , partially rotates clockwise, in sympathy with which the steel bar m rocks away from the crossing warp threads to the position m^1 and thus permits any of the easing harness to be individually lifted according to the requirements of the pattern. In a similar manner the operation is repeated with the most satisfactory results.

Driving the Jacquard Head and Easing Mechanism.

It has already been demonstrated that each crossing thread or threads in each group must be free to be slackened independently of the others. These threads which, as previously shown, are passed through the mails of the easing harness near to the back rail, have to be lifted simultaneously with the doup standards, but they do not require to be raised quite as much as the regular and doup harness, since it is only necessary to release the excessive strain upon the yarn during the formation of the gauze shed. It is therefore essential that the lift of the easing harness can be adjusted and modified independently of the figuring harness. This desideratum is accomplished by the addition of a supplementary head provided

with two griffe blades, one for each row of easing harness. These lift or leave down the uprights supporting the easing harness according to pattern.

Fig. 193 shows in elevation the connection of the main Jacquard and supplementary heads with the ordinary lifting lever.

Fig. 193.

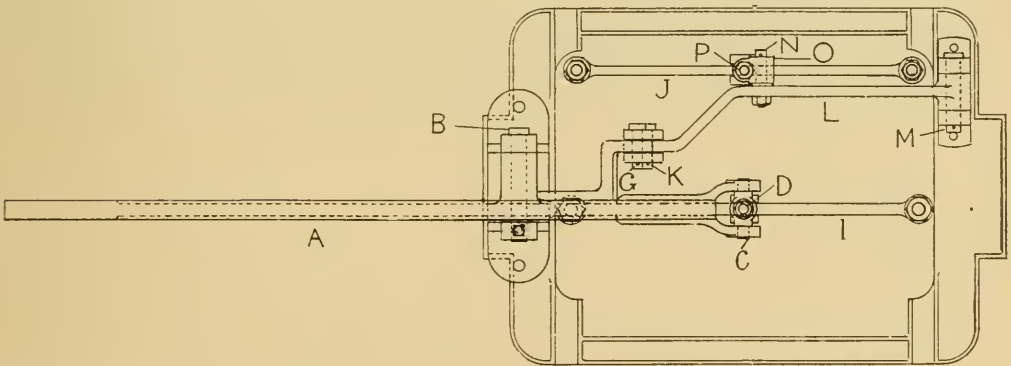
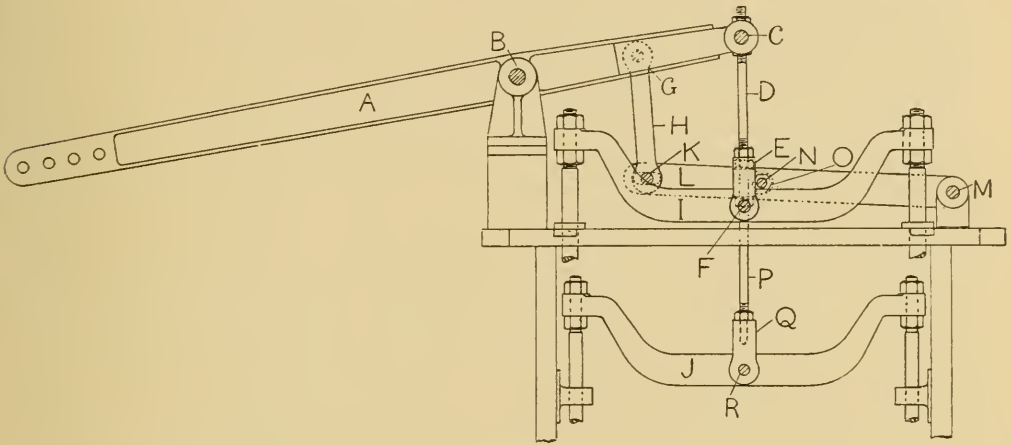


Fig. 194.

Fig. 194 is a plan of these same details. The same letters in each diagram refer to corresponding details. A is the reciprocating head lever pivoted at B, and connected after the usual manner to the crank shaft. A stud c combines through an adjustable swivel link and rod D, a second swivel link E and stud F with the main cross

head I. A stud and bracket G in lever A, midway between B and C, support a spindle H, in turn compounded through stud K with the lever L pivoted at M. A stud N passes through the lever L and supports a swivel link O and a rod P which combines through the swivel link Q and stud R to support the *supplementary* cross head J.

The constant rotation of the crank shaft reciprocates the head lever A about the pivot B, and through the mechanism described above simultaneously lifts the two heads I and J on every pick.

The respective distances which the heads I and J traverse may be calculated when the following particulars are known.

Throw of eccentric crank = 10"; length of left arm of lever A B = 28"; distance C B = 12½"; distance G B = 7"; distance K M = 23½" distance N M = 17".

(1) Then lift of main head

$$= \frac{(\text{Throw of eccentric}) (C B)}{A B} = \frac{10 \times 12\frac{1}{2}}{28} = 4\frac{1}{2}"$$

(2) And lift of supplementary head

$$= \frac{(\text{Throw of eccentric}) (G B) (N M)}{(A B) (K M)} = \frac{10 \times 7 \times 17}{28 \times 23\frac{1}{2}} = 1.8"$$

which it will be observed is less than half the distance traversed by the main cross head I. The calculated traverse of the head is always slightly in excess of the actual depth of the clear warp shed, which in the foregoing example is actually 4".

Transferring the Design on to Point Paper.

Point paper designs have necessarily to be prepared in such a manner as will facilitate the work of the card stamper. It is important to note that the doup standards B⁹ and B¹⁰ and back standards A¹ A² A⁵ and A⁶ (Fig. 187) which control the crossing threads are *never* required to be raised on the same pick of weft in any part of the pattern, see Fig. 191. It therefore follows that *each* crossing warp thread can be represented on the point paper by a single longitudinal division of small squares, irrespective of whether it must be lifted on the right, by the doup standard, or on the left, by the back standard. It is therefore only necessary on each pick, on the point paper, to indicate the elevation of each crossing warp thread by a

given mark for the doup standards and a different kind of mark for the back standards. This arrangement obviates any distortion of the pattern when disposed on the point paper and simplifies the transference of same. The development of the non gauze section of the pattern is therefore unaffected in any way.

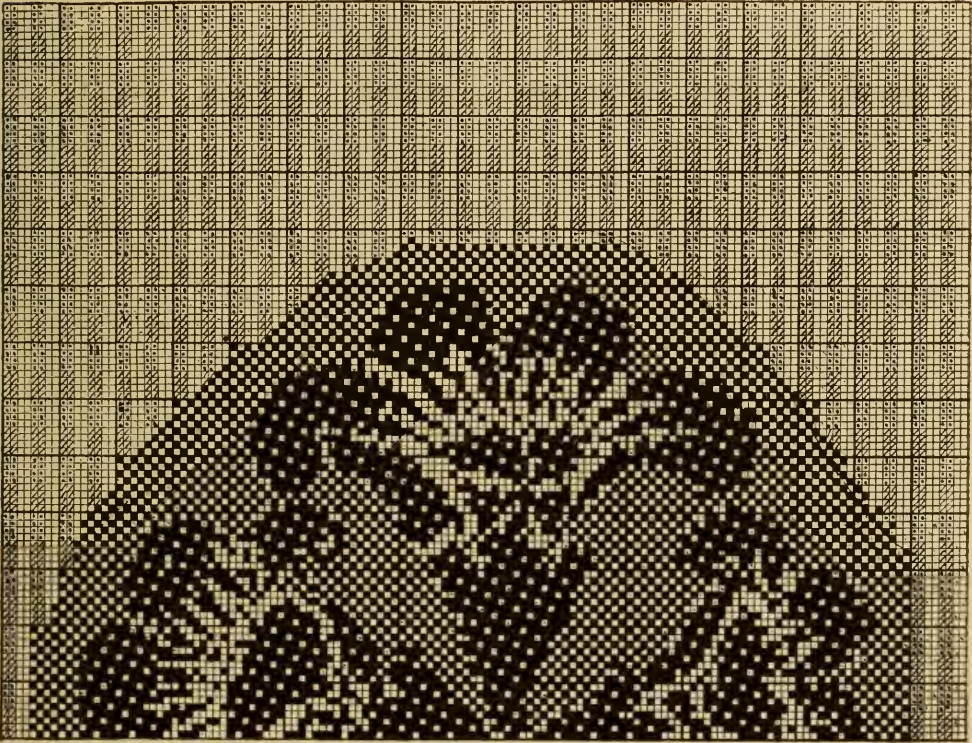


Fig. 195.

Fig. 195 shows a portion of a gauze brocade fully developed on 8×8 point paper. The flower is bound in five end sateen, the outline of the figure is plain and the ground is composed of gauze—2 threads crossing 2 for 4 picks of weft. The 4 picks in each shed in the gauze are necessary to balance the sateen weave and brocade figure. The solid squares thus ■, represent the weft on the surface of the cloth; the marks thus \square , the elevation of the doup standards and \square , the back standards. The card cutting instructions are therefore as follows:—Cut white in figure and plain and marks \square and \square in the ground.

The Leno Jacquard usually contains 10 rows of needles and a like number of rows of holes in the card cylinder as illustrated in Fig. 187. The first and last rows of needles connect and control the doup standards and easing uprights. The remaining eight rows are connected to and operate the back and regular harness standards. This arrangement permits the card stamper to cut the pattern for the ordinary figure portion of the design by working the four fingers on each hand, over the back keys of the piano card stamping machine in the usual manner. (See Card Stamping, Part IV.) The two keys which control the card punches for the doup standards are in front of the keyboard, on the piano machine, and these the card stamper operates with his thumbs.

Figuring with One Doup and an Ordinary Jacquard Mounting.

Simple brocade and geometrical effects of pattern may be produced on a plain gauze or other limited gauze ground by employing only one doup in front of an ordinary full harness mounting.

If two, three or four doups are used along with the Jacquard mounting, the production of variety and elaboration of effect may be so extended as to suggest a full harness mounting with independent doups.

Fig. 196 shows the draft and order of douping with one doup in front of a single lift 400 Jacquard machine. The first 16 threads only are shown, since the remainder are all similarly treated. The longitudinal lines represent the warp threads and the transverse lines—1 to 16, the harness mails; D S indicates the doup standard and the doup placed immediately in front of the harness.

The warp threads are first drawn through the harness in the usual and regular order, as indicated by the markings where the horizontal and vertical lines intersect, Fig. 196. Each of the *odd* threads counting from the left, is then *crossed* under the opposite side of the adjacent even threads and then 'douped,' *i.e.*, drawn through the half heald or slip. All the slips are on the same half heald and passed through the mails of the same doup standard. They must therefore all rise or fall together, either in sympathy with, or without the doup standard.

With the foregoing completed draft, any of the following combinations of figure may be produced. (1) Plain gauze contrasted
 Fig. 196.

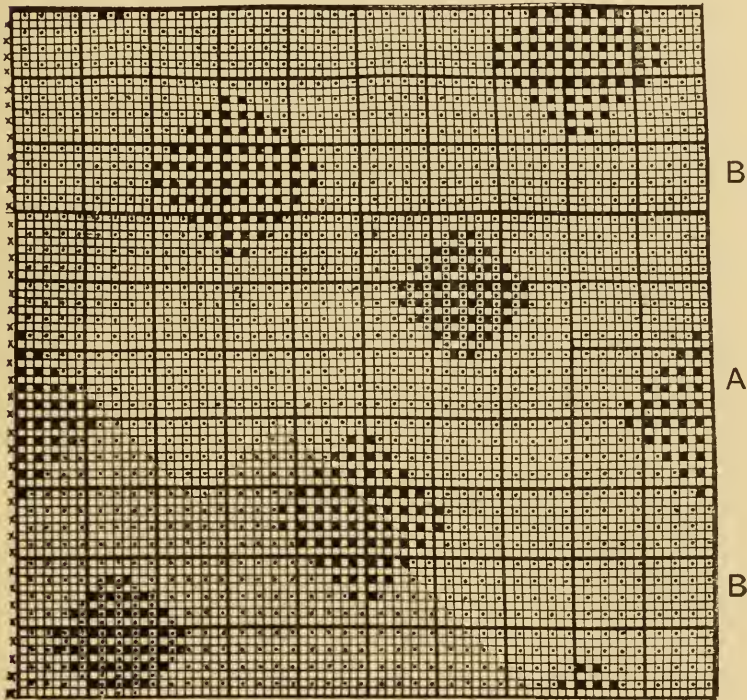
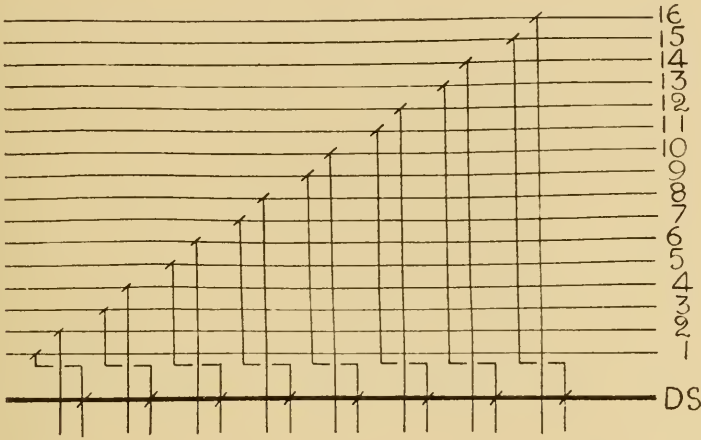


Fig. 197.

with plain weave in large or small masses, up to the limit of the figuring capacity of the Jacquard machine. (2) Plain gauze inter-
 changed with either warp or weft figures and plain weave.

The attainment of the foregoing and many other modified results, involves careful attention to the following fundamental technical points.

(1) Whenever the elevation of the doup standard is followed by the elevation of the back standard a gauze crossing results, *e.g.* If the doup standard is lifted on the odd picks and the back standard on the even, a plain gauze structure is formed.

(2) Whenever the elevation of the doup standard is followed by the elevation of the regular standard, no gauze *crossing* results, *e.g.* If the doup standard is lifted on the odd picks and the regular standard on the subsequent even picks, ordinary plain weave is the result, but with the crossing thread working on the gauze side all the time.

(3) If the doup standard and any of the regular standards are lifted on the odd picks, followed by the elevation of any two or more adjacent back and regular standards on the even picks no interlacing of any kind occurs, and hence a warp figure will be formed on the surface of the cloth.

(4) A weft figure is obtained by weaving the cloth face downwards.

Then, since the production of figured patterns on a gauze ground for the draft given, involves the application and simultaneous combination of the foregoing fundamental data, the doup standard must rise on every alternate or odd pick, after which on each succeeding pick the back standards of each *group* must be selected for elevation where gauze texture is required, but on the same even pick where plain weave is necessary, the regular standards must be lifted, whilst if any portion of the pattern must consist of warp figure, the back and regular standards must be raised on both picks and repeated to suit the pattern.

Fig. 197 is a fully developed point paper design for a small figured pattern produced to demonstrate and suggest the inherent possibilities of the above principle. The gauze portions of the design are marked A; the ordinary plain weave part B; the warp or weft figure C; the lifting marks for the doup standard X; the back standards ■ and the regular standards [•].

Relative Balance of Structure and Combinations of Gauze and Ordinary Weave Interlacings.

The difference in balance of structure of woven cloths of gauze with ordinary methods of interlacing is considerable, for which reason some observations at this juncture will not be out of place. It is desirable, however, to avoid any undue trespass, though otherwise a welcome and inspiring task, into the region of gauze designing—a field unlimited in its possibilities.

The subjoined facts should nevertheless be known by all users of Leno Jacquards and especially where only one or two doups are employed with ordinary Jacquard mounting.

The *ordinary and plain* method of interlacing the warp and weft threads, produces the *lightest* weight of fabric which can be made compatible with the same perfect balance of structure and for the same quality, thickness and counts of yarn.

A *lighter* weight fabric for the same relative perfection in balance of structure can be produced, with the same yarns, but fewer in number, when the *plain gauze* method of interlacing is substituted. This result is primarily due to the partial twisting of the yarns round each other, which not only keeps each distinctive group of threads apart, but also obviates any tendency on their part to 'slip' over each other and so close up the open or net-like spaces between each group of threads. It will now be manifest that if plain cloth and plain gauze are woven together in the same fabric, with the same yarns and number of ends and picks, the balance of the two will not agree. These weaves can only be used in combination, either when frequent changes occur or when the mass of pattern of the one weave is great as compared with that of the other.

If the plain part of the cloth is normally perfect in balance of structure, the gauze part will be tight and present a somewhat *drawn* appearance. On the contrary, if the number of warp and weft threads, be arranged to suit the gauze plan, the ordinary plain weave, with the same setting will be loose and flimsy in handle and appearance.

The knowledge of these facts makes it imperative in all combinations of gauze and ordinary weaves to introduce some structural modifications. (1) By decreasing the relative number or thickness of the yarn in the gauze crossings until the two types of cloth just balance each other in structure; this plan can be satisfactorily adopted when gauze stripes are required.

Fig. 198.

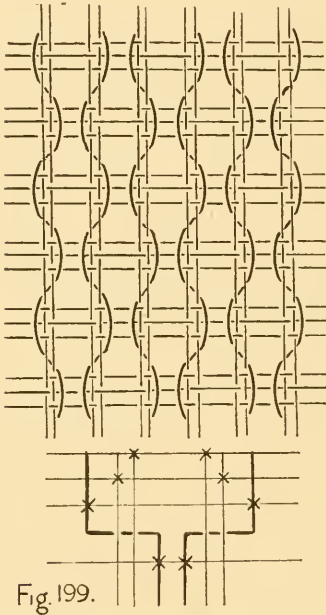


Fig. 199.

Fig. 200.

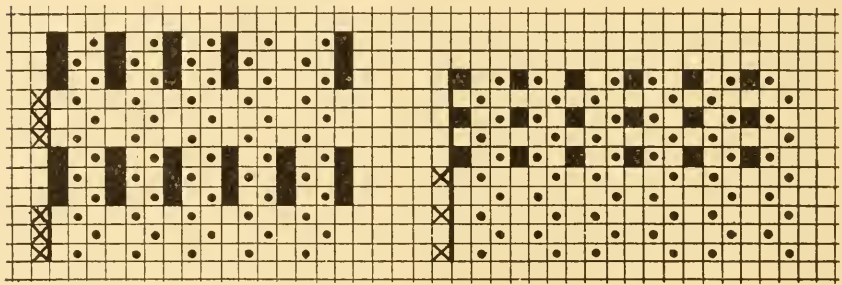
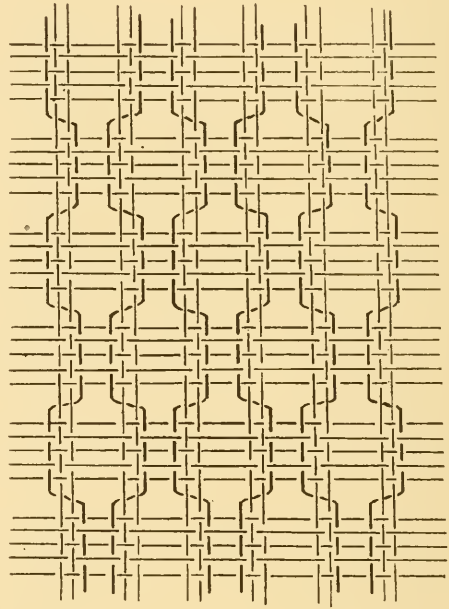


Fig. 201.

Fig. 202.

(2) By grouping two or more warp threads together and operating them as one in the gauze part of the pattern and inserting two or more shots of weft into each shed in the same gauze part; this is the most suitable plan for brocade patterns.

Experience has demonstrated that two threads of warp crossing two threads of warp with the insertion of three shots of weft in the gauze portion of any figured design approximately balances the plain weave in the same cloth. Larger groupings are necessary for combinations with weaves other than plain (see Fig. 195).

(3) By employing a thick thread in lieu of two or more of the normal threads and crossing it under two or more ends for any given number of picks. The picks and ground warp threads interlace as in ordinary plain weaving. In some instances the thick gauze warp weaves plain on both sides of the crossing.

Fig. 198 is a plan view of the *gauze section* of a figured stripe. The figured part (not shown) is composed of ordinary weave interlacings. The gauze part is 'point' drafted as illustrated at Fig. 199.

Fig. 200 shows a plan view of the gauze portion of a figured stripe, when the thick crossing threads weave plain on each side of the crossing.

Figs. 201 and 202 show a few repeats of the weave for the stamping or card cutting for gauze sections of Figs. 198 and 200 respectively. The marks $\overline{\text{X}}$ indicate the lifting of the doup and doupstandards; the marks ■ the back standards and the marks $\overline{\cdot}$ the regular standards.

CHAPTER XIV.

The Gauze Reed and Jacquard.

THE combination of the gauze reed with the Jacquard is designed to produce an embroidered effect of pattern on a plain gauze ground.

The gauze reed produces the perfect gauze crossings without the aid of the usual doups and doup standards. The Jacquard simultaneously produces the ornamentation independently of the gauze reed.

The foregoing combination of mechanism is chiefly employed to weave a type of cloth defined as *Madras muslin*, the warp of which is usually fine cotton and combines with a similar fine cotton weft to produce the gauze texture. A thick and soft twisted cotton weft is used for the ornamentation effect. It is interwoven in plain or modified plain weave order in given portions of the cloth to suit some predetermined pattern. In the remaining portions of the cloth where no ornament is required, the thick weft floats freely over the surface of the web; these loose floats are all cut off after the weaving process has been completed. The resultant effect is a closely woven figure on a loose, open and net-like ground texture.

For purposes of variety, especially when required for window curtains, two or more coloured figuring wefts are introduced.

Fig. 203 is a photographic representation of a Madras muslin woven with two figuring wefts. The photograph is taken from the cut or figure side which is in greater visible relief and is frequently classed as the face. The uncut side is usually neater in appearance and clearer in definition of outline for which reason it is finished for the 'face' when the material is to be used for dresses. The fabric can be woven with the floats on the surface or at the back of the cloth; the former method, which is the usual, is both better for the warp yarn and the Jacquard machine.

Fig. 204 is an enlarged plan view of a figured Madras muslin woven with only one figuring weft and Fig. 205 is a similar view of a second fabric woven with *two* coloured figuring wefts.

Fig. 206 is a transverse section through the weft of the former. A represents the gauze warp threads ; B the regular warp yarn ; C the ground weft ; D the first extra or figuring weft ; E and E¹ the two figuring shots (Fig. 205). These letters are common to the warp and weft yarns throughout this chapter.



Fig. 203.

Fig. 207 is a sectional elevation of the web, reeds, harness and lease rods when the figuring shed is formed.

Fig. 208 shows the same details when the gauze or ground shed is formed. F indicates the lease rods ; G the harness mails and lingoes ; H a 'tug' reed, 5" deep, free to move laterally ; I a dipping

bar or easing rod, free to rise and fall at will; J a specially constructed reed, also free to rise and fall at will, denominated the 'gauze reed' which constitutes the chief feature of this system of weaving. The ordinary, final and fixed reed is shown at K.

A detached and enlarged sketch, in perspective, of the gauze reed is shown at Fig. 209. It consists of an ordinary reed with the addition of *half* dents fixed in the lower rib of the reed. The half dents are pointed at the top and project slightly in front of the ordinary dents: they are perforated near to the points. For full constructional details see Figs. 217 to 221. The crossing warp threads A pass from the lease rods F consecutively through the harness but *not* through the mails, then under the easing rod I and tug reed H, through the eyes in the half dent of the gauze reed J, and finally through the fixed reed K to the web. The regular threads B pass in consecutive order through the mails of the harness G, the tug reed H, the gauze reed J and then through the *same* splits in the common reed K, which contain the adjoining crossing threads A with which each respective warp thread B twists.

Fig. 210 illustrates the order of drafting and reeding of the warp threads from the harness mails G to the fixed reed K.

Fig. 211 is a small geometrical figure design, fully prepared on point paper, for fabrics woven with only one figuring shot, as Fig. 204. The marks represent the figuring warp raised.

The card cutting instructions are as follows:—On each figuring pick and figuring end, controlled by the Jacquard harness, cut all black, insert the figuring weft, which consequently passes under all the figuring warp threads B, and over all the ground threads A in the figure portion of the pattern, but floats freely on the surface of the ground texture, where no figure effect is required.

The Jacquard head must therefore be controlled to rise, and the card cylinder to strike, only on the figuring shots.

Briefly, the operations of weaving with one shot of ground, alternately with one shot of figure, is as follows:—

First pick:—Gauze ground. Leave down all the harness G with threads B, pull tug reed H slightly to the left so that each thread B

Fig. 204.

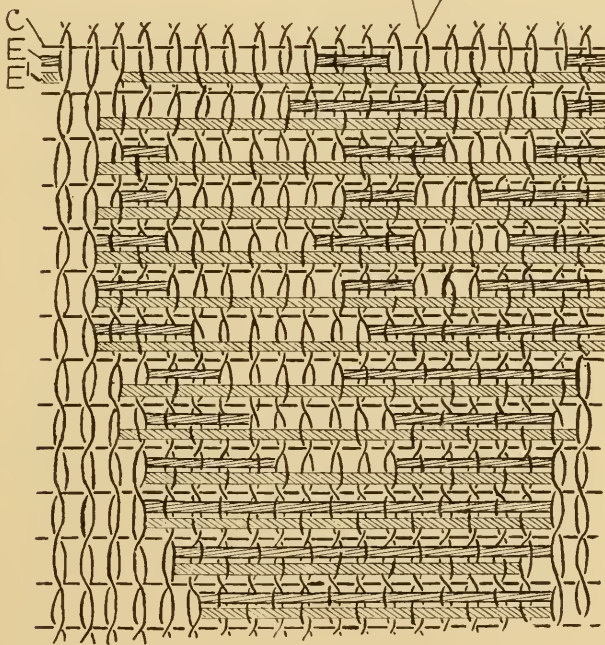
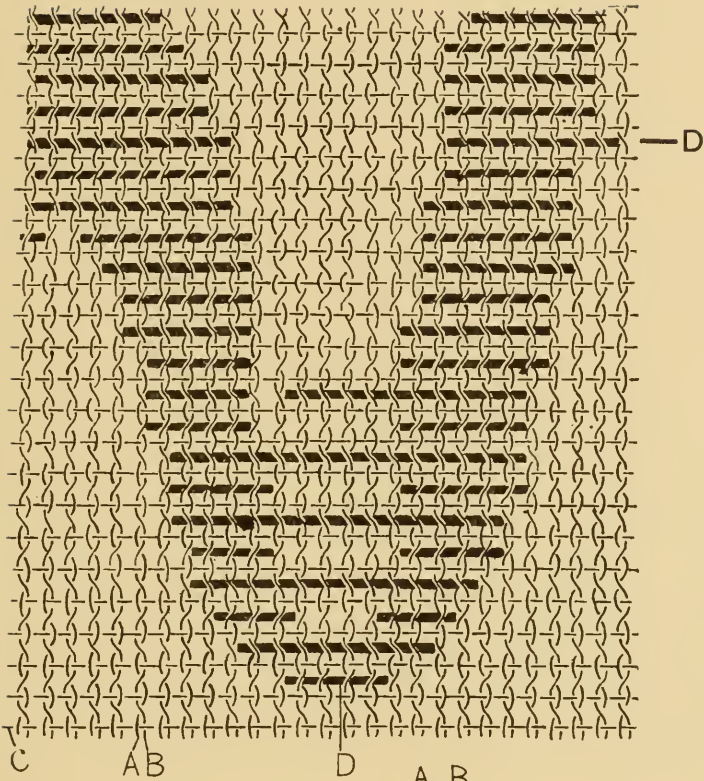


Fig. 205

moves to the left of each respective thread A in the same split; lift the easing rod I and the gauze reed J with the crossing threads A, which therefore rise on the right side of the regular threads B; insert the ground weft c, depress the easing rod I and the gauze reed J, and beat up the weft.

Meanwhile the tug reed H automatically moves laterally from the left to the right, carrying with it each thread B to the right and normal side of each adjoining and respective thread A. (Fig. 210).

Second pick:—Figure. Lift all the harness G with threads B where the ornament is required; insert the thick figuring weft.

Third pick:—Gauze ground. Repeat first pick, except that the tug reed with B remains normally on the right. The gauze threads A therefore rise on the left side of those of the regular threads B.

Fourth pick:—Figure. Repeat the second pick. Continue the sequence of operations, only varying the lifting of the harness G on the figuring shot to suit the varying ornament.

Details and Operation of the Gauze Reed Mechanism.

The details of the mechanisms which operate the gauze and tug reeds, the easing rod and shuttle boxes are fully illustrated at Figs. 212 to 215 inclusive.

Intermittent Reciprocation of the Gauze Reed.

The gauze reed must rise and fall on every gauze or ground pick and remain at rest, in its lowest position, during the insertion of each figuring shot of weft. The required intermittent reciprocation is controlled from the lay of the going part combined with the shuttle box mechanism.

Fig. 212 is a front elevation of the suspended gauze reed.

Fig. 213 is a side elevation of the controlling details as viewed from the left hand side of a right hand loom.

The position of the parts in Figs. 212 and 213 represents the reed in its highest position.

Fig. 214 shows the same side elevation and parts when the gauze reed is in its lowest position and the figuring shot is being

Fig. 207.

Fig. 206.

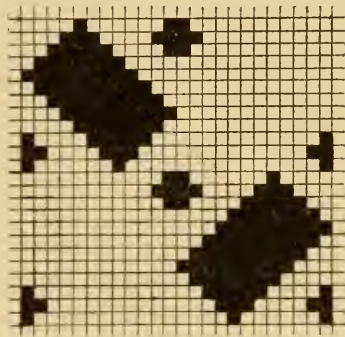
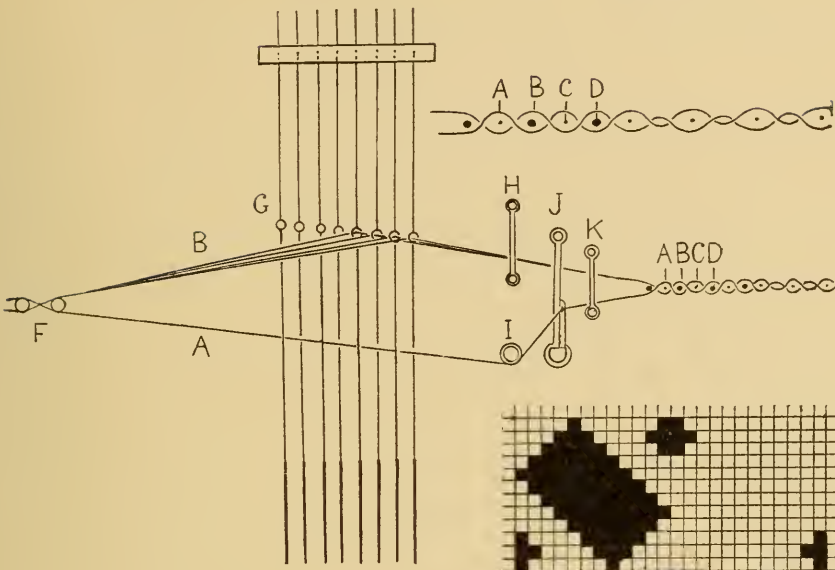


Fig. 211.

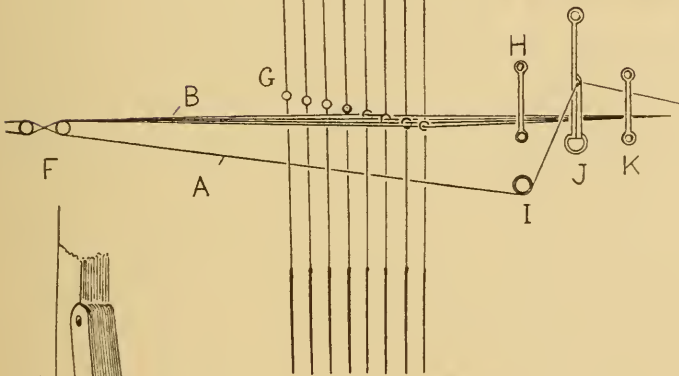


Fig. 208.

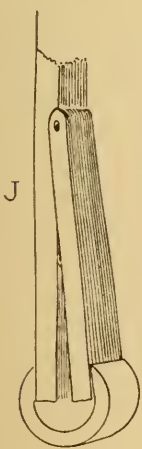


Fig. 209.

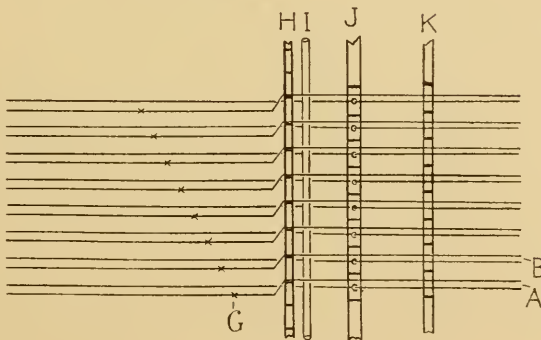


Fig. 210.

inserted. The letters indicate parts that have already been detailed and similar numerals in the three diagrams refer to corresponding parts.

The gauze reed J is suspended by leather straps and buckles 1 and 1¹ from two bell crank levers 2 and 2¹ pivoted on studs 3 and 3¹ which are fixed into the top cross rail of the loom. A connecting rod 4 combines the bell crank levers 2 and 2¹, through studs 5, 5¹ and 6 with the bell crank lever 7 pivoted on the fixed stud 8. A stud 9 combines the lever 7 with a swivel link 10 in turn combined through stud 11 with an adjustable reciprocating rod 12, the lower part of which passes freely through a guide bracket 13 secured to the loom gable. A stud 14 combines the rod 12 with a bell crank lever 15 pivoted on the fixed stud 16. The upper and vertical arm of lever 15 is bent over at the top to form a 'hook' as at 17. A 'tongue' projection 18 compounded with an angle iron 19 is free to be kept up and enclosed with the hook 17 or depressed at will; the angle iron 19 is secured through bolts and nuts 20 and 21 to the shuttle boxes 22 compounded with the lay of the going part and the box spindle 23 adjusted in tube 24, in turn pivoted on the stud 25. This stud combines the tube 24 and spindle 23 with the simple balk lever 26 fulcrumed on the shaft 27 which passes underneath the loom to support and control duplicate box mechanism, at the opposite and right hand side of the loom. The left arm of lever 26 is combined through stud 28 and link 29 with a stud pin 30 which passes through the disc collar 31 in close contact and at right angles to the periphery of a disc plate 32, see Fig. 215. The collar 31 circumscribes the disc plate 32 which is set out of centre and compounded and free to rotate with a stud shaft 33. The stud shaft 33 is compounded with and rotated, according to pattern, by a clutch wheel, under direct control of the pattern cards. The pin 30 in collar 31 is linked to a second clutch wheel under similar but independent control. This double eccentric and compound arrangement is known as Whitesmith's patent; it controls and operates the four shuttle boxes.

Fig. 215 shows four relative positions of the stud pin 30 and eccentric 32 with the fixed centre 33, which operate to place the

Fig. 212.

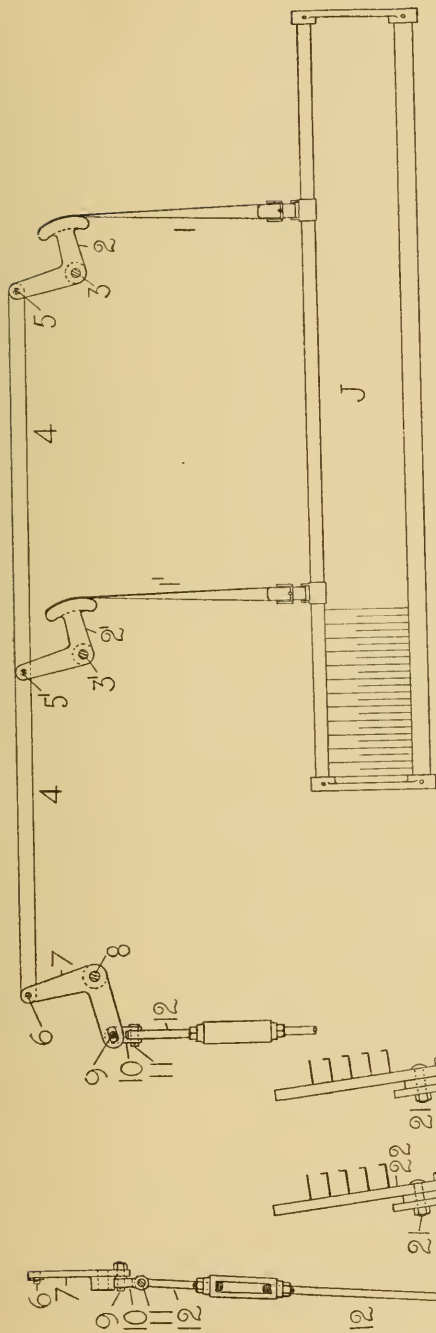


Fig. 215.

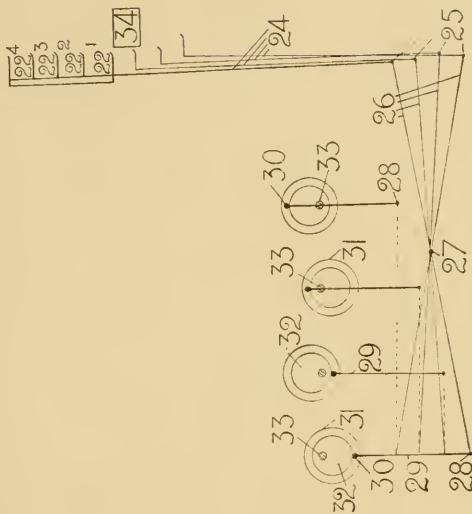


Fig. 214.

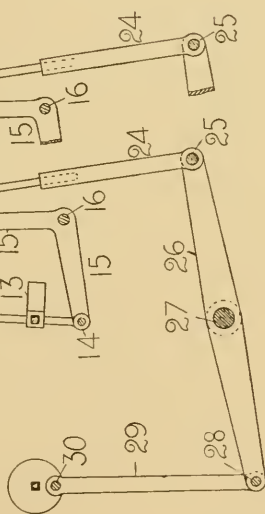


Fig. 213.

respective shuttle boxes 22^1 , 22^2 , 22^3 and 22^4 level with the shuttle race 34 as required by the pattern.

**Action of the
Mechanism.**

With the movement of the lay and shuttle boxes 22 towards the harness, the tongue 18 in angle iron 19, presses against the left side of hook 17 at the top of lever 15, and rocks the last, counter clockwise so that the horizontal arm of lever 15 descends and depresses in sympathy the parts 14, 12, 11, 10 and 9, which operate to rock the bell crank lever 7 counter clockwise, and through the lateral movement of rod 4, simultaneously to rock the levers 2 and 2^1 counter clockwise, which elevate through straps 1 and 1^1 the gauze reed J.

The forward movement of the lay and boxes reverses the action of these enumerated parts, which thus permits the gauze reed to fall by gravity to its lowest position. It is, however, suitably checked as indicated at Fig. 216.

The bottom box chamber 22^1 usually contains the ground or gauze weft, and the second, third and fourth chambers the figuring wefts, according to the number required in the pattern.

Then, when the figuring weft D is required the shuttle boxes descend until the chamber 22^2 is level with the shuttle race 34. This depression of the shuttle boxes lowers in sympathy the angle iron 19 until the tongue 18 is clear of the hook 17, Fig. 214. Consequently as the lay and boxes recede towards the harness, no influence is exercised on the lever 15, nor, through its connections, on the gauze reed J, which therefore always remains down during the insertion of the figuring weft.

**The Easing Rod
and
its Action.**

Fig. 216 shows in elevation the combination of the easing rod and the gauze reed, which operate in sympathy. The ends of the gauze reed J contain solid round studs 35, which are enclosed and free to reciprocate in a slot 36, formed in the fixed bracket 37. A stud 38 combines a link rod 39 through stud 40, with a simple lever 41 pivoted at 42 in the bracket 43, compounded with the loom rail 44. A stud 45 combines the lever 41 through rod 46 with the easing bar 1.

It will now be manifest that with each ascent of the gauze reed *J* and the crossing warp *A* (Fig. 208), the rod 39, lever 41, rod 46 and the easing bar *I* will ascend in sympathy; the easing bar *I* simultaneously releases the tension on the crossing warp threads *A*. Conversely when the figuring shed (Fig. 207) is being formed by the Jacquard harness, this same bar *I* descends in sympathy with the gauze reed, and depresses the crossing threads to their lowest and uniform level.

**Constructional
Details of the
Gauze Reed.**

The additional and complete details of this special reed are fully illustrated as follows:—Fig. 217 shows a front elevation, partly in section, of the left hand side of the gauze reed. The reed proper with the ordinary and half splits is shown at *J*; the top and bottom balks are encased in strong steel tubes *L* combined with equally strong steel ends *M*. Split pins *N* are passed through the tubes *L* and the reed *J* as shown. A special suspension clip *O* is set screwed to the upper tube *L*; a transverse section of this detail is shown at Fig. 218.

A sectional elevation of the complete reed is supplied at Fig. 219.

Fig. 220 shows a front elevation of the reed on the right hand side, and provided with an alternative suspension clip *P*, a transverse section of which is shown at Fig. 221.

**Tug Reed
Reciprocating
Mechanism.**

The tug reed, in most respects, is like an ordinary reed. Each end of it is strengthened by the insertion of a strong steel plate about $\frac{3}{4}$ inch wide. The support, control and action of this mechanism is fully illustrated at Figs. 222 to 225 inclusive.

Fig. 222 is a front elevation of the tug reed and its lateral supports.

Fig. 223 is a side elevation of the operating mechanism.

Fig. 224 is a similar but enlarged view of part of the same details.

Fig. 225 is a plan of part of these details.

Similar numerals refer to corresponding parts.

The tug reed H is supported laterally in its normal position, by two horizontal forces, acting in diametrically opposite directions. Perforations are made in the steel ends of the reed, and an iron hook 48 is passed through the hole at the right hand side of the reed and linked through the medium of a strong helical spring 49 to an adjustable hook 50, bolted fast to a bracket 51 in turn fixed to the loom gable. The opposite or left side of the reed is supported by a hook 52 combined with a leather strap 53. This strap runs over a loose flanged pulley 54, free to rotate on the stud 55 and bolted fast to the bracket 56 in turn compounded with the loom gable. The strap 53 is combined with an adjustable swivel link 57 to a simple lever 58, pivoted at 59 in a fixed bracket 60. The free end of the lever 58 carries an antifriction roller 61 which is kept in rolling contact with an oval shaped cam 62 compounded with a square prism 63, centred and free to rotate on the common stud 64. A rod and hammer 65, supported in a fixed bracket 66, is kept, through the action of a spiral spring 67, in close contact with the square prism 63 to obviate any tendency on its part to rotate too far. A small bracket casting 68 is adjusted by the set screw 69 to the vertical and reciprocating rod 12 (Fig. 213). A stud pin 70 fixed in the bracket 68 supports a small swivel lever 71 which is free to oscillate about the stud 70 but normally rests in contact with the bottom right shoulder of the square prism 63.

**Action of
the Mechanism.**

The tug reed H is normally at rest on the extreme right of its lateral traverse through the constant influence of the spiral spring 49. The position of the reed as represented by the positions of the movable parts, in the illustrations Figs. 222 to 225, is at the extreme left side of its lateral traverse. Then, with each *ascent* of the rod 12 to depress the gauze reed J, the casting 68 rises with the swivel lever 71, the free end of which presses against the bottom right shoulder of the square prism 63 and rotates it, together with the cam 62, one quarter of a revolution whilst the hammer 65 and spiral spring 67 prevent an excess of rotation. The cam 62 then assumes a position (as shown by the dotted lines, Fig. 223) which permits the bowl 61, lever 58 and rod 57 to rise and the strap 53 to pass freely over the roller 54, which in

Fig. 224.

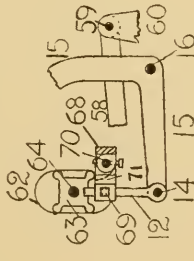


Fig. 223.

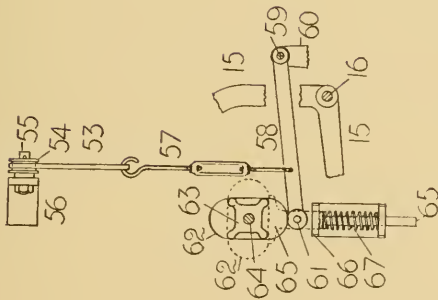


Fig. 222.

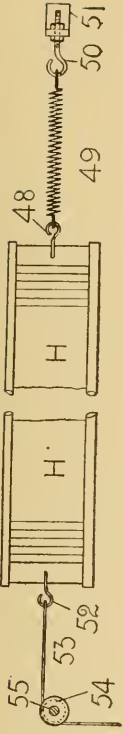


Fig. 225.

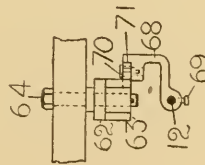


Fig. 216.

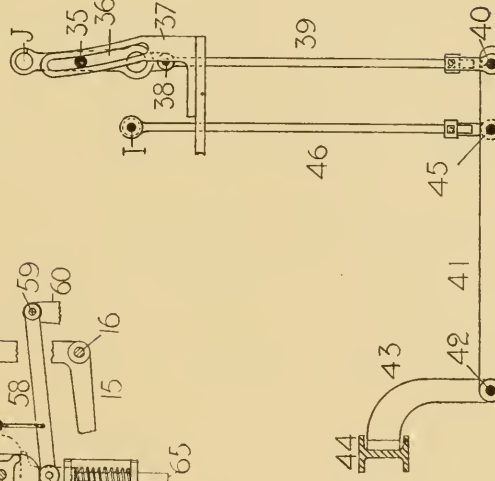


Fig. 218.

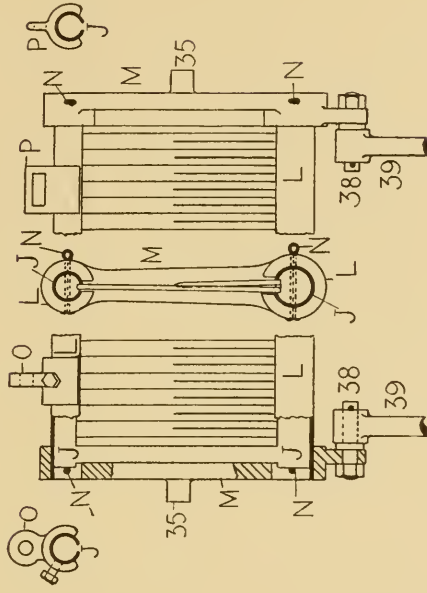


Fig. 217.

Fig. 219.

Fig. 220.

Fig. 221.

turn permit the reed H under the influence of the spiral spring 49, to return to the extreme limit of its traverse to the right, causing the regular and non-gauze threads B to move over to the right of threads A in the half dents of the gauze reed J (Fig. 210). This reed then rises as heretofore described to produce the gauze ground texture and the rod 12 *descends* carrying with it the casting 68 and the swivel link 71 which swivels clockwise about the stud 70 until the swivel lever is clearly below the bottom right shoulder of the square prism 63. Then, with the next ascent of the rod 12 the swivel lever 71 rotates the prism 63, a further quarter of a revolution and turns the cam 62 into the position shown in the diagrams. The bowl 61, lever 58 and link 57, through the strap 53, pull the tug reed H together with the threads B to the left preparatory to the next gauze crossing.

It will thus be seen that when the *gauze reed* is *stationary*, the *tug reed* must also of necessity remain normally *at rest* as for example, when the figuring shots of weft are being inserted.

CHAPTER XV.

The Swivel and Jacquard.

THE swivel is an adjunct to the loom ; it is most advantageously and effectively employed in conjunction with the Jacquard machine, and is introduced to weave small spot effects of colour, which are distributed by the aid of the Jacquard or other shedding apparatus over a plain or figured ground.

Extra Warp and Weft Figures.

The common method of distributing these extra spot effects is by using additional coloured *warp* or *weft* threads and floating them upon the surface of the texture at suitable places, so as to give any desired effect. The different kinds of extra warp or weft threads are expressly introduced for the ornamental details of the design, and when not required upon the surface are floated loosely on the back of the texture to be afterwards cut off, or are fastened to the ground cloth at suitable distances apart. In backed and double cloths, the extras are frequently made to float in between the two fabrics at those places where they are not required for figuring.

Relative Advantages of Extra Warp and Weft Spotting.

The relative and comparative advantages of warp and weft spotting may be defined as follows:—
When spotting with extra warps no extra shuttles are necessary, and consequently the web can be woven in the minimum of time; no additional pattern cards are required but two warp beams are requisite, and the extra warp yarn must be crammed into the same splits in the reed as the ground warp. When spotting with extra weft a relatively less costly yarn may be employed as compared with that for warp spotting; the figuring capacity of the Jacquard machine is not reduced as is the case when extra warp is used, and only one

warp beam is required. The introduction of extra wefts retards the output pro rata with the increase in the number of shots of extra weft as compared with the number of ground picks in each repeat of the spot pattern.

Either of the foregoing methods, it will be perceived, is wasteful of the figuring material, and generally most expensive.

Object and Advantage of Swivel Weaving.

The primary advantage of the swivel is that it practically only uses as much of the extra figuring material as the pattern requires. When displayed in the woven fabric it presents the appearance of an *extra weft*.

The swivel may be used for spotting either single or double cloths, including brocades, dress materials and vestings.

Spotting Brocades and Figured Fabrics.

Fig. 226 is a small figured dress goods design; the detached figure is arranged in simple drop order; the centre of the flowers is spotted with silk weft by the aid of the swivel mechanism illustrated and described on pages 229 to 244. The design is fully developed on 192 ends and picks as a weft sateen figure on a plain ground, and the figure is spotted with an extra silk weft as indicated by the solid marking, thus:—■. The cloth and pattern are woven face downwards. The distance between contiguous swivel shuttles in this example is *two* inches. The figuring capacity of the Jacquard machine is 400 hooks and 100 harness cords per inch, reduced to 384 hooks and 96 ends per inch to suit the given figure design.

The full details of weaving are as follows:—

Warp.	50s warp twist cotton.	96 threads per inch.
Weft.	50s weft	„ 96 ground shots per inch.
Swivel Weft.	30/2 spun silk, woven pick and pick with the ground shots in the positions indicated in the fully developed point paper design. Fig. 226.	

The card cutting instructions for the given pattern are:—

1. Cut all white and insert the cotton weft on the ground picks.

2. Cut marks ■ for the swivel cards and lace them alternately with the ground cards; insert the swivel weft alternately with the ground shots and cards.

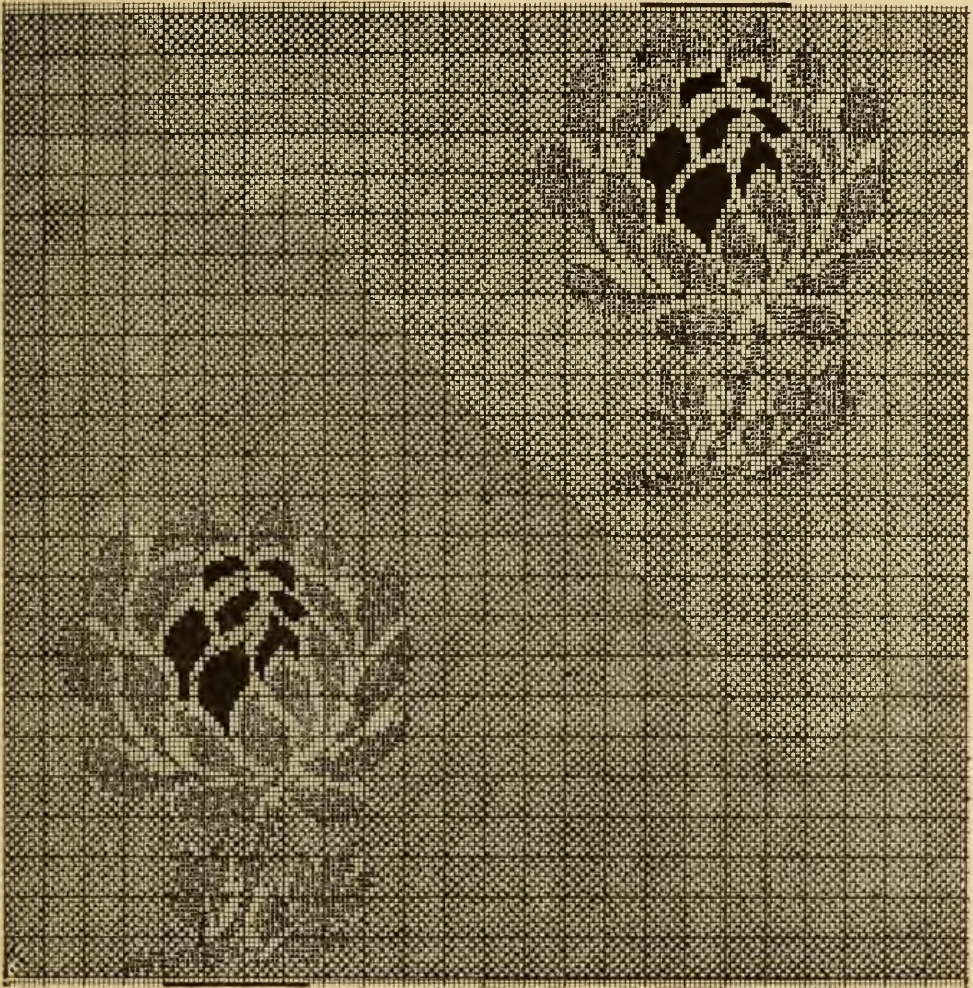


Fig. 226.

Compound Vesting Spotted with the aid of the Swivel Mechanism and Jacquard Mounting.

The decoration of vestings usually consists of a series of small spots or minute figures judiciously arranged and composed of bright coloured yarns such as silk, mohair, etc., upon a wool, cotton or linen surface. The ground weave of the texture is generally some standard make or a simple and effective design, enhanced in value by the combination of two or more weaves to produce a check effect of pattern, which is then spotted with the special colouring

threads to suit. It is the introduction of the coloured threads which gives to the fabrics their special features, and furnishes a field for the designers ingenuity in the disposition of the small coloured spots, and in making them distinctly visible on the surface of the texture.

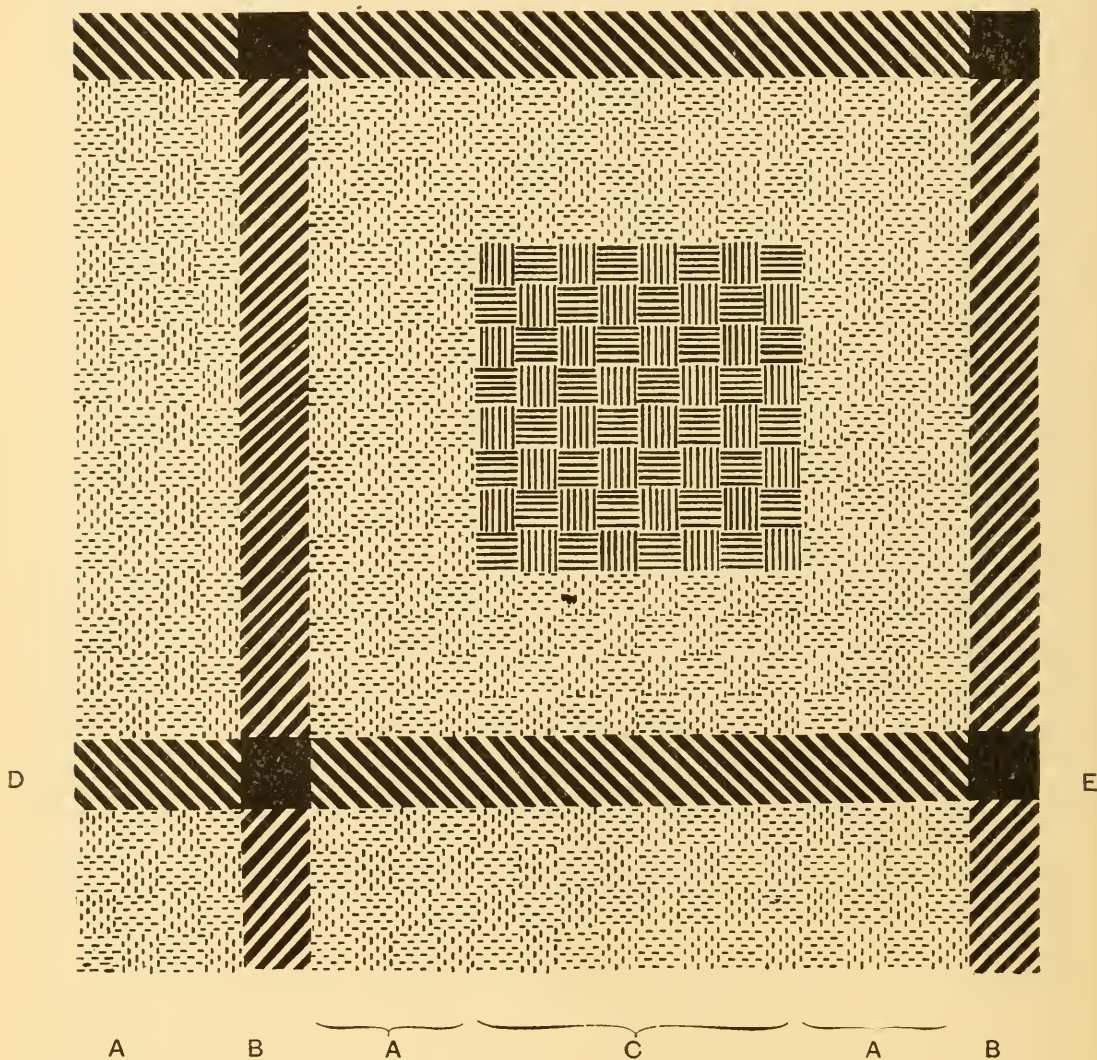
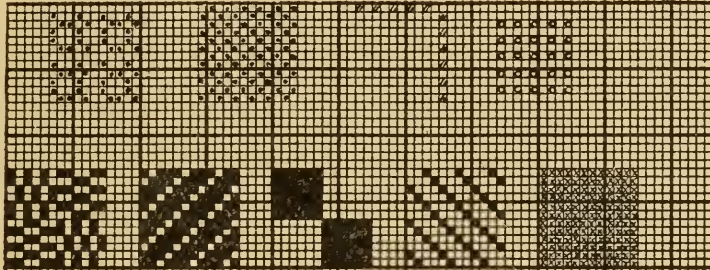


Fig. 227.

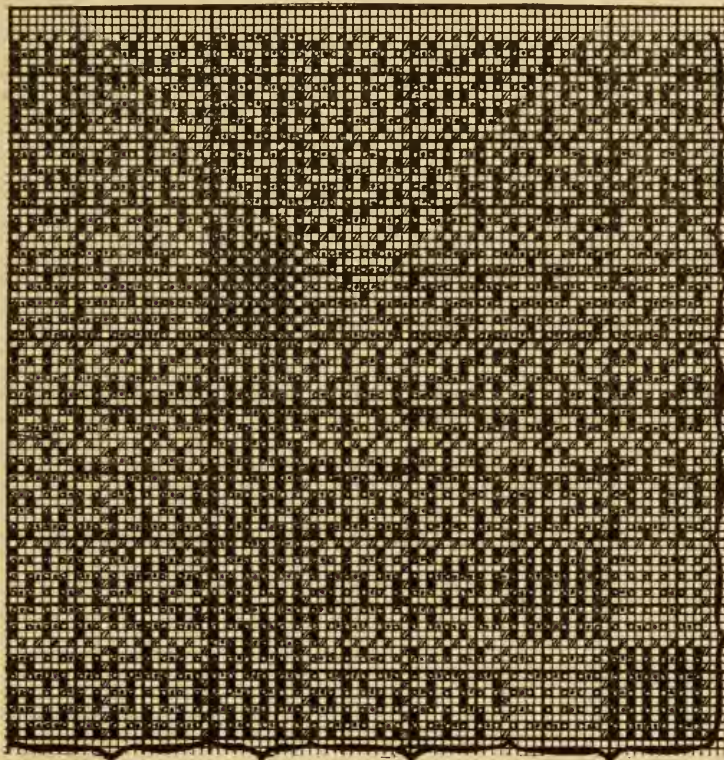
If the coloured spotting threads are used with compound weaves, the more thoroughly the designer is conversant with the fundamental principles of backed and double cloth designing, the greater will be his opportunity for obtaining the best results,

both as regards decoration and construction, though fairly good results may be obtained with only a limited knowledge of backed and double cloth structure.

Figs. 234 235 236 237



Figs. A B C D E.
 229. 230. 231. 232. 233.



A B A C

Fig. 228.

Fig. 227 is a sketch plan of the face effect of a compound woven vesting fabric.

Fig. 228 is the fully developed point paper design.

The fabric is woven with *one* end and pick of face to *one* end and pick of back, exclusive of *seven* extra swivel shots. There are *four* effects of pattern, A, B, C and D, exclusive of the swivel spot where B and D intersect, on the surface of the cloth; these represent the face weaves which are shown separately and respectively at Figs. 229, 230, 231, and 232, and the swivel effect at 233. The backing weaves for these parts are supplied at Figs. 234 and 235, the former is for the back of parts A and C, and the latter for B and D. Marks represent warp raised, except in the swivel spot where marks \times represent weft on the surface of the cloth. Every *sixth* end of *backing* warp floats over each face and under each backing pick; every sixth backing pick floats over each face and under each backing end, which is equivalent to plain weave in the compound structure. The result is a perfect "cut" and a complete stitching of the two cloths on every twelve ends and picks. This cutting and binding weave is detached and separately illustrated at Fig. 236.

The different marking of these elementary weaves, Figs. 229 to 237, is retained in the compound weave Fig. 228, which incidentally, locates their respective positions.

The separation of the two cloths, by lifting all the face warp threads when the backing weft is being inserted, is represented by the marks thus, $\overline{\square}$. Fig. 237.

The card cutting instructions for weaving the fabric face downwards are:—

1. *For ground*, cut all white and insert ground weft.
2. *For swivel spot*, cut all marks thus $\overline{\times}$ on the face and odd picks opposite the part D. Insert after each face pick, the swivel figuring weft.

The complete details of make for the given cloth are as follows:—

Warp	1	thread	2/10s	grey fawn	mercerised	cotton—face	}	204 ends
„	1	„	2/48s	„	„	—back		
Set	102	threads of warp per inch						

Weft	{	1 shot 2/10s grey fawn mercerised cotton	face	} 72 times = 144
	{	1 ,, 2/48s ,, ,, ,,	back	
	{	1 ,, 2/10s ,, ,, ,,	face	} 6 ,, = 18
	{	1 ,, 30/2 spun red silk	swivel	
	{	1 ,, 2/48s mercerised cotton	back	} 24 ,, = 48
	{	1 ,, 2/10s ,, ,, ,,	face	
	{	1 ,, 2/48s ,, ,, ,,	back	} 24 ,, = 48
	{	1 ,, 2/10s ,, ,, ,,	face	
			(binding) =	1
		Shots in one repeat including spotting shots		= 211

Swivel Mechanism.

All the essential details of swivel weaving together with its operating mechanism are exhaustively illustrated in the following diagrams, drawn to scale from Wm. Smith & Bros. swivel loom.

Fig. 238 is a front elevation of the swivel frame and swivels combined with the hand rail of the 'going part.'

Fig. 239 is a plan of the swivels and swivel frame.

Fig. 240 is an enlarged plan of one swivel and spool.

Fig. 241 is an enlarged sectional elevation through the swivel frame, swivel and spool.

Fig. 242 is a detached elevation to show the connection of the swivel shuttles with a movable rack fitted into a groove at the back of the swivel frame.

Corresponding numerals in each diagram refer to similar details.

There are sixteen swivels distributed over a width of cloth of 32" to 33"; the pitch between each contiguous pair is 2", including a space of about $\frac{1}{2}$ " which permits a portion of the warp to rise between each pair of shuttles. Any other convenient number of swivels may be employed to suit the pattern.

1 is the lay and shuttle race; 2 and 2¹ the ordinary shuttle boxes; 3 the hand rail or sley cap. Adjustably arranged on the top of 3 is a wood rail 4 normally at rest but free to move laterally at will. At the top and near each end of rail 4, two angle iron brackets 5 and 5¹ are fixed; these support a half-inch round iron rod 6 which

is free to oscillate in them. Set screwed to rod 6 on the inside, but in contact with each respective bracket 5 and 5¹, are short levers 7 and 7¹ which are combined through the respective studs 8 and 8¹, swivel links 9 and 9¹ and pivot studs 10 and 10¹ to the brackets 11 and 11¹. These brackets are screwed fast to the top of the swivel frame 12 which is free to rise and fall in a vertical plane. Compounded with the adjustable rail 4 are two right angle brackets 13 and 13¹, the perpendicular parts of which are smooth round spindles which pass through and are free to reciprocate in the bracket sleeves 14 and 14¹ also set screwed fast to the swivel frame 12; these are the factors which obviate any tendency of the swivel frame to deviate from a true vertical plane.

Adjustably set screwed to the oscillating rod 6 are two small segment levers 15 and 15¹. These are placed immediately over the respective horizontal arms of the brackets 13 and 13¹ against which they come in contact with each descent of the swivel frame 12 and thus serve to limit its fall.

Slotted grooves 16 are formed in the swivel frame which support the sixteen or other suitable number of swivel shuttles 17, each of which carries a small spool 18 containing the weft 19. A small brass spiral spring 20 with a smooth head constantly presses against the yarn on the spool; a second spiral spring 21 circumscribes the spindle on which the spool rotates, and constantly exercises a pressing and retarding influence on the end of the spool. The combined action of the two springs prevents any tendency on the part of the spool 18 to rotate too far, whenever the weft is being drawn from it for figuring purposes.

Independently of the swivel frame 12, the shuttles 17 are free to move *en masse*, laterally to the right or left, a distance of two inches, equal to the pitch between the shuttle centres. The details of the mechanism which facilitates this lateral movement are as follows:— A movable rack 22, with leather teeth, $\frac{1}{4}$ in. pitch, is fitted into a groove 23 at the back of the swivel frame 12, Fig. 242; along this groove the rack is free to reciprocate. The leather teeth of rack 22 gear into those of a small rack pinion 24 centred and free to rotate on a fixed stud pin 25, compounded with the frame 12; the teeth of

Fig. 238

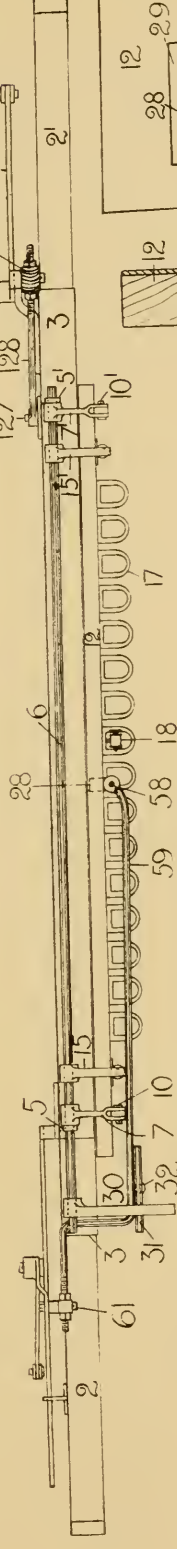
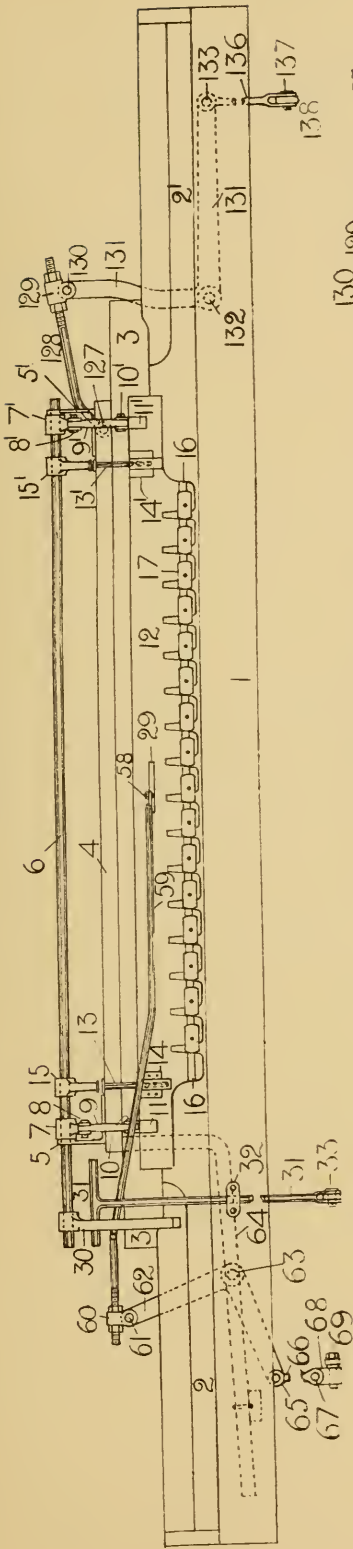


Fig. 241

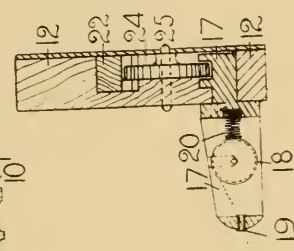


Fig. 242

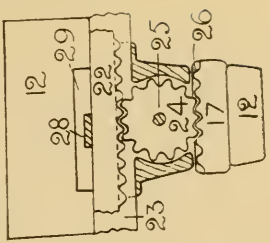
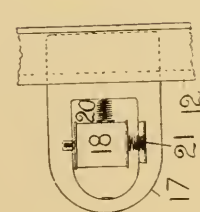


Fig. 239

Fig. 240



the rack pinion 24 in turn, gear into the teeth of a small rack 26 compounded with the lower and rear side of the swivel shuttle 17. Each shuttle is similarly combined with and controlled by the rack 22. This rack is combined with a projecting flat iron plate 28, which passes through a slot 29 in the swivel frame 12 in which slot it is free to be reciprocated as subsequently described.

The swivel frame always contains one slotted division more than there are swivel shuttles in use, consequently whenever the shuttles are moved laterally to the left side of the swivel frame the extreme division on the right is empty, and vice versa.

Requisite Whenever a shot of weft is required from the
Action of the swivel shuttles, the Jacquard machine must select
Swivel Frame for lifting according to pattern, those threads under
and Shuttles. which the extra weft must float. The warp threads selected for elevation can only be from among those threads which are directly in the same vertical plane as the spaces between the contiguous shuttles 17. Then when the lay of the going part is travelling towards the harness, and the figuring shed is gradually forming, the swivel frame 12 together with the shuttles must simultaneously descend until the shed is completely opened and the frame is fully down. During the period which the shed usually remains open, the swivel shuttles, independently of the frame, must be made to travel laterally to the right or left. Then as the lay travels towards the fell of the cloth, the frame 12 must gradually rise to its highest and normal position.

During each insertion of the extra flowering shots, the ordinary picking motion must be automatically thrown out of action.

Details of Swivel Controlling Mechanism.

Vertical The mechanism designed to produce this vertical
Reciprocation reciprocation of the swivel frame is illustrated on
of the the additional diagrams at Figs. 243 and 244; the
Swivel Frame. former is a side elevation and the latter a plan of the operating details as viewed from the left side of a right hand loom. The parts shown combine with those in Figs. 238 and 239 as follows:—A small lever arm 30 is set screwed

to the horizontal shaft 6. The free arm of this lever rests in negative contact with the top of the crosshead of a T shaped vertical rod 31 which is adjustable and passes freely through a slotted bracket 32 compounded with the front of the shuttle race 1. The rod 31 is supported and pivoted on a loose stud 33 which passes freely through and near the free end of a treadle lever 34 pivoted on the

Fig. 243.

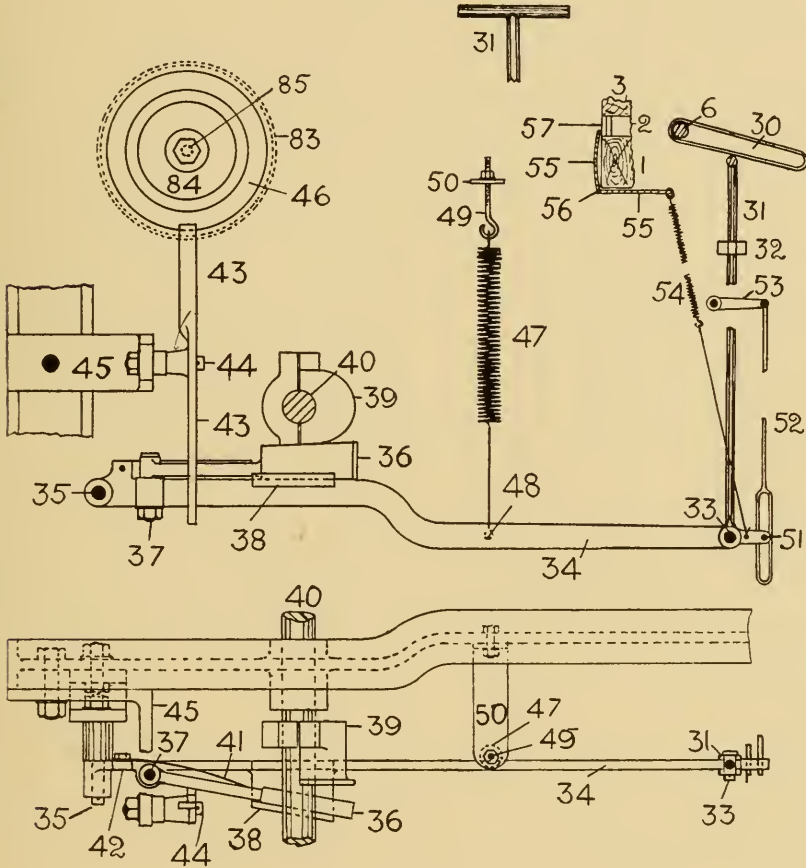


Fig. 244.

fixed stud 35. Combined with the treadle 34 is a small lever 36 pivoted on the stud 37 which passes through the treadle lever 34 in the position shown. The lever 36 is free to move at right angles to the treadle lever 34 irrespective of whether the latter is in action or not. The free arm of lever 36 rests passively upon a horizontal flat plate 38 which is compounded with the treadle lever 34. A small cam or eccentric 39 is compounded with the bottom shaft 40;

against this cam or the low shaft the free arm of lever 36 rests normally in contact, notwithstanding the constant pressure of a strong steel spring 41, pivoted on the stud 42, which exercises its energy to press the lever 36 clear of the eccentric. The action of the spring 41 may be overcome by the lower arm of a simple lever 43 pivoted on the stud 44 in a fixed loom bracket 45. The upper arm of the lever 43 is in constant contact with a clutch wheel 46 which is free to rock the lever 43 about its pivot stud 44 at will; the lower arm of the lever 43 rests in contact with the outside of lever arm 36, so that whenever the upper arm of lever 43 is rocked outwards the lower arm is simultaneously rocked inwards and overcoming the resistance of the steel spring 41 places the lever 36 normally under the cam 39, the nose of which as it rotates, presses on the top of lever 36 and through it, reciprocates the treadle lever 34 which in turn elevates or depresses the T shaped rod 31. The depression of this rod permits the lever 30 (Fig. 239) to fall and oscillates the rod 6 clockwise, which in turn, through parts 5 to 11 inclusive combines to depress the swivel frame 12 once for every two revolutions of the crank shaft (two picks), whenever the swivel effect of pattern is being produced. Immediately the pressure of the tappet nose 39 is released, the treadle lever 34 normally ascends, due to the action of a strong spiral spring 47 which combines the treadle lever, through the stud 48 and an adjustable hook 49, to a fixed bracket 50 compounded with the loom gable.

The ascent of the treadle lever 34 elevates the rod 31, and lever 30 which last rocks the rod 6 counterclockwise and through details explained, lifts the swivel frame 12 together with the shuttles clear of the warp and reed.

In the non swivel portion of the pattern, the lever 36 is pressed by spring 41 normally clear of the cam 39, and the swivel frame consequently remains in its highest position and out of operative action.

At the right end of the lever 34, a projecting stud 51 is bolted fast; the projecting arm of this stud passes freely through a slotted vertical rod 52 suspended from a fixed bracket 53. The

projecting stud 51 checks any tendency in the lever 34, to fall below the bottom of the slot in the fixed rod 52.

**Neutralising
the Operative
Action of the
Weft Fork.**

It will be evident that when the reed strikes against the fell of the cloth on the swivel pick and when the ordinary picking motion is detached, that the weft fork will normally operate to stop the loom in the ordinary way, but this tendency is neutralised as follows :—(Fig. 243). A cord and spiral spring 54 combine the treadle lever 34 with a bell crank lever arrangement 55, pivoted at 56 ; the upper arm of the lever 55 is shaped as shown and is free to be rocked into or out of contact with the back of the weft fork grid 57. Normally the upper arm of the lever 55 rests clear of the grid. When the ordinary picking motion is thrown out of action and the reed is travelling towards the fell of the cloth to beat up the swivel shot, the cord and spring 54 tighten and draw down the horizontal arm of lever 55 but move the upper arm across the back of the grid 57 and tilt the weft fork in the same way as happens when the ordinary weft lies across the face of the grid.

**The Lateral
Reciprocation
of the Swivel
Shuttles.**

The additional mechanical details designed to attain this object, and also to work in unison with the vertical reciprocation of the swivel frame are illustrated at Figs. 245 and 246 ; the former is a front elevation and the latter a plan.

A stud 58 combines the rack 22 (Fig. 239) with a horizontal connecting rod 59, which is adjustably connected by a swivel link 60 and stud 61 to a bell crank lever 62 pivoted on the stud 63. This stud is compounded with a flat iron bar 64, which in turn is screwed fast to the back of the wood frame 4 and consequently moves in sympathy with it. A stud 65 combines the horizontal arm of lever 62 with that of a vertical swivel and adjustable link 66 in turn combined through stud 67, swivel link 68, and stud 69 with a simple balk lever 70, pivoted on the fixed stud 71, Fig. 245. An adjustable stud 72 in the left arm of lever 70 combines with an adjustable link rod 73, in turn supported by and suspended from a stud 74, set out of centre in a disc wheel 75 which is pivoted and free to rotate on a

fixed stud 76. The boss of wheel 75 on the remote side is cast with ten spur teeth 77, which gear into a spur wheel 78 containing forty teeth, supported and free to rotate on a fixed stud 79. Compounded with the boss of wheel 78 is an eight socket star wheel 80, which is free to be intermittingly rotated clockwise, at will, once on every two picks, whenever the swivel pattern is required. 81 is a section through the crank shaft, and 82 a broad toothed spur pinion containing thirty-two teeth which gears into and drives a clutch spur wheel 83 containing sixty-four teeth, and which therefore rotates at half the speed of the crank shaft. The spur wheel 83 is compounded with a large segment boss 84, four inches in diameter, supported and free to rotate on a strong stud 85 fixed in the loom gable.

The segment boss 84 with wheel 83 is free to move laterally along the stud 85, and is kept normally at the extreme limit of its inward traverse through the constant pressure of a strong spiral spring 86 which fits loosely on the stud 85, combined with a washer and nut 87 as shown. The clutch spur wheel 83 contains three projecting studs, one (88) on the near, and two (89 and 90), at the rear side. The stud 88 is free to engage with one of the notches in the star wheel 80 and the studs 89 and 90, which are diametrically opposite to each other, engage alternately with a second sprocket or star wheel 101.

The outward movement of boss 84 with wheel 83 is obtained as follows:—On the side nearest the loom gable the boss forms a segment only, part of it being removed. A simple lever 91 pivoted on the fixed stud 92 carries an antifriction bowl 93 in its free end; this lever is connected by a cord 94 to the right arm of a balk lever 95, pivoted on the fixed stud 96 combined with the top cross rail of the loom, Fig. 247, which is an elevation as seen from the back of the loom. The left arm of lever 95 is kept normally down by a weight 97, which consequently lifts the lever 91 and bowl 93 normally clear of the segment clutch 84. A cord 98 joins the lever 95 to one of the Jacquard figuring hooks 99. The griffe and knife are shown at 100.

A perforation in the Jacquard card causes the hook 99 to lift the left arm of balk lever 95 and depress its right arm, which then

permits the bowl lever 91 to engage the bowl 93 with the segment of boss 84 (Figs. 245 and 246), which in turn is moved laterally outwards along its pivot stud 85, overcoming the resistance of the spiral spring 86 until the projecting steel pin 88 is directly opposite

Fig. 245.

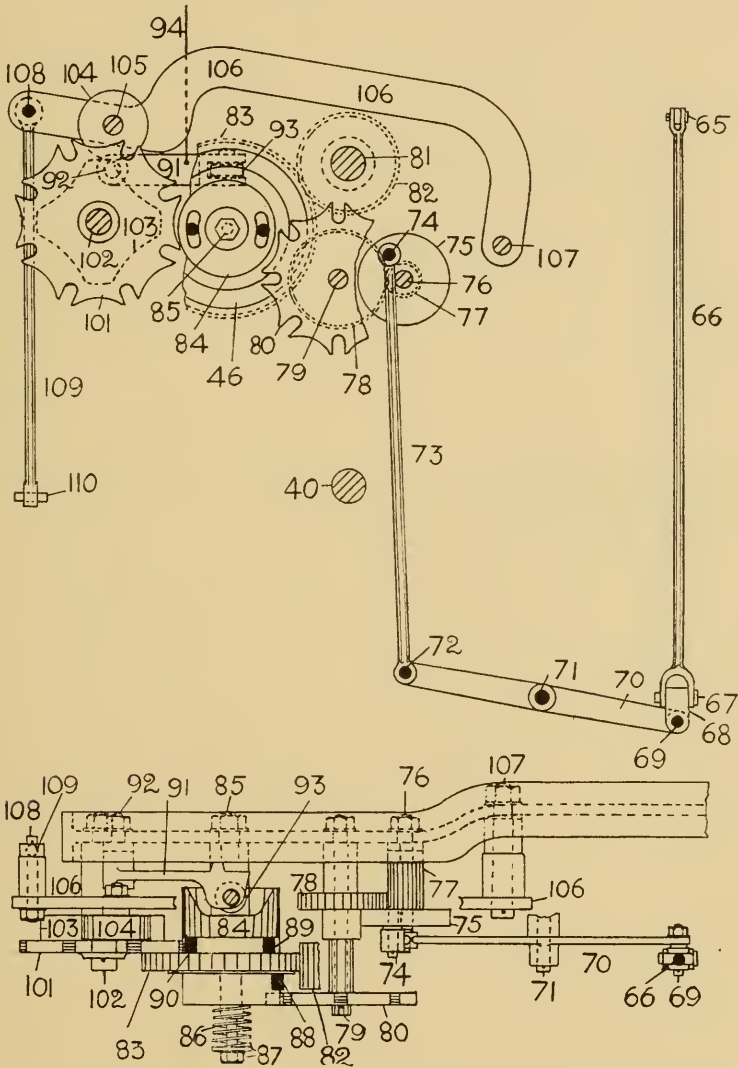


Fig. 246.

one of the notches in the star wheel 80, which it then rotates one eighth of a revolution. The star wheel 80 revolves the spur wheel 78 through which the spur boss 77 is rotated counter clockwise together with the disc wheel 75 and stud 74. This circular move-

ment of the stud reciprocates the link rod 73 and rocks the balk lever 70, which through the connecting link 66 oscillates the bell crank lever 62 (Fig. 239) about the stud 63 and through the horizontal connecting rod 59 and flat plate 28 moves the rack and rack plate 22 laterally to the right and left, and through parts 17 to 24 inclusive (Fig. 242) the swivel shuttles.

When the 'eccentric' stud 74 is rising on the right side of the stud 76, it moves through details described the swivel shuttles to the right; on the contrary when the stud 74 is descending on the left side of stud 76 it combines to produce a lateral movement of the swivel shuttles to the left. The traverse of the swivel shuttles to the right inserts the extra figuring weft and their traverse to the left brings them to their normal and stationary position; hence these parts of the mechanism are only in operation when the swivel figure is being woven.

Automatic Detachment of the Picking Mechanism.

Whenever the swivel pattern is required to be woven, the swivel mechanism automatically picks on alternate and normal shots of weft; this involves that the ordinary picking mechanism must be automatically thrown out of action during the insertion of each swivel shot of spotting weft.

On the other hand, where no swivel pattern is required the whole of the swivel mechanism is automatically detached from action, the loom runs as ordinarily and the picking takes place alternately from opposite sides of the loom as usual.

Fig. 248 is an elevation as seen from the back of the loom, of the supplementary details to the ordinary picking mechanism and which are necessarily connected with the depicted details in Figs. 245, 246 and 247.

Fig. 249 is a plan view of the same added details. Reverting to Figs. 245 and 246, the projecting steel studs 89 and 90 in clutch wheel 84 are free to engage, according to pattern, alternately with the notches of the second star wheel 101, pivoted on the fixed stud 102; compounded with the rear side of the star wheel 101 is an

octagonal cam 103 formed with four convex and four concave sides ; in continuous contact with one or other side is an antifriction roller 104 pivoted on an adjustable stud 105 in lever 106 fulcrumed on the fixed stud 107. The free arm of lever 106 supports, through an

Fig. 248

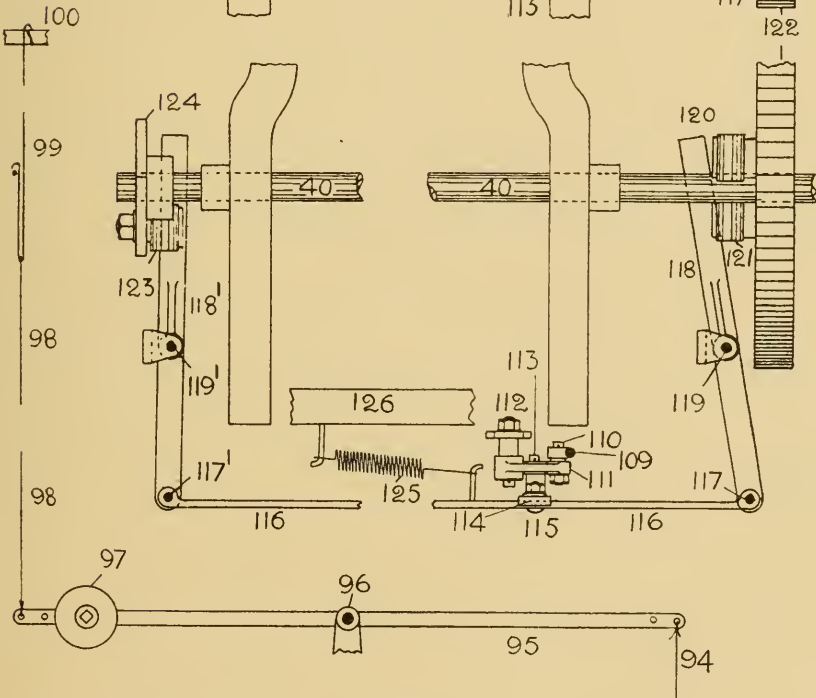
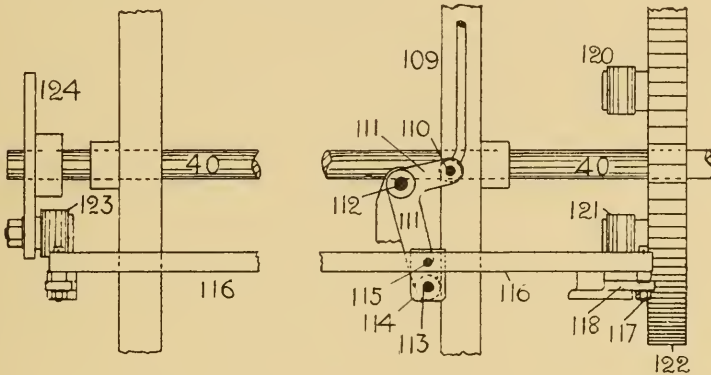


Fig. 249

Fig. 247

adjustable stud 108, a vertically suspended link 109 which in turn, through a stud 110, combines with a bell crank lever 111, pivoted on the fixed stud 112 (Fig. 248). The vertical arm of lever 111 combines with the horizontal link rod 116, through a stud 113 compounded with a small bracket 114 in turn adjustably connected

through a stud 115 fixed in the above link rod 116. This link is connected on the right side by a stud 117 to a lever 118, pivoted on the stud 119 projecting above the face of the ordinary 'treadle' picking lever, Fig. 249. The free arm of lever 118 carries the picking 'shoe' which usually is combined with, and projects above the surface of the ordinary picking lever. The free end of the lever 118 with the projecting picking shoe is at liberty to move laterally and at right angles to the surface of the picking treadle lever, into or out of contact with one or other of two picking bowls 120 or 121, adjusted diametrically opposite each other and compounded with the driven spur wheel 122, keyed to the low shaft 40.

The detailed parts are duplicated at the opposite side of the loom. A third picking bowl 123 is keyed fast to a crank lever 124, in turn keyed fast to the low shaft 40.

A spiral spring 125 combines the link rod 116 with the loom cross rail 126 as shown. The energy exercised by the spring pulls the link rod 116 to the left and through it, operates to bring the free arm of lever 118 with the tappet shoe into striking contact with bowl 120 or 121.

**Regular and
Intermittent
Action of the
Picking
Mechanism.**

1. *Regular Action.* The constant rotation of the crank shaft 81 with pinion 82, rotates the clutch spur wheel 83 together with the projecting studs 88, 89 and 90. The second or last of these studs engages with one of the sockets in star wheel 101 and rotates this wheel one eighth of a revolution for each pick or revolution of the crank shaft 81. In the diagram Fig. 245 the convex portion of the cam 103 is in rolling contact with the bowl 104, which is consequently raised to its greatest height together with the free end of lever 106 and stud 108, which in turn lift the link 109 and stud 110 to rock the bell crank lever 111 counterclockwise; the vertical arm of the lever 111 moves, sympathetically to the right, the link rod 116 and stud 117. The result of the combined action is to move the lever 118 about its pivot 119, until the picking shoe is out of striking contact with bowls 120 or 121, according to whichever is passing the bottom on the given pick. The foregoing position of

parts, automatically places the picking shoe combined with the free end of the duplicate lever 118 into striking contact with the picking bowl 123 at the opposite side of the loom.

The next and subsequent pick and revolution of the crank shaft 81 brings one of the projecting studs 89 or 90 into the notched recess of the star wheel 101 and rotates it an additional eighth of a revolution until the concave part of the cam 103 rests directly under the centre of the bowl 104, which is thus permitted together with the free end of lever 106, to fall by gravity, assisted by the pull of the spiral spring 125 acting on the rod 116 to rotate the lever 118 about its pivot 119; this results in placing the tappet shoe, in the free end of lever 118, directly under the striking bowl 120.

This sequence of operations is continued as long as the swivel mechanism is detached from action. During this period the picking bowl 121 never comes into striking contact with the picking shoe, on lever 118, since the latter is always moved out of striking range of bowl 121 when it is passing the bottom centre.

2. *Intermittent Picking.* When the swivel figure is being woven, the Jacquard hook 99 is lifted on alternate picks and revolutions of the crank shaft 81. The hook 99 operates through the mechanism already described to lower the free arm of lever 91 with bowl 93 into acting contact with the segment clutch socket 84, and move it outwards until the clutch studs 89 and 90 are out of striking contact with the star wheel 101, but it simultaneously places the clutch stud 90 into working contact with the star wheel 80, and through mechanism already described operates the swivel details.

The ordinary shuttle during the foregoing period must consequently remain stationary at either the left or the right hand side of the loom. The addition of the picking bowl 121 makes it possible to pick from this same side of the loom on either the odd or even picks of weft.

Supplementary Lateral Movement of the Swivel Frame and Swivels.

It is frequently desirable to weave each second and subsequent alternate horizontal row of spots, so that they fall midway between

the first and alternate rows, as in Fig. 226. When this is successfully accomplished it is equivalent to doubling the number of swivels with which any given loom is equipped.

Part of the mechanism added for this purpose is shown in Figs. 238 and 239. The wood frame 4 which supports the swivel frame 12 and swivels 17, is combined through a stud 127 and link 128 with an adjustable swivel link 129, which through a stud 130 is connected with a bell crank lever 131, pivoted on the stud 132 in the shuttle race 1. The lever 131 is combined, through a stud 133, a vertical reciprocating link 136 and a stud 137, with a lever 138.

The remaining details of the mechanism designed for the attainment of the above object are illustrated at Figs. 250 and 251; the former is a side elevation and the latter a plan.

The reciprocating rod 136 is combined through a stud 137 with a simple lever 138 pivoted on the fixed stud 139. A heavy weight 140 is combined by a bolt 141 with the lever 138 as shown. A stud 142 combines the lever 138 with a vertical connecting rod 143 which in turn is linked through the stud 144 to the lever 145 fulcrumed at 146. The lever 145 carries a stud 147 on which an antifriction bowl 148 is free to rotate. This bowl is kept, through the gravitation force of weight 140 in close or rolling contact with a set of tappets 149. The chain of tappets is combined and rotates with a chain cylinder 150 on the fixed stud 151. Compounded with the same boss as the chain cylinder 150 is a star wheel 152 containing eight notches in its periphery, any one of which is free to engage, as required by the pattern, with a clutch pin 153 projecting from the back of a spur wheel 154, free to rotate on the fixed stud 155.

The spur wheel 154 is geared into and continuously driven by a spur pinion wheel 156, keyed fast to the crank shaft 81. The face of the wheel 154 is raised to form a cam 157. A small lever 158, centred and free to rock on the fixed stud 159, carries, near the end of its left arm a stud 160 and a small antifriction bowl 161, which is normally out of contact with the face of the cam 157, due to the gravitation action of the right arm of lever 158 which is the heavier. A cord 162 connects the heavy arm of lever 158 with one of the

Jacquard hooks. A strong steel spring 163 is in constant contact with the boss on the remote side, of the clutch spur wheel 154,

Fig. 250

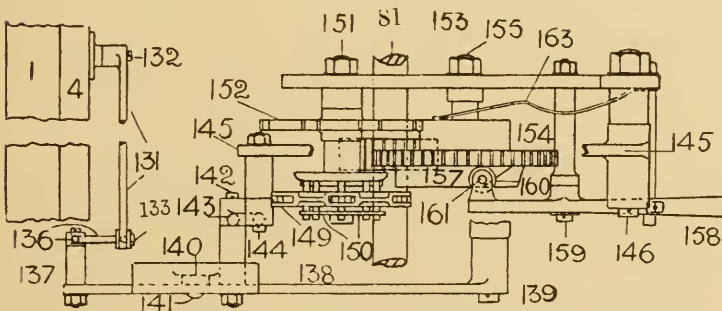
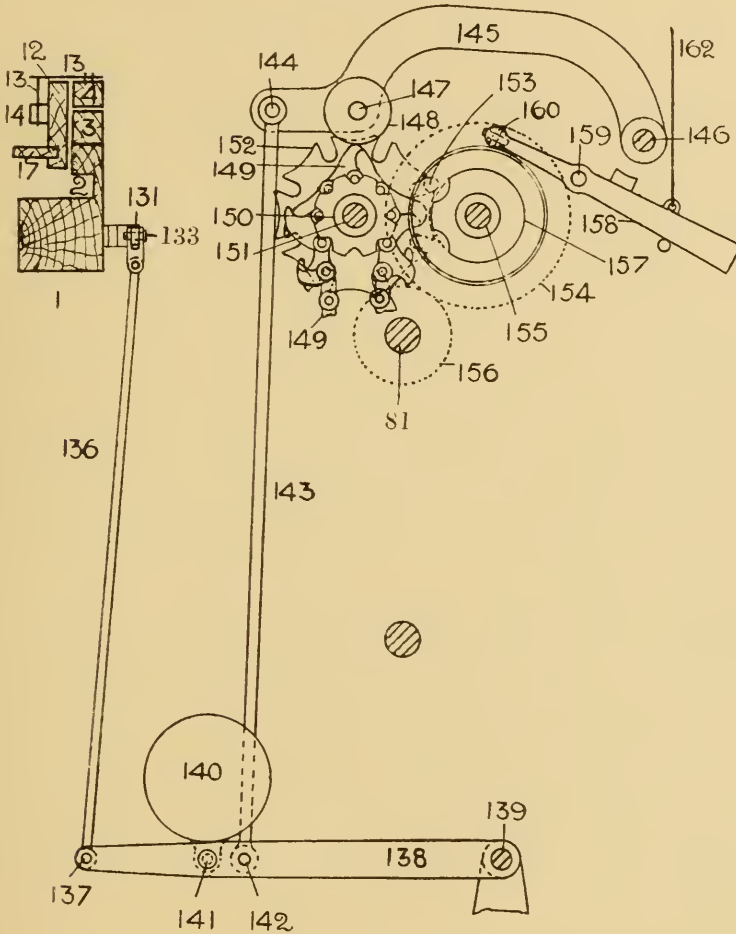


Fig. 251

which thereby operates to keep the clutch pin 153 normally out of working contact with the star wheel 152.

**Action of the
Mechanism.**

A hole punched in the pattern card opposite the controlling hook linked with the cord 162 results in this last being lifted together with the right arm of lever 158 and also in depressing its left arm with bowl 161 into operating contact with the cam face 157; the result and effect of which is to move the spur wheel 154 with the projecting clutch pin 153 laterally along the stud 155 and overcome the resisting force of the steel spring 163. The lateral movement of the clutch wheel 154 moves the clutch pin 153 into working contact with the star wheel 152 which it immediately rotates one eighth of a revolution. This wheel rotates in sympathy with it, the chain cylinder 150 which consequently rotates the next successive link tappet 149 into contact with the bowl 148.

If the change of tappet is from the larger to the smaller size then the bowl 148 together with the free arm of lever 145, link rod 143 and the free arm of lever 138 descend, assisted by the gravitation load of weight 140.

In sympathy with the falling lever 138 the rod 136 descends, which, acting through stud 133, rocks the bell crank lever 131 clockwise, the upper and vertical arm of which moves the swivel frame with the swivel shuttles to the right, a distance equivalent to the requirements of the pattern. The various parts of the mechanism can be finely adjusted to accurately suit any lateral traverse of the swivel frame.

In the above changed position, the swivel frame and shuttles remain and operate, according to pattern, until the cord 162 is again lifted and as heretofore described, rotates the next and larger tappet 149 into contact with the bowl 148 which it consequently lifts to operate through mechanism described to rock the bell crank lever 131 counterclockwise and through its action moves the swivel frame 12 laterally to the left into its original position as illustrated in the diagram.

CHAPTER XVI.

Index and Special Types of Jacquard Machines.

THE 'Verdol' index and fine pitch Jacquard as now made by Herm. Schroers, Krefeld, is used in the linen damask, as well as the silk trade, where very large repeat patterns are common.

An upright hook and needle is provided, in this machine, for each thread of warp in one repeat of pattern, hence the development of the figure together with the binding twill of the pattern is free and unfettered as compared with split, pressure harness and twilling Jacquards which are also designed for, and extensively employed in weaving large repeat patterns.

The machine is constructed on the centre or open shed principle and designed to accommodate the maximum number of uprights in a minimum amount of space, the saving thus effected in this respect being fully 25%. The greatest economy is attained in the saving of cards and card lacing. The number of square inches of pattern paper per pick for an 896 Schroer's machine is $12\frac{5}{8}'' \times 1\frac{1}{16}'' = 13.4$ whereas for an ordinary 408 machine and pitch, each pattern card measures $16\frac{1}{2}'' \times 2\frac{1}{2}'' = 41.25$ sq. ins.—equal to a saving of approximately 700% of paper in favour of the fine pitch machine. Card lacing is unnecessary, since instead of the usual paste board cards, a continuous roll of paper is used, perforated according to pattern to produce the requisite varieties of warp sheds.

The pitch of the perforations in the card cylinder plate is so fine that it is impossible to operate the cross wires directly from the pattern cards and cylinder; the usual crosswires or needles are therefore extended about seven inches beyond the ordinary needle board by a supplementary and detached straight needle, and are subsequently operated upon by a set of very fine vertical wires which in turn are controlled by the continuous roll of perforated

paper. All the essential principles of this machine are fully illustrated from Figs. 252 to 263 inclusive.

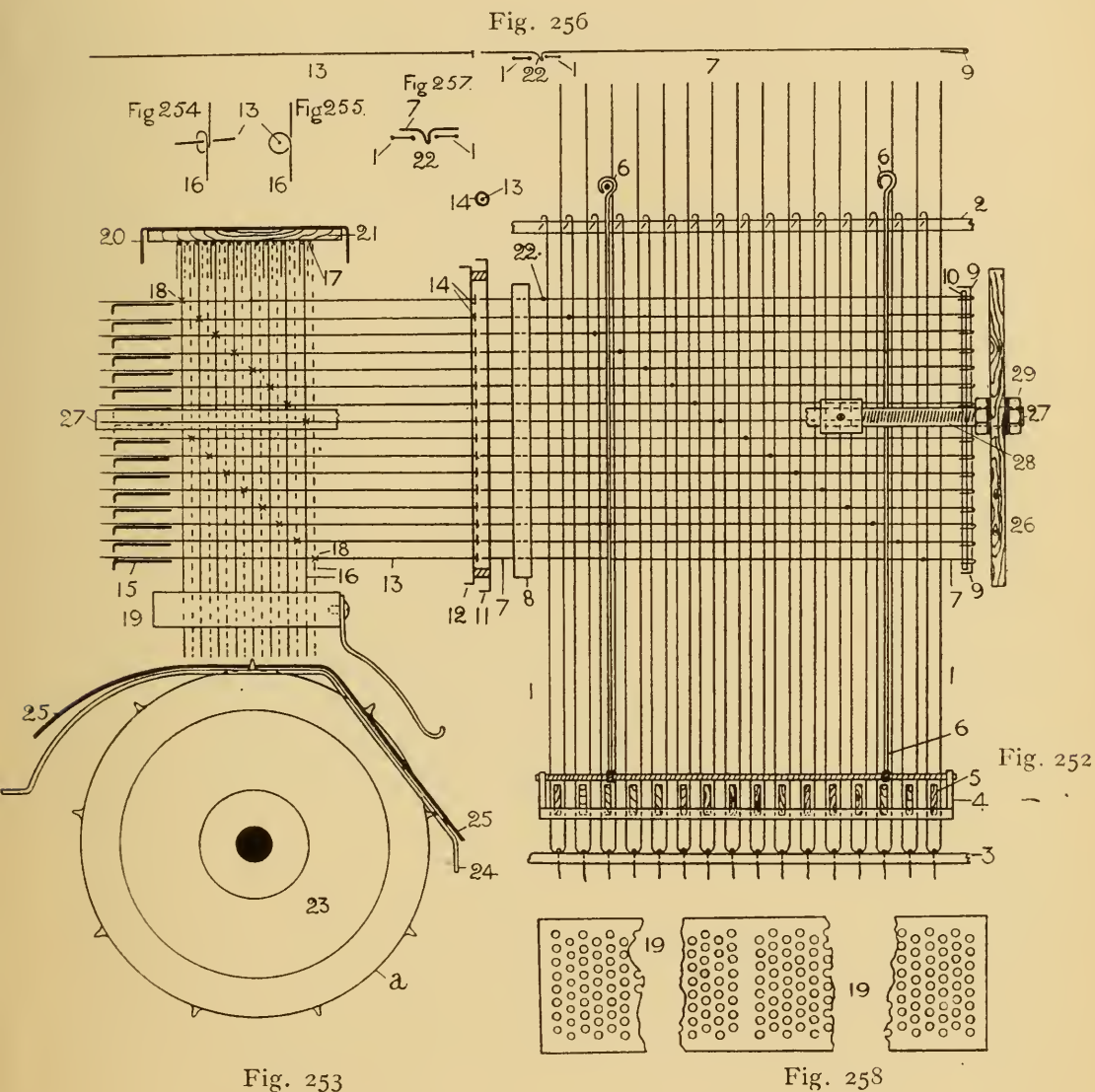
Figs. 252 and 253 are sectional elevations showing one row of uprights, crosswires, 'feelers,' driving plates and card cylinder. The uprights 1 are formed of double wire, the non hook part projects five inches above the ordinary hook. The hooks normally project over the griffe blades 2; the bottom or return portion of the double wires rests normally in the board 3; the tug cords attached to these hooks pass through perforations in board 3. The board 3 and griffe 2 are supported between two sliding blocks which are free to move in a vertical plane. An iron grid 4 carrying fixed wooden staves 5, is suspended from the griffe 2 by strong wires 6 as shown; the wooden staves are passed between the two shanks of each respective upright. Then with each ascent of the griffe bar 2, the staves 5 rise in sympathy and are thus free to neutralise any tendency in those uprights, when lifted clear of the board 3, to rotate on their axes.

The ordinary crosswires or needles 7 are supported in the needle board 8 and at their right terminals in a fixed brass grid plate 10, where they are each doubled backwards to form a loop about half an inch long; through each vertical row of the loops a pin wire 9 is inserted to limit its forward traverse. These pin wires are fixed to and suspended from the top of the grid plate 10. The needles 7 project slightly and freely through a perforated plate 11 combined as shown with a like perforated plate 12. A second and supplementary set of needles 13 is passed through the perforations in the plate 12. Compounded with the right terminals of needles 13 are small round heads 14 each of which is placed directly opposite the left terminal of its corresponding needle in the series 7.

The left terminals or free ends of each row of needles 13, rest freely on the surface of a corresponding number of plates 15 each of which is turned down on the outside to form a short vertical arm or right angle with the horizontal part. The whole of these plates is rigidly connected into a compact series by brass mountings the ends of which are adjusted and set screwed to suitable bracket levers which together with the angle plates 15 are free to travel

outwards to the left and simultaneously rise on every pick. A detached and separate elevation of plate 15 is shown at Fig. 261.

A number of very fine wires 16, denominated feelers is suspended from fixed crosswires 17. Each wire 16 is looped round a



separate needle 13 at the points 18 as illustrated separately at Figs. 254 and 255. The lower terminals of the suspended wires 16 are threaded through perforations in a fixed plate 19, a plan of which, showing the arrangement of the perforations is supplied at Fig. 258.

A brass plate 20, with turned down sides both front and rear, is fixed about $\frac{5}{16}$ in. above the upper terminals of the feeler wires 16. It serves the double purpose of keeping the dust from lodging amongst the fine wires and limiting the upward traverse which they are free to make.

A flat piece of wood 21, $\frac{3}{16}$ in. thick, is placed inside the cover 20 and rests loosely on the top of the feeler wires 16. Its weight is sufficient to keep the wires down, but not so great as to prevent their free ascent.

A plan of one of each of the wires 7 and 13 is shown at Fig. 256. Each wire 7 is doubled to form a short projecting arm 22, also illustrated on an enlarged scale at Fig. 257. When the wires 7 are placed in position in the Jacquard machine the projection 22 is in front of the respective upright under its control and immediately behind the back of the spring part of the preceding hook. Its function is to press, as required by the pattern, its own hook 1 clear of the griffe knife 2 and assist, on its return, to place the preceding hook into its normal position on every pick.

The card cylinder 23, more correctly a roller, is adjusted and suspended from the ends of the fixed perforated plate 19. An elevation of the card cylinder, etc., is shown at Fig. 260. It contains three plate wheels *a b c*; *a b* and *b c* are equidistant. Nine spikes, as shown, are fixed into the periphery of each wheel and the card paper is subsequently punched with holes at the sides and centre to coincide with these spikes.

Immediately above the card roller 23 and directly underneath the plate 19 is a semi-circular brass plate 24, the top of which is flat and perforated to correspond with the holes in the plate 19; additional parts are cut away to permit of the free rotation of the spikes in wheels *a b c*, through and just above the surface of the plate 24, as shown.

A continuous string of card paper 25 fits on to the spiked rollers *a b c* and is free to be rotated clockwise over the plate 24 and under the feeler wires 16.

A clamp board 26 is bolted fast to four iron rods 27—two at either side of the machine and supported by passing through the

back gable of the machine and the needle board 8. Their free terminals are almost in close contact with the closed ends of the driving plate 15. A spiral spring 28 circumscribes each rod 27 and is contained between the adjustable collar and nut 29 and the machine gable. This spring normally exercises its energy to keep the clamp board in contact with the double terminals of the needles 7.

Fig. 259

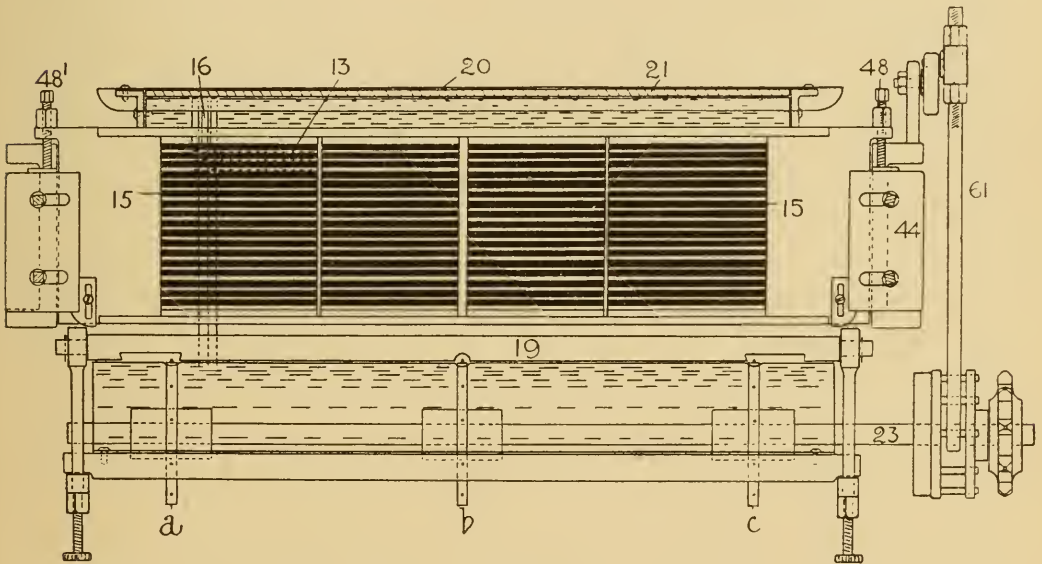
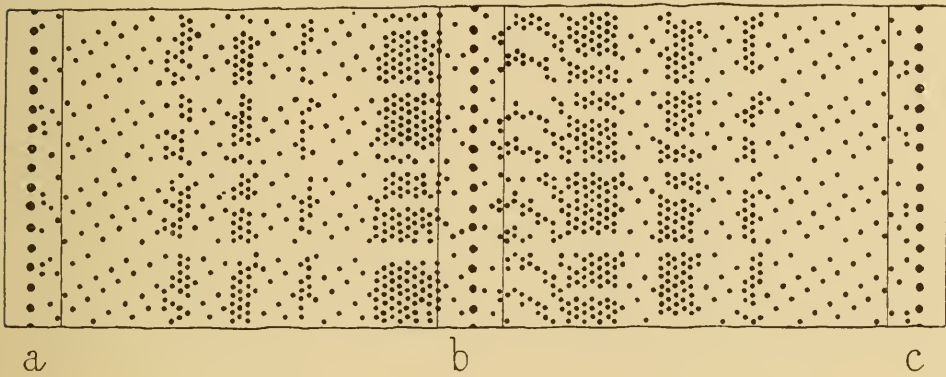


Fig. 260

Fig. 259 shows a length of the perforated card to equal four shots of weft and reduced to $\frac{1}{4}$ scale. The body of the roll is about $\frac{1}{80}$ in. thick, but at the sides and centre (portions *a b c*) where the 'peg' holes are cut, it is increased by an extra layer of paper ($\frac{3}{4}$ in. broad), to about $\frac{1}{50}$ in. in thickness.

**Action of the
Jacquard Cards
and Mechanism.**

With each ascent of the Jacquard head, the driving series of plates 15 are pushed outwards to the left about $\frac{3}{4}$ of an inch and simultaneously raised approximately half an inch. The upward traverse lifts all the free ends of the needles 13, which in turn lift the feeler wires 16 until their free ends are clear of the lower surface of the perforated plate 19 which ensures an opening, between 19 and feeler plate 24, of sufficient depth to allow the spiked card roller 23 to rotate the next 'pick' length of paper 25, forward until the perforated section is directly under the vertical feeler wires 16.

Immediately the Jacquard head begins the descent, the needle driving plates 15 return inwards and simultaneously descend, thus permitting the feeler wires to fall on to the partly perforated paper, assisted by the gravitation load of the wood 21. Then wherever there are perforations in the paper, the feeler wires 16 pass freely through and also through the perforations in the brass guide plate 24 and therefore exercise no influence on the needles 13 and 7 and uprights 1. The non-perforated part of the paper holds up the feelers 16 directly over this part and the feelers in turn keep *up* the needles 13 until the vertical parts of plates 15 have receded a sufficient distance to be clear of and free to press on the ends of the needles 13, the round heads 14 of which press against the free end of the needles 7 until the projection 22 moves the upright hook 1 clear of the griffe blades 2. Consequently, on the succeeding pick these uprights, falling in sympathy with the board 3 gradually lower the corresponding threads to form the lower division of the warp shed. On the contrary the remaining uprights which are left normally over the griffe blades 2 are lifted to form the upper division of the warp shed. When the driving plates 15 press on the free terminals of the needles 13, the closed ends of the frame which carries the plates, also press against the free terminals of the rod 27, overcome the resistance of the spiral spring 28, and move the clamp board 26 outwards, to permit the free lateral traverse of the needles 13 and 7. Immediately the pressure is released from the rods 27 and needles 7 by the plate 15, the spiral spring 28 exercises its potential energy to move the rods 27 and clamp board 26 into their original position. The

board 26 presses against the double terminals of the needles 7 and moves them, in turn, to their normal position. The same sequence of operations is repeated for every pick of weft.

Fig. 261

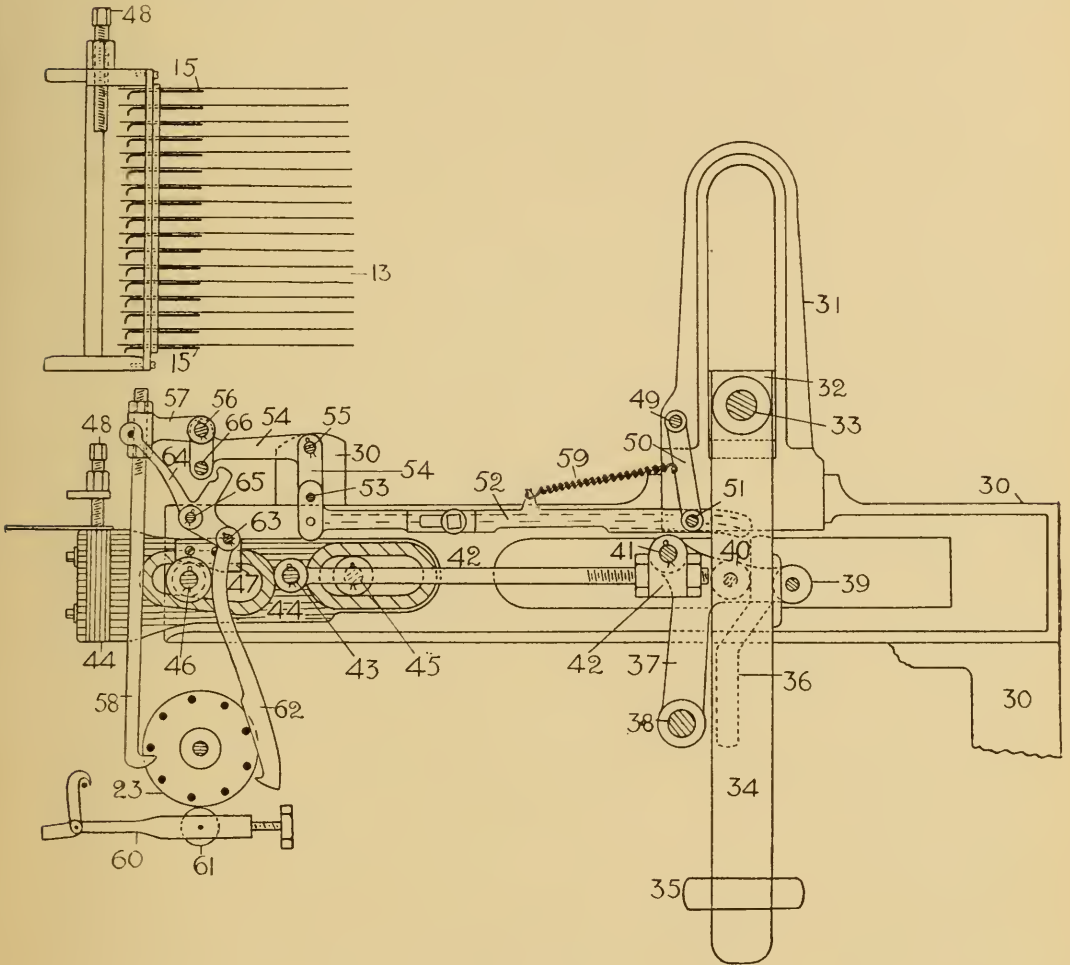


Fig. 262

Details of Mechanism and Driving the Needle Plates.

Fig. 260 is a front elevation of the card roller and needle driving plates.

Fig. 261 is a detached and side view of part of the needle driving plates, together with their distribution and compounding into one whole series.

Fig. 262 is a side elevation of the essential details of the operating mechanism, including the connections with the Jacquard head.

Similar numerals throughout the chapter refer to corresponding details of mechanism. 30 shows a portion of the Jacquard gable; 31 a fixed slide bracket; 32 a square steel block centred on a fixed stud 33 in turn compounded with a slide bar 34 the lower end of which passes through the fixed slide bracket 35. The parts 32, 33 and 34 are free to slide vertically in the brackets 31 and 35. On the remote side of the slide bar 34 a cam shaped projection is formed as indicated by the dotted lines 36. A bell crank form of lever 37 is pivoted at 38; its horizontal arm carries two studs and antifriction bowls 39 and 40, one or other of which is kept in rolling contact on opposite sides, with the cam plates 36. A stud 41, combines the lever 37 with a swivel link and rod 42 which is free to reciprocate. This rod combines through a pivot stud 43, a bracket 44 which is supported and free to slide obliquely on antifriction rollers 45 and 46; immediately over and in contact with the antifriction roller 46 a small cam plate 47 is adjusted to the bracket 44. Adjusted to the end of this same bracket by means of a set screw 48 and its duplicate on the opposite side of the Jacquard, is the set of driving plates 15. (See Fig. 261).

The parts which connect and operate the card roller 23 are as follows:—A pivot stud 49, fixed in the bracket 31, supports a link 50 which in turn combines with the pivot stud 51 to support the right end of a suspended rod 52. the opposite end of which is supported on a pivot stud 53 in the lower arm of the bell crank lever 54 which is fulcrumed on the fixed stud 55. The upper arm of lever 54 is T shaped, the top wing being combined through a link stud 56 to a link 57. The link 57 is adjusted and supports a vertical spindle 58, the bottom of which is hook shaped and normally rests immediately under one of the pins in the card roller 23. The free arm of the suspended rod 52 is rounded and kept in surface contact with the left face of the cam plate 36, through the medium of a spiral spring 59, which links the rod 52 to the fixed bracket 31 as shown. A small swing lever 60 supports an anti-

friction bowl 61 and these combine to prevent the card cylinder from rotating too far.

The parts 62 to 66 inclusive are introduced for the purpose of reversing the movement of the card cylinder by hand when necessity arises. 62 is a pawl catch suspended from the pivot stud 63 fixed in the lower arm of a small tri-armed lever 64 pivoted on the fixed stud 65. To the left arm of 64 a cord is attached and falls to within reach of the weaver. 66 is a fixed stud in the lower wing of the \perp arm of the bell crank lever 54, its object being to limit the amount of oscillation in the tri-armed lever 64.

Action of the Mechanism.

With each ascent of the Jacquard head, the block 32, stud 33, slide bracket 34 and cam plate 36, all rise in sympathy. The inclined face on the left side of cam plate 36 presses outwards to the left, the bowl and stud 40, stud 41 and rod 42 supported in lever 37 which oscillates in sympathy about the pivot stud 38. The outward movement of the rod 42 pushes, through the stud connection 43, the plate 44 together with the driving plates 15, also outwards to the left. Simultaneously with this outward movement, the projecting face of the cam plate 47 in passing over the bowl 46, is lifted together with the sliding bracket 44 and the driving plates 15, a distance sufficient to raise the ends of the needles 13 with the feeler wires 16 clear of the brass plate 24 and allow enough space for the pattern paper 25 to be moved forward between the plates 19 and 24 without interruption from the feeler wires (Fig. 253). The falling Jacquard head causes the projecting cam plate 36 to press on the antifriction roller 39 outwards to the right which through the details enumerated reverses the movements of the described parts and thereby places them into their normal position.

The rotation of the card roller 23 is accomplished from the same source. The cam plate 36, as it ascends, presses against the rounded end of the rod 52 which, through stud 53, partly rotates clockwise, the bell crank lever 54 about the stud 55. The upper arm of 54, the stud 56 and link 57 in turn, elevate the pawl catch 58 a distance sufficient to rotate the card roller 23 one ninth

of a revolution and bring up the next card division. With the descent of the Jacquard head the spiral spring 54 is free to exercise its energy and so pulls the suspended rod 52 laterally to the right, which through the parts described depresses the pawl catch 58 into its normal position below the next cross wire in the cylinder 23 ready for a repetition of the operation on the next shed.

Mechanism and Driving of the Jacquard Head.

Fig. 263 is a sectional elevation of the chief parts designed to reciprocate the griffe 2 and the sinking board 3. Combined with the pivot stud 33 fixed in the griffe bar 2 is a swivel link 68 to which is adjusted a link 69 as shown. This link is coupled by a pivot stud 70 to the simple lever 71 which is keyed fast to a shaft 72 suitably supported by brackets bolted fast to the Jacquard gantries. Keyed fast to the same shaft 72 but on the remote side of lever 71 and the Jacquard machine is a second lever 73 to which is connected, through stud 74, swivel link 75 and stud 76 a reciprocating rod 77. A duplicate set of these parts similarly connects the lower or sinking board 3 with a second reciprocating rod 89. The parts represented from 69 to 77 agree respectively with those from 81 to 89 both inclusive. A swivel link 79 combines through stud 80 and bracket 78 with the head 3.

The reciprocating rods 77 and 89 are adjusted in the usual manner to a double eccentric which is keyed fast to the crank shaft of the loom. Then, as the crank shaft and double eccentric revolve, the rod 77 and lever 73 combine to oscillate the shaft 72 clockwise, and lift the lever 71, links 69 and 68 together with the Jacquard head and griffe knives 2 with the requisite uprights to form the top shed. Simultaneously the rod 89 ascends and through its connections produces a downward movement in the sinking board 3 and lowers those uprights which are to form the bottom shed. As the eccentric completes its rotation the foregoing motions are reversed preparatory to the next pick.

The principle of this Index and fine pitch Jacquard is also applied and used for double acting Jacquards with two sets of

uprights, combined with one or two sets of needles, feelers and card rollers.

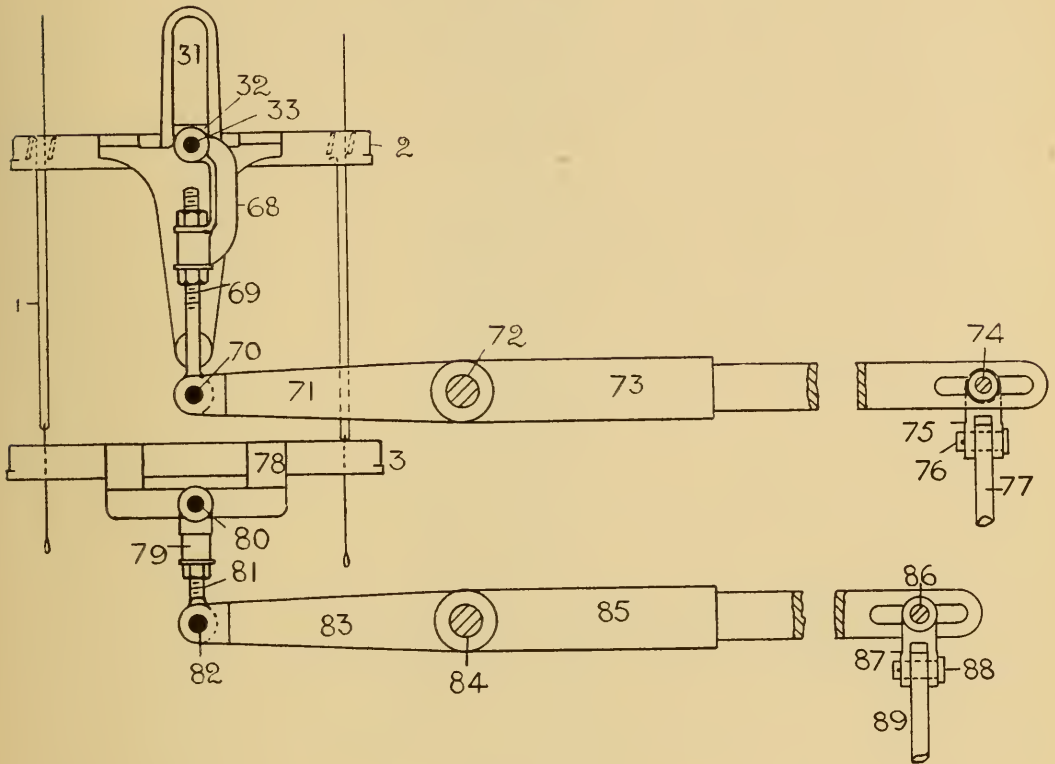


Fig. 263

The Centre Shed Jacquard.

As the title suggests, the centre shed Jacquard machine is built to produce a warp shed on the closed and centre shedding principle. It consequently merits all the advantages which characterise this principle of shedding, but it also inherits all its defects. See pages 27 and 28.

A centre shed Jacquard is very suitable for use in weaving figured gauzes where one or two doups is placed in front of the harness mounting.

The chief details of mechanism in the centre shed Jacquard are supplied in Fig. 264, which is a line diagram, showing one row of uprights and needles, together with a vertical section through the griffe blades and upper and lower reciprocating boards. A indicates the top and usual griffe bars; B the resting or suspension hook

board, free to rise or fall. The griffe A is connected to the spindle c at the position D and the board B is similarly connected to the second spindle E at the position F. The uprights are shown at G and the cross wires or needles at H. The usual card cylinder, needle board and spring box are also indicated.

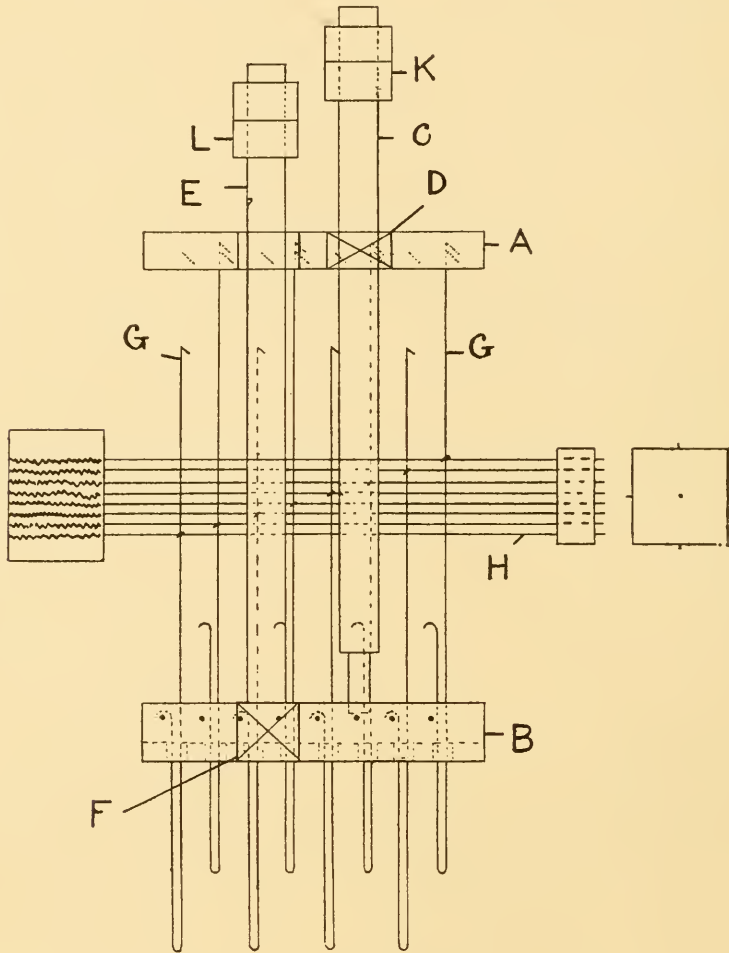


Fig. 264

The designs are painted and the cards cut in the usual way. There are two Jacquard cross heads K and L, and two head levers and reciprocating rods and a double throw eccentric as in double lift machines, but the eccentric is set screwed fast to the crank shaft, so that as the cross head K rises and falls, the cross head L falls and rises once for each pick of weft or revolution of the crank shaft.

Fig. 268

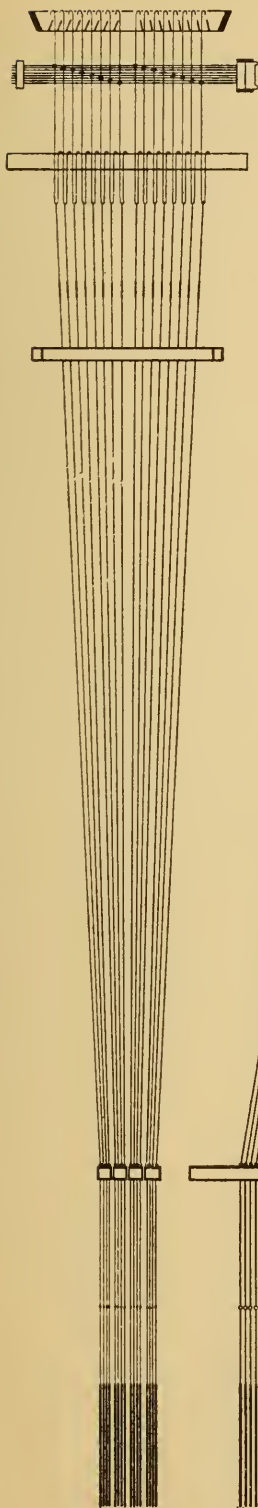


Fig. 265

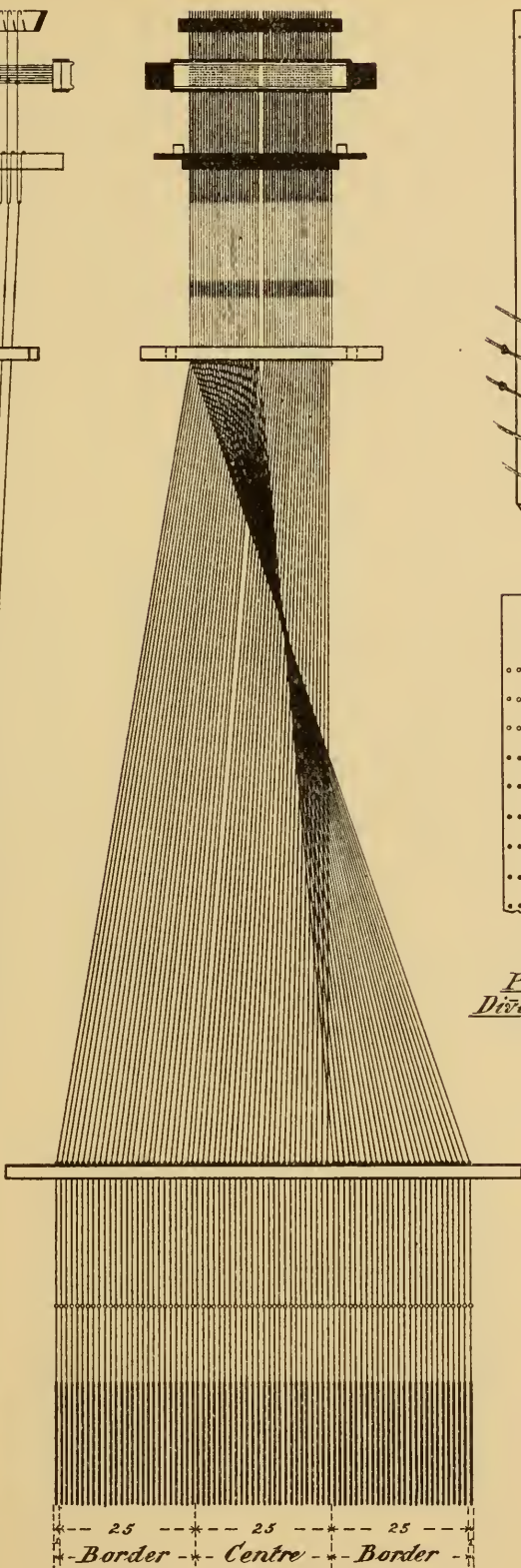
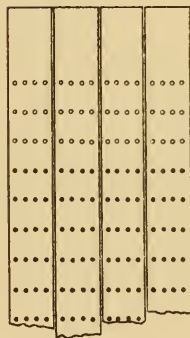
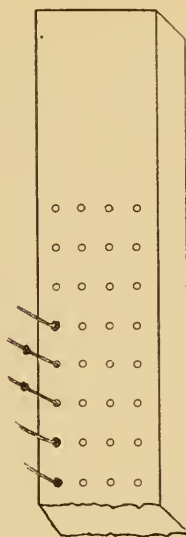


Fig. 266



*Part views of
Divided Comber B.^d*

Fig. 267

Action of the Mechanism. The crank shaft of the loom revolves as usual once, for every shot of weft. The cross head κ rises with the spindle c and griffe A with all the hooks G that have been left over the griffe knives, according to pattern, to form the top warp shed. Simultaneously the cross head L with spindle E descends together with the bottom board B , supporting all the hooks G that have been left clear of the top knives in griffe A , according to pattern, to form the bottom shed. The weft is then inserted and the griffe A descends whilst B ascends until the uprights G meet in the centre, irrespective of the position which they are to occupy on the next and succeeding picks of weft. The operation is similarly repeated for each shot of weft.

In the given diagram the shed is fully open.

Brussels and Wilton Carpet Jacquard.

This machine is designed to control the coloured pile yarn and produce a figure effect of pattern in different colours on the surface of either Brussels or Wilton Pile Carpets.

The mechanism, harness mounting and operation of this machine is fully illustrated and described on pages 85 to 102 inclusive in *Carpet Manufacture*, for which reason it is unnecessary to repeat it in this treatise.

The Double Cloth and Ingrain Carpet Jacquard.

This Jacquard is constructed to produce an effect of figure in double and compound woven structures such as Tapestries, Roman, Scotch and Ingrain Carpets. Each cloth is composed of differently coloured yarns and the figured pattern is obtained by causing these cloths to interchange.

A description of the principle and Hutchinson and Hollingworth's Ingrain Loom is described and illustrated on pages 280 to 301 inclusive in *Carpet Manufacture*. A supplementary set of illustrations is supplied at Figs. 265 to 268 inclusive.

Fig. 265 is a side elevation of Jacquard harness, comber boards, mails and lingoos.

Fig. 266 is a front elevation of the same details.

Fig. 267 is a part plan of the four comber boards.

Fig. 268 is a part plan ($\frac{1}{3}$ scale) of one of the comber boards.

PART III.

HARNESS MOUNTING.

CHAPTER XVII.

Principles and Routine of Harness Mounting.

HARNESS mounting, which is very frequently designated the 'tie-up' of the harness, is the generic term used to express the arrangement, order and number of harness twines which are connected to each neck band, tug cord or hook, and their distribution in the comberboard. It is not necessarily a part of the Jacquard machine; on the contrary the Jacquard apparatus is an invention designed to select and operate the harness twines which in earlier days were acted upon by the draw loom.

Sequence of Processes in Harness Building.

Harness building embraces a series of operations, involving the preparing and making of the mail couplings, cutting and tying the tug cords to hooks, warping the harness twines, tying the harness twines to the tugs, threading the harness twines through the perforations in the comberboard after the latter has been marked off according to pattern, hanging the couplings on to the harness twines and then levelling the harness. Varnishing is an auxiliary operation.

**Variety of
Knots in
Harness Tying.** A complete connection from the uprights to the lingoes with all the different kinds of *nautical* knots which have to be used in the processes of harness building is shown at Figs. 269 to 272 inclusive.

Fig. 269 shows one complete series of knots in the cords for tying *below* the comberboard.

Fig. 270 shows the same details and their relative positions when tying *above* the comberboard.

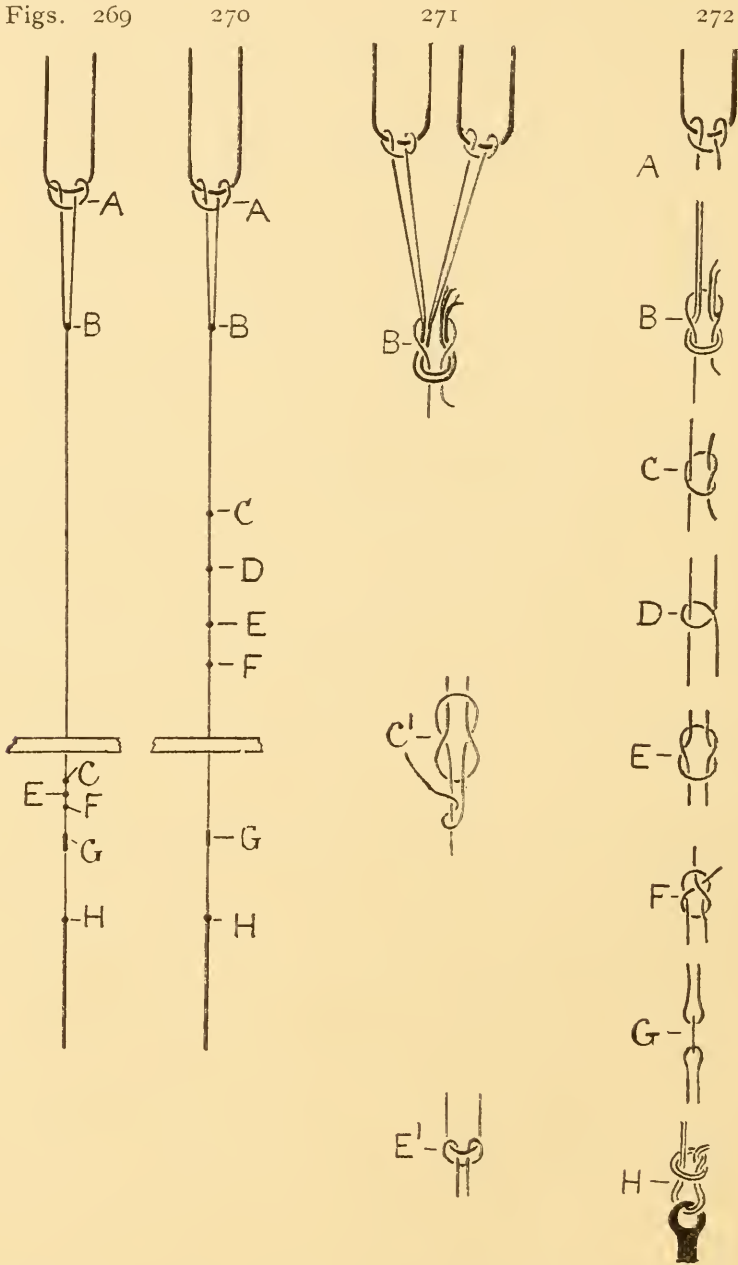


Fig. 271 shows the connection of the harness twine with two uprights of a double acting Jacquard.

Fig. 272 shows all the foregoing knots in detached and enlarged form so that they may be more readily and thoroughly understood.

A is the tug knot ; B the top harness knot ; C a sailor's knot. Sometimes the loose end of the twine for the knot C is hitched back as shown at C¹ and especially is this plan adopted when only one harness cord is tied up to each hook ; *e.g.*, in twilling machines the twines are usually knotted direct to the hooks, the life of the harness being, as a rule, more than sufficient to outlast the style of pattern. D is a 'hitch' knot ; E and E¹ flat knots, in two forms for connecting the upper coupling with the harness twine ; in their initial stages both knots are formed alike. The form E¹ is the firmer and cannot slip whether varnished or not ; the loop is sometimes left as at E which after varnishing does not slip. If it is necessary subsequently to untie this knot, as is frequently the case when the width of the border or harness has to be changed, the bottom *loop* can be easily turned back, which facilitates the loosening. F is a weaver's knot in the top coupling. G is simply threaded through the mail. H is the regular sailor's knot and connects the bottom coupling with the lingoe. From the hook to the lingoe there are four distinct lengths of cord, viz. :—(1) The tug or neck between A and B ; (2) the harness twine from B to E and back to C ; (3) the upper coupling between F and G connecting the harness with the mail and (4) the lower coupling from G and H which connects the mail with the lingoe weights.

Tying below and above the Board— a comparison.

Tying below the board is almost universal in the North of Ireland where an enormous amount of Jacquard weaving is practised. The chief advantage claimed for this method is the increased facility for levelling the harness since each cord hangs in the same vertical and normal position below the board, and each knot is tied under the same conditions and strain or pull on the harness twine. When tying above the board, especially for border patterns, the strain or pull on the harness at both sides of the loom is different, in addition to which there is a constantly varying pull from the inside to the outside of each border, due to the various angles from the hook to the comberboard, all of which increase the difficulty of tying and levelling the harness. When tying below the board, the harness twines pass singly through it, but when tying above, they are threaded doubly through the perforations.

The height of the board above the mails must be greater in the former case than in the latter, which is a certain disadvantage, since the further the board is from the mails, the greater is the tendency of the lingoes to swing to and fro with the mails and warp.

**Making the
Upper and
Lower
Couplings.**

The upper couplings connect the mails to the harness and the lower couplings link the mails with the lingoes. Both the upper and lower couplings are made of cotton; they have to be reeled and cut *double* length. The usual reeled length of the upper is $12\frac{3}{8}$ " and that of the lower $16\frac{1}{2}$ " which when doubled and knotted, yield 6" and 8" respectively, being sufficient in length to permit the formation of the warp shed without any interference from the knots F and H (Fig. 269).

Fig. 273 is a front elevation of the adjustable reel as used for winding the required lengths of coupling cords.

Fig. 274 is a side elevation of the same reel, the wings or arms A of which are free to be shortened or drawn out to suit the required circumference of reel and length of cotton cord. The central shaft B is supported by and free to rotate between the fixed uprights c and c¹. The mechanism is simple and therefore requires no detailed explanation.

After reeling and cutting, the upper couplings are threaded through the mails, then knotted and slipped on to the arm of the operative until a convenient number has been made. They are then placed on a straight round iron bar c as in Fig. 275, where A represents, in elevation, a portion of an ordinary table.

B and B¹ are two upright iron standards fixed to the table top; c rests freely in the grooved tops of the standards B and B¹. An end elevation of these details is supplied at Fig. 276. The mails D with the upper couplings E are next slipped from the operative's arm on to the rod c, two such couplings being shown in the position E¹. The next operation is to thread the lower coupling F through the mail D as shown in the position G. The coupling cord F is then doubled and fastened by a reef or sailor's knot to the lingoe H as shown in the position I. As the couplings are completed they are

placed alternately in front and behind the cord J, so as to form a half lease and avoid any entanglement.

Tugging Operation.

The next process in order of sequence is 'tugging' which consists of first reeling the cords to the required approximate length as for couplings, and then fastening them by reef knots to the bottom of the Jacquard hook, after the manner shown at A, Fig. 272.

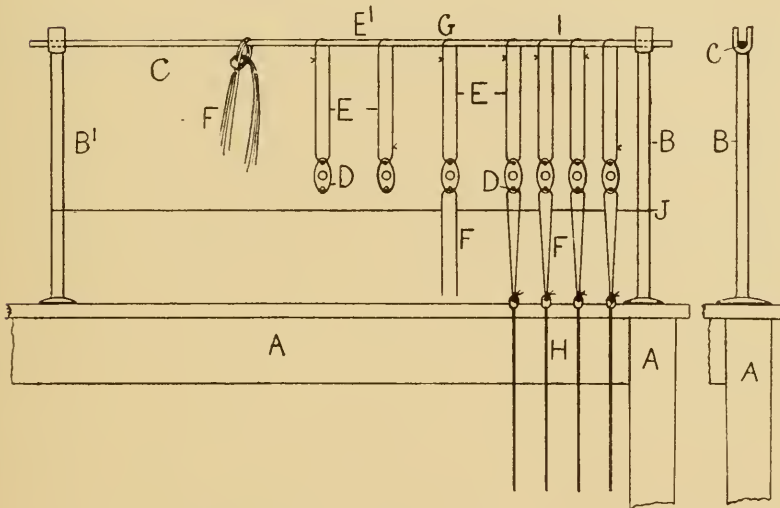
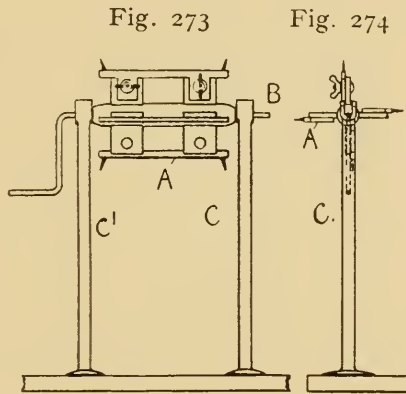


Fig. 275

Fig. 276

Warping the Harness Twines.

This process is simple and is frequently performed as follows:—Figs. 277 and 278 show respectively an elevation and a plan of the chief details which facilitate the operation. A is an extension of the table shown at Fig. 275. κ and κ' are smooth and flat pieces of

hard wood fastened to the table A, but a slot in the table admits of a free and extended or contracted distance between κ and κ^1 to suit the length of twine L required. M is a warper's small bank constructed to hold ten spools or bobbins N.

The harness twine L may be taken from one or more spools N to suit the number of twines which have to be attached to each tug cord. When only one harness twine is required to be attached to each tug cord the warper might use one or any odd number of threads and warp in the usual manner until the full complement of twines have been warped. A lease cord is then passed through the divisions formed by the rods κ and κ^1 . The twines L are afterwards cut at both ends κ and κ^1 , but a cord is previously tied round one or both to prevent subsequent 'tossing.' When two harness twines are required for each tug, the warped twine is only cut at the end κ^1 . If, owing to the different angles they have to form in the subsequent mounting, one twine must be longer than another, *e.g.*, in a cross border, on a wide loom, then the cords are cut in one or other position near κ^1 as indicated by the arrows o. When there are four, six, eight or any even number of twines to be tied to each tug cord, it is generally most convenient to warp with two, three, four or half the number of twines required for each tug. The lease is then formed in twos, threes, fours or other number used for warping; the lease cord is next put in between the pegs κ and κ^1 , and the twines are cut and tied at κ^1 . The groups of four, six, eight or other double number of twines warped can be readily drawn from each completed bunch of harness twines and knotted on to the tugs. If nine twines are wanted to each tug cord, then two bunches are warped, one containing double fours, and one single twines. The harness mounter then extracts eight of the double fours and one of the single, and knots the same to the tug cord. The single twine is sometimes doubled back a few inches to form a loop before tying it to the tug, see c¹ Fig. 272, in which case these particular twines must be warped two or three inches longer than the double fours which have a natural loop. This arrangement prevents the single cord from slipping out of the tug knot.

When there are several twines connected to the same tug cord, they are usually interlaced by a fine cord, a few inches below the tugs to form a flat surface and keep them in their normal position.

When all the harness twines have been knotted to the tugs, they are threaded through the comberboard, after which the lingoos are 'hung' on to them. These, together with the couplings are first loosely tied to the harness, and then allowed to remain for a

Fig. 277

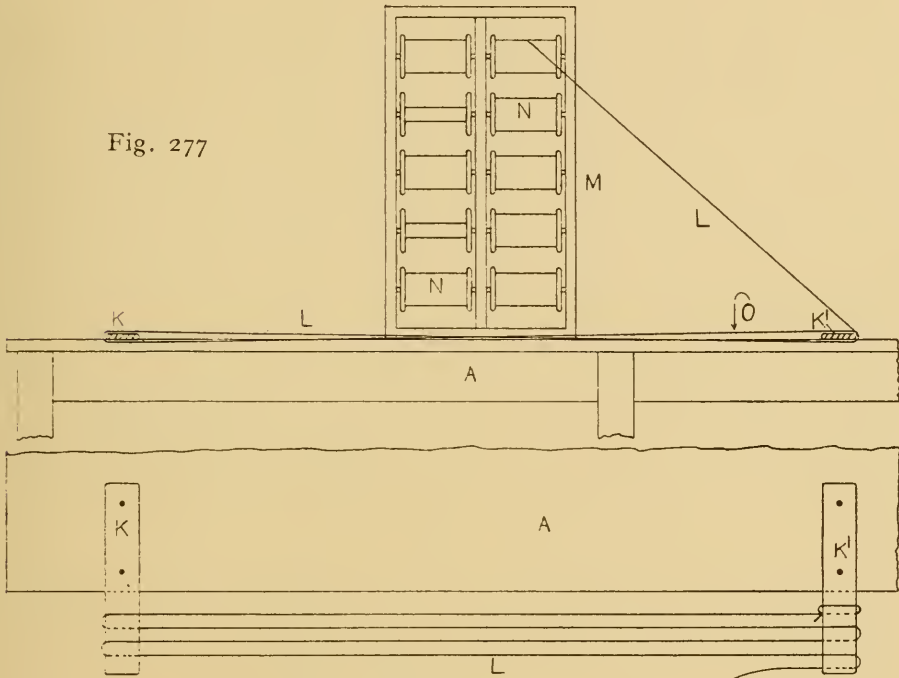


Fig. 278

few days, so as to stretch the twines and accustom them to the surrounding atmospheric conditions, before proceeding with the levelling operation.

Levelling the Harness Below the Board.

Fig. 279 shows in elevation, and 280 a plan of the arrangement for levelling the harness, when tying has to be performed below the board. The mails, upper and lower couplings and lingoos are indicated at D E F G respectively. N is a rectangular frame made of either wood or iron, and perforated as at o. The inside dimensions of this frame are slightly in excess of the width and length occupied

by the lingoes suspended from the harness. It is supported by two adjustable angle bars P and P^1 to the loom gable Q . Both bars are slotted and adjustable as shown, at the overlapping part as well as at the positions connected with the frame N and the loom gable Q . The comber board is shown at R , and the harness cords attached to the couplings, before levelling at S , and after levelling at S^1 . The frame N is first adjusted, made perfectly level and then screwed tight between the loom gables Q . A line, consisting of a strong piece of cord T , is laid straight across the top of the frame N and weights U and U^1 are suspended at either end (see also Fig. 281). One row of couplings is then placed alongside this straight line of cord T , the temporary knots V are untied and the harness twine is drawn through the upper coupling E until the centre of mail D is perfectly coincident with the line T ; the harness twine is then knotted after the manner shown at $F E C$, Figs. 269 and 272. Each succeeding harness, coupling and mail in every row of harness from front to back is similarly levelled. As each row of harness is completed it is lifted behind one of the movable steel pins W , which is passed through the perforations in N . These pins are used simply to keep the levelled harness separate from the unlevelled and thereby leave sufficient room for the harness mounter to work freely with his hands.

**Levelling the
Harness 'Above
the Board.'**

Whenever this method is adopted the lower couplings, on one full row of harness, are placed individually over a long narrow levelling board technically called a 'slabstock.'

Fig. 282 is a front elevation of a portion of the slabstock with the upper and lower couplings slipped over it. Fig. 283 is a sectional elevation of the same details. $D E F G$ are the mails, upper and lower couplings and the lingoes respectively. w is the slabstock with a groove x large enough to admit of the mail D . A steel wire y is passed through the eyes of mails D and maintained in the groove x through the medium of a piece of cord z tied at regular intervals over the wire y and slabstock w . The slabstock is then adjusted to the loom gables as in Fig. 279, and levelled preparatory to tying in the harness. When this operation is complete a young person threads the upper coupling E through the perforations in the comber

Fig. 279

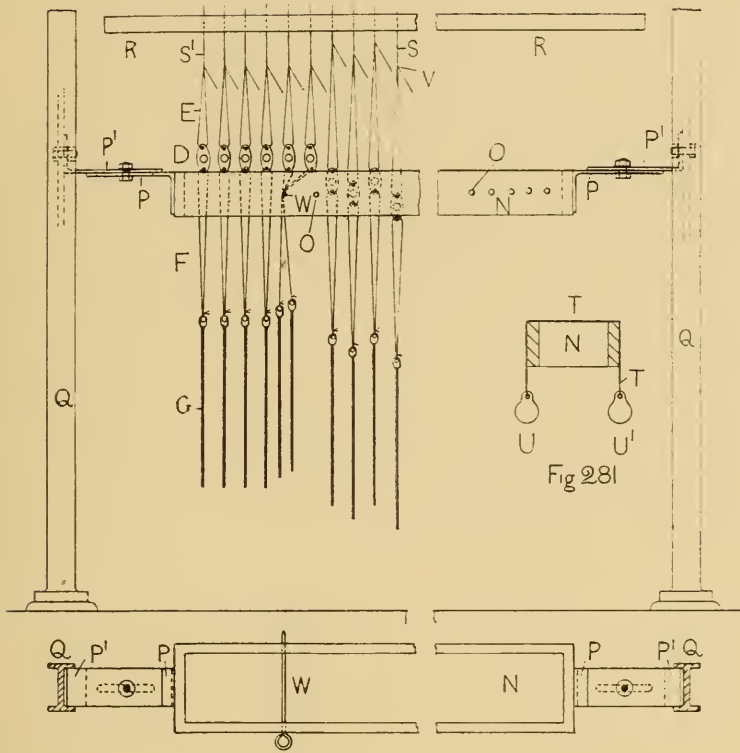


Fig. 280

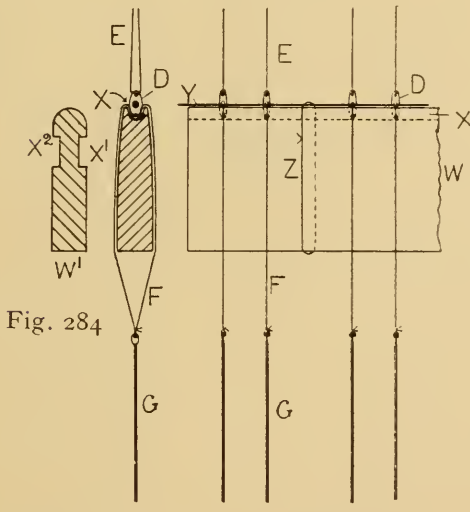
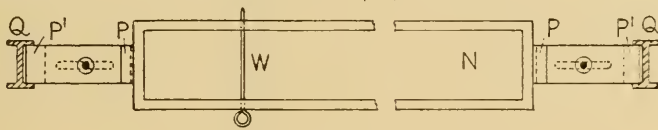


Fig. 284

Figs. 283

282

board after the latter has been marked off to suit the width of the harness. The harness is next passed through the loop of the upper couplings ϵ , which together with the harness twines are drawn to their normal tightness and then knotted as at $F E D C$, Figs. 270 and 272. This process is repeated with each separate row of harness until the whole is complete.

In some districts the harness twine is threaded through the mail D , there being no upper coupling.

An alternative type of slabstock is sometimes preferred, and this is illustrated at Fig. 284. w^1 is the slabstock with two grooves x^1 and x^2 . By this arrangement two rows of harness can be manipulated at the same time. The harness twines are selected close to the tug cords, in rotation, by an assistant who then passes them down in the same order to the harness tier.



CHAPTER XVIII.

Principles and Varieties of Harness Mounting.

IT is of primary importance to determine which hook in a Jacquard has to be reckoned as the *first* for purposes of mounting and subsequent card stamping and lacing.

In this treatise the *first hook* and *harness cord* are invariably reckoned from the *left* when viewed from the front of the loom and the spring box ; this is equivalent to reckoning from the top hole in the card cylinder and the bottom needle in the needle board on the right hand side when viewed from the back of the loom and facing the card cylinder, see Figs. 285 and 286.

The above method, being most natural will commend itself to most practical minds, *e.g.*, if the point paper or painted design be placed in front of the harness at the loom, then the warp thread on the extreme left will coincide with the harness cord and the front hook on the same side ; also the direction and appearance of the reproduced design in the cloth, as it appears in the loom, will exactly agree with that of the painted design. The card cutting will then begin, for the first pick, at the bottom and left hand corner of the point paper design.

In some districts, the converse of this principle is adopted, the first hook being reckoned from the left hand as viewed from the back of the loom. With this arrangement the tying up is reckoned from the right hand side at the front of the loom and the point paper design, for cutting, has to be read from the top right hand corner, which to say the least is somewhat confusing.

Systems of Harness Mounting.

There are two chief systems in common use, *viz.* ; the Norwich and the London, sometimes denominated the French ; the former method is however most generally adopted.

**Norwich
System.**

With this system the Jacquard machine and card cylinder are arranged parallel to each other so that the cards and cylinder operate either at the back of

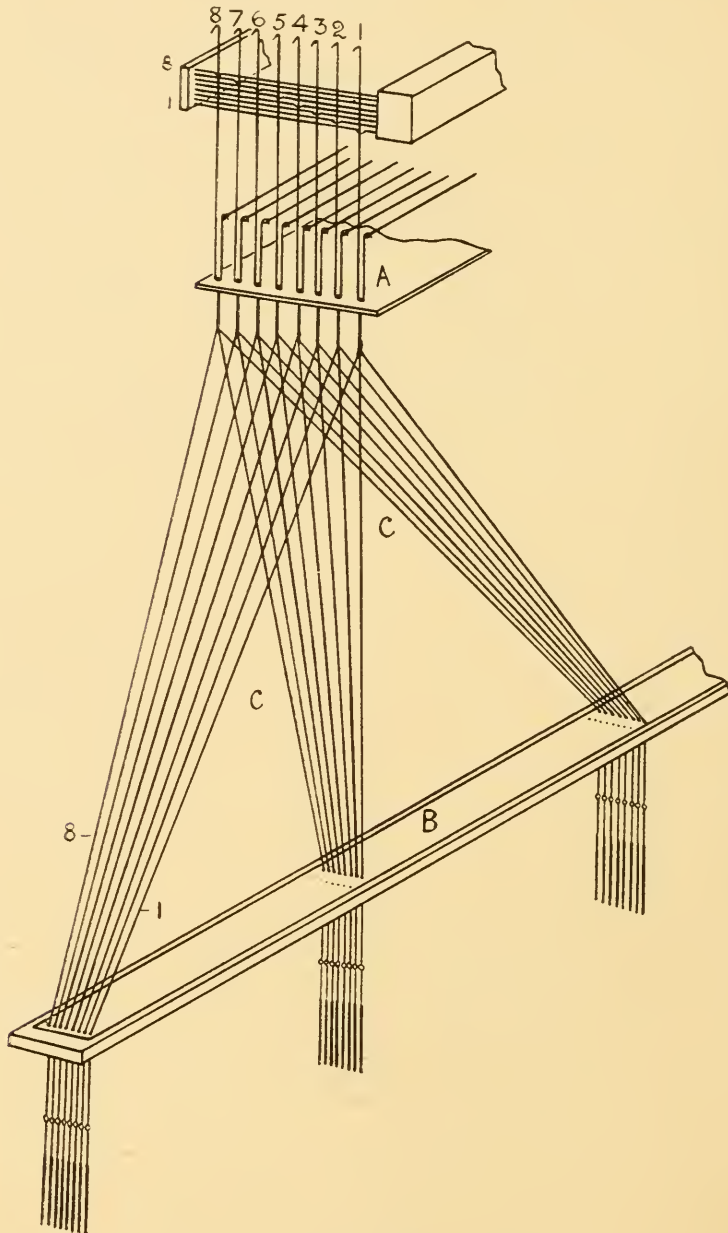


Fig. 285.

the loom, over the warp yarn, or at the front, above the head of the weaver.

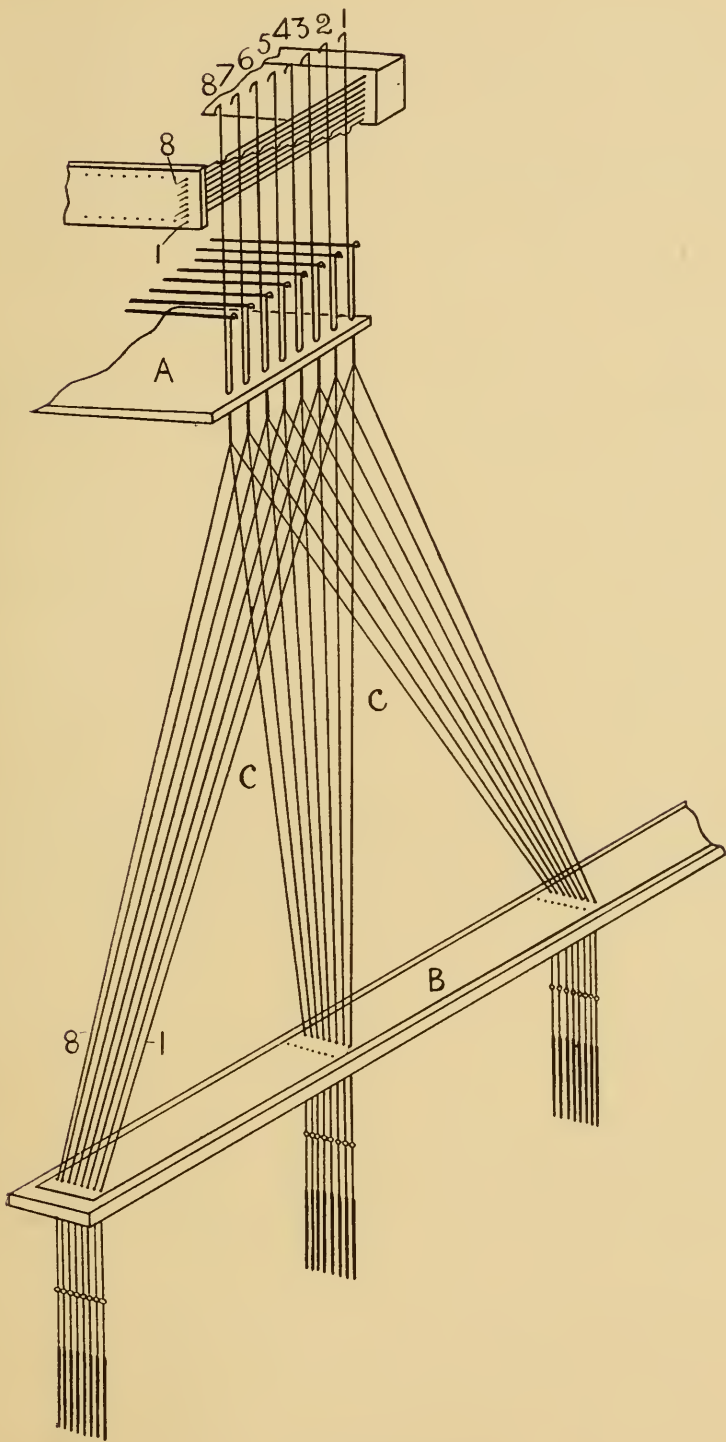


Fig. 286

Fig. 285 is a perspective sketch of this system. The view is from the left front of the loom. A shows the tug board and B the comberboard; three repeats of the harness c are shown tied up to the first hook of each row from front to back. Each row of harness twines is brought straight down and through the comberboard B and the number of such rows usually coincides in depth with the number of rows of uprights from the front to the back of the machine, as in the illustration.

**London or
French System.**

With this system the Jacquard machine and card cylinder are placed at right angles to the comberboard, so as to allow the cylinder and pattern cards to work at one side of the loom. This is a convenient method for the hand loom weaver since he can watch, reach and control the cards as he sits and weaves. The disadvantage of this method is that each row of harness receives a quarter twist in passing from the hooks at the left side of the loom, to and through the comberboard at the front, which generates friction and complicates the mounting. Fig. 286 is a perspective sketch of this method of mounting as seen from the left front of the loom. A and B indicate the top and bottom boards respectively, and c the harness twines for three repeats tied to the first hook of each row.

Comberboards and Harness Reeds.

The comberboard may consist of one solid board of box, beech, or other suitable wood, and is perforated to any required fineness, each perforation normally corresponding to one thread of warp in the cloth.

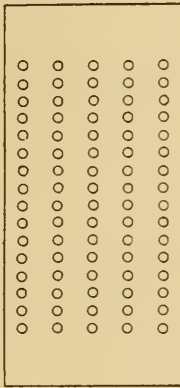
During recent years the solid comberboard has been extensively replaced by the use of small slips which represent transverse sections of the ordinary comberboard. The slips are perforated according to fineness, fixed in a frame and tightened up to correspond to the solid comberboard. The chief advantage of the slips is that they permit a slight adjustment in the width of the harness by the insertion of solid pieces of wood between them.

There are three chief orders of perforations in the comberboard or slips, and these are shown as follows :—

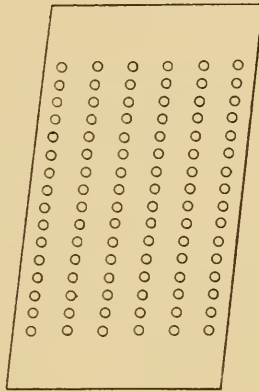
Fig. 287 shows one slip with the perforations in the same order as a "plain weave pattern." This style is the most common ; it is economical in respect to the distribution of the perforations and the subsequent distribution of the lingoos.

Fig. 288 shows one slip with the perforations arranged in straight order from front to back.

Figs. 288



289



287

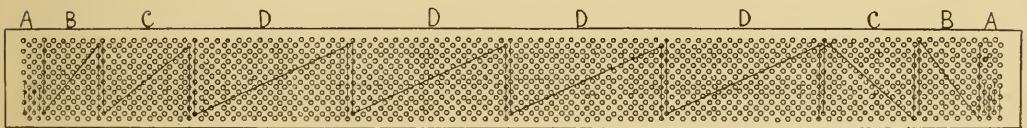
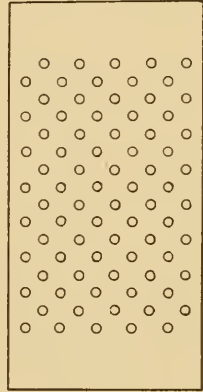


Fig. 290

Fig. 289 is a modification of the order illustrated at 288. It shows one slip in which the perforations are designed to run diagonally from the front to the back of the comberboard, the object being to cause each mail, together with its subsequent warp thread, to lie, without strain, directly in the same plane as the split in the reed and the warp in the cloth.

Harness Reeds. Ordinary loom reeds are sometimes used instead of comberboards or slips, one short row of harness being threaded through each split in the reed. Each row of harness is kept distinct by drawing cords tightly across the full length of the reed and between the rows of harness.

The splits per inch in the harness reed are determined by the number of harness cords per inch divided by the number of harness cords which are designed to pass through each dent in the reed.

Marking off the Comberboard. The comberboard is usually perforated to correspond with the exact fineness of the required set in the harness; sometimes however, it is slightly finer, in which case the extra rows must be left empty, or it may be that in some sections of the pattern, only part of a row is required.

First mark off the width in the comberboard which the harness must cover—usually a shade wider than the width of the warp in the reed. The centre of the harness and the comberboard should exactly coincide with the centre of the loom.

Next divide the portion of board set off into the required number of sections, to suit the tie up; each section must contain the necessary number of rows and holes for the harness cords allotted to it; then draw diagonal lines from the first to the last hole in each section, in the direction the twill is required to run. These serve as guides to the proper threading of the harness. Lines are only drawn across the holes in the comberboard which require to be filled.

Fig. 290 illustrates the common method of marking off a comberboard to the following given particulars.

	No. of hooks	Cords per hook	Total cords
A Edges	4	4×2	16
B Sateen	16	6×2	96
C Border	144	1×2	288
D Centre	240	4	960
			1360

Classification of Harness Ties.

Harness mounting may be divided into four chief classes:

1. **The Single Tie.** This tie is only required when there is no repetition of any of the pattern. One harness cord only is tied up to the hook of the Jacquard and there must be as many hooks as there are threads of warp. The cords

are tied to the Jacquard hooks and taken down through the comber-board in regular order from first to last consecutively. The warp threads are successively drawn through the mails of the harness in the same order.

This principle of mounting, though affording unfettered scope, for the designer, to the full capacity of the figuring hooks, is not extensively employed except for carpets and similar fabrics which

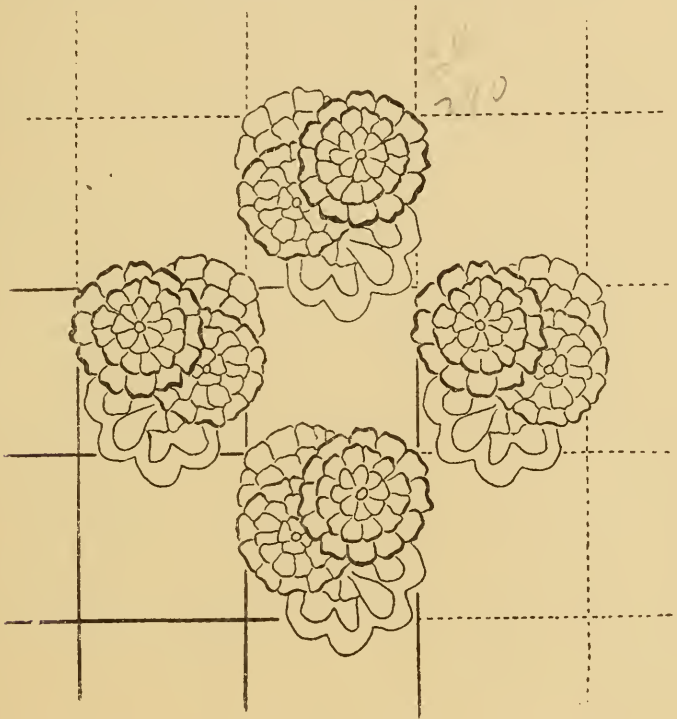


Fig. 291

have subsequently to be stitched together to make greater widths of fabric. Under these circumstances the principle may be employed advantageously to produce an effect of figured pattern which is equal to double the normal figuring capacity of the machine.

Fig. 65, page 69, shows an example of mounting the harness twines to the Jacquard hooks for a single repeat. The frontispiece is an example of a pattern requiring a *single* mounting tie.

2. The Repeating or 'Lay Over' Tie.

This is the commonest tie and is used for all figure designs which contain more than one repeat of pattern in the full width of the cloth.

Fig. 51, page 47, shows an example of a repeat-

ing tie with four repeats of pattern across the comberboard and warp. The first row of harness only is shown, each subsequent row being a duplicate of it. Fig. 291 shows two repeats of a simple repeating pattern.



Fig. 292.

3. The Centre, 'Point' or Turn-over Tie. This tie is used when the two halves of any figure or border are alike when turned over. In all such cases a repeat of the pattern only requires half the number of hooks to complete it. This principle of mounting is largely used for silk ribbons, curtains, serviettes, tray cloths, upholstery and carpets. Its chief advantage probably consists in its adaptability and extensive use for border and compound effects of pattern. The method usually adopted is to connect the harness twines in regular order from the first to the last hook of the machine and then to pass them successively through

the comberboard. Then, from the last hook but one, the harness twines are selected in the reverse order and again passed through the comberboard, with the result that the pattern is turned over and made double the original size.

The first half of the mounting of Fig. 266, shows an example of tying up the harness twines for a simple turn-over effect of pattern. Fig. 292 shows a simple turn-over pattern.

4. **Complex Ties.**

Complex ties are composed of a judicious combination and re-arrangement of two or all three of the foregoing classes of mounting. It is in this section that the greatest skill and ingenuity of the designer is called forth and utilised. Not only may the full capacity of the figuring apparatus be used, but by judicious combinations of mounting very elaborate patterns can be woven which carry the impress of a greater figuring capacity of machine than has actually been employed.

The primary object of complex mounting or distribution of the harness twines in the comberboard is to produce large repeat patterns without a corresponding increase in the figuring capacity of the Jacquard machine—figured stripes composed of single, repeating and turnover sections and double cross border patterns are examples to wit.

When tying up for stripe patterns, the upright hooks of the Jacquard machine are divided into *sections*, the harness cords are tied up to each section of hooks and passed through the comberboard according to the size and form of stripe desired, the design having been previously prepared for each set of hooks.

Harness Mounting—Examples.

No specific advantage would be gained by adding examples or amplifying the principles of mounting unless each subsequent example from this point possessed some inherent and distinguishing characteristic, or embodied some new principle and special feature.

**Damask Tie,
with repeating
centre.**

Fig. 293 shows one row of harness in two 12 row twilling machines, combined and mounted for a cross border damask pattern and a centre containing three repeats of pattern. Each machine contains 51 rows by 12 hooks per row and 25 needles to each row of hooks, for which reason there is a like number of perforations in each row of the comberboard, but these are arranged to run diagonally from the front to the back as shown in the part plan below the lingoos, Fig. 294.

No. 1 machine is set aside exclusively for the centre where three harness twines are tied directly to each upright.

No. 2 machine is devoted absolutely to the borders where two harness twines are tied to each upright. It should be observed that the first twine of No. 1 upright at the left of the machine, is taken across to the extreme left hand side, and the second twine to the extreme right hand side of the comberboard. The first twine of No. 2 upright consequently goes to the left, and the second to the right hand side, and so on throughout the whole series of uprights.

It is important to note, (1) the twist in the harness is on the same side of the loom as the Jacquard machine and clear of all the twines coming from No. 1 machine; (2) the twines of No. 1 upright of No. 2 machine, being nearer to the left side of the comberboard, form a much smaller angle than if first taken straight down to the comberboard for the right border in continuance of the centre, to be afterwards reversed for the left border, which is sometimes inadvertently done.

The border tie is "free," so any border type variety of pattern can be produced, *e.g.*, a unit figure, stripes, double borders interspersed with sateen or plain, at will.

Fig. 295 is a border pattern designed for this type of mounting.

**Cross Border
Tie, with
part Single in
Centre.**

Fig. 296 shows a cross border with a portion of single tie in the centre, suitable for small table "tops." Monograms or private characters may be woven in the centre where the single is shown.

The machine contains 76 rows of needles, 8 deep, making 608 in all. There are three uprights to each needle, as

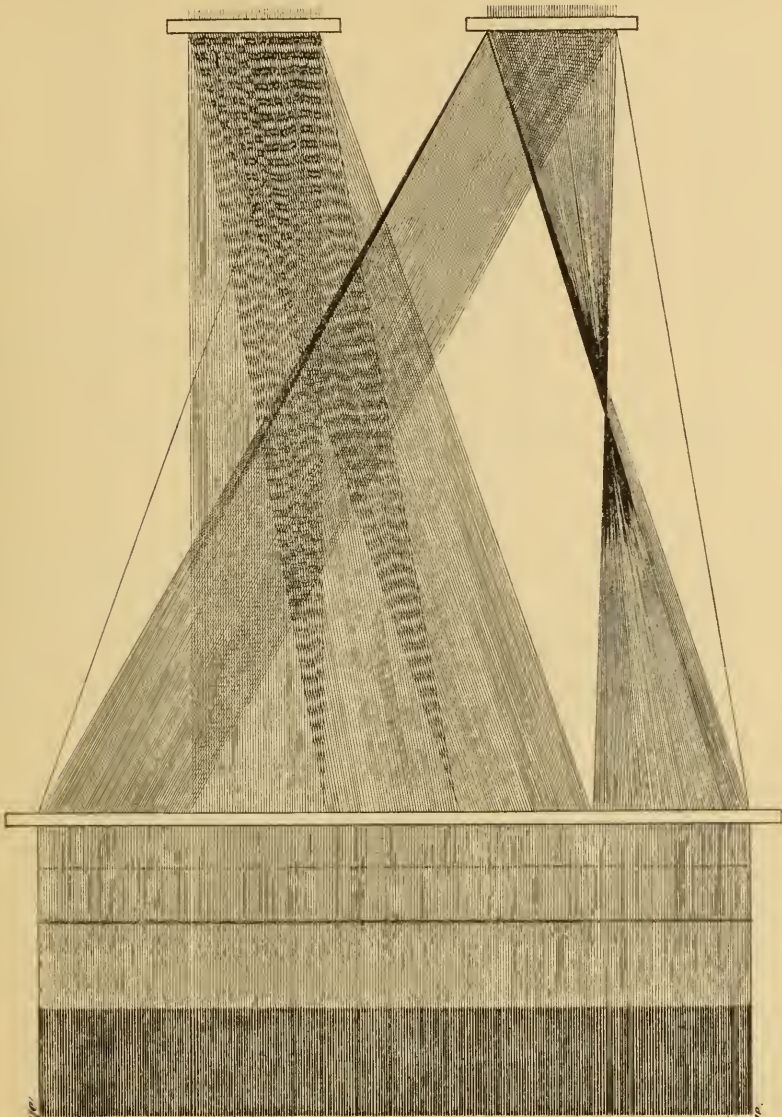


Fig. 293



ENLARGED PART PLAN

OF

COMBER BOARD

Fig. 294

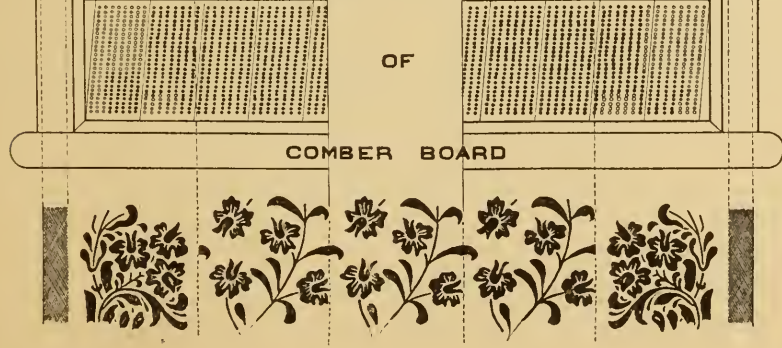
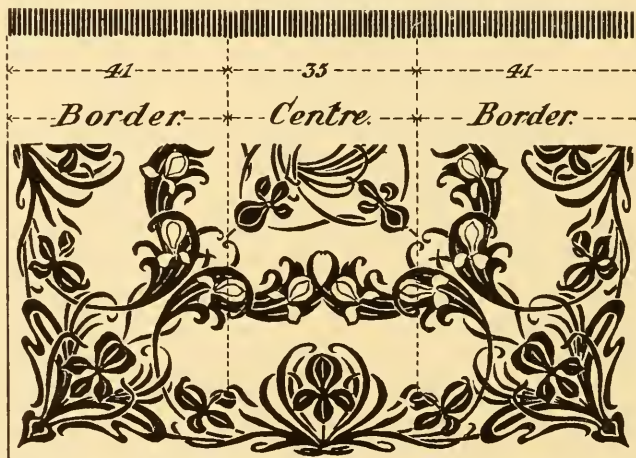


Fig. 295

shown by the side view of the machine, which thus gives a unit figuring capacity of 1824 uprights, of which 984 are set aside for the borders, and the remaining 840 are devoted to the centre and are tied up "Single." Hence, the complete effect of pattern is distributed over 2808 warp threads—in this example the full width of the warp. The complete details for designing are shown in tabulated form below the illustration.

Fig. 296



DETAILS FOR DESIGNING.				
	<i>Needles.</i>	<i>Hooks.</i>	<i>Cords-p.Hook.</i>	<i>Total.</i>
<i>Selvedge.</i>	—	—	—	—
<i>Sateen.</i>	—	—	—	—
<i>Border.</i>	328	984	1X2	1968
<i>Centre.</i>	280	840	1	840
<i>Total Harness Cords in Loom.</i>				2808
<i>Width in Reed 40 inches. Sett 70 ends per in.</i>				

Fig. 297 is a front elevation of the Jacquard machine and first row of mounting.

Fig. 298 shows a side elevation of the twilling hooks.

Fig. 299, a side elevation of the ordinary hooks and their connection with the needles.

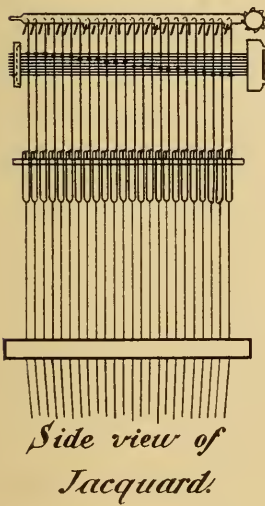
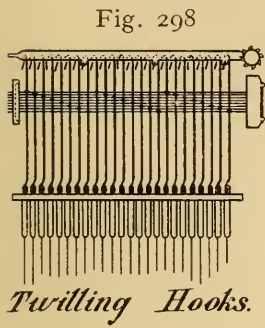


Fig. 299

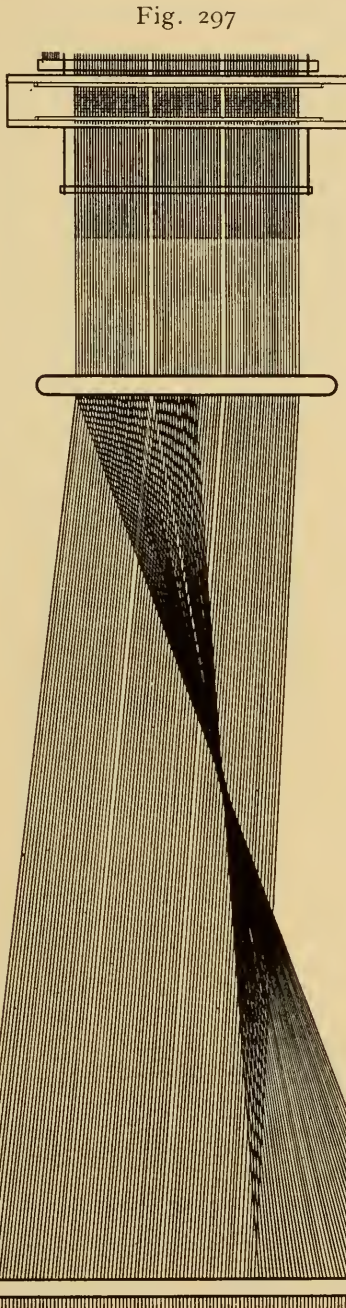


Fig. 300

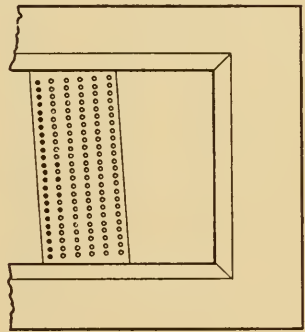


Fig. 300 is a plan of part of the comberboard.

**Damask Tie,
with Point and
Single Centre.**

Fig. 301 shows a damask tie for two 612 twilling machines (25 rows of uprights), mounted to produce the maximum variety of effect of pattern with the minimum amount of figuring apparatus. The border twines are taken all from No. 2 machine. It is a free border, but from No. 1 machine 360 uprights are set aside for a point draft and accordingly 360 cords are drawn through the comberboard, in successive and regular order, adjoining the left hand side of the border, but the second set of cords from the same uprights is passed through the board adjoining the right hand side of the border but working, like the first set, gradually towards the centre. The remaining 252 uprights are tied up "single" in the centre of the board, which arrangement facilitates the production of woven designs which at first sight suggest a simple turn-over from the centre, but on closer observation it is seen that the design does not turn over from this point and so engenders thought on the part of the observer, and a variety is imparted to a woven product which always commands an increased price, and enhances its choice of selection. Of course the "single" can always be used for monograms or other distinguishing marks which involve mounting.

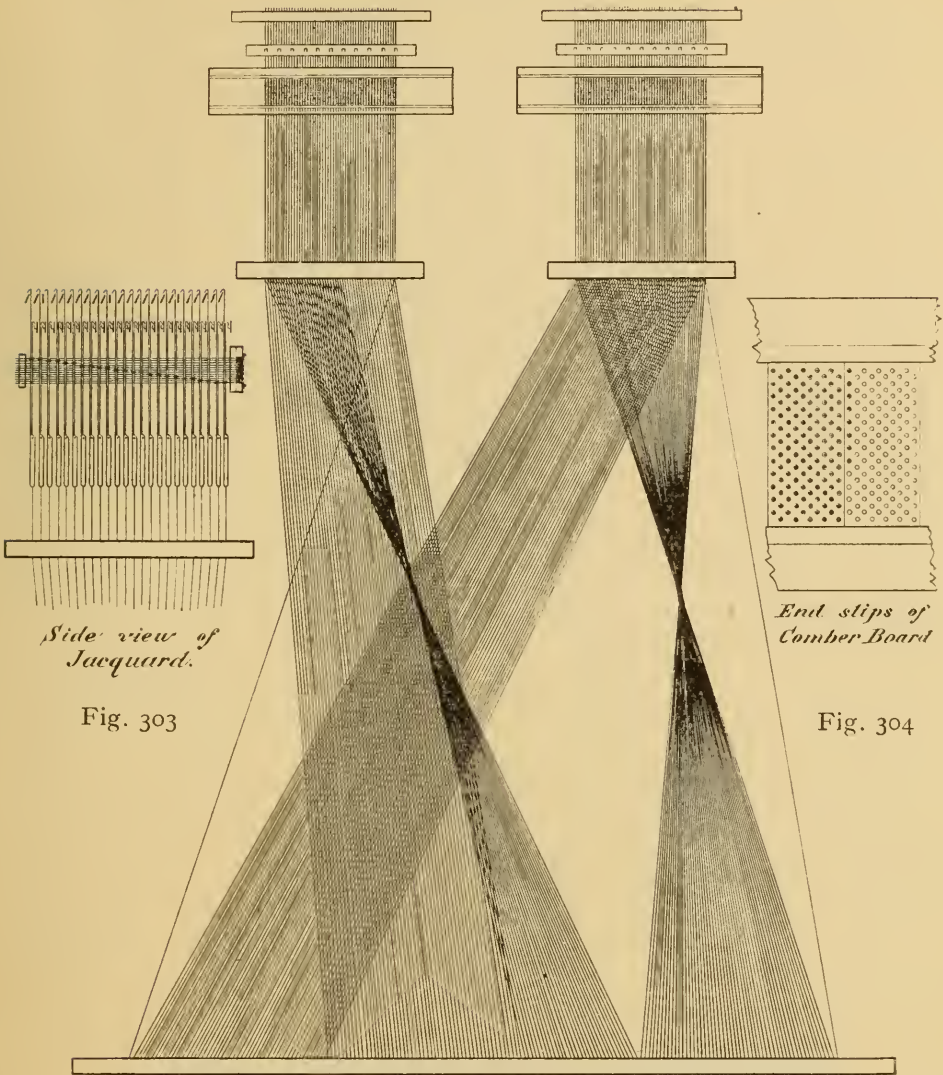
Fig. 302 shows a suitable pattern designed for this type of mounting.

Fig. 303 gives the arrangement of the hooks per needle, and Fig. 304 is a plan of part of the comberboard.

**Apparent Increase in the normal figuring capacity
of Jacquards.**

The harness mounting for napkins and the cheaper kinds of figured and bordered fabrics has frequently to be so arranged as to produce a figured effect of pattern in the cloth, which appears large in comparison with the figuring capacity of the machine, with which for economical reasons, it must be woven.

Fig. 301.



Side view of Jacquard.

Fig. 303

End slips of Comber Board

Fig. 304

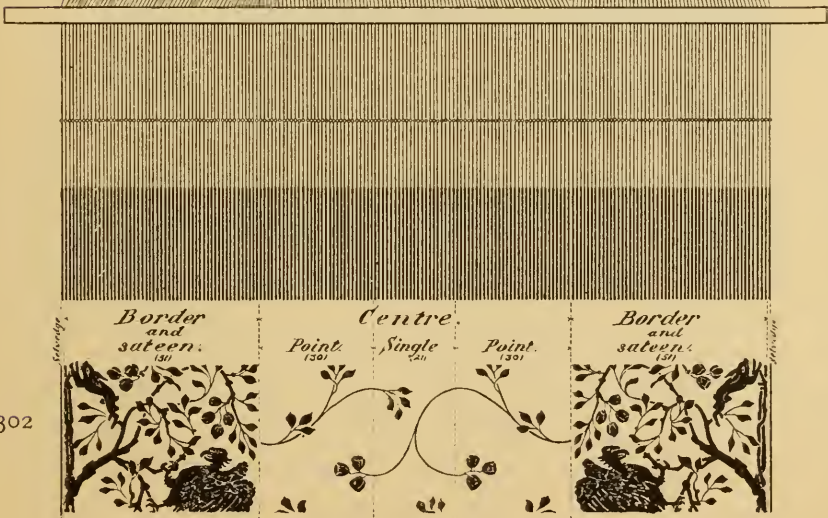


Fig. 302

Border sateen (32)

Point (30)

Centre Single (24)

Point (30)

Border sateen (32)

**Part Repeat
of 'Single' in
Border.**

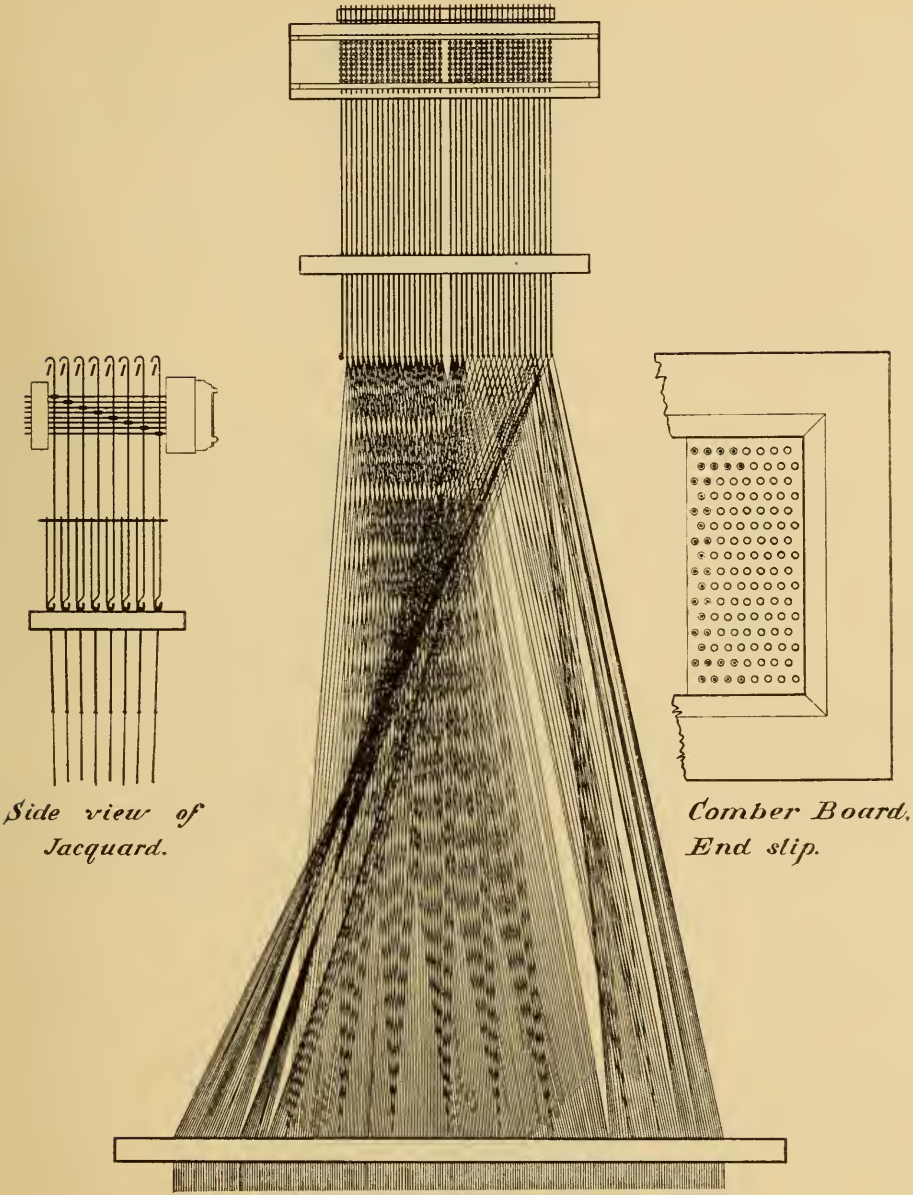
Fig. 305 shows the complete napkin tie for the first row of hooks in a 304 machine, and Fig. 306 a simple sketch design illustrative of the figuring possibilities of such a mounting. A tabulated distribution of the mounting is set forth below. The selvedge portion A is controlled by 20 cords distributed over 4 hooks; 8 threads of warp sateen B are repeated six times in each border; C once; D—a point tie, twice; E—the special feature, is taken from 88 hooks for which a *single* repeat of a *repeating* pattern is designed; part of this design is then repeated at E¹ with a narrow strip of warp sateen between the two parts E and E¹. The resultant effect of this modification is to add variety to the complete border pattern, and though the parts E and E¹ are from the same hooks they have a tendency to suggest a difference in effect. F, the centre, contains six repeats of pattern, three only of which are shown. The complete details of this mounting are tabulated as follows:—

BORDER.												CENTRE, 6 Repeats.	
Selvedge.	Warp Sateen.	Warp Sateen.	Warp Sateen.	Point Tie.	Warp Sateen.	Repeat of Part of E.	Warp Sateen.	Single.	Warp Sateen.	Repeat of D.	Warp Sateen.		
4	8	8	—	24	—	—	—	88	—	—	—	176	No. Hooks.
20	8	32	8	48	8	64	8	88	8	48	8	1056	No. Cords.
A	B	C	B	D	B	E ¹	B	E	B	D	B		

**Re-arranged
'Single'
in border.**

Fig. 307 illustrates a method of mounting a small Jacquard in such a manner as to produce a reasonable amount of variety for so small a machine. The front row of uprights fully mounted and the order of passing the harness cords through the comberboard are also shown. Each subsequent row of hooks is an exact duplicate of the one supplied. Altogether the machine contains 208 figuring hooks, apart from spare hooks for selvedges, etc. The first 96 hooks are

Fig. 305.



Side view of Jacquard.

Comber Board, End slip.



Fig. 306

devoted to weaving the centre A of which there are six full repeats three only of which are shown. The next 96 hooks—97 to 192, are tied up *single* for weaving the border part B which may be of the

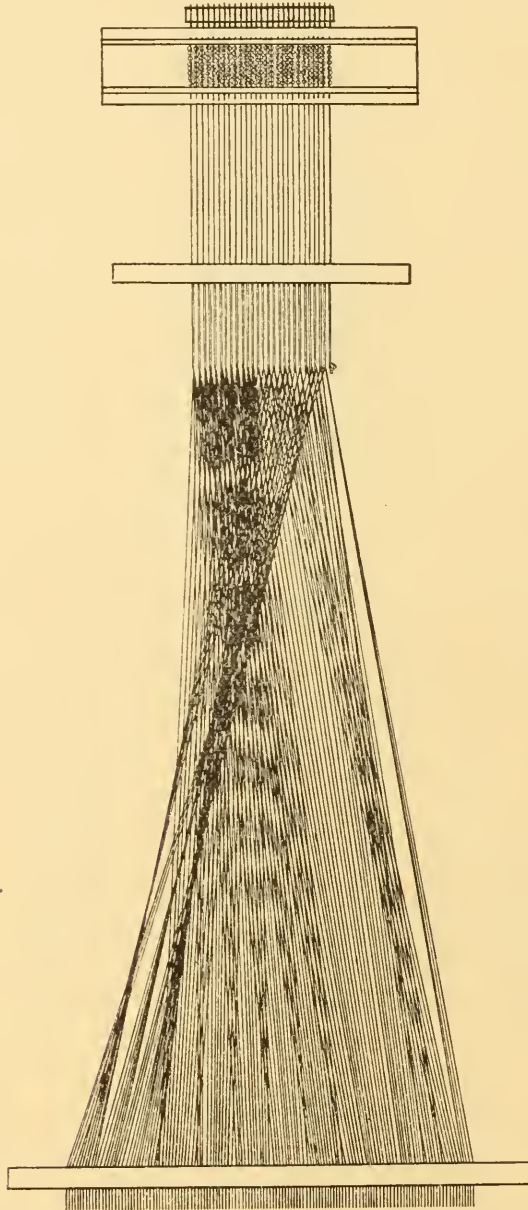


Fig. 307.

single repeating type of pattern; next comes 16 twines from 8 uprights for warp sateen c or other weave; 16 twines are taken from the same hooks and drawn through the comberboard in the

reverse order, after which the single part B in the border is repeated in a modified form as at B¹. The first harness to be threaded through the comberboard in this part commences with hook 145 and continues to hook 192. Then the next cord is taken from hook 97 and continues to hook 144. This arrangement modifies any repeating figure in such a manner as to impart a changed effect of pattern as at B¹ which feature is illustrated at Fig. 308. The border is completed by 24 cords for the sateen as at D and the selvedge at E.

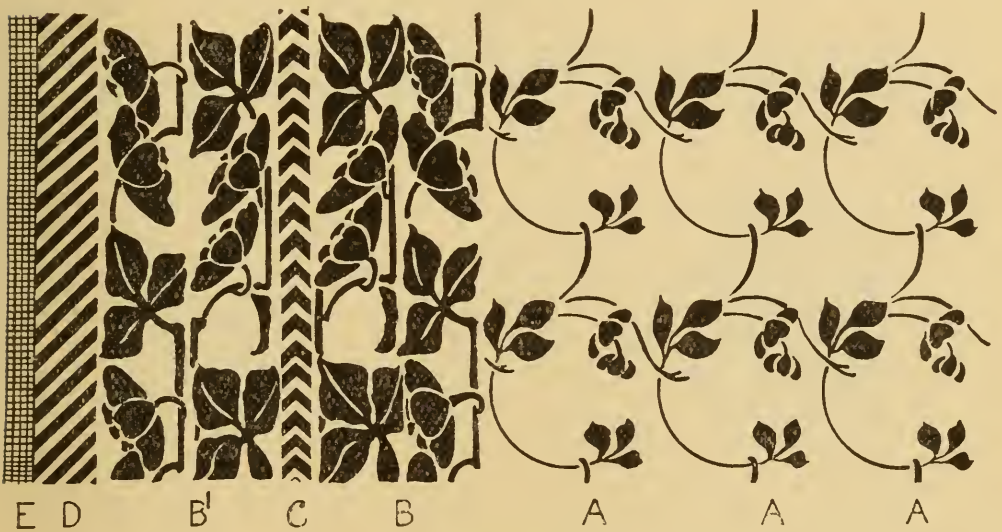


Fig. 308

Inversion and Repeat of the Point tie in the border.

An apparent increase in the figuring capacity of any small or other Jacquard machine may be effected as follows :--

Fig. 309 is a plan of one complete repeat of the pattern on a much reduced scale together with a tabulated list of designing details.

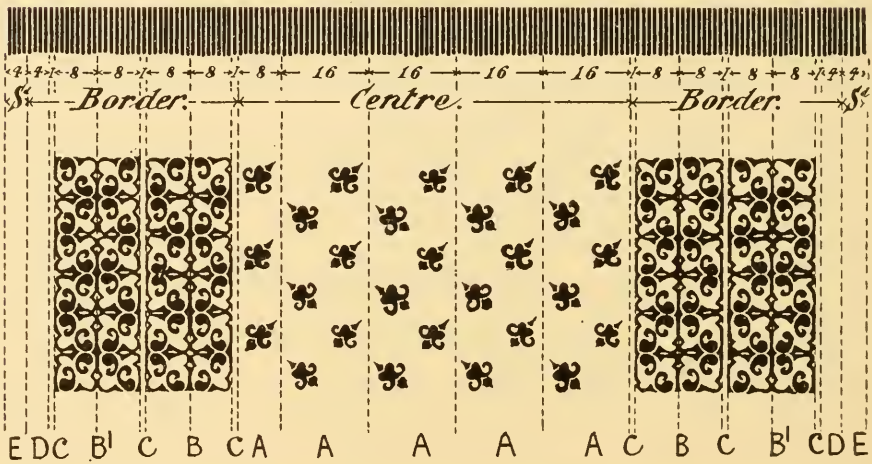
Fig. 310 is a front elevation of the mounting for a 208 machine. The cords from the first and last hooks for each section of the mounting are only shown.

Fig. 311 is a side elevation of the Jacquard and Fig. 312 a plan of part of the comberboard.

The centre A, $4\frac{1}{2}$ repeats, 576 threads is controlled from hooks 1 to 128 inclusive.

„ part c, warp sateen,	8	„	„	„	193 to 200	„
„ „ B, point tie	} 127	„	„	„	129 to 192	„
					and back from 191 to 129	„
„ „ c, warp sateen,	8	„	„	from hooks	193 to 200	„
„ „ B ¹ , point tie	} 127	„	„	„	191 to 129	„
					and forward from 130 to 192	„
„ „ c, warp sateen,	8	„	„	controlled from hooks	191 to 200	„
„ „ D, weft sateen,	32	„	„	„	201 to 208	„
„ selvedges E	— 16	„	are	„	from 4 spare hooks.	„

Fig. 309.

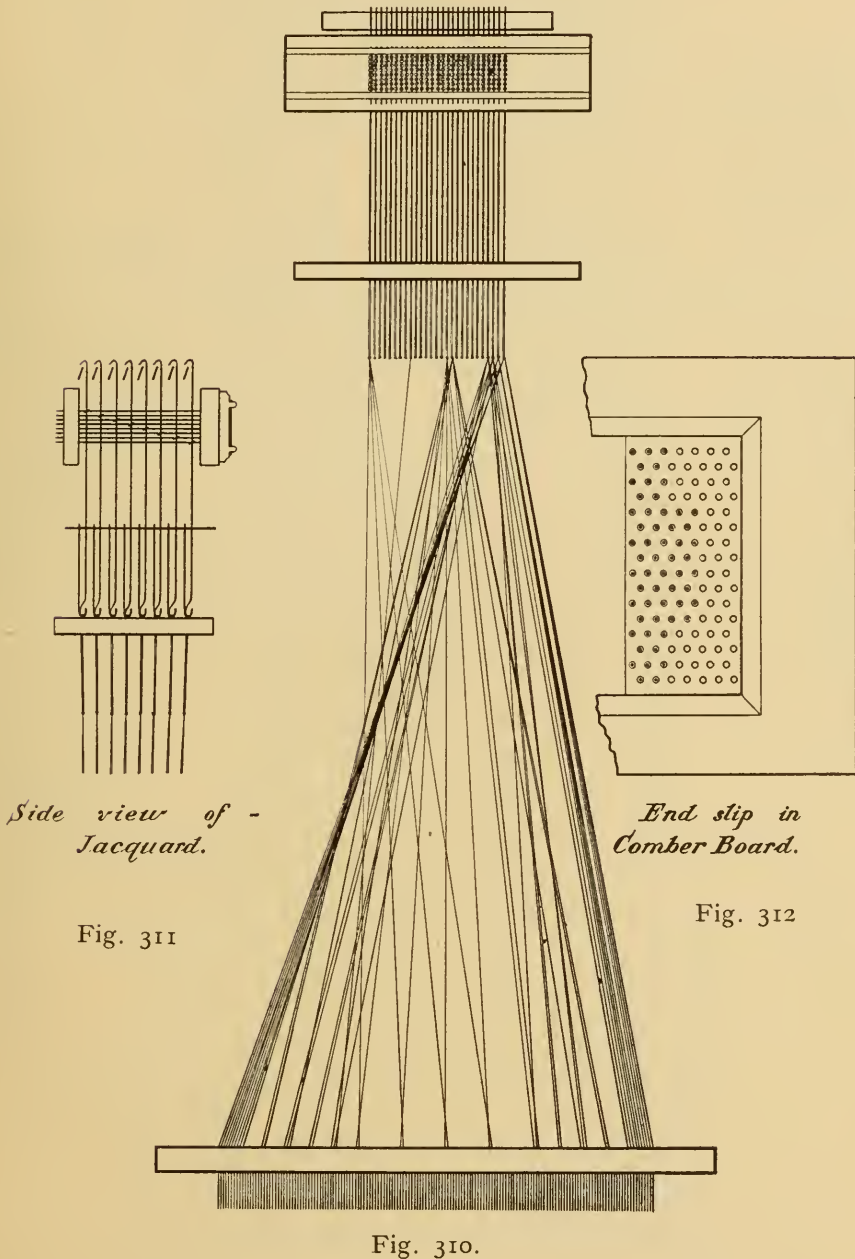


DETAILS FOR DESIGNING.					
	Needles.	Hooks.	Cords p.Hook.	Total.	
<i>Selvedge.</i>	4	4	4X2	32	
<i>Border.</i>	<i>Sateen.</i> <small>WFT.</small>	8	8	4X2	64
	<i>Point.</i> <small>WAP.</small>	64	64	1X3X2	48
<i>Centre</i>	128	128	4½	576	
<i>Total Harness Cords in Loom</i>				1232	
<i>Width in Reed</i> 22½".				<i>Sett</i> 55 ends p.in.	

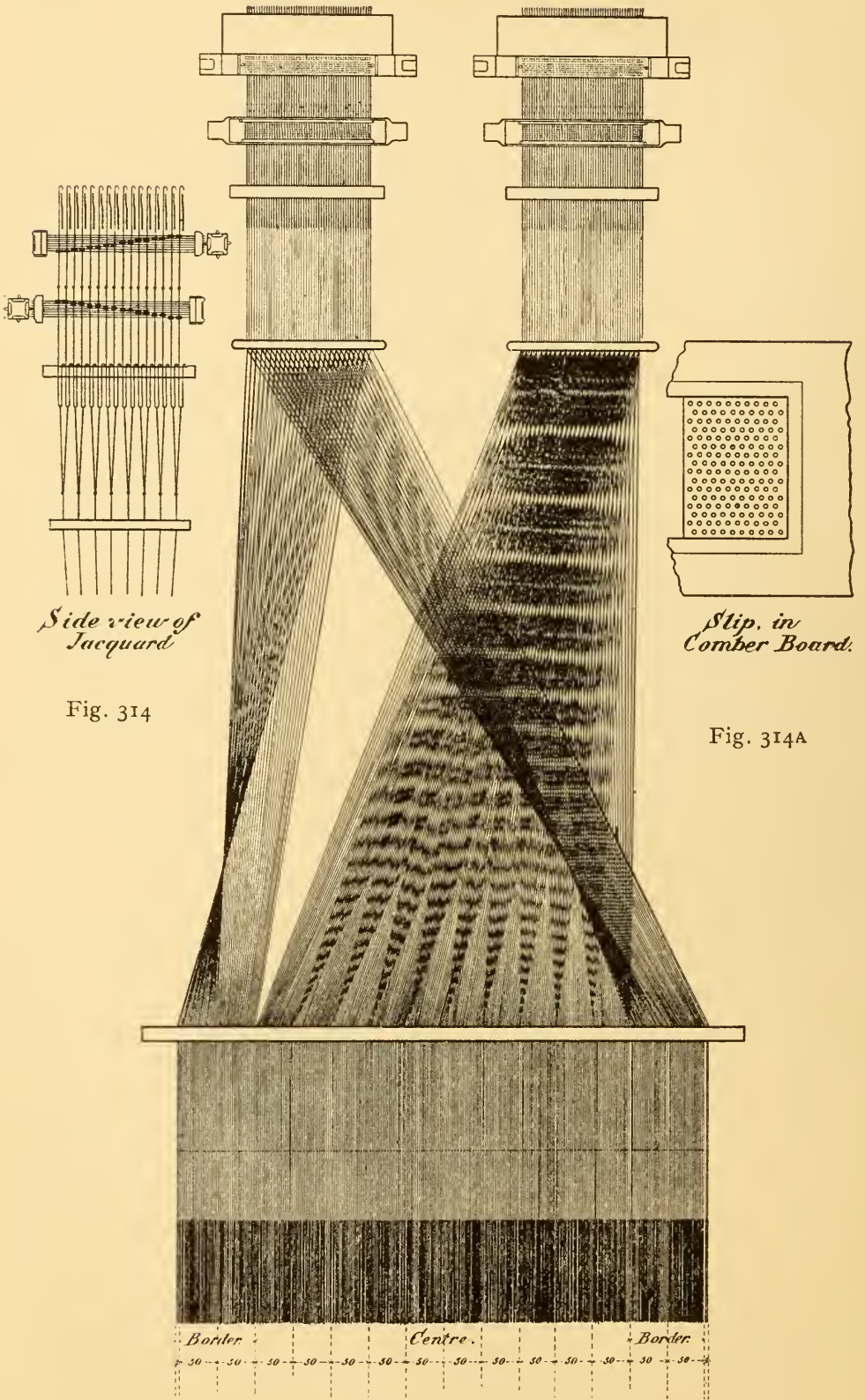
For the left border the harness cords, from hooks 193 to 208 together with the selvedges, are reversed as shown in the mounting.

The special feature of this mounting is in the border sections B and B¹ where the unit pattern idea is doubled as ordinarily by the

point tie and then modified by inversion as at B¹ to give a second



double effect, and producing as a consequence four times the unit idea in different forms of combinations.



Side view of Jacquard

Fig. 314

Slip, in Comber Board.

Fig. 314A

Fig. 313

**Point Tie
Border, with
Repeating
Centre.**

Fig. 313 is a front elevation of the complete mounting of two 400 double lift Jacquard machines designed to produce figured patterns for a point tie with repeating centre.

Fig. 314 is a side elevation showing the connection of the hooks and needles, and Fig. 314A a plan of part of the comberboard.



Fig. 315

No. 1 machine is devoted exclusively to control the borders. There are four cords tied to each hook—two for each border. The harness cords are taken from the successive hooks 1 to 400 inclusive, and threaded through the comberboard beginning in the centre of each border and working alternately to the right and left.

No. 2 machine is reserved exclusively for the centre, where the harness cords are taken from hooks 1 to 400 inclusive for ten repeats. The selvages are taken from one row of spare hooks from either or both machines.

The full particulars of mounting are as follows:—Selvages 64 threads, both borders 1600 threads, and centre 4000 threads; total 5664, set 80 cords per inch.

Fig. 315 is a sketch, suitable for the above class or style of mounting.

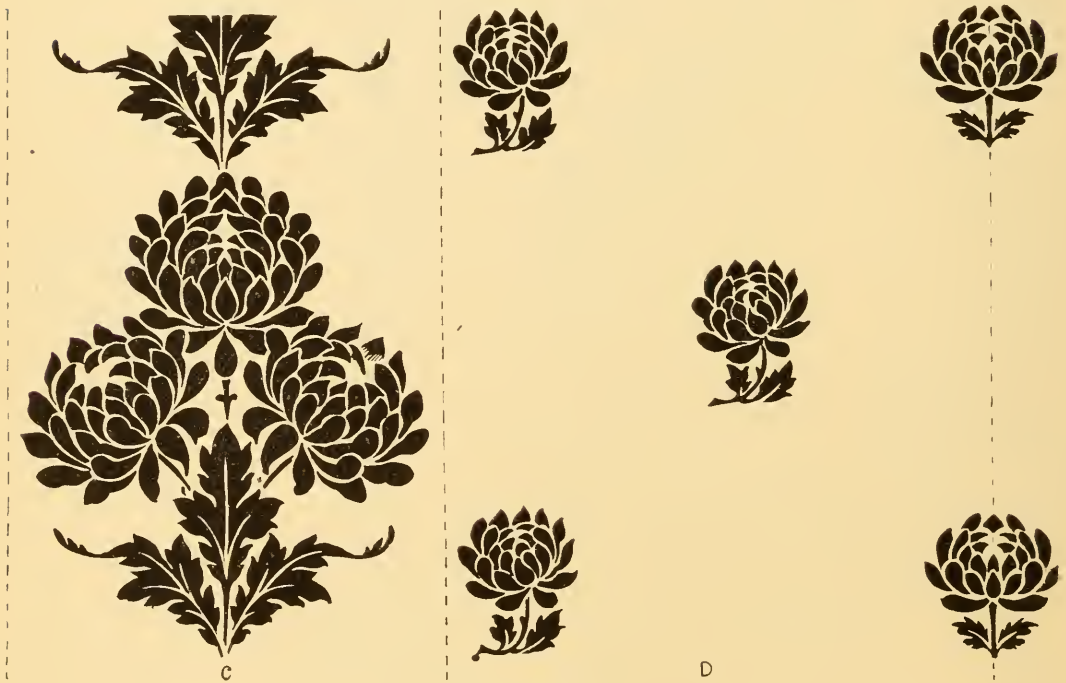


Fig. 316

**Double
Point Tie.**

Fig. 316 illustrates a type of design which may be woven with this principle of mounting. The main border c is turned over from the centre and produced on 240 hooks and the centre D, also a point tie, is produced on 660 hooks.

This mounting is also well suited to the production of multi-symmetrical patterns with a portion near the outside 'turned over.'

Fig. 317 is a front elevation of the harness tie for a 912 twelve row, fine pitch machine together with the distribution of the harness twines through the comberboard. Four hooks in the first row are set apart to the weaving of the selvages A, the remain-

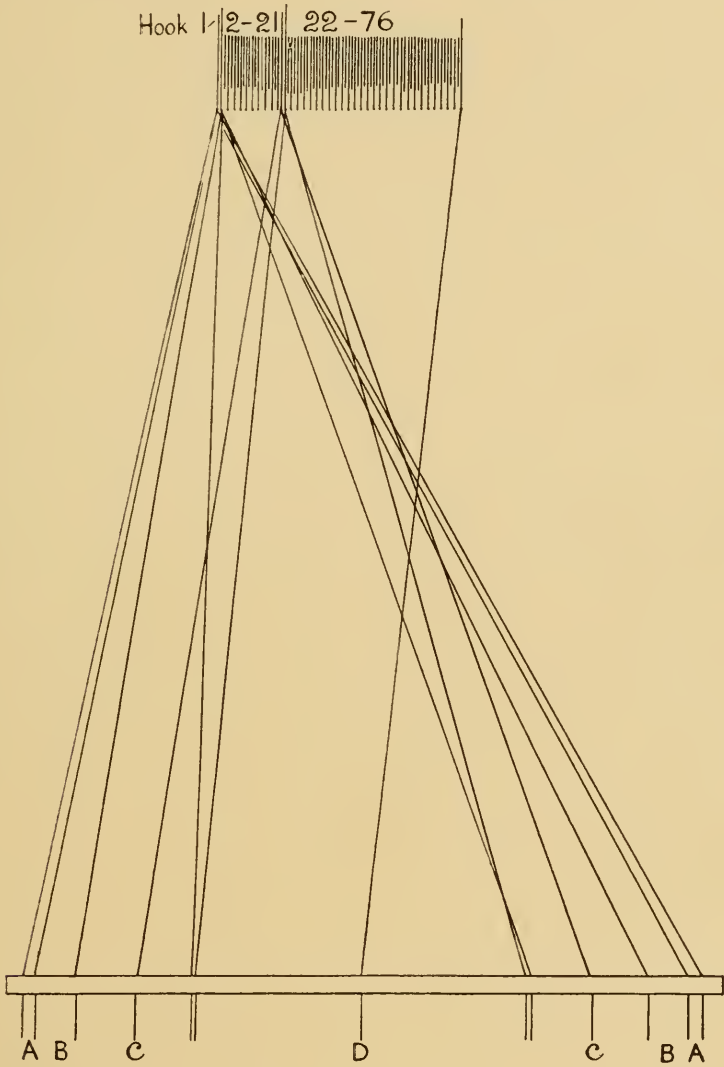


Fig. 317.

ing eight hooks in this row being reserved to work a sateen or other eight end stripe B. Twenty rows (2 to 21) are set aside to control the borders c. The mounting, from the thirteenth hook, commences in the centre of the border c on the left and then the cords from the successive hooks are threaded, one to the right and one to the left

from hook 13 to 252 inclusive, and similarly for the opposite and right border. The remaining fifty-five rows (22 to 76) are reserved for the body or centre D of the cloth. The mounting for this part is then continued from hook 253 to 912 until the centre of the board and pattern is reached from which point the harness cords are taken from hook 911 to 253 inclusive and threaded through the comberboard to the point where the right hand border joins up to the centre.

It is important to note that the mounting for the foregoing tie is designed so that the harness cords are taken from the hooks 13 to 912 in arithmetical and successive order, *i.e.* from the centre of the left border c to the centre of the filling D; from this point to the centre of the right border c it is reversed. Consequently 1800 threads in the body of the cloth are available for a perfectly multi-symmetrical effect of pattern, virtually composed of 'single' point tie, and suitable for a silk cover or linen or cotton napkin. The remaining outside harness, if not required for figure work, may be lifted clear of the warp, which may then be drawn through special heddles to weave a plain, twill or striped sub-border, when the width of the cloth will, like the original mounting, be suitable for 'table tops.'

The full details of this mounting are tabulated as follows:—

Selvedge A	Left	}	4 hooks	8 cords		Total cords =	32	
„	Right		—	8 „	„	„	32	
Sateen B	Left	}	8 hooks	14 „		„	112	
„	Right		—	14 „	„	„	112	
Border c	Left	}	240 hooks	2 „	point tie	„	480	
„	Right		—	2 „	„	„	480	
Centre D			660 hooks	2 „	„	„	1320	
							<hr/>	2568

Set 60 cords per inch, 43in. in comberboard.

Border Pattern formed from Repeating Centre. When the figuring capacity of the Jacquard machine is relatively small in comparison with the size of the pattern and cloth required, the following method is sometimes adopted.

The Jacquard is tied up for a repeating centre and the border is obtained exclusively, or in part, by 'lifting' a portion of the centre

into the border. The following arrangement sufficiently illustrates the idea. A indicates the figured portion of the fabric.

Selvedge 16 threads.	BORDER.			CENTRE.			Repeat Border.
	Plain 120 threads.	A 560 threads.	Plain 120 threads.	A 600 threads.	A 600 threads.	A 600 threads.	

The following alternative plan is sometimes adopted. The different letters represent differently figured portions and consequently a different set of hooks.

Selvedge 16 threads.	BORDER.				CENTRE.				Repeat Border.
	A 384 threads.	Plain 60 thds.	B 400 threads.	Plain 60 thds.	A 400 thds.	A 400 thds.	A 400 thds.	A 400 thds.	

Tying up the Harness to serve for two widths of cloth.

Damask mountings and most border patterns have frequently, for economical reasons, to be tied up in such a way, that the *same* "tie" and pattern cards may be made to serve for two different widths of cloth. It is essential to note the following before proceeding with the mounting for this purpose. (1) Ascertain the two widths of cloth which are most likely to be required for any given set or fineness.

(2) Arrange to always have a complete number of repeats of pattern in the centre without any break.

(3) Contrive to make the number of ends in the repeat of pattern some multiple of the difference in the number of ends between the two widths of cloth required, *e.g.*, an eight inch repeat of pattern and an eight inch difference in width.

(4) Make up small differences in width, say to three inches, by increasing the amount of sateen or selvedges.

Example 1. Given $49\frac{1}{2}$ inch damask containing 45 threads per inch and five repeats of pattern in the centre from a 304 machine.

The border pattern is worked from a second 304 machine. Between the border and the selvedge, there is almost one inch of plain or sateen. If it is also required to weave in the same loom and from the same set of cords, a damask $57\frac{1}{2}$ inches in width, then the harness must be tied up to give six repeats in the centre. It will be evident to the student that the increase in the width of the cloth is 8 inches and that one repeat of pattern in the centre is only equal to $6\frac{3}{4}$ inches, and therefore the remaining difference must be made up by increasing the amount of plain or sateen, between the selvedge and border, which amount is so slight as to be almost imperceptible.

Example 2. The following tabulated grouping of hooks and harness cords is arranged to weave two extreme widths of damask or other cross bordered fabric with two ordinary 400 Jacquard machines. Cloth A is 48 inches wide and cloth B $64\frac{1}{3}$ inches wide, and both contain 50 threads per inch.

BORDER.						CENTRE.					
Selvedge	Plain or Sateen	Sheeting Twill	Plain or Sateen	Point Tie	Single	REPEATING-TIE.					
A 4	8	4	8	88	304	408 = 816 needles					
16	24	44	24	176	304	408	408	408	= 2400 cords.		
B 16	24	44	24	176	304	408	408	408	408	408	= 3216 cords.

Mechanism for varying the width of the Harness. Fig. 318 illustrates a special arrangement designed to adapt the harness to suit two different widths of cloth with the same harness tie. The chief feature is the addition of two short supplementary comberboards, adjustably placed one on either side of the harness.

The tie of the harness is arranged for a bordered fabric with a repeating centre. The pattern in the border is composed of two

sections A and B, arranged A B A B, and worked by hooks 1 to 288 inclusive, followed by six repeats of the centre, controlled by hooks 289 to 600 inclusive, the last row of 12 hooks being reserved for contingencies.

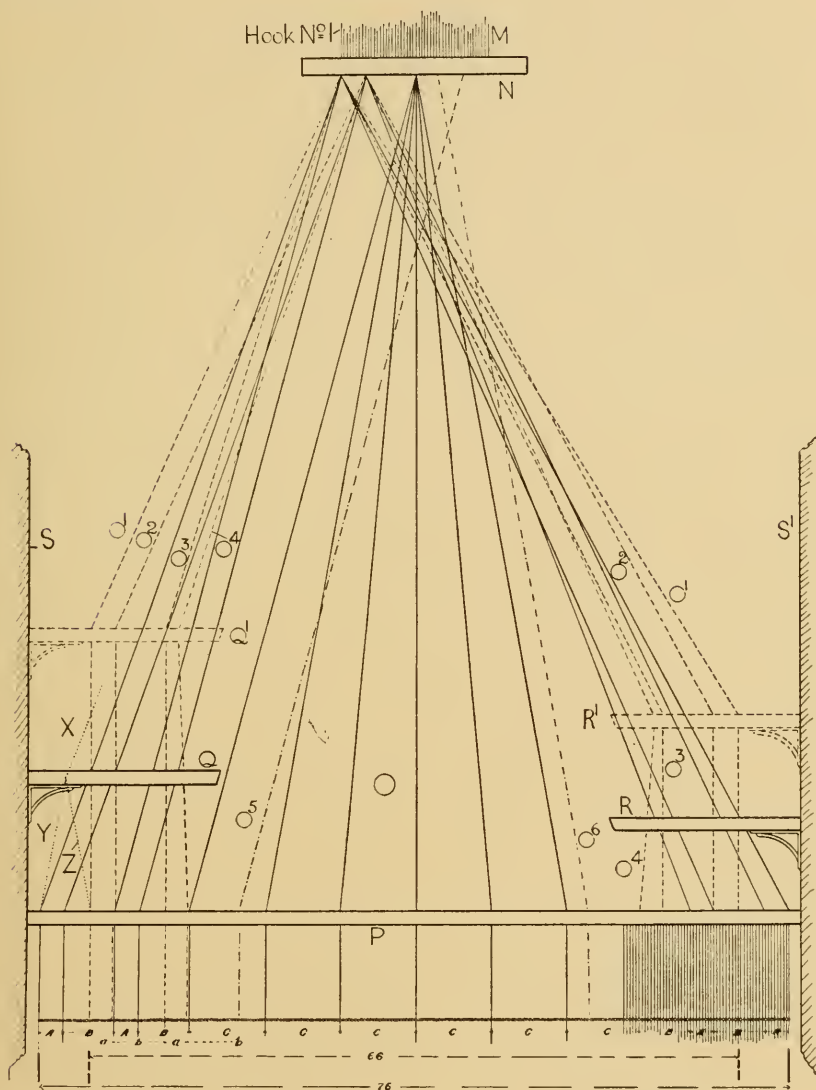


Fig. 318.

It is immaterial whether there be one, two or more machines—the principle of application remains constant.

In the illustration supplied, M indicates the hooks and tug cords, N the tug board, o the harness cords, P the ordinary comberboard,

Q and R the supplementary comberboards, Q¹ and R¹ the same boards in a different position, and S, S¹ the loom gables; the position of the mails and lingoes are as shown.

All the harness cords o for each border are first threaded through their respective supplementary comberboards Q and R, after which they are threaded through the slips of the ordinary and fixed comberboard after the usual manner.

Then, if it is required to weave a cloth narrower in proportion to one or more repeats of the pattern c, it is usual to *lift* the required reduced amount of harness with slips and lingoes, bodily from both sides of the 'centre.' The border harness is then moved close up to the remaining centre harness, the first and last cords of which are shown by the dotted lines o⁵ and o⁶ respectively. Under ordinary circumstances the mails of the border part would then be lower than those of the centre. In the illustration supplied this difficulty is overcome by raising the supplementary boards Q and R until the harness twines assume the positions as indicated by the dotted lines o¹, o², o³ and o⁴, and until all the mails are level. The changed position of the supplementary boards is as shown at Q¹ and R¹. The new position of the border pattern is shown by the small letters a b a b.

If it is desired, the width of fabric may be reduced by lifting out the harness for section A on the outside or section B on the inside of each border part.

The chief defect of this principle is the acute angles formed in the border harness and the increase of 'strive' on these harness twines; the gain however more than compensates for these objections.

An alternative plan for known changes consists in adjusting the supplementary boards in such a position above the normal board, that the angle in the harness twine between the two boards Q and P is the same for both widths of harness. This modification is illustrated by the dotted lines x y z, where x is the harness cord above the supplementary board Q; y the same cord below the board for the wider width, and z its new position for the narrower width.

The Necessity and Use of the Heck.

The heck is used as an accessory to the Jacquard machine whenever the harness is tied up for wide widths.

It is extensively employed in linen damask weaving.

Its purpose is to assist in the production of an equal depth of warp shedding from selvedge to selvedge, and also to insure the same vertical pull in the harness and tug cords as is imparted to the hooks.

The heck is in the form of a grate; it consists of a number of steel or wooden bars, set equidistant and supported in a wooden frame. A number of wood rollers equal to the number of rows of uprights, are frequently placed at right angles and above the steel bars to keep each row of harness separate and distinct, and from swaying to and fro during working.

The dimensions of the heck must be slightly larger than the plan of the tug cords, for the whole machine, but the divisions must be so arranged as to permit the tug cords to rise and fall in a vertical plane. It should be placed two or three inches immediately below the bottom of the tug cords and near the top of the harness cords.

The excessive friction generated between the harness cords and the steel rods of the heck constitute its chief defect.

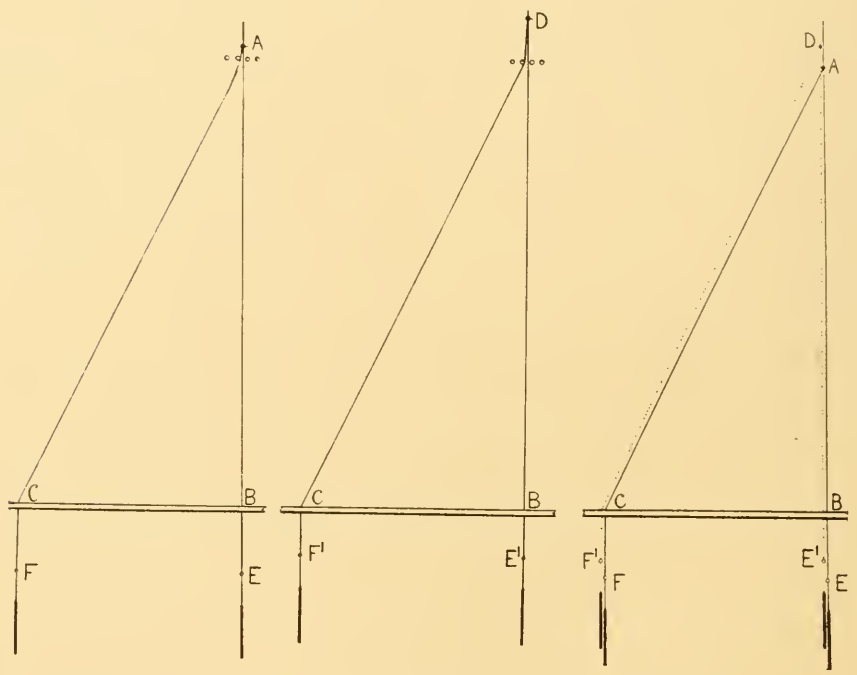
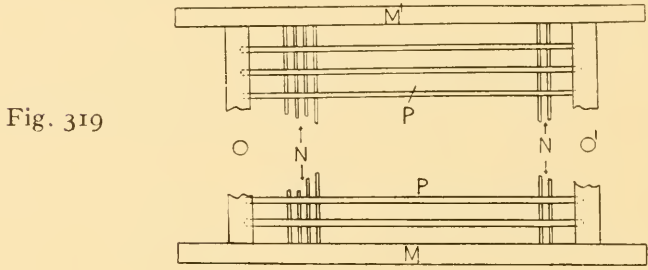
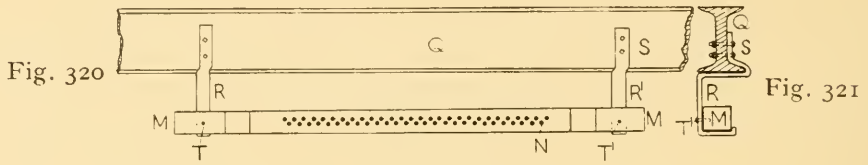
Heck Mechanism.

Fig. 319 is a plan of a heck as used for a 612 twilling machine. M and M^1 are the front and back wood rails, between which two rows of steel wires N are fixed. The main rails M and M^1 are combined, at right angles, by wood rails O and O^1 supported between which and free to rotate are wood rollers P , which pass freely between each longitudinal row of harness.

Fig. 320 shows a front elevation and Fig. 321 an end elevation of the heck as adjusted to the Jacquard gantry Q . Special hooked brackets R and R^1 are bolted to the gantry by bolts S , as shown.

The heck is adjusted to the suspended brackets R and R^1 by bolts T and T^1 and their duplicates at the rear side of the loom.

Fig. 322 is a graphic representation of the distances between the tug board and the centre and side of the comberboard, when a



Figs. 323

324

322

heck is *not* used. A.B, equals the distance from the tug knot to the middle of the comberboard ; A.C, the distance from the same tug knot to the outside harness cord through the comberboard ; A.D, the

lift of the hook and tug cord ; E the normal position of the mails below the centre of the comberboard ; F the normal position of the *outside* mail. E¹ and F¹ indicate their relative changed position when the Jacquard head is lifted to the top.

Fig. 323 shows the same details when the harness is at the bottom and when the heck *is* used.

Fig. 324 shows the same parts when the harness is lifted and the heck is used. It will thus be seen that the mails of the harness, both at the centre and the side, are at the same level.

**Hecks
Adjustable.**

The heck should be fixed in such a manner that it can be readily adjusted or fixed to adjustable brackets, for two reasons ; *first*, that it may be lowered considerably to admit of repairs to the harness, and *second*, because the harness occasionally varies in length, due to atmospheric changes which, unless neutralised, tends to produce a defective shed ; an adjustable heck may be raised or lowered at will so as to act on the harness and mails to suit the ‘race’ of the ‘going part.’

As an alternative method, the sword of the ‘lay’ is sometimes made in two parts, which being adjustable may be raised or depressed to suit the level of the warp threads.

**Heck
Problems.**

Example 1.—Assume the width of the harness in the comberboard is 90 inches, the distance from the centre of the comberboard to the tug cord, in its lowest position, is 90 inches, and the lift of the Jacquard head and knives is 4 inches.

Find the lift of the harness cord in the comberboard at 45 inches from the centre of the same, as in Fig. 322.

Then by Prop. 47, Book 1, Euclid :

$$\begin{aligned}
 AB^2 + BC^2 &= AC^2 \\
 &= (90 \times 90) + (45 \times 45) = AC^2 \\
 \therefore AC^2 &= (8100 + 2025) = 10125 \\
 \text{and } AC &= \sqrt{10125} = 100.6'' \\
 \text{also } CD^2 &= CB^2 + BD^2 = (45 \times 45) + (94 \times 94) \\
 \therefore CD &= \sqrt{2025 + 8836} = \sqrt{10861} = 104.2'' \\
 \text{and } 104.2'' \text{ (CD)} - 100.6'' \text{ (AC)} &= 3' 6''
 \end{aligned}$$

= the distance which the mail F rises as compared with mail E which travels the full distance of the lifting hook, viz :—4 inches.

Example 2.—Given the perpendicular distance from the tug cord to the comberboard as 60 inches, the width of the harness in the comberboard is 96 inches. If the head of the Jacquard machine rises 4 inches, find the reduced distance which the mail rises at the edges as compared with the mails in the centre of the comberboard.

Hypotheses.

Let $AD = 60''$, the perpendicular distance from the tug cord to the comberboard.

and $AB =$ the diagonal distance from the tug cord to the extreme harness cord.

also $BD = 48''$, being half the width of the harness.

and $AE = 4''$, the distance travelled by the tugs.

Solution.

$$\text{Eq. (1) } AB^2 = AD^2 + BD^2 = 5904$$

$$\text{Eq. (2) } EB^2 = ED^2 + BD^2 = 6400$$

$$\text{Eq. (1) } AB^2 = \sqrt{5904} = 76.83''$$

$$\text{Eq. (2) } EB^2 = \sqrt{6400} = 80$$

Then $80 - 76.83'' = 3.17''$, the distance which the extreme harness cords elevates the warp thread as compared with 4 inches in the centre of the comberboard.

The student should make a line diagram, lettered to correspond with the above hypothesis, to prove this example.

CHAPTER XIX.

Harness Mounting—Problems.

Example 1.—A Jacquard machine has a capacity of 400 needles and uprights. If there are 80 harness cords per inch, and 60 inches wide in comberboard, find the number of harness cords to be attached to the tug cord of each upright, the number of repeats of pattern, and size of each repeat.

Then the number of harness cords per hook and repeats of pattern

$$= \frac{\text{Harness cords per inch} \times \text{width}}{\text{Capacity of machine}} = \frac{80 \times 60}{400} = 12.$$

The size of each repeat of pattern

$$= \frac{\text{Capacity of machine}}{\text{Cords per inch}} = \frac{400}{80} = 5 \text{ inches.}$$

Example 2.—A finished figured fabric having a pattern which occupies $3\frac{1}{2}$ inches, counts 86 threads per inch. Ascertain the capacity of the Jacquard machine which was employed to produce this design.

Then the product of the ends per inch and the repeat of pattern in inches is equal to the capacity of the machine, thus:—

$$86 \times 3\frac{1}{2} = 301, \text{ apparently a } 304 \text{ Jacquard machine.}$$

Example 3.—Given a warp containing 3560 ends 16s reed 4s, with 80 cords for selvages taken from 1 row of hooks, and $8\frac{1}{2}$ repeats of pattern tied to the remaining 400 hooks. Ascertain (a) the width of harness in comberboard; (b) the size of repeat of pattern.

Then (a)
$$\frac{\text{Total ends or cords}}{\text{Ends or cords per inch}} = \frac{3560}{64} = 55\frac{5}{8}'' \text{ wide.}$$

and (b)
$$\frac{\text{Capacity of machine}}{\text{Ends per inch}} = \frac{400}{64} = 6\frac{1}{4}'' \text{ in one repeat of pattern.}$$

Example 4.—Ascertain the number of harness cords tied to each hook in a Jacquard machine mounted for weaving borders thus:—
1 row for edges, 25 rows for border, 25 rows for centre, 408

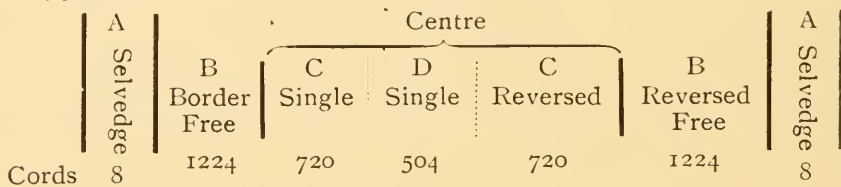
machine, 60 harness cords per inch, and width of harness 72" distributed as follows:—1 inch for each edge, 10 inches for each border, 50 inches for centre.

$$\text{Edges } 1 \times 2 \times 60 = 120 \therefore \frac{120}{1 \times 8} = 15 \text{ harness cords to each hook.}$$

$$\text{Borders } 10 \times 2 \times 60 = 1200 \therefore \frac{1200}{25 \times 8} = 6 \text{ harness cords to each hook.}$$

$$\text{Centre } 50 \times 60 = 3000 \therefore \frac{3000}{25 \times 8} = 15 \text{ harness cords to each hook.}$$

Example 5.—Given harness mounting as below, find the required number of twilling machines and capacity. Set 60 threads per inch and $73\frac{1}{2}$ inches wide.



Assume 2 uprights to each needle, then:—

$$\text{Border} = \frac{\text{Uprights}}{\text{Hooks per Needle}} = \frac{1224}{2} = 612 \text{ needles, No. 1 machine.}$$

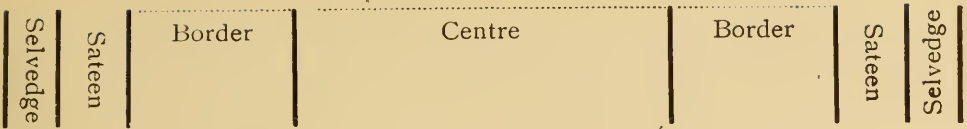
$$\text{Centre} = \text{Do.} = \frac{720 + 504}{2} = 612 \text{ needles, No. 2 machine.}$$

Example 6.—If two twilling Jacquards, each containing 612 needles and 25 uprights to each row of 12 needles, be mounted as tabulated below, with 85 harness cords per inch in comberboard, find (a) the full width of the harness; (b) the width of the selvedge, sateen and 'free' border on each side of the woven fabric; (c) the size of each repeat of pattern in the centre, together with the full width of centre.

DETAILS FOR DESIGNING.

	Needles.	Uprights.	Cords to each Hook.	Harness Cords.
Selvedge	2	5	$(3 \times 20) + (2 \times 30)$	120
Sateen	10	20	5 + 5	200
Border	600	1250	1 + 1	2500
Centre	612	1275	3	3825

Total Harness Cords 6645



(a) $\frac{\text{Total harness cords}}{\text{Cords per inch}} = \frac{6645}{85} = 78 \text{ inches.}$

(b) Each Selvedge $\frac{120}{2 \times 85} = \frac{12''}{17}$
 „ Sateen $\frac{200}{2 \times 85} = 1\frac{1}{6}''$
 „ Border $\frac{2500}{2 \times 85} = 14\frac{2}{3}''$

(c) $\frac{3825}{85 \times 3} = 15''$ repeats of pattern, $15'' \times 3 = 45'' = \text{width of centre.}$

Varying the Set of the Harness, Fineness of Cloth and Size of Pattern.

The great variety of different degrees of fineness in woven fabrics frequently necessitates a modification in the fineness or set of the harness.

Any modification of the harness after it has been mounted, must of necessity be in the direction of reduction in fineness, if the system of mounting and style of pattern are to be retained. This modification is technically known as ‘casting-out.’ It is resorted to

1. When the set in the harness is finer than the requirements of the cloth to be produced.
2. When the number of ends in one repeat of the design is not divisible into the number of hooks which represents the figuring capacity of the machine.
3. When an increased size of pattern is required, a reduction, pro rata, in the fineness of the texture is involved, but a retention and use of all the hooks in the Jacquard machine.

Casting-out may be accomplished in the following ways :—

Casting-out.

1. The surplus mails may be cast out in rows across the full width of the comberboard. Thus a 12 row machine may be reduced to a 10 or 8 row ; an 8 row machine may be reduced to a 7 or 6, according to circumstances (preferably to 6 rows).

2. The method usually adopted is to leave complete vertical rows of needles and corresponding hooks idle, and to 'cast out' the warp threads from the mails connected with the hooks and needles which are to remain idle.

Both these methods reduce pro rata the figuring capacity of the Jacquard machine.

It is important to note that the rows of hooks and mails cast out, should be evenly distributed over the whole of the machine so as to avoid any undue friction in the warp yarn between the mails and the reed at the places where the mails are standing idle.

3. A very good method is to cast out 1 or more harness mails connected with each neckband or upright in the Jacquard machine. The chief feature in this system of casting out, is that it retains the full figuring capacity of the machine—the 'set' only being reduced according to the requirements of the fabric.

4. When only a slight difference in the set is required and when a variation in the width of the piece of 1 to 1½ inches does not matter, it is sometimes advisable to sley the warp into a finer or coarser reed. The defect of this method is that it generates friction upon those warp threads nearest the edges.

5. If the comberboard is in slips, a slightly modified increase of width and reduction of set can be obtained, by the simple insertion of plain narrow pieces of wood between the divisions of the perforated slips. Any increase in the width of more than 3 or 4% interferes too much with the level of the harness.

Example 1.—The figuring capacity of a 12 row Jacquard machine is 600. The harness is mounted with 80 cords per inch. It is required to reduce the set to 72 cords per inch. To what extent will this change reduce the figuring capacity of the machine and in what order should the uprights be left idle.

$$\text{Reduced figuring capacity} = \frac{\text{Standard capacity} \times \text{reqd. set}}{\text{Standard set}} = \frac{600 \times 72}{80} = 540.$$

$$\text{No. of uprights to cast out} = 600 - 540 = 60.$$

$$\text{Order of casting out} = \frac{\text{Total uprights}}{\text{Uprights to cast out}} = \frac{600}{60} = \frac{10}{1}$$

∴ 1 row to cast out in every 10 rows.

Example 2.—A small pattern complete on 80 threads of warp and weft is woven in an 8 row 400 Jacquard machine with 60 harness cords per inch. It is required to reduce the fineness of the cloth from 60 to 48 ends and shots per inch but retain the same size of pattern. (1) What number of threads of warp and weft would the pattern occupy? (2) What would be the reduced capacity of the machine? (3) How many hooks should be cast out? and (4) How should they be distributed?

$$(1) \text{ Given Set : reqd. Set } :: \begin{array}{l} \text{Ends in} \\ \text{given pattern} \end{array} : \begin{array}{l} \text{Ends in} \\ \text{reqd. pattern.} \end{array} \\ \therefore 60 : 48 :: 80 : 64 \text{ ends and shots.}$$

$$(2) \text{ Original Set : reqd. Set } :: \text{full capacity} : \text{reqd. capacity.} \\ \therefore 60 : 48 :: 400 : 320$$

$$(3) \text{ Full capacity} - \text{required capacity} = \\ 400 - 320 = 80 \text{ hooks to cast out.}$$

$$(4) \frac{\text{Full capacity}}{\text{Uprights idle}} = \frac{400}{80} = \frac{5}{1}$$

∴ Cast out one row of uprights in every 5.

Example 3.—In a 400 machine, mounted with 80 harness cords per inch, 32 inches wide, 256 harness cords are cast out without reducing the capacity of the figuring harness. Find the reduced set and the size of pattern in each case.

$$\frac{80 \times 32 - 256}{32} = \frac{2304}{32} = 72 \text{ set or cords per inch.}$$

$$(1) \frac{400}{80} = 5 \text{ inches in 1 repeat of pattern.}$$

$$(2) \frac{400}{72} = 5\frac{5}{9} \text{ " " " "}$$

Suitable sizes of Point Paper and Shots per Card for Ordinary and Twilling Jacquards.

The size of point paper for ordinary Jacquard machines varies directly in proportion to the ends and picks per inch.

Example 1.—Required a fabric to contain 80 ends and 60 shots per inch finished, find the number of ends and shots which the design paper must be ruled so that the design, when woven, will not be distorted, but proportional to the sketch.

$$\therefore \frac{\text{Ends on paper}}{\text{Shots on paper}} = \frac{80 \text{ ends in warp}}{60 \text{ shots of weft}} = \frac{8}{6} \text{ for 8 row machines.}$$

$$\text{or } \frac{12}{9} \text{ for 12 row machines.}$$

The foregoing problem is simple and the solution self-evident, but for more complex problems the following method will be found to admit of general application.

Let x = the relative number of picks to ends in the point paper.

$$\text{Then } \frac{\text{Ends per inch}}{\text{Picks per inch}} = \frac{\text{Needles per row in needle board}}{x} = \frac{\text{Ends on point paper}}{\text{Picks on point paper}}$$

Applied to the above problem, for a 12 row machine.

$$\text{Then picks per square of ruled paper for a 12 row machine}$$

$$= \frac{80}{60} = \frac{12}{x} \therefore x = \frac{60 \times 12}{80} = 9.$$

Example 2.—A silk fabric is woven in a reed containing 2400 splits, 2 threads in a split, in a width of 30 inches. Assuming the fabric must contain 100 picks per inch of weft, what size of point paper must be used for an 8 row Jacquard machine ?

$$\text{Then } \frac{\text{Ends per inch}}{\text{Picks per inch}} = \frac{\frac{2400 \times 2}{30}}{\frac{100}{1}} = \frac{8}{x} \therefore x = \frac{8 \times 100 \times 30}{2400 \times 2 \times 1} = 5$$

Where x = the relative number of picks to ends in the point paper.

Example 3.—A silk fabric contains 1600 splits, 2 threads in a split, in a reed width of 21 inches and 120 picks per inch, what sizes of point paper are most suitable to avoid any distortion of the woven figure? A for an 8; B for a 12 row machine.

$$\text{Then } A = \frac{\frac{1600 \times 2}{21}}{\frac{120}{1}} = \frac{8}{x} \therefore x = \frac{8 \times 120 \times 21}{1600 \times 2} = 6\frac{3}{10}$$

Approximately $\frac{8}{6}$ paper.

$$\text{and } B = \frac{\frac{1600 \times 2}{21}}{\frac{120}{1}} = \frac{12}{x} \therefore x = \frac{12 \times 120 \times 21}{1600 \times 2} = 9\frac{9}{20}$$

Approximately $\frac{12}{9}$ paper.

Note.—When designing for twilling machines each end on the point paper represents as many threads of the pattern as there are uprights controlled by each needle, and each weft line on the point paper represents as many shots as the card strikes before the cylinder turns.

Other factors remaining constant, an increase in the number of uprights per needle involves a corresponding increase of shots per card and vice versa.

Example 4.—A finished web is to contain 90 ends and 150 shots per inch. There are 3 uprights to each needle and 2 shots to each card. Find the relative number of ends to shots on the point paper to prevent any distortion of the pattern when woven.

Then the warp threads will be relatively increased with the shots per card and the weft divisions in proportion to the number of uprights per needle, thus :—

Formula —

$$\begin{aligned} \frac{\text{Ends} \times \text{Shots per Card}}{\text{Shots} \times \text{Uprights per needle}} &= \frac{\text{Ends on point paper.}}{\text{Shots on point paper.}} \\ = \frac{90 \times 2}{150 \times 3} &= \frac{2}{5} = \frac{8}{20} \text{ for 8 row cylinder.} \\ &= \frac{12}{30} \text{ for 12 row cylinder.} \end{aligned}$$

Example 5.—Design paper is required for a twilling Jacquard, 24 hooks to each row of 12 needles, and 2 shots to each card. Finished web contains 80 ends and 120 shots per inch.

Obviously 24 hooks to 12 needles equals 2 hooks per needle. Then proceeding as per formula above.

$$\frac{80 \times 2}{120 \times 2} = \frac{2}{3} \text{ or } \frac{12 \text{ ends.}}{18 \text{ shots.}}$$

Example 6.—It is required to weave a pattern to finish 80 ends and shots per inch with a set of cards which were previously used for a cloth containing 80×120 ends and shots and woven alternately 4 and 5 picks per card, what shots per card are necessary and also state the number of uprights there are to each needle.

1. Obviously the variation of shots per card will be in direct proportion to the shots in the two cloths, thus :—

Let x = the shots per card in the required cloth.

Then as $120 : 80 :: \frac{5 + 4}{2} : x$.

$$\therefore x = \frac{5 + 4}{2} \times \frac{80}{120} = 3 \text{ shots.}$$

2. And, since the ends and shots per inch with the 3 shot cards are equal, the number of uprights to each needle must be the same.

Example 7.—Given a design on 12×12 paper for a damask which is to contain 80 ends and 120 shots per inch, bleached. If the twilling Jacquard machine contains 24 hooks to 12 needles, find the number of shots per card necessary to avoid any distortion of the pattern when woven.

Let $x =$ Shots per card.

$$\left. \begin{array}{l} \text{Then as } 80 : 120 :: 1 : x \\ \quad \quad 12 : 24 :: \end{array} \right\} \therefore x = \frac{1 \times 120 \times 24}{80 \times 12} = 3$$

Exercises.

1.—A Jacquard harness is mounted with 7 cords to each upright, the capacity of the machine is 240 hooks, there are 64 cords per inch in the comberboard, find the full width of the harness in same, exclusive of edges; also ascertain the size of one repeat of pattern.

Ans., $26\frac{1}{4}''$; $3\frac{3}{4}''$.

2.—Given a single lift Jacquard machine containing 240 uprights with 8 needles in each row of the needle board, if the harness be set over 28 inches including one inch for selvages, which latter cords are taken from the last row of hooks, find (a) the number of repeats of pattern and the harness cords required to each tug cord; (b) the size of each repeat of pattern, when the set is 72 cords per inch.

Ans., 9 approx.; $3\frac{2}{9}''$.

3.—Given 80 harness cords per inch for a 600/12 row machine. Find rows per inch in comberboard.

Ans., $7\frac{1}{2}$ or 15 per every 2 inches.

4.—Assume that a reed contains 56 threads per inch, and the Jacquard 8 needles per row, give the most suitable method of boring the slips for the comberboard.

Ans., 14 rows of 8 each in a 2" slip.

5.—Arrange a tie on two Jacquard machines of 612 hooks each, for a damask with 75 threads per inch; $77\frac{1}{4}''$ reed space. There must be a border at both sides of the cloth.

6.—A hand loom is mounted with a single lift Jacquard containing 208 upright hooks. 8 hooks are set aside for the selvages, and 200 for the body of the fabric. The mounting is tied up on the

14.—Fig. 325 is a plan of a “marked off” comberboard to particulars given therewith. Ascertain (1) the capacity of the machine, (2) the total harness cords and ends of warp, and (3) the width of the harness in the “board,” and the warp in the reed. Ans., 400; 2348; 42”.

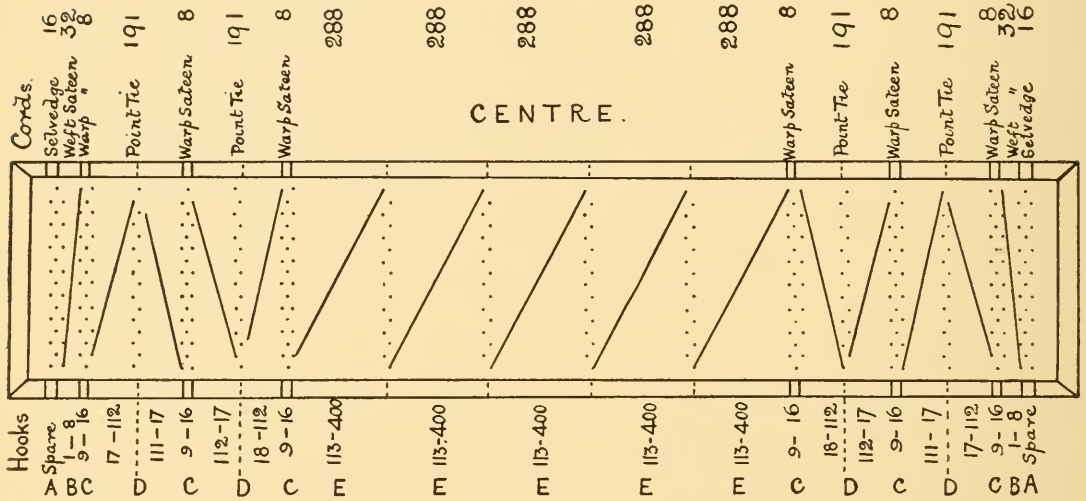


Fig. 325

15.—What point paper would you use to paint a design for a cloth containing 80 threads to the inch in warp, and 160 threads to the inch in weft? Ans., 8 × 16.

16.—What ruling of point paper would be required for a cloth counting when finished, 60 warp and 80 weft threads per inch, if woven in (1) 400; (2) 500; (3) 600 machines? Ans., 8 × 11; 10 × 13; 12 × 16.

17.—What ruling of design paper should be used for a design 6 inches square, to be woven in a cloth containing 68 ends and 48 picks per inch? Ans., 8 × 6.

18.—What point paper would be required to paint a design for a 600, 8 row twilling Jacquard, 3 hooks to needle and 3 shots to card, cloth to count 70 ends and 108 picks per inch? Ans., 8 × 12.

19.—Give suitable rulings of design paper to suit :—(a) 50×35 ; 40×30 ; 30×35 ; ends and picks per inch for a 300, 8 row machine. (b) 55×60 ; 60×40 ; 50×45 ; 45×40 ; ends and picks per inch for a 400, 8 row machine. (c) 70×90 ; 65×80 ; 80×85 ; ends and picks per inch for a 500, 10 row machine. (d) 85×100 ; 80×110 ; 70×95 ; 90×135 ; ends and picks per inch for a 600, 12 row machine.

Ans., (a) 8×6 ; 8×6 ; 8×9 . (b) 8×9 ; 8×5 ; 8×7 ; 8×7 . (c) 10×13 ; 10×12 ; 10×11 . (d) 12×14 ; 12×16 ; 12×16 ; 12×18 .

20.—A design which has been painted for two, 300, 8 row machines is to be woven by a 600, 12 row machine, what re-ruling of the design paper will be necessary?

Ans., ruled 12s instead of 8s.

21.—A pattern is painted on 50×50 squares of 8×12 paper, for a cloth counting 50 ends and 80 picks per inch, what will be the size of the repeat in the cloth?

Ans., 8in. \times $7\frac{1}{2}$ in.

22.—A set containing 2700 pattern cards is weaving a damask cloth, 72 inches long, counting 90 ends and 150 shots per inch, in a loom with two, 600, 12 row twilling machines, 3 hooks per needle; what ruling of point paper should the design be painted on?

Ans., 12×15 .

23.—A sketch measuring 10 inches wide by 8 inches long, is to be transferred to design paper for a cloth counting 60×70 threads per inch, to be woven by a 600 machine; how many squares of point paper will be required, and what will be the ruling of each square?

Ans., 50×40 ; 12×14 .

24.—A Jacquard is filled with 384 hooks and mounted with 16 harness cords to each hook, distributed over a width of 35 inches in the comberboard. It is desired to weave a pattern with 72 ends in each repeat in a fabric containing 132 threads per inch over a width of 32 inches. Ascertain the number of hooks to cast out, and state how they should be distributed.

Ans., 96; 1 row out of 4.

25.—A Jacquard is mounted with 2 hooks to each needle, and the pattern has to be woven with 2 and 3 shots per card alternately; the finished fabric must contain 100×150 ends and picks per inch.

What ruling of design paper must be employed for a 12 row machine? Ans., 12×14 .

26.—A cloth is woven with 90 ends and shots per inch, by a machine with 3 hooks per needle, and 3 shots per card. Find the shots per card if the picks are increased to 135 per inch?

Ans., 4 and 5 shots per card alternately.

27.—A silk fabric contains 2700 splits, 2 threads in a split, in a width of 30 inches. If the design paper be ruled 8×6 , how many picks per inch must the cloth contain to avoid any distortion of the figure? Ans., 135.

28.—Assume a figured pattern, to repeat on 288 ends, has to be woven on a machine with a capacity of 304 hooks, which is tied up to 60 ends per inch; ascertain the number of hooks to be cast out and the reduced set. Ans., 16; $56\frac{1}{9}$.

29.—If a design must occupy 76 ends and picks in a 60 set harness, how many ends and picks ought a 40 set harness to occupy to give the same size of pattern, also what relative number of hooks must be cast out in any given machine so as to weave straight in the harness? Ans., $50\frac{2}{3}$; 1 row out of 3.

30.—Suppose that from a 400 machine it is desired to weave a pattern occupying 60 ends, find the number of complete repeats of pattern, and say how many hooks would have to remain idle.

Ans., 6 repeats; 40 idle.

31.—If a harness is tied up to 72s set, and it is desired to produce a cloth 56s set, how many hooks would have to be cast out in a 400 machine, and how should they be distributed?

Ans., 88; 1 out of 5 and 1 out of 6 alternately.

32.—How many pattern cards would be required to weave a damask cloth 72 inches long, 90 shots per inch, the weft being inserted 2 and 3 shots per card alternately; the cross border repeat being 18 inches long and centre repeats 9 inches?

Ans., cross border set 648 cards, centre 324 cards.

33.—A napkin 28 inches long counting 100 shots per inch, is woven by a set of 1200 pattern cards; find the shots per card.

Ans., 2, 2 and 3.

34.—A 90" damask cloth is woven by a set of pattern cards with 2 picks per card; it is required to weave a similar cloth by the same cards, 108" long. How many picks per card will be necessary?

Ans., 2, 2, 3, 2, 3.

35.—In a Jacquard machine drive, the throw of the crank is 7", length of head lever from connecting rod to fulcrum 28", length of head lever from fulcrum to link 16". Find the lift of the machine.

Ans., 4".

36.—The average lift of the head in single and double-acting and twilling Jacquards is $4\frac{1}{4}$ ", $3\frac{1}{2}$ " and $3\frac{1}{4}$ " respectively. If A equals 3 units of length of head lever on the Jacquard side of the fulcrum and B equals 4 units of length on the side linked with the reciprocating rod, for single and double-acting Jacquards, what length of throw should be given to the crank lever and double eccentric respectively?

If the stud E in eccentric c in Fig. 156, is set out of centre $2\frac{3}{4}$ ", what ratio value of compound levers will give the required average lift to the head?

Ans., $5\frac{2}{3}$ "; $4\frac{2}{3}$ "; $4\frac{1}{3}$ "; $\frac{2}{1}\frac{2}{3}$.



PART IV.

DESIGNING, CARD STAMPING, REPEATING AND LACING.

CHAPTER XX.

Design Preparation and Card Stamping.

THE machinery and mounting being completely understood for weaving every variety of figured fabric, it remains to consider how the designs are prepared and made ready for reproduction in the loom. The processes involved include sketching, designing or drafting, and transferring the design on to the pattern cards.

**Sketching or
Drawing.**

This is the first and most important factor in the designing process, and involves originality combined with natural or acquired artistic ability. A knowledge of drawing and the ability to draw are first essentials, since no person can design without the ability to draw or sketch well, combined with a knowledge of the variety and forms of flowers in every stage of growth, together with their habits and dispositions. The origin, development and specific characteristics of art in different countries must also be studied, and to all the foregoing must be added common sense, combined with a sound judgment of the fitness of each subject for the different type of fabric intended to be woven.

The variety of textile fabrics for which designs are prepared comprises *simple warp* and *weft figures*, for such cloths as napkins, damasks and dress goods, and more *complex weave structures*, involving two or more coloured wefts to one warp, or two or more cloths woven

together and interchanging in form or colour to suit any desired effect of pattern, for such fabrics as tapestries, quilts, upholsterings, carpets and compound figured structures of every description. The finished sketches are first submitted to the manufacturer or buyer for selection, when particulars are given for drafting.

A detailed description of all the fundamental principles of figure design as applied to woven fabrics is given in *Carpet Manufacture* pages 17 to 47, and a few of the chief compound weave structures as applied to the development of complex figured woven fabrics on pages 280 to 289, for which reason, only a passing note is required in this companion volume.

**Transferring
the Design to
Point Paper.**

This process is frequently designated 'drafting'. The operation involves a considerable amount of technical knowledge before the sketch is fully painted on the ruled paper to suit the capacity of the Jacquard machine, the tie of the harness, the fineness of the cloth, and to give practical effect to complex designs. The mere painting or transferring of the sketch to point paper, which is intended to simplify the transference of the design to the pattern cards, is simple enough.

Each set of horizontal and longitudinal squares, on the point paper, corresponds respectively to one pick and one end in the subsequent woven cloth. The markings on these squares, usually represent the warp *raised*, but this is a detail which varies to suit the circumstances. The marks or blanks on each horizontal line of point paper are indicated on the pattern card by perforations or 'misses.' Except for special and complex fabrics, each horizontal line on the paper represents *one* pattern card and each pattern card consequently represents *one* pick in the cloth.

Card Stamping or Cutting.

When a painted design is ready for transference to the Jacquard pattern cards, instructions are written on the painted point paper for the guidance of the card cutter in reference to which marks have to be 'cut' or left blank on the Jacquard card.

There are several machines on the market for punching holes in the Jacquard cards according to the required pattern. The 'piano' card stamper is the one most generally adopted. It may be worked by foot or belt driven.

The hand selection of punches and filling of the 'book plates' combined with the railway press is at present largely discarded.

The 'plate' principle with *vertical* press is now chiefly used in carpet manufacture, where the pitch of the holes in the card cylinder is much larger than for ordinary Jacquard machines, see pages 146-150, *Carpet Manufacture*.

The principle of stamping the cards is the same for all machines.

The Piano Card Stamper.

The various essential parts of this machine are illustrated at Figs. 326 to 333 inclusive. Fig. 326 is a plan of the cross head or punch box, punches and card carriage; Fig. 327 is a sectional elevation—front view—of the same details and Fig. 328 a side elevation of the chief mechanical parts. The remaining illustrations refer to specific details only. Similar letters in each diagram refer to corresponding parts.

A is the fixed table plate of the machine; B B, two spindle shafts which pass freely through A; the shafts B B are combined by a cross bar c to which they are adjustably fixed by lock nuts as shown. D, the punch box is fixed to, and supported by the spindles B B, in sympathy with which it is free to move in a vertical plane. Suspended inside the punch box are twelve small steel punches, a, b, 1, 2, 3, 4, 5, 6, 7, 8, c, d, and one large steel punch e, the lower ends of which pass freely through perforations in a fixed plate E which is in two distinct parts—E¹ being the lower, and an exact duplicate of E, except that a portion F is planed away to admit of space for the free insertion of a twelve row pattern card, underneath the steel punches at will.

Finger keys 1¹, 2¹, 3¹, 4¹, 5¹, 6¹, 7¹, 8¹, are inserted into the punch box D at the back, and a¹, b¹, c¹, d¹ and e¹, at the front, all of which are at right angles to the punches, but immediately above

them. Each key is circumscribed, near its centre, by a spiral spring, enclosed within the punch box, as shown. These springs operate to keep the keys normally clear of the heads of the punches. F¹ shows the card race in front of space F, and level with the perforated plate E¹. G, G¹ are brackets which can be adjusted to suit

Fig. 327

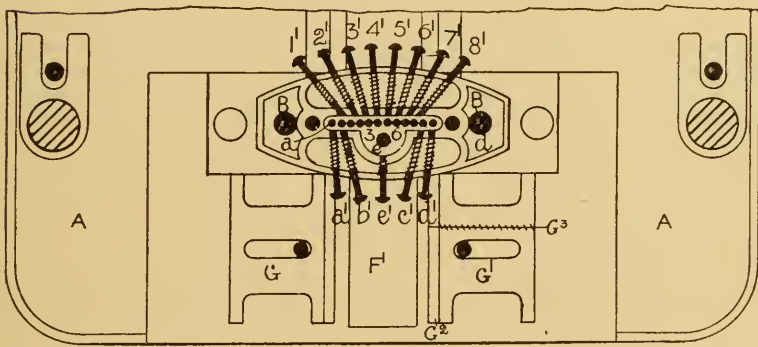
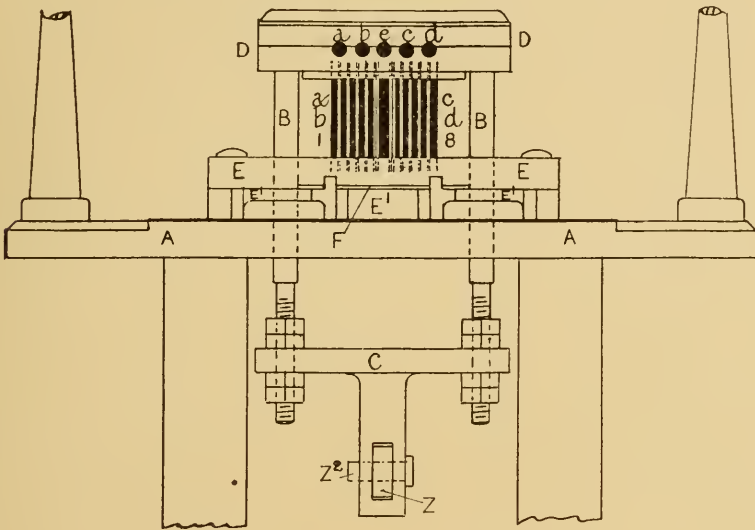


Fig. 326

any width of pattern card within the limits of the machine. G² is a supplementary guide plate, sensitively kept in contact with the pattern cards by the pressure of the small spiral spring G³, which serves to steady the traverse of the pattern card during the subsequent operation of stamping.

The pattern cards are placed on the race F^1 and passed through the space F , between the fixed plates E, E^1 , to the nip H^1 of the card carriage H , (Fig. 328) which rests freely and is free to slide laterally on two steel rails I, I . A steel plate, containing short projecting steel pins J , is fixed to the left side of the card carriage H . The distance between the pins corresponds to the pitch of the holes in the Jacquard cylinder, for which the pattern cards have subsequently to be stamped. K is an iron bar, shaped to form a spring, one end of which is bolted fast to the table A , and the other is bent upwards as shown. Secured to this iron spring is a small iron casting L , containing one fixed and one movable steel "finger" blade, L^1 and L^2 respectively; the latter is fixed to the end of a small spindle L^3 supported and free to move in the casting L as shown. A spiral spring L^4 circumscribes the spindle L^3 and is contained between the shoulder of the iron casting L on the left side, and a pin L^5 , through spindle L^3 , on the right. The energy of the spiral spring L^4 is exercised to press the spindle L^3 with its movable finger L^2 , outwards to the right whenever no opposite force is pressing on the finger. An enlarged elevation of this small but important detail is shown separately at Fig. 329, a transverse sectional elevation at Fig. 330, and a plan at Fig. 331.

Normally the fingers L^1 and L^2 rest between the pins J in the card carriage H , from the end of which a weight M is suspended by a string which passes over a small pulley at the end of the machine as shown, the object of the weight being to draw forward the card carriage whenever it is released from contact with the fingers L^1 and L^2 . Fixed in the card carriage H are two brackets with pivot studs N and O . Upon stud N a simple lever N^1 is pivoted, the right arm of which is bent at a right angle to form the nip H^1 and the left arm normally rests on a spiral spring P . Fulcrumed at O , is an inclined lever O^1 , which is normally at rest upon the left arm of the lever N^1 . The energy of the spiral spring P is exercised to lift the left arm of lever N^1 , and so cause the right arm to nip close to the plate H^1 , but pressure applied to the free arm of lever O^1 overcomes this resistance, and turns lever N^1 counterclockwise, thus making an opening at H^1 which permits the insertion of the pattern card.

Fig. 328

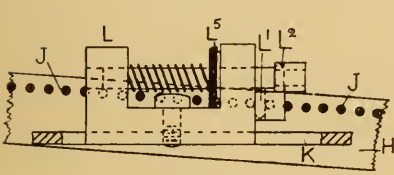
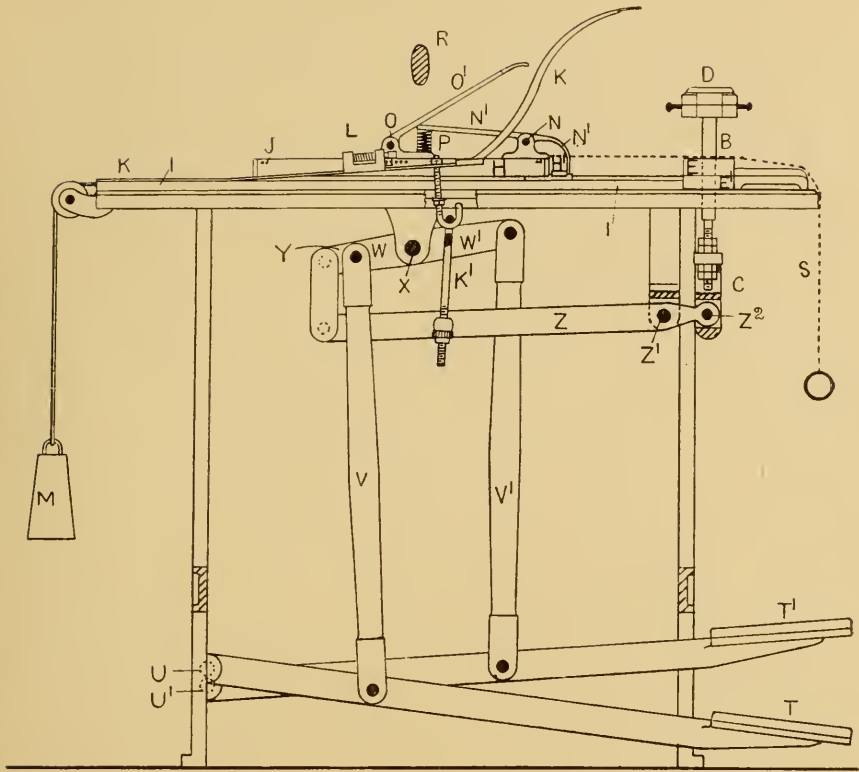


Fig. 329

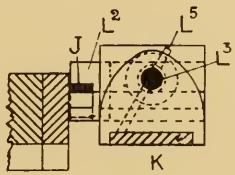
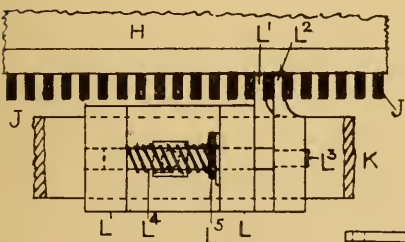
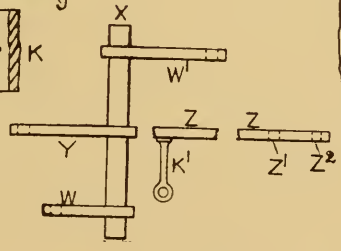


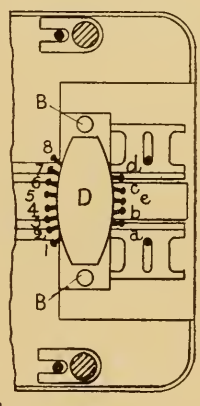
Fig. 330



Figs. 331



332



333

By pressing down the free end of the lever κ by hand, or subsequently through its connections with the treadle levers, the bracket L with both finger projections L^1 and L^2 , is pressed below and absolutely *clear* of the projecting steel pins J in the carriage H which is then free to travel outwards to the left. R is a fixed iron buffer to prevent the card carriage from running too far back, and s is a string attached to the carriage which facilitates its being pulled up at will, to the starting or other point.

**Mechanism for
Reciprocating
the Punch Box
and Punches.**

Reverting to Fig. 328, τ τ^1 are the left and right treadles pivoted at u and u^1 respectively. A connecting link v joins the treadle τ to the lever w , and v^1 similarly connects τ^1 with lever w^1 both of which levers are on the common fulcrum x . A third lever y , pivoted on the same fulcrum x and compounded with the levers w and w^1 is linked as shown to a long lever z pivoted at z^1 and terminally connected through the stud z^2 to the cross rail c and through it to the reciprocating punch box D . A plan of the parts w x y z is separately shown at Fig. 332 and a block plan of the punch box at Fig. 333.

**Combined
Action of the
Mechanism.**

The card, upon which the pattern is to be cut, is passed over the race F^1 to the opening F . The treadle τ is then depressed and it in turn depresses the levers w and y which move the lever z in sympathy and counter clockwise about its pivot z^1 , so that the cross rail c , spindle B , and punch box D with the punches, rise until they are sufficiently high to permit the insertion of the pattern card, through the opening F , between the plates E and E^1 and into the nip H^1 of carriage H which is then pulled by the string s into its starting position close to the punch box D .

Next the finger keys are selected and pressed over the heads of the punches; simultaneously the right treadle τ^1 is depressed, the result of which, through link v^1 , turns the levers w^1 and y , clockwise about the stud x , and also oscillates in sympathy and direction, the lever z about the pivot z^1 so that the stud z^2 descends and pulls, with considerable energy, the punch box D with its punches, down-

wards. All the *free* punches rest upon the surface of the pattern card and rise as the punch box descends.

On the contrary, the punches covered by the finger keys descend and overcoming the resistance of the pattern card, punch holes in it, equal in diameter to the punches and the holes in the plate E and E¹.

The actual force applied to the card at the punches is x times the load applied by the foot to the treadle lever τ^1 multiplied by the product of the compound levers τ^1 , w^1 , w , y , z .

If a = the distance τ^1 , u^1 ; b = u^1 , v^1 ; c = w^1 , x ; d = y , x ; e = y , z^1 ; f = z^1 , z^2 and x = the force applied in lbs. by the foot to the treadle lever τ^1 . Then resultant force applied to the cards at the punches = $x \frac{a}{b} \times \frac{c}{d} \times \frac{e}{f}$

The illustration Fig. 327 is drawn to scale, hence the student can ascertain the necessary data to solve the problem.

The successive movements of the card carriage for *each tread* are accomplished as follows;—With each ascent of the punch box D and descent of lever z , the link κ^1 is depressed together with the iron spring κ and the bracket L until the fingers L^1 and L^2 are clearly below the steel pins J in the card carriage H. This allows the spring L^4 to press outwards the spindle L^3 with its finger L^2 , but immediately the pressure is released from the treadle τ and the foregoing reversed, the iron spring κ responds to its elasticity and rises with the finger pin L^2 up between the next pair of pins J. The weight M and carriage H then pull the finger L^2 directly over that of L^1 , in which position it remains until the next row of holes in the card has been stamped. This sequence of operations is repeated until this and all the cards have been stamped.

CHAPTER XXI.

Card Repeating.

It frequently happens that several sets of punched cards are required from the same pattern for different looms and also in some cases, many of the 'ground' cards are exactly alike. In all such cases it is desirable to reproduce the original set (punched on the piano machine) by the aid of a card repeating machine.

Broken cards have also to be copied and replaced, but since they are usually few in number, they are either re-cut on the 'piano' or reproduced by the aid of a hand 'carrier plate' worked in conjunction with the railway or vertical press for punching cards.

There are two chief types of card repeaters viz. :—the 'Table repeater' which is worked in conjunction with the railway or vertical press—and the 'Automatic card repeater' which both selects the punches and stamps the cards at the rate of about 22 cards per minute.

NOTE.—Before duplicate sets of cards are made, the blank pattern cards are all punched with a Peg and Lace hole cutter and then laced on an automatic card lacer.

Automatic Card Repeaters.

There are several very good machines, now on the market, designed for the repeating of cards, the chief of which are McMurdo's, of Manchester, and Schroers, of Crefeld. The fundamental principles in each are identical.

Fig. 334 shows a sectional elevation of one row of punches and Jacquard uprights with needles which control the action of the punches and briefly the essential details.

The ordinary Jacquard needles are shown at 1, opposite which is the card cylinder containing the original set of cut cards to be

Fig. 334.

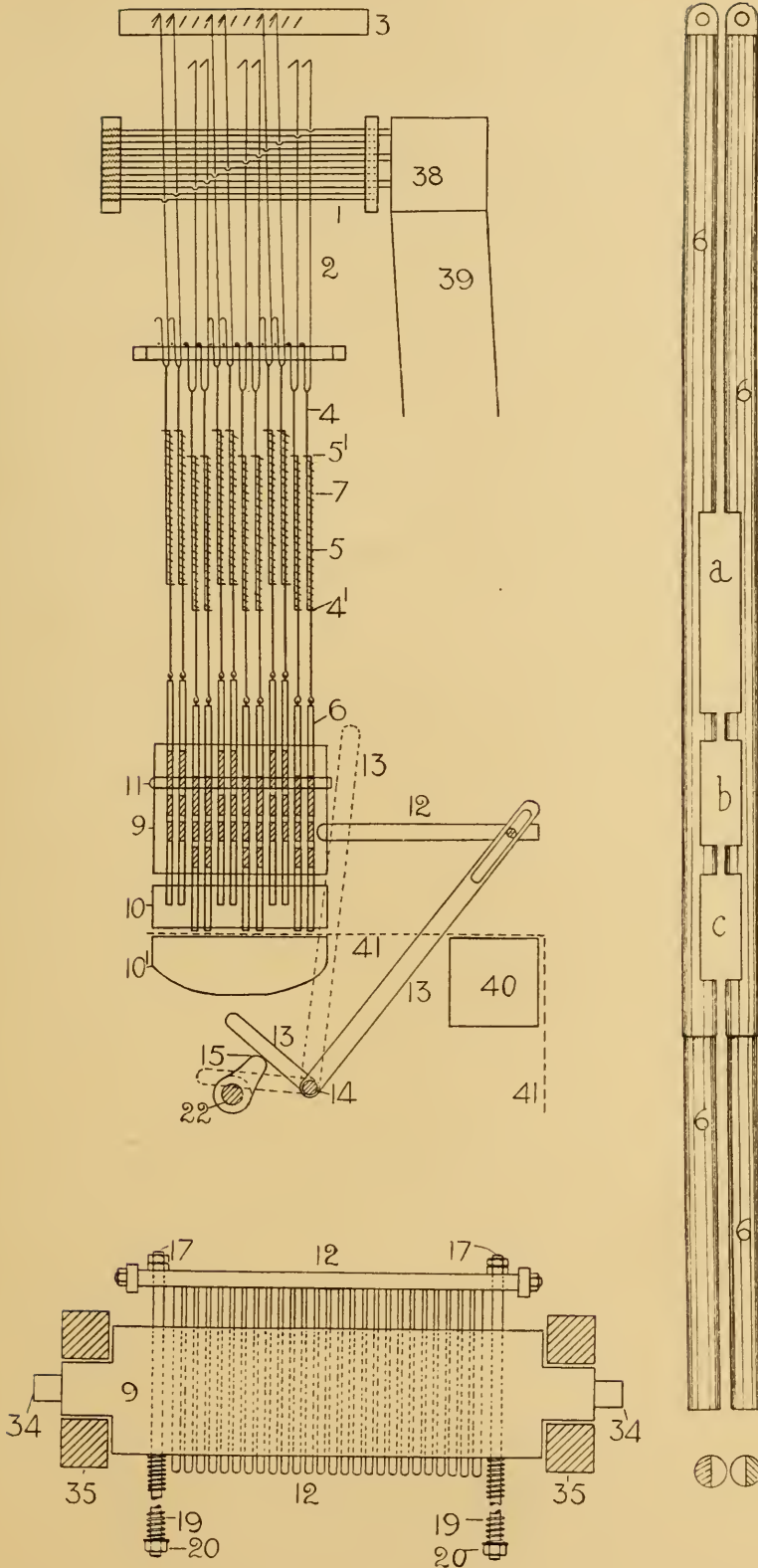


Fig. 336

Fig. 335

duplicated. The upright hooks are shown at 2 and the griffe blades at 3. It will be observed that the hooks are normally *clear* of the griffe blades, hence a blank in the card is equal to a lift of the corresponding upright. 4 and 5 are two pieces of steel wire which combine to link the hooks to the punches 6. The bottom of wire 4 is returned so as to form a loop 4^1 through which the wire 5 is passed, the top of wire 5 again being similarly looped at 5^1 and through this loop the wire 4 is passed. A spiral spring 7 is placed on the wire 5 and contained between the loops 4^1 and 5^1 .

The punches 6, of which there are 612, equal to the full capacity of a 600/12 row Jacquard machine, are suspended through perforations in a strong iron box 9 designated the punch box. The perforations in this box are equidistant and coincident with the pitch of the required pattern cards. The box is free to move in a vertical plane, with or without the punches 6.

A second iron 'box' or plate 10, rigidly fixed to the machine gables is likewise perforated, the holes being directly under and in the same plane as those in box 9.

A third iron box 10^1 , likewise perforated, is compounded at each end with the underside of box 10, a space being left, except at the ends, between the two 'boxes' 10 and 10^1 sufficient to permit the free traverse of the blank cards, which require to be punched. These are first placed and adjusted by hand in the space, after which they are automatically and intermittingly carried forward.

The punches 6, two of which are shown drawn to a larger scale at Fig. 335, constitute one of the special features in the mechanism (see also Fig. 337). Each punch is recessed or cut away to form a 'half round' in three places $a b c$. a is $1\frac{3}{4}$ inches and b and c each $\frac{3}{4}$ inch in length. In a 612 machine there are 51 rows and the punches are so placed that the *flat* sides of the half rounds, in every two rows are directly opposite each other. This arrangement permits the insertion of a fixed steel comb 11 through the slots a to prevent the punches rotating about their centres, and a second movable comb 12 containing twenty-six teeth, each of which fits into the slots of either b or c in the two rows of punches. The teeth

of this comb can however only enter into the slotted part *c* when this part of any given punch has been raised by the Jacquard to the normal height of *b*.

One end of the steel comb 12 is swivel linked to the free end of the vertical arm of a bell crank lever 13, pivoted on a stud 14 fixed in the gable of the machine. The short horizontal arm of this lever is kept in surface contact with a cam 15 keyed fast to the shaft 22, which rotates constantly and uniformly when the machine is in operation, see Figs. 334 and 337.

A plan view of the punch box and movable comb 12 is shown at Fig. 336. Two steel rods 17 are shown bolted by lock nuts to the ends of the comb 12, and then passed through holes in the punch box 9 as indicated, and project $11\frac{1}{2}$ inches through the opposite side plate. A strong, spiral spring 19 is placed on each rod and contained between the nut 20 and the punch box 9. These rods serve to keep all the teeth in this movable comb in a perfectly horizontal plane during its traverse outwards or inwards. The spring 19 serves to keep the short arm of bell crank lever 13 in contact with the rotating cam 15.

**Reciprocation
of the
Punch Box.**

Fig. 337 is a side elevation of the details of mechanism, designed to control the rise and fall of the punch box with punches. 22 is a strong steel shaft supported between the machine gables and having a uniform rotary motion derived by spur gearing combined with the driving pulleys. 23 is a loose pulley and 24 is compounded with a sleeve 25, which is free to rotate on the shaft 22; 26 is a spur pinion containing sixteen teeth, compounded with the sleeve 25. The pinion 26 gears into and drives a stud wheel 27 containing thirty teeth; compounded with wheel 27 is a stud pinion 28 containing sixteen teeth, which gears into and drives a spur pinion 29 containing thirty teeth; this last wheel, 29, is keyed fast to the shaft 22 as is also an eccentric 30, circumscribed by the steel collar 31. An adjustable reciprocating shaft 32 combines this collar with a swivel link 33, which fits loosely on the stud shaft 34, projecting from the end of the punch box 9, which is free to rise and fall between the machine gables 35. The reciprocating rod 32 contains right and left

screw threads by which means the punch box 9 can be most minutely adjusted at any time. Fig. 338 is a detached side view of the eccentric and its connection with the punch box.

From the main driven shaft 22 the Jacquard head is reciprocated by an eccentric 36, and the usual connections. The card cylinder is vibrated through the influence of a "swan neck" lever combined with the Jacquard head. 37 is a balance wheel; 38 the card cylinder, on which the set of cards 39, to be copied is placed; 40 is a feed card cylinder over which the cards 41, to be punched are automatically rotated. (Fig. 334.)

Fig. 337.

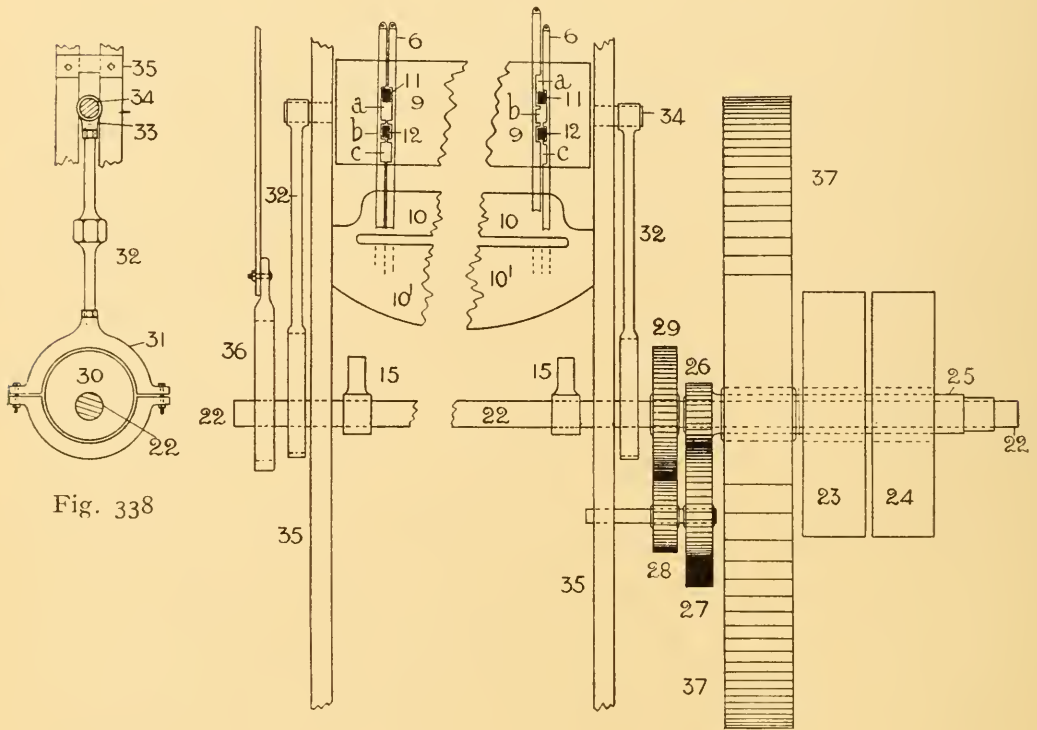


Fig. 338

**Action of the
combined
Mechanism.**

The originally cut cards 39 which have to be repeated are placed over the Jacquard cylinder 38 in the usual way. The cards 41 to be stamped as duplicates, which are blank except for the peg and lance holes, are automatically fed, through the agency of the card cylinder 40, between the plates 10 and 10¹ and under the punches 6.

It will now be evident that if a *fully* perforated card is placed against the Jacquard needles 1 and the machine set in motion, all the uprights 2, will be left clear of the griffe knives and will remain down together with the punches 6 so that the notched portions *b* are in the same plane as the teeth of the comb 12 which now enters into and through the punch box 9 and so locks all the punches 6 which have their ends projecting below the base of the punch plate 10. Simultaneously the eccentric 23, through its connections already described, has moved the punch box 9 into position ready to bring it down with sufficient force as to cause *all* the punches to *pierce holes* in the pattern card—an exact duplicate of the original.

A *blank* original card would press all the hooks 2 over the griffe knives 3, which acting through the mechanism already described, would lift all the punches 6 until the notched parts *c* are in the same plane as the comb 12, which would then enter between the notches and serve to hold *all* the punches 6 *clear* of the space between the punch box 10 and the punch box 10¹; consequently when the box 9 descends *no holes* are punched in the required duplicate card.

It therefore follows that between a fully and a non-perforated card any selection of punches may be manipulated, and variety of pattern stamped on the cards 41 to coincide with those of the original or parent cards 39.

The two front and back rows of punches may remain out of action to allow the machine to be used for an 8 row card.

CHAPTER XXII.

Card Lacing and Lacing Machines.

AFTER stamping the Jacquard cards to suit the pattern, it is necessary to lace them into one continuous string or chain so as to make it possible for them to be rotated over the card cylinder.

Small lots are usually laced by hand but larger quantities are preferably and more economically strung together by a machine.

Fig. 339 shows four cards for an eight row machine as laced by hand. 1 and 2 are the lacing cords and 3 the card.

Fig. 340, the same lacing, minus the cards.

Fig. 341 illustrates the machine style of lacing with ordinary *single* rows for a twelve row machine.

Fig. 342 the same style of lacing, minus the cards.

Fig. 343 for *double* rows of lacing holes.

Fig. 344, the same style of lacing minus the Jacquard card.

In machine laced cards, the cord marked 1 is always on the top of the card and that marked 2 on the underside, except at the lace holes and between the cards, where it is shown locked over cord 1.

Hand Lacing.

The operation of lacing the pattern cards by hand is usually accomplished on a long and narrow wooden frame, studded with wood pegs, set equidistant and coinciding with the pitch of the peg holes in the card cylinder.

Fig. 345 illustrates a portion of the standard type of card lacing frame; A is the frame, which is suitably supported on wood trestles; B pegs on which the cards to be laced are placed; C the pattern cards; E the lacing cords and F a wire interlocked with the cords E

between two cards. A wire corresponding to F is repeated about every 12 to 20 cards.

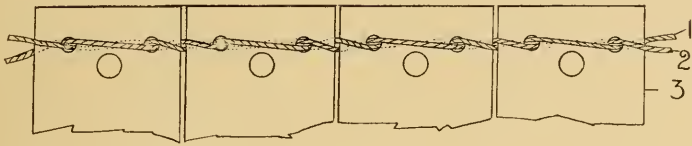


Fig. 339



Fig. 340

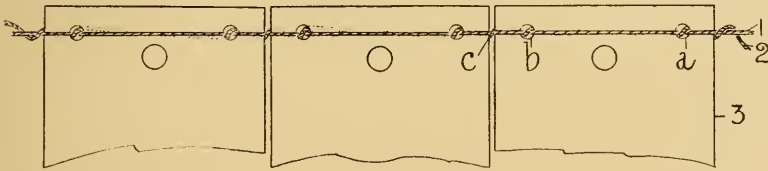


Fig. 341

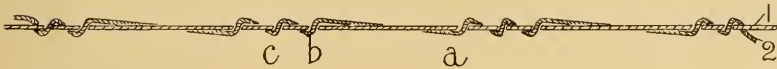


Fig. 342

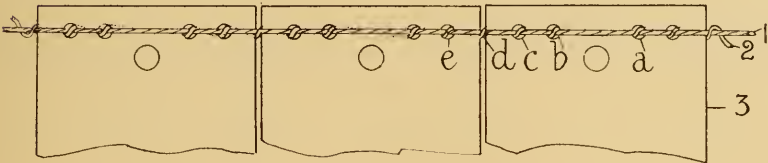


Fig. 343



Fig. 344

Automatic Card Lacing Machines.

There are two chief types of machines for this purpose in common use :—

- (1) The Rotary Wheel as made by Singer's, of London, and Schroers, of Krefeld.
- (2) The "Rapid," Parkinson's patent.

The Rotary Wheel Machine.

This machine is made to lace any width of card containing from two to six lines of lacing holes and involving as many heads and shuttles. It is made with from three to six heads and shuttles, each of which is adjustable to suit the different sizes of pattern cards.

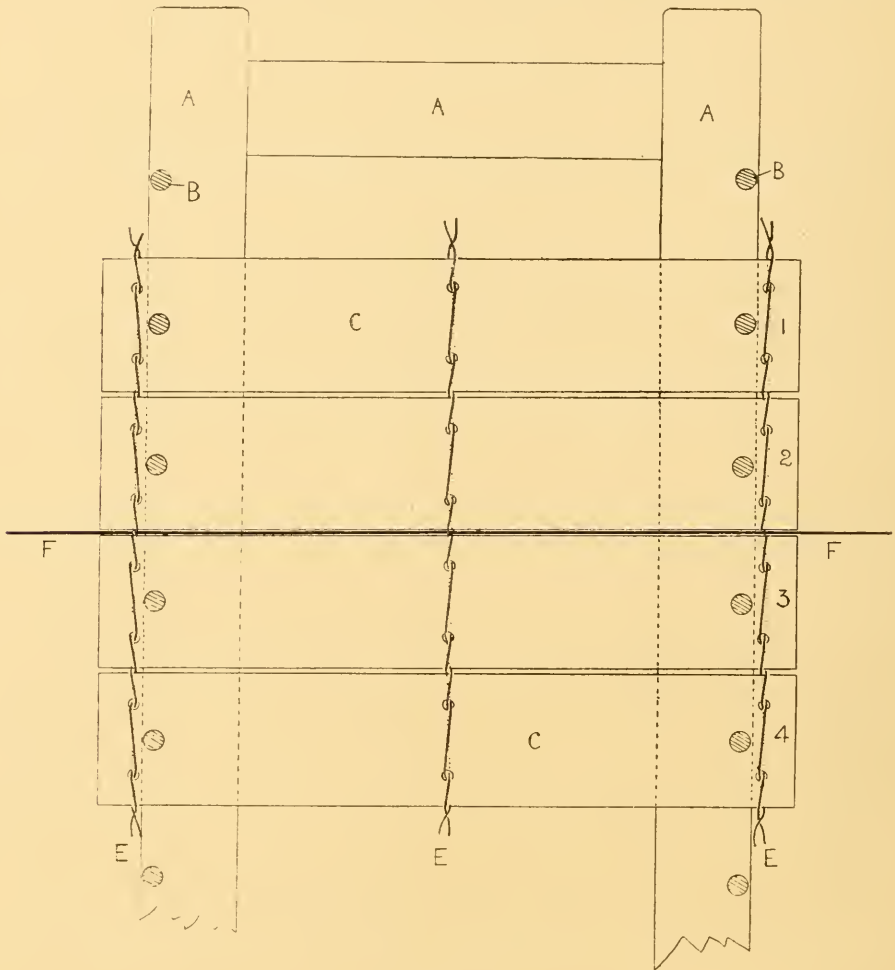


Fig. 345.

The average number of cards laced per minute is twenty-eight. Adjustable feed wheels with carrier pins for holding the cards are used which constitute its chief feature. The shuttle bobbin will hold cord sufficient to lace over 3000 cards for an eight row machine; it is also visible during the whole process of operation which is a distinct advantage since the shuttle can then be changed before all the cord has run off.

**Shuttle
Vibratory and
Lock-stitching
Mechanism.**

Fig. 346 shows in elevation the main features of this principle of lacing including the vibration of the shuttle and the lock stitching mechanism. The pulley driven shaft of the machine from which all the other motions are derived is indicated at 1. Keyed fast to it is a positive tappet 2 in the groove of which an antifriction bowl 3 is free to rotate on stud 4 in lever 5 and also to rise or fall under the controlling influence of the tappet. The lever 5 is keyed fast to shaft 6 and on its remote side is a vertical lever 7 also fastened to the shaft 6. The free end of lever 7 connects, through a swivel link 8 and studs 9 and 10, the shuttle carriage 11, the upper part of which is omitted in the diagram in order to show the shuttle 14. The base 11¹ of the bracket arm compounded with the carriage 11 is circular in section and rests freely and is free to oscillate in the recessed bracket 12 which circumscribes the rotary wheel shaft 20. The shuttle rests freely in the carriage 11 and is oscillated in sympathy with it. The locking cord is shown in the shuttle at 15, the feeding cord in the needle at 16 and the needle itself at 17. The transport wheel 18 contains the projecting pins 19 on which the cards to be laced are placed. This wheel and its duplicates are composed of two detachable halves which are combined and adjustably fixed to the shaft 20. This shaft extends over the full length of the machine being supported and free to rotate between the machine gables. A smooth segment plate 21 is compounded with each transport wheel 18. Against the face of the segment plate the shuttle 14 vibrates; a recess 22 made in the plate 21 permits the free traverse of the feeding needle 17. A portion of the lacing minus the pattern cards is indicated at 23.

**Needle
Reciprocating
Mechanism.**

A lever arm 24, fitting loosely on the shaft 6, carries at its free end a stud and antifriction bowl 25, which fits and works freely in the groove of a positive tappet 26 keyed fast to the main shaft 1. A reciprocating rod 27 links stud 25 with the stud 28 which is fixed in the free end of a short lever 29, in turn keyed fast to a shaft 30 which is free to oscillate. This shaft extends the full length of the machine and is supported near the top of it, between the two gables.

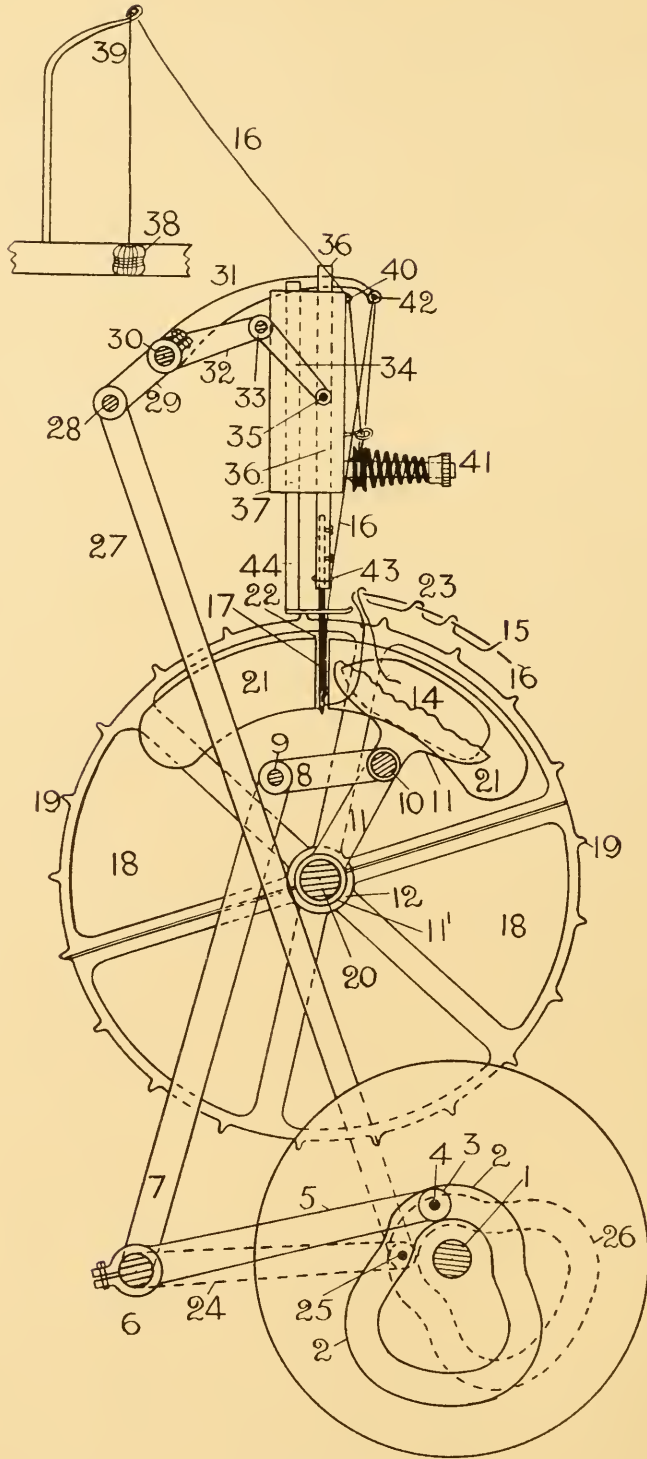


Fig. 346

Fastened to this shaft, for each head, there are two short levers 31 and 32, the former is designed to regulate the feed of the lacing cord 16, and the latter reciprocates the spindle with the needle 17, containing it. The lever 32 carries in its free end, a fixed stud 33, on which fits loosely a swivel link 34, the opposite end of which fits on stud 35 adjustably fixed to the spindle 36 which is supported and free to slide in a vertical plane between two collars of a bracket 37 fixed to the cross head of the machine. The lacing cord 16 passes from the ball 38, over the tension rod 39, through a guide eye 40 and then under the projecting stud 41 with spiral spring and rotary tension washers, as shown. From the stud 41, the cord passes upwards and through the eye 42, in lever 31, then back through the fixed guide eye 43 in the spindle 36 to the needle 17, a guide spindle for which is shown at 44.

Action of the Mechanism.

With the constant rotation of the pulley driven shaft 1 and the positive cam 2, the bowl 3, stud 4 and lever 5 combine to constantly oscillate the shaft 6 which in turn vibrates the lever 7, stud 9, swivel link 8, stud 10 and shuttle carrier 11 together with the shuttle 14, to and fro for each complete lock stitch required.

Simultaneously actuated from the same initial source, the cam 26 reciprocates through stud and bowl 25 the rod 27, which in turn, through stud 28 and lever 29, oscillates the shaft 30. This shaft correspondingly alternates the lever 32, and through stud 33, swivel link 34 and stud 35, the spindle 36 together with the needle 17 and lacing cord 16.

The supply and regulation of the delivery of this cord is controlled from the same shaft 30 which also alternates the lever 31 in sympathy with lever 32 and spindle 36.

Mechanism and Rotation of the Feeding Wheels.

The details of the mechanism designed for this purpose are arranged to operate at the opposite and right hand side of the machine. Fig. 347 shows an elevation of these parts. Upon the rotary shaft 1, a positive tappet 46 is keyed, in the groove of which an antifriction bowl 47, carried by a stud 48 is kept

in rolling contact. The stud 48 is fixed in the vertical arm of a balk or double acting lever 49 which is pivoted on the fixed stud 50. The left arm of this lever carries a stud 51 on which a reciprocating rod 52 fits loosely and combines, through the adjustable stud 53, the ratchet lever 54 which fits loosely on the transport or feed wheel shaft 20 upon the end of which a large ratchet wheel 55 is adjusted. A small pawl lever 56 fitting loosely on the stud 57, in the lever arm 54, engages with the ratchet teeth of wheel 55.

Fixed in the right arm of lever 49 is a stud 58 upon which a reciprocating rod 59 is placed; the same links through an adjustable stud 60, a second ratchet lever 61 also fitting loosely on the shaft 20. A pawl lever 62 on stud 63 in lever 61 also engages with the teeth of the ratchet wheel 55. The throw of the arm on the right is greater than on the left, consequently whenever the pawl lever 62 on this lever engages with the teeth of the ratchet wheel 55, the latter is rotated clockwise, a greater distance, than when the ratchet pawl lever 56 operates at the opposite side. A third pawl lever 64, but stationary, is pivoted on the fixed stud 65, above the top of the ratchet wheel 55, the object of which is to prevent the ratchet wheel from slipping backwards.

Two out of every three ratchet teeth on the wheel 55, are only cut half way across the face of it, see part plan Fig. 348. The pitch between the teeth *a b c* for a 12 row 600 machine is $\frac{3}{4}$, $\frac{3}{4}$ and $1\frac{3}{4}$ inches respectively. The pawl lever 56 engages with the half teeth and rotates the wheel 55 a distance equal to *a* or *b* while the pawl 62 engages with the full teeth to rotate the ratchet wheel a distance equal to *c*. The pitch of these teeth and the size of the wheel are designed to give the correct amount of rotation to the transport wheels 18 so as to bring the lace holes in the cards 23 directly underneath the feeding needle 17 (see also *a, b, c* Fig. 341).

The action of the mechanism is as follows:—With the constant rotation of the pulley driven shaft 1 and the positive tappet 46, the antifriction bowl 47 and stud 48 together with lever 49 are reciprocated about the pivot stud 50 which motion in turn, is generated through stud 51, rod 52 and stud 53 to lever 54 and pawl lever 56

to oscillate the same about the shaft 20, so that with each upward movement of pawl lever 56 the wheel 55 is rotated $\frac{3}{4}$ of an inch at its periphery.

Fig. 348.

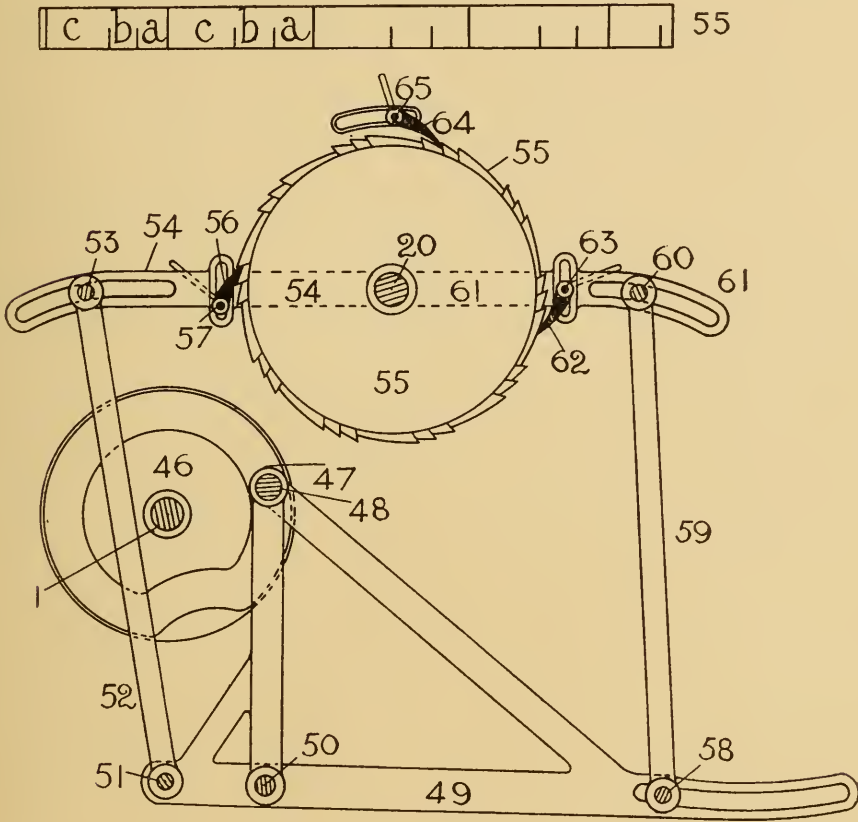


Fig. 347

In a similar manner the details 58 to 62 inclusive, combine to rock the lever 61 and pawl lever 62 so that with each downward throw, this pawl rotates wheel 55, a distance equal to $1\frac{3}{4}$ inches at its periphery representing $2\frac{1}{2}$ inches in the length of the stitch.

The ratchet wheel 55 and transport wheels 18 are all interchangeable so that with the adjustment of the connections with the double acting lever 49 any required variation in number of stitches per card and length of stitch can be obtained.

The "Rapid" Machine.

GENERAL PRINCIPLES OF THE MECHANISM.

There are three important parts and motions in this machine, viz:—(a) The chain support and traverse for the cards; (b) the shuttle which contains the locking cord and (c) the needle which feeds the cord.

The intermittent motion of these details is important and full of interest.

Fig. 349 is a sectional elevation to illustrate the chief features of this mechanism and method of lacing.

The feeding or straight cord is shown at 1, and the locking cord at 2; the pattern card is omitted. 4 is the needle, which is free to rise and fall, and carries cord 1 in a vertical plane. 5 is a free shuttle contained in a slide carriage (see 74, Fig. 352), which is free to move in a horizontal plane; this shuttle carries cord 2. 6 is a fixed iron plate against the face of which the shuttle travels; the plate 6 contains a groove 7 into which needle 4 reciprocates without interfering with the shuttle. The plate 6 is fixed to the two shafts 8 and 8¹, in turn supported by the machine gables 9 and 9¹ respectively. From each link, in the link chain 10, projects a peg 10¹ on which the cards to be laced are placed. The chain is supported on the square prism 11 fixed on the shaft 13 which is free to rotate partially and intermittingly between the bracket support 14 and its duplicate on the opposite side of the machine. The pulley 12 fits loosely on a fixed shaft 15 in turn supported by the bracket 16 which is secured to the shaft 8 and gable 9, as shown. A tension pulley 17 is carried in the bracket lever 18 pivoted on the fixed stud 19. A spiral spring 20 combines lever 18 with the fixed bracket 16 and thus keeps the tension pulley exercising a sufficient negative pressure on the chain 10.

There are three important movements to be performed for each complete stitch. The card chain is rotated with the pattern cards into position, *i.e.*, with the lace holes directly under the point of the needle 4 which then descends into the groove 7, the shuttle receding

but immediately returning to complete the lock stitch, whilst the needle remains stationary at the bottom.

Illustrations showing three positions of the shuttle in its relation to the formation of the lock stitch are supplied. (1) In Fig. 349 the shuttle 5 is shown fully back, the needle 4 being at

Fig. 351

Fig. 350

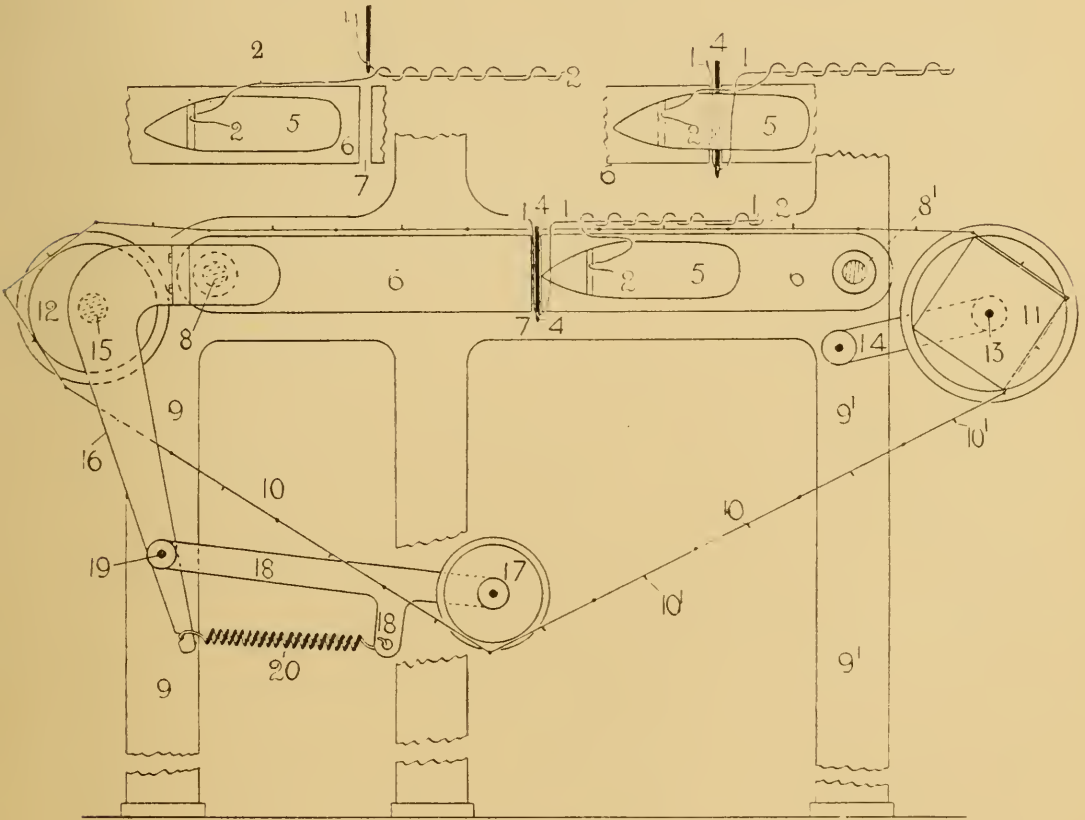


Fig. 349

the bottom with the locking cord in its double form from its eye upwards, one strand of which returns to the store spool and the other to the last hole in the pattern card.

(2) In Fig. 350 the shuttle 5 is shown in the centre of its forward traverse, the needle 4 having risen, but the cord 1 on the *card* or *right* side of the needle eye has gradually bulged outwards so as to permit the shuttle 5, which simultaneously moves forward to the left, to enter behind strand 1 on the right, but to pass

in front of the needle 4 with strand 1, on the left side during which latter period the needle remains stationary.

(3) In Fig. 351 the final and forward position of the shuttle 5, together with its relation to the cords, is shown.

The mechanism and operation of these foregoing motions is shown and described separately as follows :—

Mechanism and Operation of the Card Chain. Figs. 352 and 353 are sectional elevations as seen from the sides of the machine—the former being on the driving pulley side and the latter on the opposite or right hand side of the machine. 21 is the driving pulley on shaft 22; a spur pinion 23 on this shaft gears into a spur pinion wheel 24 fixed on shaft 25, which is supported and free to rotate between the machine gables. At the opposite side of the machine a *change* spur pinion 26, Fig. 353, gears into a large *change* spur wheel 27 set screwed to a short stud shaft 28 suitably supported to the machine gable. Free to rotate with the stud shaft 28 is a disc plate 29 with which segment wings or tappets *a, b, c, d, e*, of various heights are adjustably compounded; whilst the disc, or one or other of the tappets is kept in rolling contact with an antifriction bowl 30 centred on lever 31 in turn fulcrumed on the stud 32 compounded with the machine gable 9. A loose stud 33 combines the free end of lever 31 with a link 34 which is, in turn, combined by a similar loose stud 35 to a small bell crank lever 36, pivoted loosely on the fixed shaft 37. A loose stud 38 combines the vertical arm of lever 36 with a “pawl” pushing “catch” 39, the edge of which rests freely on the ratchet wheel 40 keyed fast to the shaft 37. The shaft 37 contains the chain driving pulley 11, see Fig. 349, where this shaft is numbered 13. The pitch of the teeth in the ratchet wheel 40 varies to suit the amount of rotation required in the shaft 37 and the traverse of the pattern chain 10. The different heights of the segment wings in tappets *a, b, c, d, e*, are designed for the same object—the longer the tappet wing, the greater the lift in lever 31, which in turn is subsequently transmitted to lever 36 and pawl 39. The continuous rotation of the tappet disc plate 29, by the train 21 to 27 lifts intermittingly the bowl 30 and lever

31 which, in turn, oscillates the bell crank lever 36 and moves the pawl 39 to and fro, which thus engages with the teeth of the ratchet wheel 40 and pushes it forward one tooth at a time and so rotates the chain shaft 37 and chain 10 with the cards intermittingly.

There are five stitches to be made for each pattern card (Fig. 343); these are shown at *a b c d e*. The distance from *a* to *b* is $1\frac{5}{16}$ in., and from *b* to *c*, *c* to *d*, *d* to *e*, and *e* to *a*, $\frac{9}{16}$ in. each. The

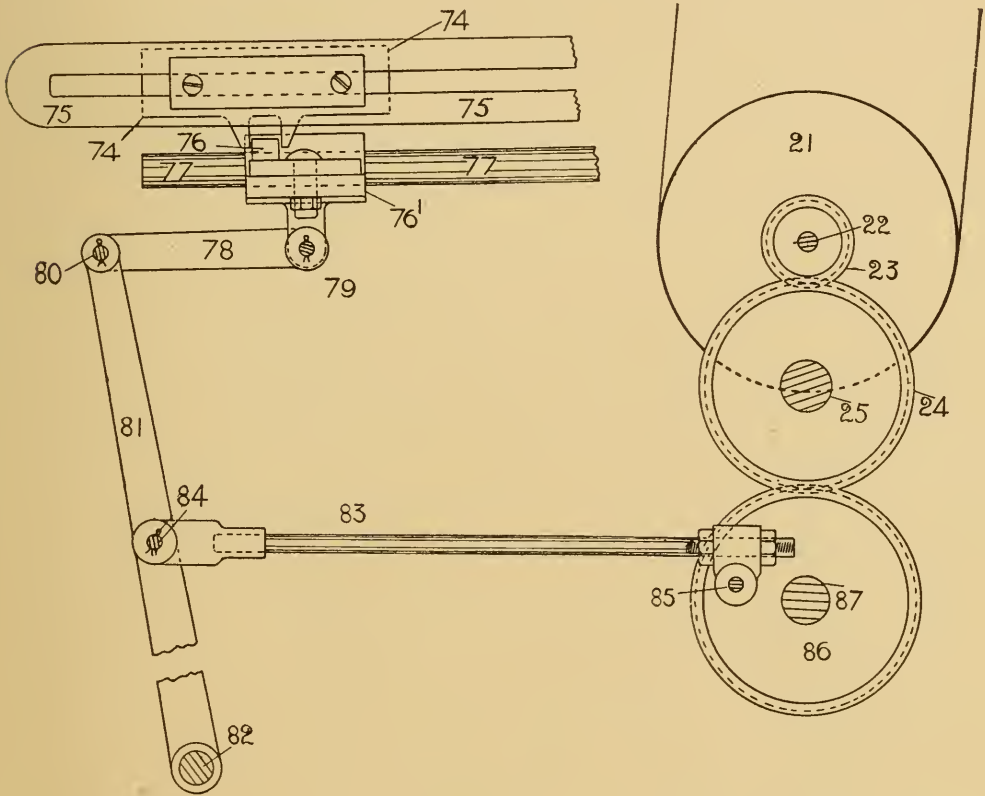


Fig. 352

wings *a b c d e* on the disc tappet plate 29 and the spaces similarly lettered on the ratchet wheel 40, respectively combine to move the pattern chain the required distances mentioned above.

The accessory details 41 to 53 inclusive, serve to brake the wheel 52 combined with the ratchet wheel shaft 37. A five pointed cam 41 is secured, on the remote side of the disc plate 29 to the shaft 28; the tappet 41 is kept in rolling contact with an antifriction roller 42 on stud 43 in lever 44, suspended and pivoted to the fixed

stud 45; the free arm of lever 44 is combined by a spiral spring 46 to a fixed stud 47. A second spiral spring 48 combines the lever 31 through hook 49 also with stud 47. A fixed pin 50 in the sleeve of lever 44 retains one end of a thin but strong steel 'band' 51, which circumscribes the periphery of the brake wheel 52 compounded with the shaft 37; the spring 51 is adjustably terminated and fixed to the lever 44 in the point 53.

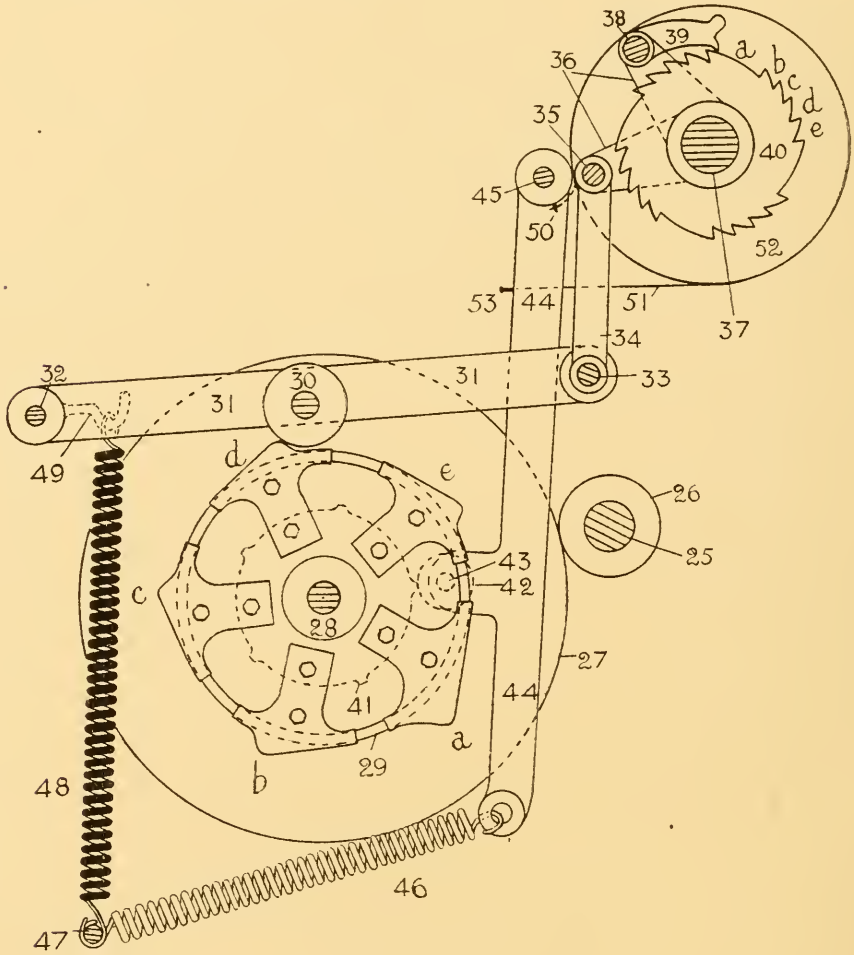


Fig. 353

**Mechanism and
Action of the
Feeding Needle.**

The next movement in order is the operation of the feeding needle, the essential details of which are shown in a sectional elevation at Fig. 354.

The feeding needle 4 is adjusted in a spindle 53, which passes freely through the short arms projecting from the fixed

bracket 54, and it is held in position by a reciprocating link 55, which is combined with a stud and collar 56, the latter being set screwed fast to the spindle in the position shown. The link 55

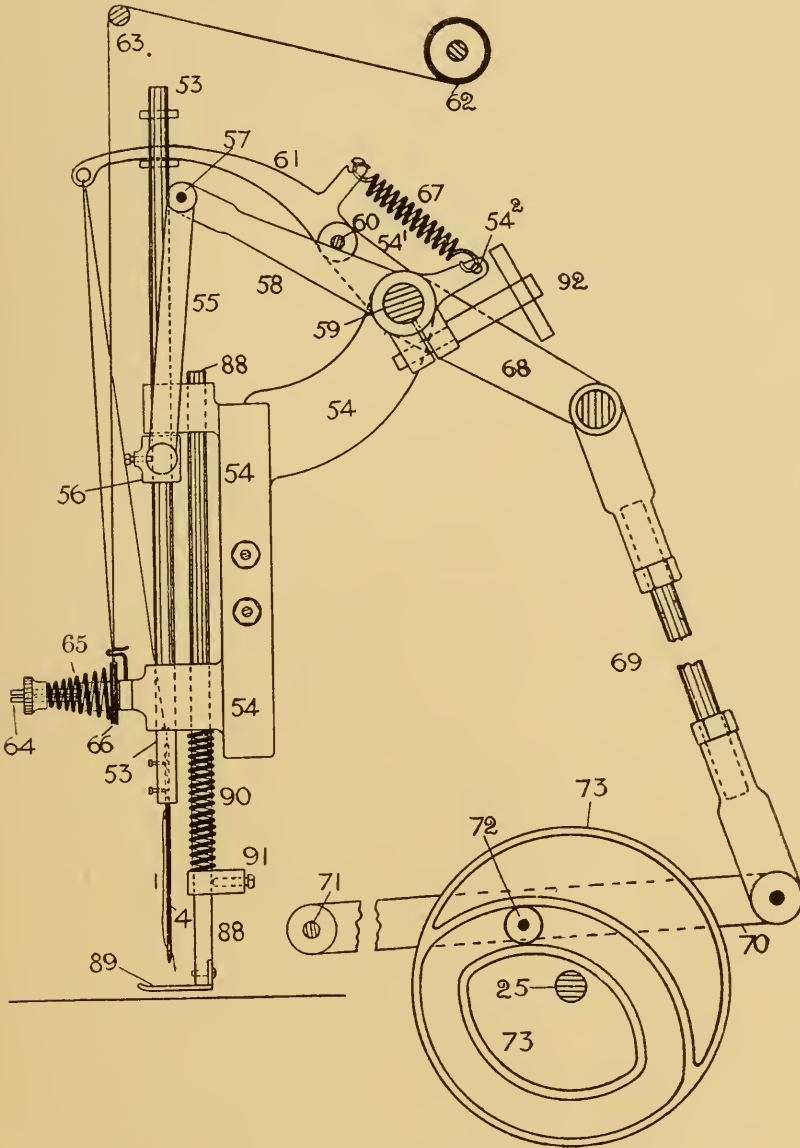


Fig. 354

combines through a loose stud 57 with the simple lever 58 adjusted to the shaft 59 which is supported and free to oscillate in the right arm projecting from bracket 54 and its duplicate at the opposite side of the machine.

54¹ and 54² are two fixed wings of the bracket arm 54. A stud 60, fixed in the wing 54¹, serves as a pivot for a quadrant lever 61, the free arm of which passes through a slot in the spindle 53 which is large enough to permit the free movement of the lever 61 independently of the spindle or vice versa. A hole is perforated near the free end of this lever through which the lacing cord 1 is passed. The cord is taken from the supply spool 62 over the tension bar 63, and sometimes over a second tension bar, then down and under a fixed spindle 64, upon which loose washers are placed at each side of the cord.

An adjustable spring 65 placed also on the spindle combines with the washers 66 to fully tension the cord 1, which next passes upwards through the hole near the end of lever 61, and back downwards through the eye in the feeding needle 4. The quadrant lever 61 is kept normally under tension by the spring 67, which combines the wing on lever 61 to the bracket arm 54².

The oscillating shaft 59 receives its motion through the following connections. 68 is a simple lever keyed fast to the shaft 59. An adjustable reciprocating rod 69 combines the lever 68 with a second lever 70 pivoted on the stud 71 fixed in the machine gable; an anti-friction bowl 72 carried by the lever 70 is kept in rolling contact with the positive tappet 73 keyed fast to the shaft 25. This tappet is constructed to reciprocate through the bowl 72 and lever 70, the rod 69 which, in turn, through lever 68, oscillates the shaft 59 and lever 58 which, through link 55 and collar 56, reciprocates the spindle 53 with the locking needle 4. The motion of the spindle with the needle to the bottom of its journey is continuous, after which it immediately begins the upward journey for a short distance so as to form a loop which admits of the entrance of the tip of the shuttle, after which it dwells until the shuttle has passed through the loop thus formed, see Figs. 349, 350 and 351. Then immediately the shuttle continues the return journey until it reaches the top of its traverse, where it dwells a sufficient length of time to permit the free traverse of the card chain which moves a card forward, ready for the next lock stitch.

When the machine is in action the cord 1 is tight and keeps the free arm of the quadrant lever 61 under tension and clear of the upper shoulder in the groove near the top of the spindle 53, as in Fig. 354. After descending about one inch the spindle begins to pull down the quadrant lever 61 in sympathy until it has reached the bottom of its traverse, tension meanwhile being put upon the spring 67. The spindle 53 dwells at the bottom to allow the shuttle sufficient time to complete its traverse and lock stitch. Immediately the spindle commences to rise clear of the pattern cards, the spiral spring 67 in sympathy, exercises its stored energy to lift the quadrant arm 61 to its highest position and to take up any 'slack' formed in the feeding cord 1.

This sequence of intermittent operations is automatically continued until all the pattern cards have been laced.

**Operation
of the Shuttle.**

Fig. 352 is a sectional elevation of the details designed for this operation. The shuttle rests freely in a carriage 74 which is supported by the slotted plate 75 and along which it can slide freely. The shuttle carriage and its duplicates are kept in close contact with a straight and longitudinal bar 76 which is compounded with a sleeve 76¹ and its duplicate at the opposite side of the machine. The sleeve 76¹ fits loosely on the fixed shaft 77 along which it is free to reciprocate. A link 78 combines the stud 79, compounded with sleeve 76¹, with the stud 80 in the simple lever 81 pivoted at 82. A reciprocating link 83 combines lever 81 in the point 84 to the stud 85 which is set out of centre in the spur wheel 86 on the fixed stud 87. The wheel 86 is continuously rotated through its connection with the spur wheel 24 on shaft 25. The continuous rotation of this train of wheels impart through stud 85 and details 74 to 87 inclusive, the requisite varying velocity of movement to the carriage 74 with shuttle 5. The shuttle begins to travel slowly until its tip enters behind the loop formed in the feed cord 1; the needle 4, with cord 1, has simultaneously commenced its return journey, but dwelt a sufficient length of time to permit the free passage of the shuttle, through the loop, after which it travels with increasing velocity to

the centre of its traverse, from which it decreases in the same velocity ratio to the end of its journey.

Card Irons or Cradles.

After the pattern cards are cut and laced, it is necessary to 'wire' them which consists of interlacing thin iron wires with the lacing cords between every 12 to 20 cards. The wires should be of sufficient length to project from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch beyond the width of the pattern cards, see Fig. 345.

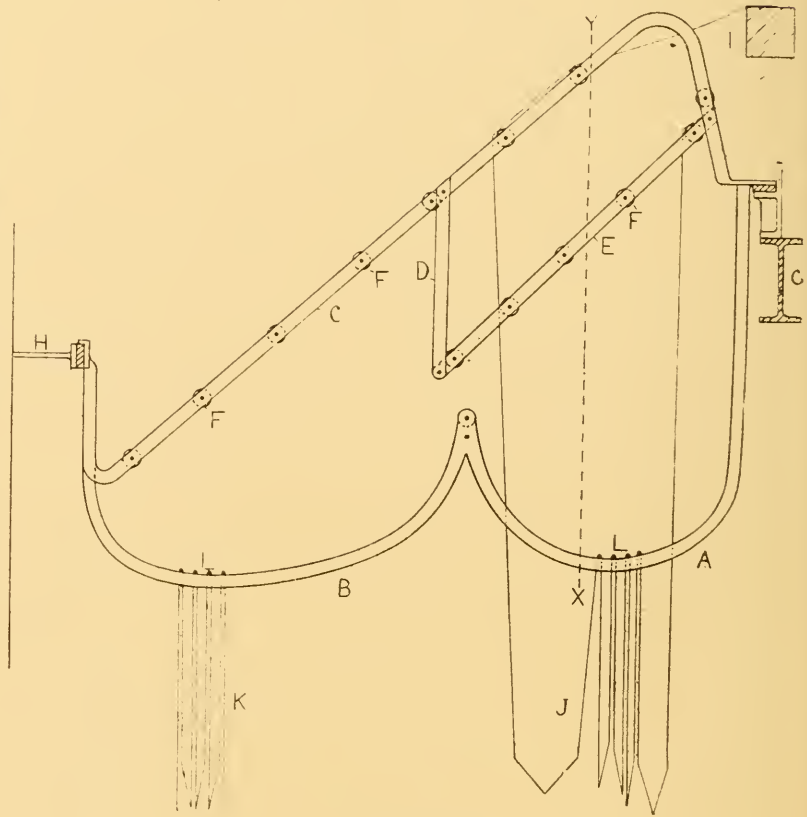
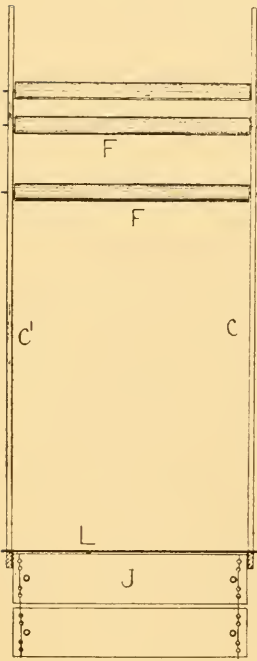


Fig. 355

Fig. 356

'Card irons' or a 'card cradle' is an arrangement which consists of two groups of flat irons, fixed at the back of the loom directly underneath the card cylinder. The wired cards are normally supported and suspended between the two series of card irons, which are set apart a sufficient distance to allow the cards to

fall down from, or to be drawn up to the card cylinder, without any obstruction from the card irons.

Figs. 355 and 356 are front and side elevations respectively of the foregoing, the former being a section through *x y*.

A B C D E, together with their duplicates at the opposite side of the machine are the card irons; combined with wood rollers *F*, the whole of which constitute the card cradle for two sets of cards which may be interchanged at will. The ends of the cradle are adjustably combined with Jacquard gantry *G* on the right, and a fixed wall or loom bracket *H* on the left, as shown. The position of the card cylinder is indicated at *I*, the set of cards at *J* and the duplicate set at *K*. As the pattern cards *J* leave the card cylinder *I* they pass over one of the rollers *F* in iron *E* and fall until the ends of the wires projecting beyond the cards rest upon the irons of the cradle section *A* where they are stored and gradually pushed to the back from whence they are drawn up over the rollers *F* in the iron *C*.

In a similar way the second set of cards *K* may be worked from the cradle section *B*, as for example when weaving crossborder patterns.



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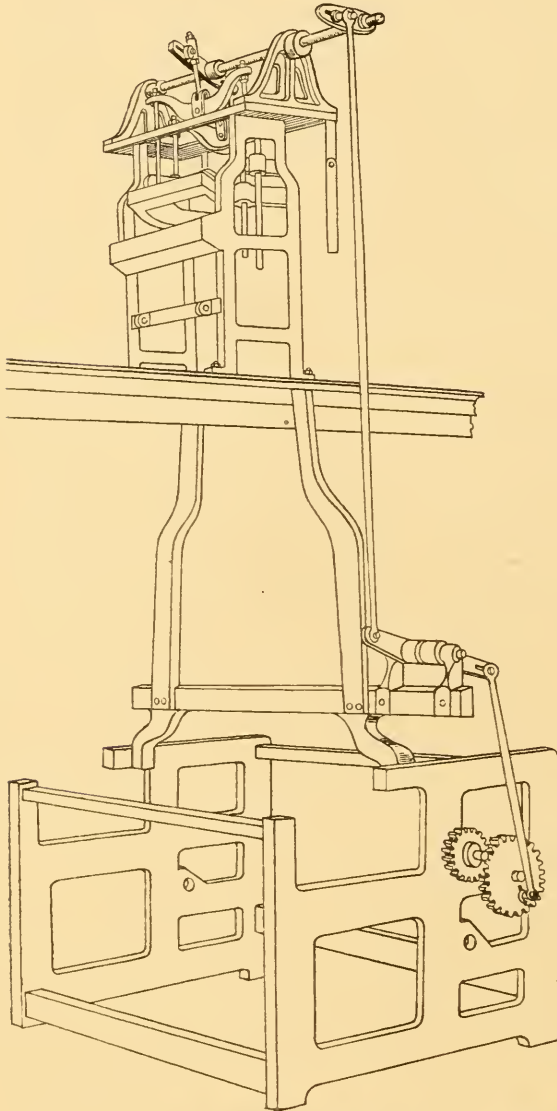


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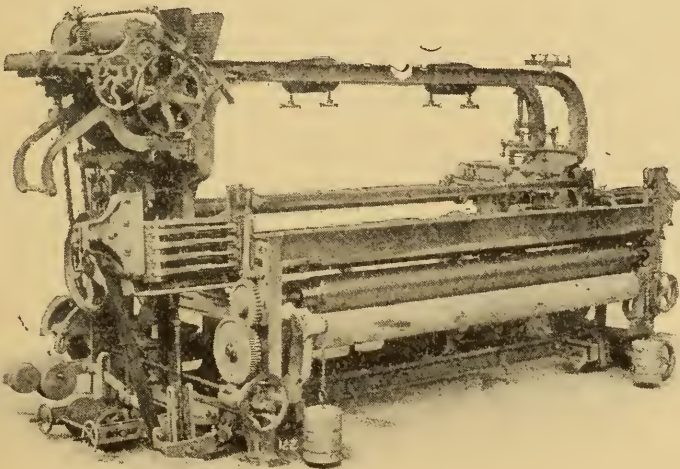
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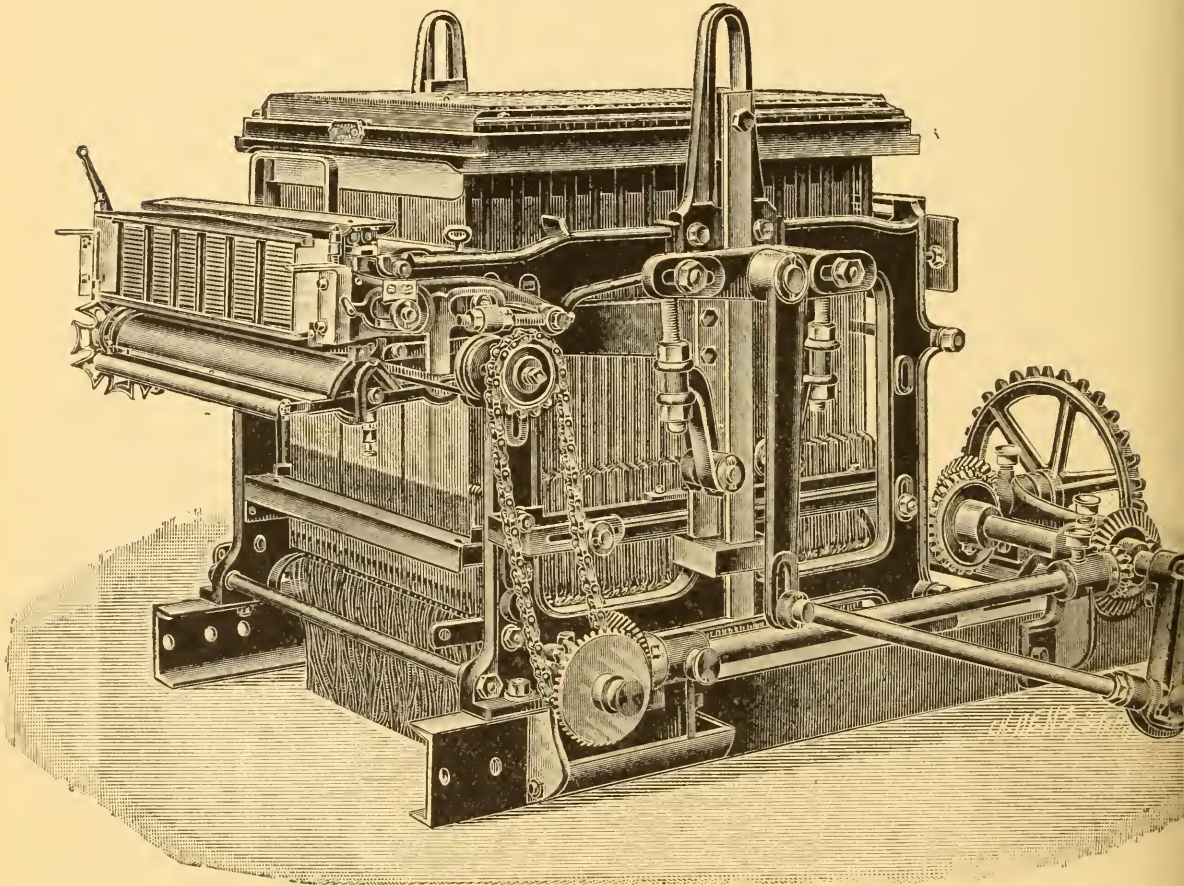
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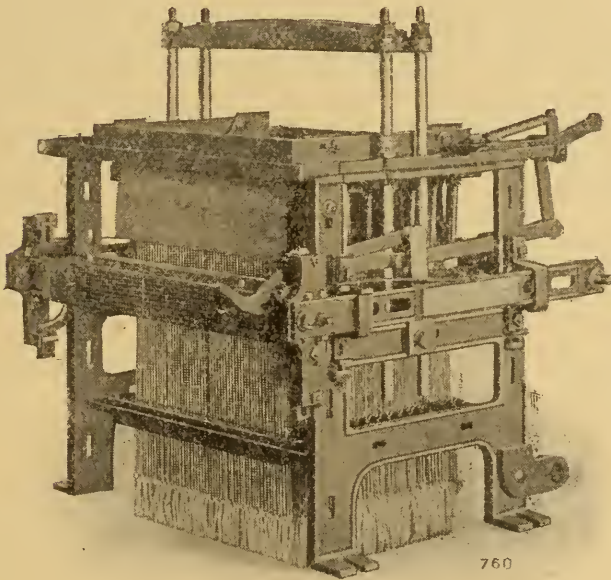
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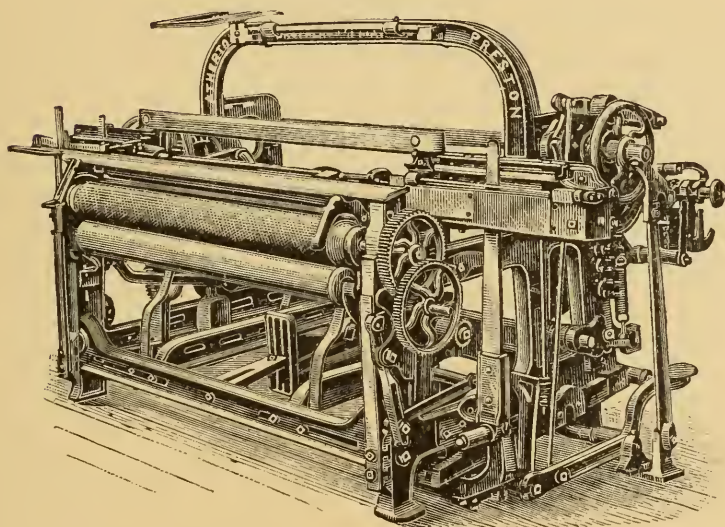
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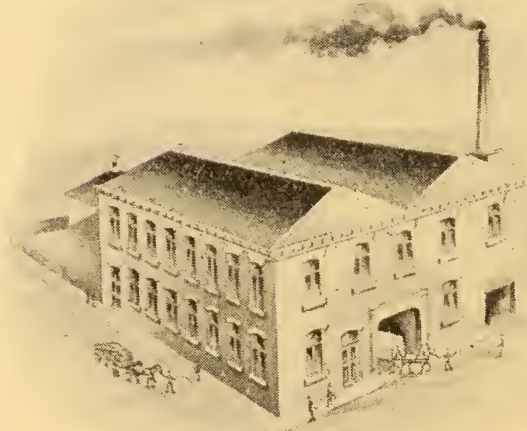
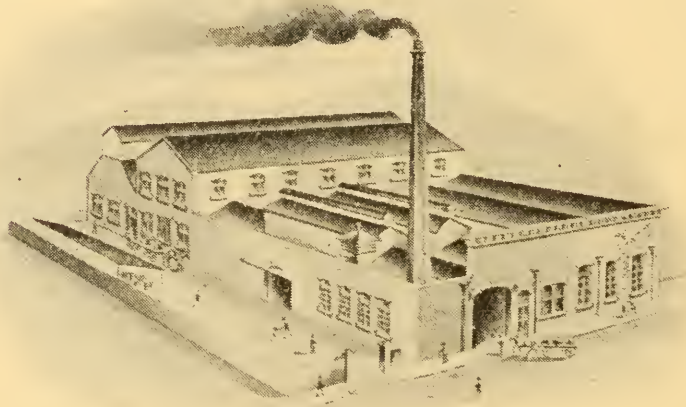
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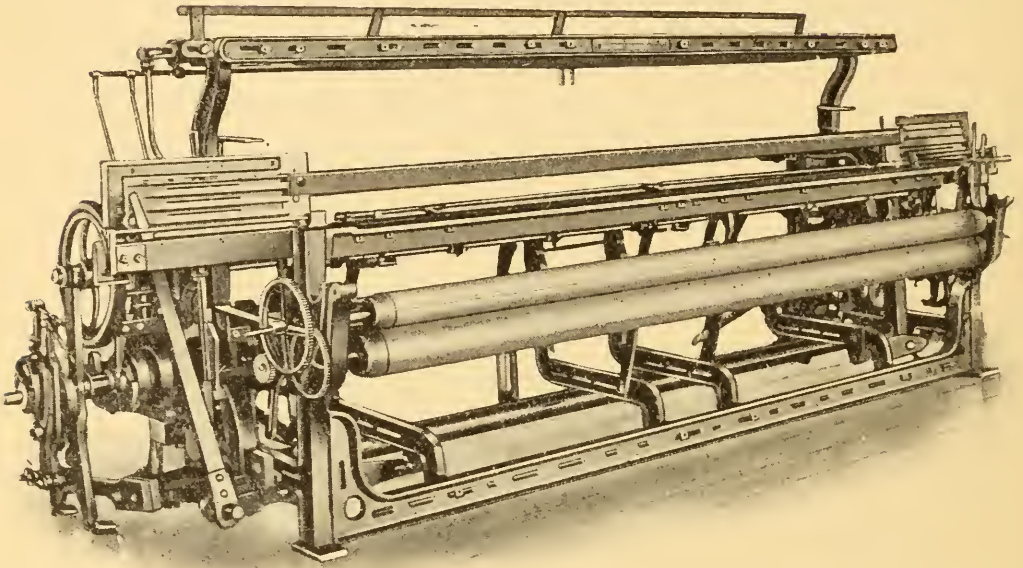
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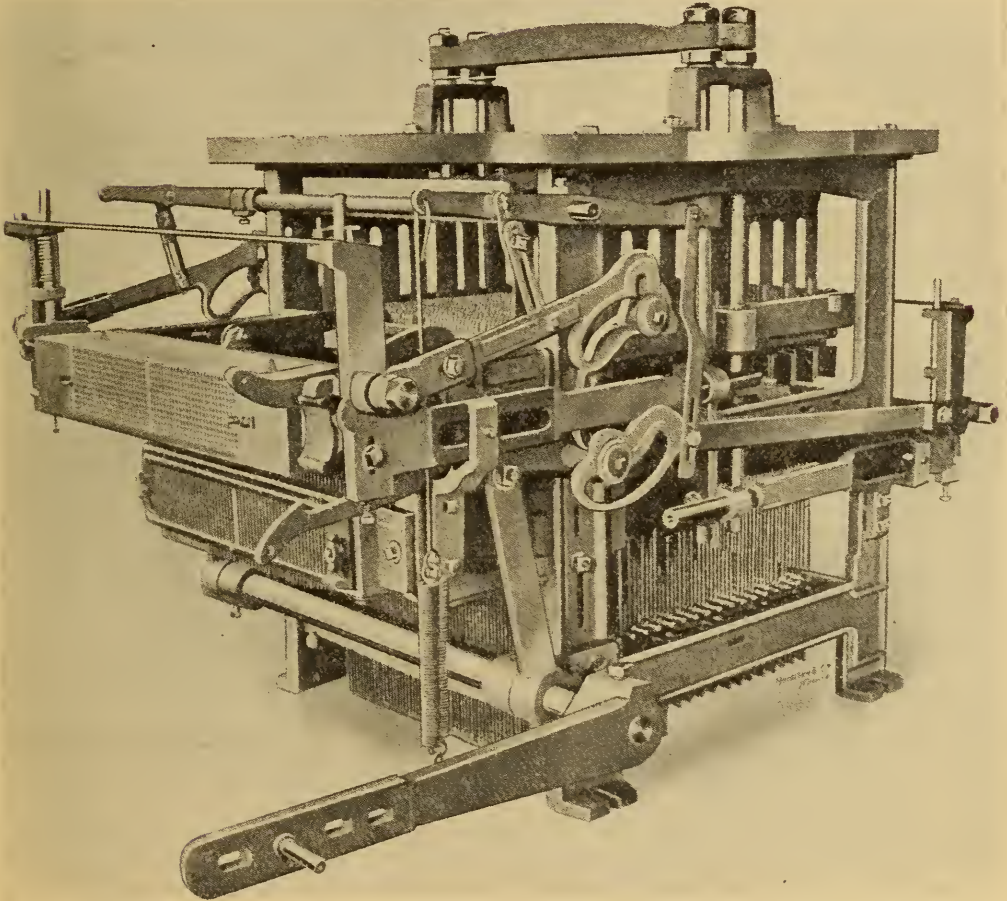
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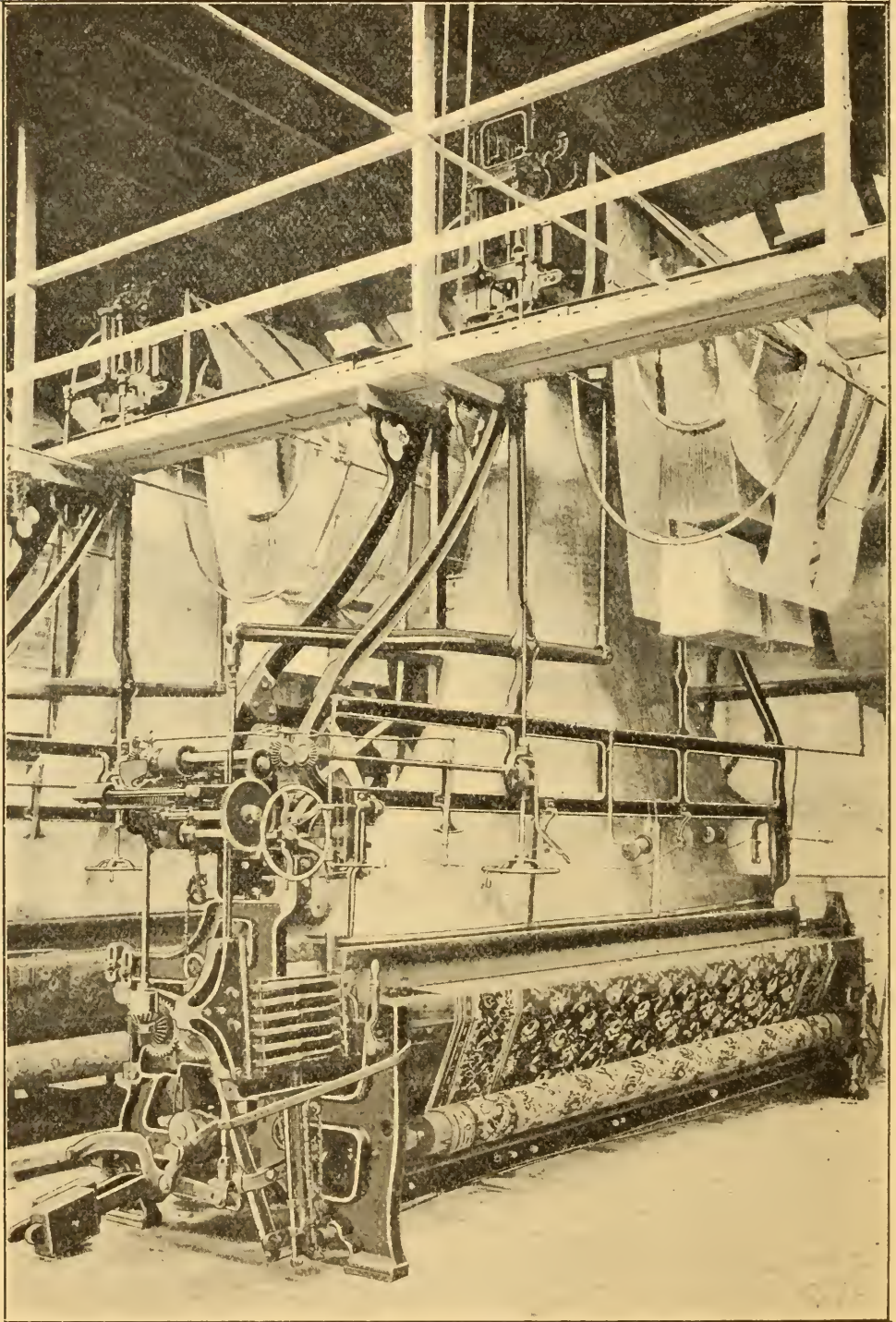
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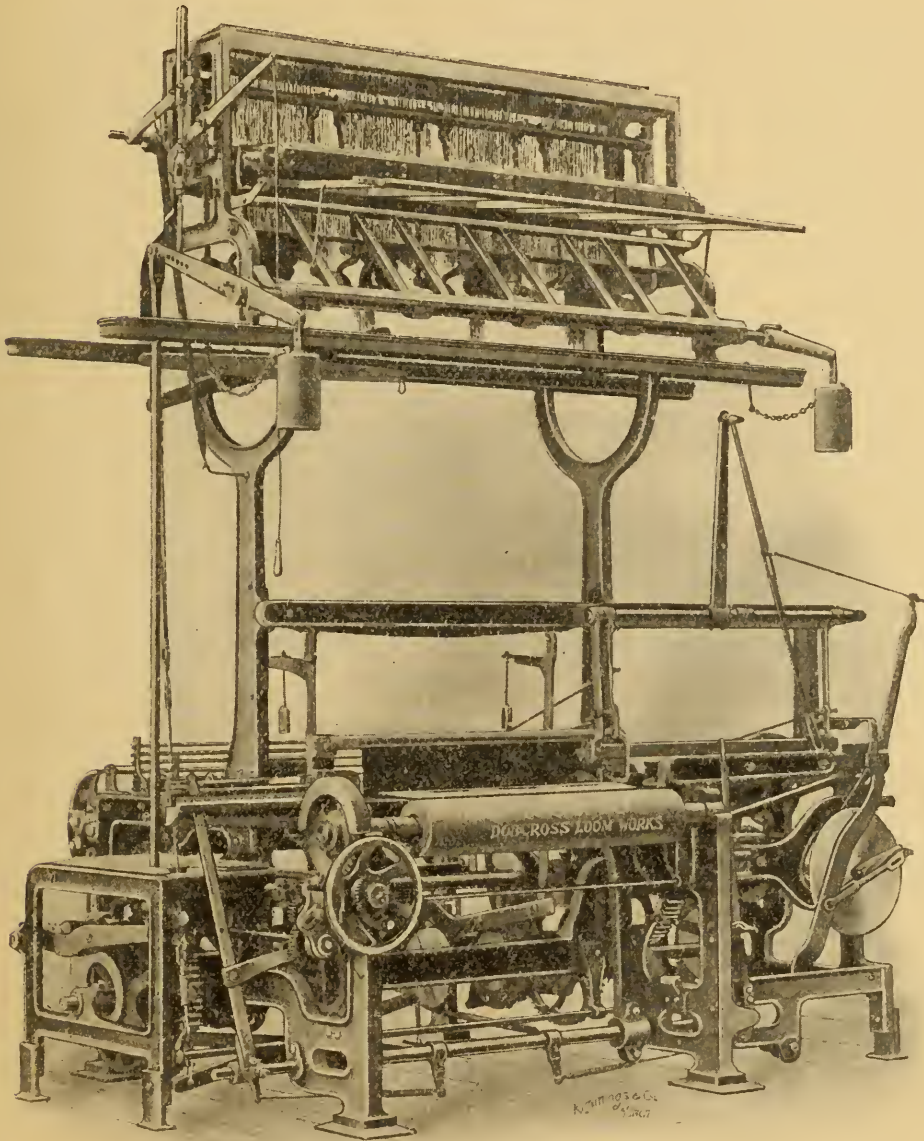
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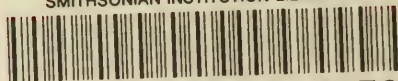
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