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DUNDEE, *March* 1921.

CONTENTS.

	PAGE
AN EXPLANATION, - - - - -	17
DESIGNING A LOOM.	
The practical knowledge necessary to the designing of a loom, - - - - -	18
Summary of the principal points to be considered in designing a loom, - - - - -	18
THE DELINEATION OF CAMS AND TAPPETS FOR SHEDDING.	
The distinctive features in a pair of well-constructed cams for plain shedding, - - - - -	20
Geometrical delineation of a cam for plain shedding, - - - - -	20
A peculiarity in a pair of shedding cams and its explanation, - - - - -	22
The difference in size between the two blades of a wyper and method of constructing them for actual work, - - - - -	24
The construction of wipers or tappets for other than plain shedding, - - - - -	27
Why always multiply the number of treads by four in order to find the number of divisions in the circle? - - - - -	28
TOP ROLLER MOUNTINGS.	
The top roller mounting for plain weaving, - - - - -	28
The top mounting for a three-leaf twill, - - - - -	29
The top mounting for a four-leaf twill, - - - - -	29
The treadles—a peculiarity, - - - - -	30
The position of the treadles in the loom for twill shedding, - - - - -	31
How the skewed bevel wheels are made, - - - - -	31
To find the relative number of teeth in the driving wheels for tappet shafts, - - - - -	31

DOBBY AND JACQUARD SHEDDING.

	PAGE
The Dobby machine, what is it?	33
The Jacquard machine,	34
The Jacquard machine explained and illustrated,	34
How the machine is driven,	37
Another arrangement for moving the cylinder,	39
The cylinder reversing movement,	40
The single-lift machine,	42
The double-lift machine,	42
The twilling Jacquard,	44
Jacquard and tappet shedding compared,	48

THE CONE PICK.

The unsatisfactory condition of the movement,	49
Causes that lead to an unsatisfactory movement in the "cone" or "over" pick,	49
The length of tappet considered in relation to the length of picking arm,	50
How the force applied by the tappet should be transmitted to the shuttle,	51
The method of constructing the picking cam,	53
The vertical adjustment of the anti-friction roller,	55
Two methods of driving the loom,	57
The sum of the whole matter,	57

THE UNDER PICK.

The under pick : its advantages over the cone pick,	58
The disadvantages of the under pick and how they are being met,	60
Why always buffalo hide for pickers?	61

BEATING UP THE SHOT.

What actually takes place in the making of cloth in the loom,	62
--	----

**TO COMBINE AND HARMONISE THE THREE
PRINCIPAL MOVEMENTS OF THE LOOM.**

	PAGE
The relative position of the principal parts of the loom, -	64
The rocking shaft, the swords, and the lay, -	65
The cause of so much breakage in the swords, and its remedy, - - - - -	66
The position of the crank shaft in relation to the swords, -	67
The position of the tappet shaft in relation to the crank shaft, the treadles, and the upright picking shaft or spindle, - - - - -	69
The upright picking shaft, - - - - -	71
The end frame, - - - - -	74

THE POSITIVE TAKE-UP MOVEMENT.

Its action, - - - - -	74
The roller covering, - - - - -	75
Driving the take-up movement, - - - - -	75
The arrangement of the wheels in the take-up movement, -	77
A continuous positive movement not wanted, - - - - -	79

THE NEGATIVE TAKE-UP MOVEMENT.

Purposes for which it is better adapted than the positive movement, - - - - -	79
--	----

THE LET-OFF MOVEMENT.

As it is and might be, - - - - -	80
The proper tension of the yarn in the loom, - - - - -	80
The put-back motion, - - - - -	81

**THE YARN PROTECTOR—AUTOMATIC STOP
MOVEMENT.**

Its threefold purpose, - - - - -	82
The momentum of its stroke, - - - - -	82
Its construction and arrangement, - - - - -	83
The length of the protector, - - - - -	84
The fly-reed protector, - - - - -	84

STOP MOVEMENTS WHEN A WARP OR WEFT
THREAD BREAKS.

	PAGE
When they become necessary, - - - -	84

THE SHUTTLE RELIEF MOVEMENT.

What experience has taught about it, - - - -	85
Its purpose, - - - - -	85
What the movement is, - - - - -	85

THE NORTHROP LOOM.

The two distinct methods at present being employed to increase the amount of work produced by machinery, -	87
The principal feature in the "new loom," - - - -	87
The weft changer considered in relation to the other automatic movements, - - - - -	88
Some of the new automatic movements, - - - - -	90

HIGH SPEED LOOMS.

Is the power-loom being driven as fast as it can be with economy? - - - - -	90
What is necessary in a high-speed loom? - - - - -	91
A practical hint as to increasing the speed of looms employed in the jute trade and the making of other coarse fabrics, - - - - -	92

MAKING THE LOOM.

How a well designed loom can be spoiled in the making, -	92
How the frame-work should be fitted, - - - - -	93
Gauge and jig in loom making, - - - - -	93

THE WEAVING SHED.

The model loom factory, - - - - -	94
The columns, - - - - -	94
With the shafting underground, - - - - -	96

DRIVING THE POWER-LOOM.

	PAGE
The distribution of power from the generating station to the loom, - - - - -	96
What has been done in the past to get a steady movement for the power-loom, - - - - -	97
What is being done and what may be done to lessen the vibration on the line shaft, - - - - -	100
The ideal method of driving power-looms, - - - - -	102

SHAFTING, PULLEYS, LEATHER BELTS, AND ROPES.

Driving power-looms, - - - - -	102
Fixing the main shaft brackets, - - - - -	103
Erecting the shafting, - - - - -	103
Levelling the pillow blocks, - - - - -	104
Drums or pulleys, - - - - -	104
To find the unknown quantity in pulleys, - - - - -	104
To find the circumferential velocity of pulleys, - - - - -	105
The fast and loose pulleys and the friction pulleys—where each can be employed with most advantage, - - - - -	105
The convexity of pulleys, - - - - -	106
Belts—their width and thickness, - - - - -	106
How the lap-jointed belts should run—the length of lap, - - - - -	107
A belt clamp, - - - - -	107
The necessity of squaring the ends of a butt-jointed belt, - - - - -	109
How a butt-jointed belt should be laced, - - - - -	109
The management of belts, - - - - -	110
How to get the most power out of belts—the direction in which they should run, - - - - -	111
The construction of rope pulleys, - - - - -	111

ERECTING AND FIXING LOOMS IN THE FACTORY.

How the parts of the loom should be marked, - - - - -	113
How the main wheels should come into gear, - - - - -	113

	PAGE
The arrangement of the looms, - - -	114
The main points to be observed in fixing looms to the floor,	116
Another method, - - - - -	117
A template necessary for this work, - - -	118
To find a proper bearing for the loom, - - -	119
Points necessary to notice before starting the loom, -	119

WORKING THE LOOM.

THE MECHANICAL DEPARTMENT.

Some practical points worth noticing, - - -	119
To the young student, - - - - -	121
The loom "knocking off"—to find the cause, -	122
The causes that make the loom knock off, - - -	123
When the loom knocks off from a deficiency of power, -	123
When the loom knocks off from an obstruction to the shuttle,	124
When the protector is at fault, - - - - -	125
The value of the ear in detecting what is wrong, -	125
Causes that throw the shuttle out of the loom, -	125
The main principle that should guide the mechanic, -	126
Some things to be guarded against, - - - - -	126

WORKING THE LOOM.

THE TENTING, TACKLING, OR TUNING DEPARTMENT.

The power-loom tenter's work, - - - - -	127
Tackling, - - - - -	128
The most important point in cloth making, - - -	129
Spreading the warp threads—what actually takes place amongst the yarn to cause the threads to spread— how it is done, - - - - -	129
What part the shedding cams or wipers play in making good cloth, - - - - -	131
The lease rods—the part they play in making good cloth, -	131
The tension at which the yarn is held, and the adjustment of straps and cords, - - - - -	132

JACQUARD WEAVING.

	PAGE
Shedding with the Jacquard machine, - - -	133
Setting the machine to the comber-board, - - -	134
Setting the cylinder, - - - - -	136
Mounting the harness, - - - - -	136
Preparing the lingoos, - - - - -	136

SOME DETAILS THAT SHOULD BE KNOWN BY ALL
CONNECTED WITH WEAVING.

A peculiarity in the construction of the shuttle, and the reason for it, - - - - -	137
Management of the picking movement, - - -	138
The use of the check-strap, - - - - -	139
The intermediate or patent selvage—how it is formed, -	140

HOW THE PATTERNS IN THE CLOTH ARE
PRODUCED.

Tappet, Dobby, and Jacquard shedding, - - -	143
Plain cloth, - - - - -	144
Setting the heddles to the reed, - - - - -	145
Regular twills, - - - - -	146
The same twill with the draughts reversed, - - -	147
How the pattern should be turned, - - - - -	147
Irregular twills, - - - - -	148
Common twills that are equally flushed on both sides of the cloth, - - - - -	148
The combination of common twill and plain cloth, - - -	149
How the draughts and treading form the patterns in the cloth, - - - - -	150
How the patterns are produced by the Jacquard machine, -	152
How the cards are found and cut from the sketches, -	154
A striking peculiarity in linen damask cloth, - - -	155

TEXTILE CALCULATIONS.

	PAGE
The different standards or bases of calculations used in different localities, - - - - -	155
The "setts" or "porters" of the reed, - - - - -	156
The calculation of warp yarns, - - - - -	158
To find the weft, - - - - -	159
An example showing how to find the quantity of warp and weft in any given piece of cloth of any material, -	160
To find the weight and cost of yarns, - - - - -	161
Considerations that must be taken into account in deter- mining the price of cloth from that of the yarn, -	162

INDEX.

PAGE	PAGE
<p>Advantages and disadvantages of the underpick, 58-60</p> <p>All about the best picking movement, - - - 49-56</p> <p>An explanation of the design of this book, - - - 17</p> <p>Arrangements for moving the cylinders in Jacquard weaving, - - - 37-42</p> <p>Beating up the shot, - - - 62</p> <p>Belts, butt joints of, - - - 109</p> <p>Belts, how to lace (illustrated), - - - 108-110</p> <p>Belts, lap joints of, - - - 107</p> <p>Belts, stretching clamp for, 107</p> <p>Belts, to preserve the, - 110</p> <p>Breast beam, its relative position in the loom, - 64</p> <p>Calculations for warp and weft yarn and cloth, 155-161</p> <p>Cams for picking movement (illustrated), - 49-56</p> <p>Cams for movements in twilling Jacquard loom, - 48</p> <p>Cam for shuttle relief movement, - - - 85</p> <p>Cams for twills, etc. (illustrated), - - - 27</p> <p>Cams for two-leaf shedding (illustrated), - - - 20-26</p>	<p>Card cylinder, the, - - - 36</p> <p>Cause of much breakage in the swords, - - - 66</p> <p>Causes that lead to bad picking movement, - - 49</p> <p>Check strap, the, - - - 139</p> <p>Centre selvage (illustrated), 140-142</p> <p>Clothmaking, the, - 129-133</p> <p>Cloth tension in loom, - 132</p> <p>Combining and harmonising the three principal movements in the loom, - 64-74</p> <p>Cone pick, anti-friction roller of the, - - - 49</p> <p>Cone pick, causes that lead to an unsatisfactory movement of the, - - 49</p> <p>Cone pick, direction of the force in the (illustrated), 51-55</p> <p>Convexity of pulleys—when required, - - - 106</p> <p>Crank, relative position in the loom of the, - - 67</p> <p>Crank, diagrams of its movement, - - - 68-70</p> <p>Crank, throw of the, - - 69</p> <p>Cylinder for reversing movement in Jacquard loom, - - - - 41</p>

	PAGE		PAGE
Comber-board, the, - - -	135	Gauge and jig in loom	
Delineation of cams and		making, - - - - -	93
tappets for shedding,	20-28	Geometrical delineation of	
Designing the patterns of		cams for shedding, -	20-28
cloth, - - - - -	143-155	High-speed looms, -	90-91
Designing the loom, - - -	18	How the force applied by	
Dobby and Jacquard shed-		the picking tappet should	
ding, - - - - -	33	be transmitted to the	
Dobby machine, the, - - -	33	shuttle, - - - - -	51
Double-lift Jacquard machine,	42	How the needles act on the	
Driving of loom, two		hooks in Jacquard weaving,	34
methods of, - - - - -	57	How the swords are broken,	66
Driving the Jacquard		Irregular twills, - - -	148
machine, - - - - -	37	Jigs in loom making, -	93
Driving the take-up move-		Jacquard and tappet shed-	
ments, - - - - -	74-79	ding compared, - - -	48
Drums and pulleys, -	104-106	Jacquard machine explained	
Draughting in heddle		and illustrated, -	34-48
leaves, - - - - -	145-150	Jacquard shedding, -	33-49, 133
Draughts and treading com-		Knocking off the loom,	122-124
bined from pattern of		Lay, its eccentric move-	
cloth, - - - - -	150	ment illustrated, -	67-69
Eccentricity of lay's move-		Lease rods, how they affect	
ment (illustrated), -	67-71	the making of the cloth,	131
End frame, the considera-		Length of tappet for pick-	
tions that determine its		ing movement considered,	50
form, - - - - -	74	Let-off movement, -	79-80
Erecting looms in the		Looms, arranging and erect-	
factory, - - - - -	113-119	ing in factory, -	113-119
Erecting the shafting, -	103	Looms, breakages in the,	119-126
Factory, design of, -	94-96	Looms, speed of, -	90-91
Fly reed, - - - - -	84	Looms, trimming the,	127-132
Frame-work of loom, how		Looms, working the, -	119-133
it should be fitted, -	93	Making looms, - - - -	92

	PAGE		PAGE
Making the cloth, -	143-155	Shedding, arrangement of	
Momentum of moving parts, -	82	cams for, - - -	131
Mounting the harness, -	136	Shedding to produce pat-	
Needles in Jacquard weaving, -	34	terns, - - -	145-151
Negative take-up move-		Single-lift Jacquard ma-	
ment, the, - - -	79	chine, - - -	42
Northrop loom, the, -	87-90	Shuttle, causes of being	
Peculiarity in a pair of		thrown out, - - -	125
shedding cams, - - -	22	Shuttle, position of points of, -	137
Peculiarity in the construc-		Shuttle relief movement, -	85-86
tion of the shuttle, -	137	Spreading the warp threads, -	129
Picking movements, -	49, 62	Swords, cause of so much	
Position of treadles in the		breakage in the, - - -	66
loom for twills, - - -	31	Swords, position of, in loom, -	65
Positive take-up move-		Summary of principal points	
ment, - - -	74-79	to be considered in design-	
Principal features of the new		ing a loom, - - -	18
loom, - - -	87	Tappet and Jacquard shed-	
Proper tension of cloth in		ding, - - -	48
loom, - - -	132	To find the unknown quan-	
Protector, the yarn, -	82	tity on pulleys, - - -	104
Pulleys, speed to find, -	105	Top roller mountings, -	28-30
Put back motion, - - -	81	Treadles, their position in	
Regular twills, - - -	146	the loom for twills, -	31
Rocking shaft, - - -	65	Treadles, a peculiarity of	
Ropes, driving with, -	111	the, - - -	30
Rules for calculating		Twilling Jacquard, - - -	44
speeds, - - -	104-105	Under pick, the, -	58-61
Rules for calculating warp,		Upright picking shaft, the, -	71
weft, reed, etc., -	155-161	Warp, calculations for the, -	158
Shafting, erecting in fac-		Warp line, - - -	130-131
tory, - - -	102-104	Warp spreading, -	129-130
Shafting, torsional strain		Wheels, momentum of the, -	90-91
on, - - -	96-102		

A PRACTICAL TREATISE
ON THE
CONSTRUCTION OF THE POWER-LOOM
AND THE
ART OF WEAVING.

AN EXPLANATION.

It will be as well to explain at the outset the lines on which we intend to proceed ; we shall then know what to look for and what we may expect to find. We need not trouble our readers with the relative merits of this, that, or the other loom ; to the student of the art of weaving these are of minor importance ; neither shall we occupy space with descriptions of parts of the loom when such parts can be more readily understood by a careful observation at the loom, nor with processes which require some practical experience to enable a person to understand them. As in former editions of this work, we shall endeavour to describe the principles involved in, and the parts which govern, the various movements of the power-loom and the processes of weaving. We do not intend to theorise on this important subject, but will endeavour to make the book suitable for practical mén.

DESIGNING A LOOM.

The practical knowledge necessary to the designing of a loom.—Before attempting to design a loom we must make ourselves thoroughly well acquainted with every detail in its construction. The timing of every movement must be studied in detail so that the working of the loom may be understood. There are correct times for all the different movements to take place, and each movement has therefore to be timed in relation to all the others in order that all parts may do their share to preserve harmony.

Summary of the principal points to be considered in designing a loom.—Perhaps the best starting point will be the size of the shuttle. That in turn will depend on the particular fabric to be produced on the loom in hand. As a general rule the depth and breadth of the shuttle are less for fine yarns than they are for coarse yarns, and the length is often increased as well for heavy or coarse wefts. Consequently the throw of the crank, the depth of the shed, and strength of the pick will be proportionately smaller for fine wefts than they are for heavy wefts, thus giving possibilities of a higher speed. For heavy yarns the shuttle is increased in size in order that it may contain as much yarn as possible, so that the stoppages of the loom may be as few as possible; but the speed of the loom must in this case be slower, as the throw of the crank must be larger, the shed deeper, and the pick stronger.

The principal features in all looms are the same. The shed is formed, the pick is put in and beaten up, and the cloth is taken away at the required pace to give the desired number of shots per inch. How this should be done to give the best results will form the subject of the following chapters relating to these movements.

The principal features we have to note here in connection with these movements are the following:—The shed should be no larger than what is absolutely necessary to clear the shuttle as the latter passes across the loom. The smaller the shed, the less friction will be thrown on the yarn in this operation, consequently the throw of the crank and the depth of the shed will be made to suit the size of the shuttle. As to the pick, no more force should be applied than what is absolutely necessary to carry the shuttle across the loom; to do more than this will be a waste of power and will do a great deal of damage to the loom itself. The beating up of each shot of weft is done by the reed or slay carried by two oscillating lay swords and the shuttle race. The movement of the shuttle race, reed, and lay swords varies in speed from point to point, and it is usual to say that this movement is of an eccentric form. Part of the shuttle or warp protector is carried by the lay, while the other part is attached to the loom frame. When the tongue of the protector strikes the buffer, knee, or frog, that buffer should yield somewhat, and a spring can easily be inserted for that purpose; when the stroke is “dead,” it throws too much vibration on the swords and other parts of the loom. As to the take-up and let-off movements they will be considered in connection with the fabric of cloth to be produced. There is no need to go into particular figures here, more particularly as it is principles we are dealing with. We will now consider the various parts in detail, and then endeavour to combine them into a harmonious whole in the construction of the framework.

THE DELINEATION OF CAMS AND TAPPETS
FOR SHEDDING.

The distinctive features in a pair of well constructed cams for plain shedding.—These cams must be so constructed as to give a graduated movement to the heddle leaves. Towards the centre of the shed they will move fastest, while there is no stress on the yarn, getting gradually slower until they merge into the full pause. With a uniform movement the stress would come too suddenly on the yarn, with a tendency to cause frequent breakages in the latter.

The length of pause to be given—that is, the length of time the shed is to remain open—will be regulated partly as the warp threads require to be spread or otherwise, and partly according to the width of the loom. The usual dwell or pause is approximately one-third of a revolution of the crank shaft.

The heddle leaves must be entirely free from any jerkiness in any part of their movement. To accomplish this the two sheaves or blades of the cam must be so constructed that they will remain in constant contact with the anti-friction rollers in the treadles during their entire revolution without overstraining the cording or the heddle leaves. This will be fully explained.

In determining the length of stroke to be given to the cam we must understand that the shed should be no larger than is absolutely necessary to allow the shuttle to pass through freely.

The geometrical delineation of a cam for plain shedding.—Let us presume that the exact dimensions of this cam, tappet, or wyper have already been ascertained as to depth of shed, etc. Then draw the perpendicular line shown at fig. 1. With a radius equal to the distance

from the centre of cam to the nearest point of contact with the anti-friction roller of the treadle, describe the inner circle A. Then to this radius add what is necessary to give the desired length of stroke to the cam, and with this larger radius describe the outer circle B. On this circle B set off the length of pause or dwell to be given to the cam or wyper. In this figure the distance C to D represents the dwell when the leaf is down, while the

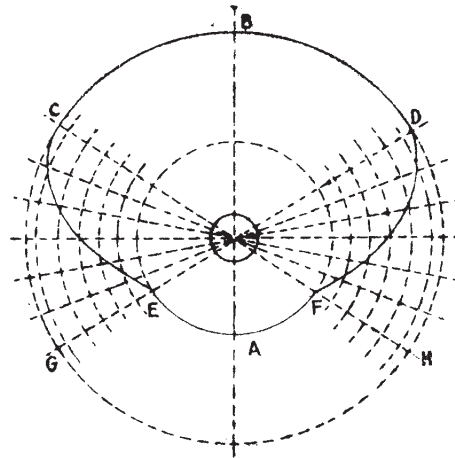


FIG. 1.

distance E to F, equal in time to the distance G to N, represents the dwell when the leaf is up. The dwell in this figure is much longer than that usually allowed in looms up to 50 inch reed space. Divide C G into six equal parts, and D N also into six equal parts, and draw lines to the centre. Then the stroke or distance G E or F N should be divided according to the variable movement which it is desired to impart to the leaf. If,

now, a curved line is drawn from C to E, and another curved line from D to F, each passing through the intersections of the curved and radial lines, the outline will then be very similar in shape to a wyper for plain cloth. The shape of the wyper formed by the two curved lines imparts a graduated movement to the treadle and to the leaf from the full open high position to the full open low position, and *vice versa*. The illustration in fig. 1 does not take into account the size of the treadle bowl, and such a bowl must be used in practice. This essential feature will be explained shortly.

A peculiarity in a pair of shedding cams and its explanation.—The cam we have just described is constructed in the manner necessary for operating one leaf for plain shedding, but if we put two of these cams of the same dimensions together to work in conjunction from the same centre we find they do not give the results required. This is owing to the two treadles on which the cams operate being placed at right angles to the leaves of heddles, and consequently attached to these leaves of heddles at different points of their leverage, one taking down the one leaf further than the other. What is exactly wanted is that both cams be so constructed that the one will just give off what the other takes away, and that they both remain in constant contact with the anti-friction rollers in the treadles without overstraining the cordings at any part of the cam's revolution. It is evident that two cams of the same dimensions working from the same centre will not do this. This will at once be understood with reference to fig. 2. The treadles A and B are pivoted at C, which is termed the "heel-pin" or fulcrum, and this heel-pin is immediately under the warp beam, while the anti-friction rollers or "treadle bowls," which are represented by the

solid circles D and E, rotate in the treadles and are in contact with cams or blades of a wyper. The fell of the cloth is at F, and the front leaf with its threads G is in the highest position, while the back leaf with its threads H is in the lowest position. The line J represents the reed. The ends of the treadles are attached by suitable means to the lower staves of the cams, while the upper staves are connected by straps K and L which pass partially round the two circular rods or shaft M as shown. When the blades of the wyper have rotated

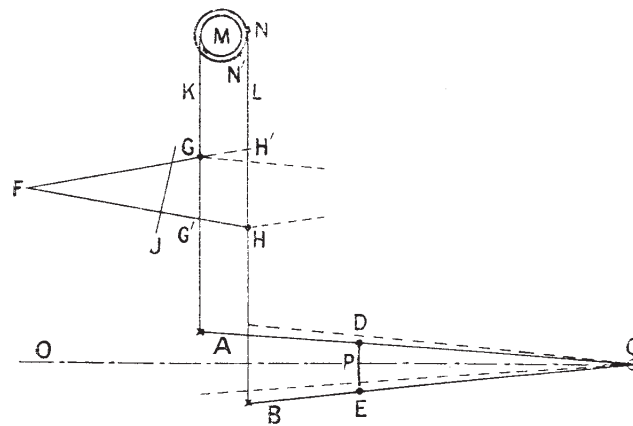


FIG. 2.

half-way round from the positions shown, the treadle bowl D with its treadle A will have forced the threads G to the point G1, and at the same time will have rotated the rod M until the threads H reach the point H1 and the set-screw N gets to the point N1. It will be seen that the threads H have to travel through a greater distance than threads G, and consequently the treadle B

must travel through a greater distance than treadle A. If we assume that the blade of the wyper shown in fig. 1 is to operate the treadle A, fig. 2, then the companion blade of the wyper must have a greater throw or stroke in order that it may move the treadle B through the greater distance required for the depth H to H1 of the back shed. The dot and dash line O C represents the level position of the treadles, and P represents the level position of the travel of dots D and E. The difference between the distance P D and the distance P E is the extra throw required for the blade of the wyper which has to operate the treadle B. Since the threads H and their leaf travel so much more than threads G, it is desirable that the strap L should pass over a larger circle or rod M than what is intended for the strap K.

The difference in size between the two blades of a wyper, and method of constructing them for actual work.—Fig. 3 illustrates a blade of a plain wyper to operate the front leaf and its threads. The construction is somewhat similar to that followed in fig. 1, but in the present case the size of the treadle bowl has been shown in fourteen different places, and the dwell is only 120 degrees of the crank circle, or 60 degrees of the wyper circle; it is therefore 60 degrees in fig. 3. As in the former figure, the angle formed by the lines C D represents the dwell down, and G N the dwell up; in these places the outline of the wyper is part of a large circle for the dwell down, and part of a small circle for the dwell up.

Fig. 4 shows the other blade of the wyper for operating the back leaf and its threads. It is drawn 180 degrees farther round, and the stroke is greater for the reasons already mentioned; otherwise the construction is

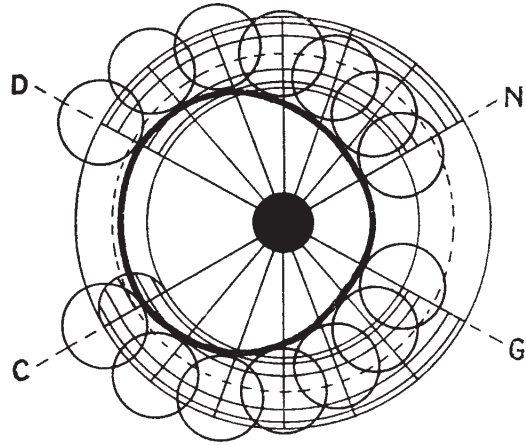


FIG. 3.

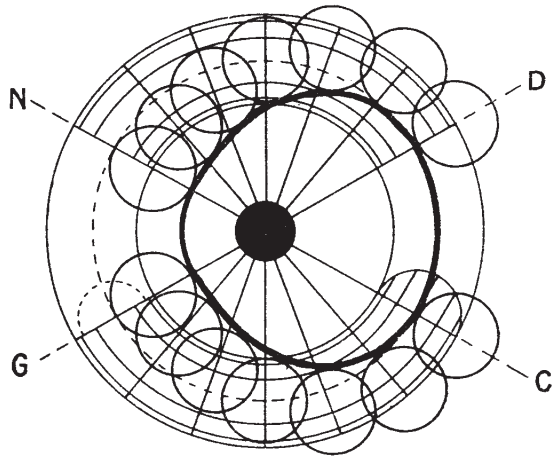
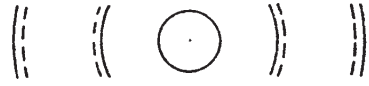


FIG. 4.

identical with that in fig. 3. When in work the blade in fig. 4 would be placed alongside that in fig. 3, with their thick sides in the positions shown; as a matter of fact, the two blades form one solid piece, or else the wyper is made in two halves, each half containing part of the two blades.

The diagram between the two blades in figs. 3 and 4 shows the wyper shaft and parts of the dwells of each blade. The solid curves indicate the distances of the

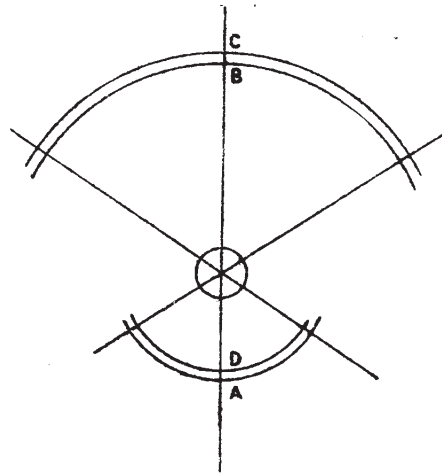


FIG. 5.

thick and thin parts of the larger blade from the centre of the shaft, while the dotted curves show the distances from the centre of the thick and thin parts of the smaller blade. The distances from the centre are illustrated in a different manner in fig. 5, where C and D represent the thick and thin parts of the larger blade, while B and A represent the thick and thin parts of the smaller blade.

The construction of wipers or tappets for other than plain shedding.—In connection with plain weaving each of the blades illustrated in figs. 3 and 4 makes one complete revolution for every two shots or picks, because there are only two picks in a round, as indicated by the design or weave in fig. 62. This weave shows six picks or three repeats. Suppose, for example, that a blade of a tappet for a four-leaf twill had to be drawn; and suppose that the four-leaf twill was the one illustrated in

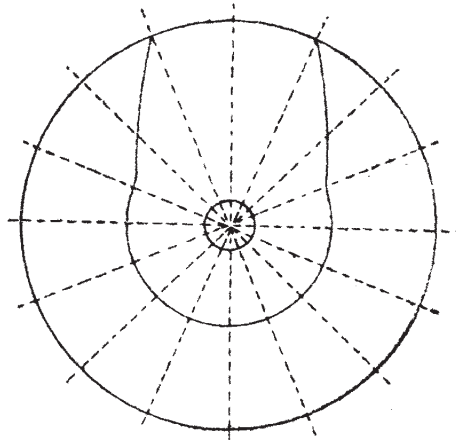


FIG. 6.

fig. 65. There are four picks to the round in this weave, and therefore the tappet would make one complete revolution every four picks. One-quarter of the circle would therefore represent one pick. If one-third of a pick were utilised for the dwell or pause, each pick would be divided into three parts, and the full circle into $4 \times 3 = 12$ parts. Instead of taking one-third of a pick for dwell

let us take one-half of a pick, then the circle would require to be divided into $4 \times 4 = 16$ parts. Fig. 6 illustrates a circle so divided, and it also shows diagrammatically as in fig. 1 the outline of a blade for a four-leaf twill. The thick part of the blade extends over two of the sixteen divisions, and since four divisions are required for each complete pick, it will be seen that the two divisions represent a dwell or pause for the leaf of half a pick. A correct blade could be drawn for this weave by following the method illustrated in figs. 3 and 4.

Why always multiply the number of treads by four in order to find the number of divisions in the circle?

—This is a rule we introduced in the early editions of this book which simplifies the production of these tappets. If we multiply the number of treads in one revolution of the tappet shaft by four, whatever the number of parts may be, four will always represent a complete revolution of the crank shaft, and, as the half of that is all that is necessary for the pause in these tappets, two divisions will give it where only one pick is put in. Where two or more picks are put in before that leaf rises again we must add four parts for each additional pick, as a complete revolution of the crank shaft is made between each pick. If instead of half a pick dwell, one-third of a revolution of the crank shaft is allowed, then, as already stated, the number of treads or picks to a round must be multiplied by three.

TOP ROLLER MOUNTINGS.

The top roller mounting for plain weaving is shown in fig. 2, where it is proved that the shaft for the strap of the back leaf must be larger than the shaft for the strap of the front leaf.

The top mounting for a three-leaf twill.—The top mounting for a three-leaf twill generally consists of stepped rollers, as in fig. 7; the largest one is attached to the back leaf. That roller will be as much larger than the other one as will raise the back leaf to its full height when one of the others goes down. The actual dimensions will depend on the size of shed to be made. What we have called the smaller roller, around which the straps pass for leaves 1 and 2, as indicated in fig. 7,

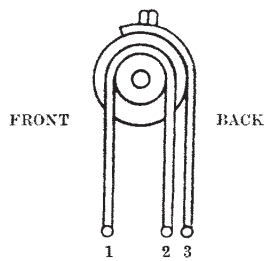


FIG. 7.

really consists of two steps, and is, indeed, exactly like the plain top roller mounting illustrated in fig. 2.

The top mounting for a four-leaf twill.—Fig. 8 shows the arrangement generally used for a four-leaf. It will be noticed that in this figure three distinct rollers are used, and no account has been taken of the two steps in each roller. The upper roller would be in two steps, the larger one to support the strap for leaves 3 and 4. The front roller would be exactly like that in fig. 2, while the back roller would be similar but larger, because of the extra throw required. The mounting illustrated

in fig. 8 is for the four-leaf twill, 3 up, 1 down, often indicated as under:—

$$\frac{3}{1}$$

It could also be used for the 1 up, 3 down twill:—

$$\frac{1}{3}$$

For the $\frac{2}{2}$ twill, illustrated in fig. 69, the upper roller in fig. 8 is not required. In most twills beyond a four-leaf springs are now generally used. They are

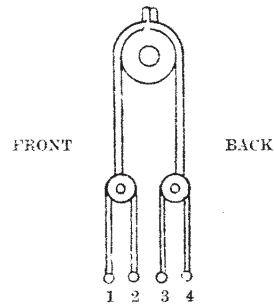


FIG. 8.

easily fixed but not so satisfactory as the roller mountings.

The treadles—a peculiarity.—There is a peculiarity in shedding by treadles in twills as well as by all other sorts of tappet shedding which we have not yet noticed—the treadles at their point of contact with the tappets move in an arc of a circle. As the tappets are made to act on a straight line, we must reduce this defect as far as we can by arranging for each treadle to move an

equal distance above and below its horizontal position, and that the fulcrum of the treadles shall be as far back as possible. With this arrangement the defect will not be noticeable.

The position of the treadles in the loom for twill shedding.—The treadles for three-leaf and four-leaf *cams are usually fulcrumed at the back of the loom in much the same position as those for plain weaving. In some few cases, however, they are placed right under the heddle leaves, and parallel with them; the treadle points being connected directly to the heddles. This arrangement necessitates the tappet shaft running at right angles to the ordinary cam shaft from which it is driven, consequently, bevel wheels will be necessary in this case; and as it is not convenient always to have these two shafts in the same plane, the teeth of these wheels will require to be “skewed” to suit the particular circumstances.

How these skewed bevel wheels are made.—In what they differ from the ordinary bevel wheel is shown at fig. 9. The teeth, instead of running to the centre, are drawn tangent to a circle. The diameter of this circle is found by taking the distance between the centre of the two shafts and dividing it proportionally to the mean radii of the wheel and pinion. Each of these divisors is then taken as a radius of a circle to which the teeth of the wheel and pinion respectively are drawn tangent.

To find the relative number of teeth in the driving wheels for tappet shafts.—The ordinary cam shaft of the loom is only available for plain cams, as it makes one complete revolution for every two picks, and conse-

*Cams is the word used in Scotland for the articles which operate the threads; these articles are also termed—healds, gears, heddles, and leaves of the cauld, in other places.

quently can only make two sheds in one revolution. This makes it needful to have an auxiliary shaft to carry the tappets when more than two treads are necessary to complete the pattern; but the ordinary cam shaft is the most convenient point from which to drive it. In these circumstances then, in order to find the relative number of teeth in wheel and pinion respectively we have only to consider the relation in which the number of treads in one revolution of the shaft that is driven stands to the number of picks in one revolution

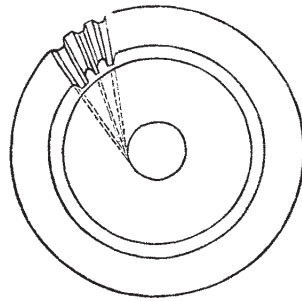


FIG. 9.

of the driving shaft. Take a five-leaf twill for example. The number of teeth in the driving and driven wheels will be to each other as two is to five. Then to find the exact number of teeth that each will contain, take any convenient number and multiply both by it—say eight. 8 times 2 are 16, and 8 times 5 are 40, therefore 16 and 40 will be the number of teeth in wheel and pinion respectively. Any other number may be used as a multiplier that will give more convenient dimensions, but the total number of teeth in the two wheels must be

so arranged that the centres of the two wheels when in gear will be the correct distance apart.

When a large number of treads are required to make the pattern, the wheel on the tappet shaft necessary to produce the proper speed may become too large for the space at our disposal, or otherwise inconvenient. In this case, we must introduce an intermediate wheel and pinion, both fixed to a spindle or shaft: then the product of the two driven wheels divided by the product of the two driving wheels will give half the number of treads or picks per round. If we include the wheel on the crank shaft and that on the low shaft, then we should have:—

$$\frac{\text{Product of 3 driven wheels}}{\text{Product of 3 driving wheels}} = \text{picks per round.}$$

DOBBY AND JACQUARD SHEDDING.

The Dobby machine, what is it?—There is a mistaken idea abroad in some quarters regarding the Dobby method of shedding: that it is something apart and distinct by itself. This is not so; it is simply a small Jacquard machine with from eight to forty-eight hooks acting on heddle leaves, or shafts as they are called when used in this way. In tappet weaving the patterns that can be produced are very limited in number and comparatively small in size, but with the aid of the Dobby machine more elaborate patterns can be made; but as it is by leaves of heddles that the patterns are formed the latter are still of the same class as that produced by tappet weaving, namely, “squares,” “diamonds,” etc. As more leaves can be employed with the Dobby loom than with the tappet loom, and as the repeats in a pattern are practically unlimited, it will be

seen that the number and variety of these patterns can be greatly increased when the Dobby loom is used.

The Jacquard Machine.—The Jacquard Machine is for separating the threads into a great number of different orders, and one by which almost any pattern can be produced. It is named after its inventor, and has been considerably improved in some of its details since its introduction about 1820. Makers differ somewhat in their methods of construction, but the original principle is still the same; they cannot get away from it. In the following paragraphs we will endeavour to unfold this principle and see what it is.

The Jacquard machine explained and illustrated.—Fig. 10 is a vertical section of a Jacquard machine with all the framework removed, showing a row of eight hooks A resting in their lowest positions on the rods B of the grate C, and the corresponding eight needles D. The needles are supported on the right by the needle-board E, and on the left by a number of horizontal wires at right angles to the needles. Each needle D is cranked as shown at F at the bottom of the illustration, and has also a loop G through which a pin H passes as indicated. The back portion of the bend G is in contact with a light spiral spring J in the spring-box K, and a pin L holds the springs as shown. These springs J keep the needles D to the right, except when they are pressed to the left by a blank part on the card M, which is shown between the needle-board E and the card cylinder N. It will be seen that, reading downwards, needles 1, 2, 3, 5, 6, 7, and 8 have passed through holes in the card and through corresponding holes in the cylinder N; but needle No. 4 has been pressed to the left, and has thus forced the hook A1 and its spring J to the left. If, now, the griffe which carries the lifting knives O were

raised, the knives would raise all hooks A except the fourth from the right; the latter hook A1 would remain down, and thus the row of hooks illustrated would

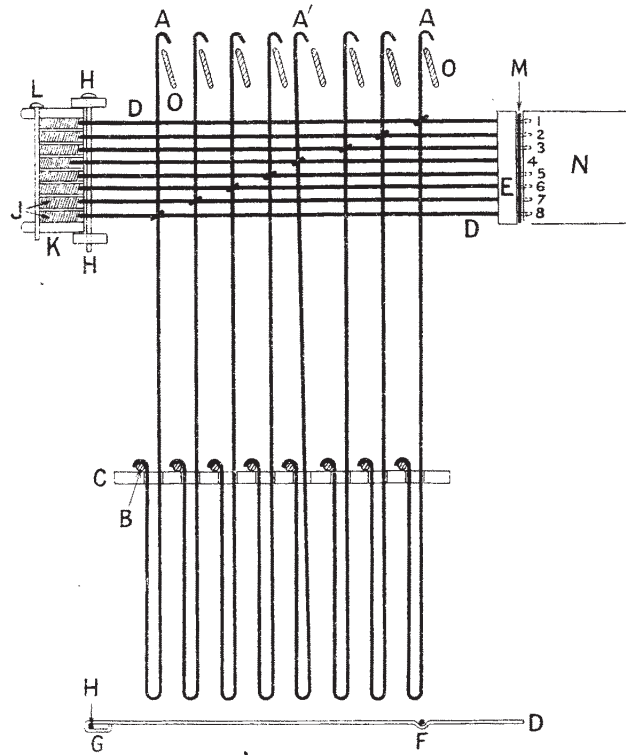


FIG. 10.

arrange the threads as follows:—3 up, 1 down, 4 up. The cards can be cut to any desired pattern, and the needles and hooks arranged in the corresponding order.

All the four faces of the cylinder are provided with holes, one hole on each face for each needle. When the

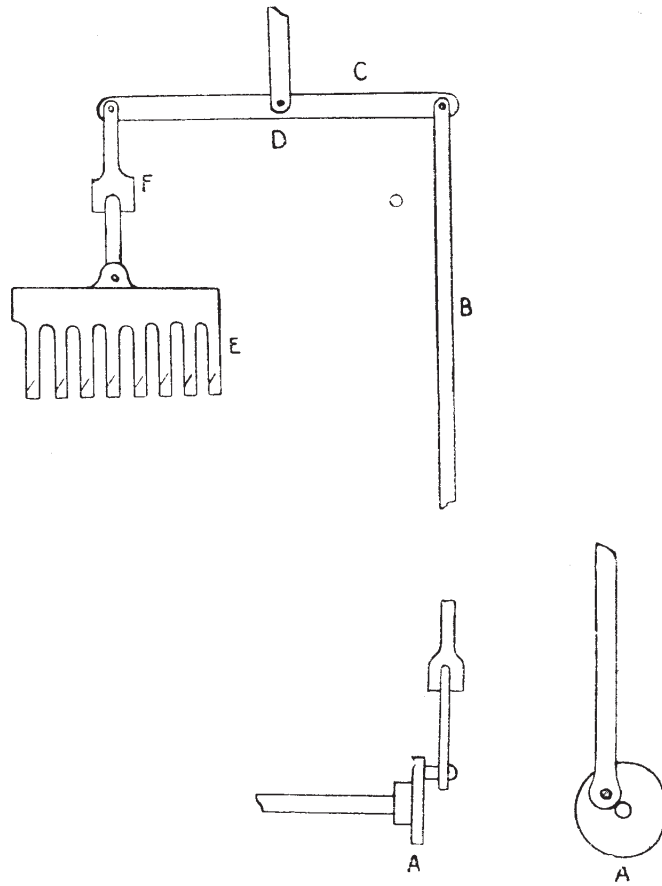


FIG. 11.

griffe and knives are rising, the cylinder N is moved to

the right and turned one quarter counter-clockwise to bring the next card for the next shot of weft. All the cards are laced together so that they may move round and round to repeat the pattern.

How the machine is driven.—The griffe is raised by means of a crank. This crank may be a simple lever, or it may consist of a disc from which projects a stud; it is placed on the outer end of the crank shaft of the loom. The disc has a slot in which the stud for the connecting rod is fixed, and in which it can be moved to regulate the depth of shed required. This movement is simple, and is fully shown at fig. 11. A shows the disc on the end of the crank shaft of the loom. As it revolves it moves the connecting-rod B up and down; the latter is connected to lever C pivoted at point D (the support of which is often taken from the roof of the shed), the other end of lever C being connected to the griffe E carrying the knives that lift the hooks. In this griffe the ends of the eight knives are shown near the ends of eight depending arms, because the particular griffe illustrated is for what is known as a double-lift Jacquard. For single-lift Jacquards, such as that shown in fig. 10, these arms of the griffe in fig. 11 are not required, and the knives are fixed in the solid part immediately above the arms. It will be noticed that both these connecting-rods take the form of link motions. Any skilled mechanic will at once understand that this is necessary to prevent overstraining in any part of the movement.

There are two distinct kinds of mechanism used for operating the card cylinder. One is known as an "independent cylinder motion," one type of which is illustrated in fig. 12. Motion is imparted from the crank shaft of the loom, and the mechanism is worked

by an eccentric instead of by the disc used to move the griffe. We may notice in passing that the larger the disc the greater will be the dwell given to the cylinder in its approach to the needles. The eccentric on the crank shaft moves the connecting-rod A upwards and downwards; the rod A is connected to lever B, and this lever is fulcrumed at C (a rocking shaft in a bracket

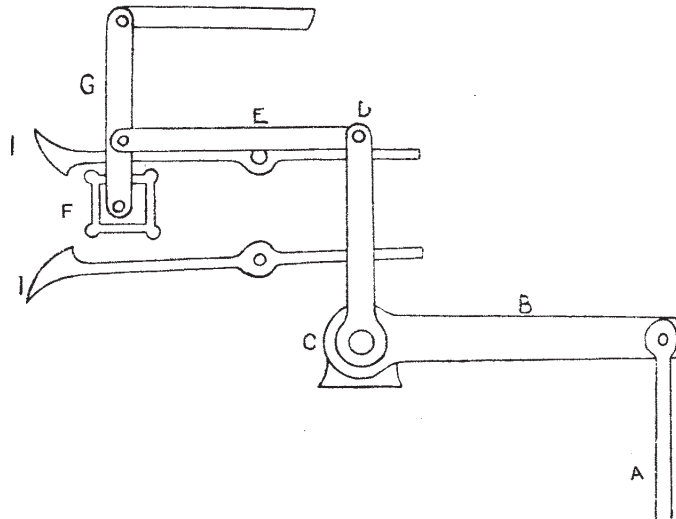


FIG. 12.

sometimes fixed on the framework of the machine). The other end of the lever is connected at point D to a link E, and the opposite end of this link is attached to the cylinder batten G. The batten or frame G is fulcrumed on a bracket attached to the top of the Jacquard, while the lower ends of the batten support the cylinder F. As the lever D oscillates, the link E carries the batten G to and from the machine, and thus carries

the cylinder to and from the needles. The card cylinder has to be turned one quarter round, bringing a new card every time it comes forward. This is done by what is called the shears or catches, shown at H and H1. The cylinder swinging in the lever G as it moves back is caught by shear H and turned round one quarter, bringing another card with it. The use of the under part of the shears will be explained presently. We may explain here that the cylinder extends quite across the machine, with the same arrangement of levers except B on the other side. It is made of wood, and, as already explained, is perforated with holes on each side exactly

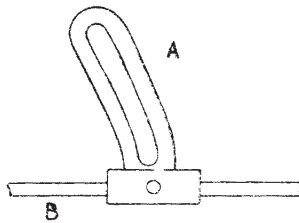


FIG. 13.

opposite each needle in the machine. Thus any needle whose hook requires to be lifted will pass through the pattern card and leave the hook in its place to be lifted by the knife O, fig. 10, in the griffe as it comes up. The ends of cylinders are provided with iron ends, termed lanterns, with a knob at each corner: it is by means of these knobs that the cylinder is turned by the hooked part of the catches H, fig. 12.

Another arrangement for moving the cylinder.—The second and most largely adopted kind of cylinder motion is that known as the “swan-neck” motion, part of which is illustrated in fig. 13. In the slot of the

swan-neck A is an anti-friction bowl carried by a stud projecting from the end of the griffe. As the latter moves upwards and downwards it will be easily understood that the swan-neck will move backwards and forwards, and the cylinder with suitable attachments being connected to rod B will move with it. The slide brackets for the rod B are fixed to the machine.

The cylinder reversing movement.—In the foregoing paragraphs we have endeavoured to show the main principles adopted in the mechanism for Jacquard weaving. There is the lifting of the hooks to form the shed, and the bringing forward of the cylinder with the pattern card to move the needles and so regulate what hooks are to be lifted. There are other movements which might be called auxiliary movements. The one with which we are now to deal—the cylinder reversing movement—is a necessary adjunct, for the following reason. In weaving of all descriptions a flaw will take place now and again. A few shots will have to be picked out, and, of course, the yarn will have to be rolled back on the beam until the fell of the cloth comes to its proper place again. Consequently in Jacquard weaving the card cylinder must be turned back also until the card turns up to match the place of the pattern where we are again to make a fresh start.

Fig. 14 shows what we might call an escapement movement, and represents the “duck-bill” motion employed, amongst others, for that purpose. The lever A is put loosely on the rocking shaft B; this lever is moved by the connecting rod C from an eccentric on the crank shaft of the loom. Beyond lever A is another lever fixed to the rocking shaft, and carrying the connecting rod D which works the cylinder movement. The manner in which this lever A, being loose on the rocking shaft,

comes to work them all is this: to the rocking shaft is fixed the handle E, of which the quadrant F forms part. It will be noticed that there is in the middle of the quadrant a notch which will hold the square pin attached to the lever. Now so long as this pin remains there, the lever A will work the whole arrangement. Then when it is necessary to turn back the cylinder, we must sever the connection of the lever E, quadrant F,

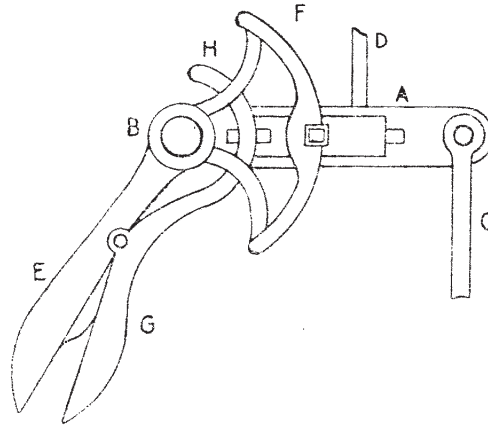


FIG. 14.

and the lever connected to rod D from the driving eccentric on the crank shaft by disengaging the pin from the notch of the quadrant. This is accomplished by compressing the two halves of the handle with the hand. The part G is fulcrumed on E, and its curved end H works between two pins, not shown on the drawing, but which project from the plate to which the square pin is fixed. This plate with pins attached is movable, and when the two parts of the handle are pressed together the

square pin is pressed out of the notch in the quadrant, and leaves the whole arrangement, except lever A and rod C, free to be worked by hand. This fig. we hope is clear enough to show all this.

To complete this backward movement we must refer again to fig. 12 to explain the use of the under part of the shears H and H1. These are attached to each other by a piece of wire, and simply by pulling a cord fixed to their right extremity, H is taken clear of the lantern and H1 brought up, so reversing the cylinder when the latter moves out. When the handle E, fig. 14, is let go the spring between will bring back the pin to the quadrant, and all will go on again as usual.

The single-lift machine.—The main features of the single-lift machine are those we have just described. The type of shedding made by this mechanism is termed “bottom shedding.” The shed is closed at the bottom, and the threads that rise to form the upper part of the shed have to move the whole depth of the shed every time it is formed. This method of shedding makes good cloth, but the loom cannot be driven at the highest speed. This will be more fully explained further on.

The double-lift machine.—The griffes of this machine work oppositely to each other on the centre-shedding principle, but the shed formed by the threads is on the semi-open principle. The rod and levers for the griffes are driven by a double crank from the tappet shaft. There is no need for an illustration to explain this. As the yarn has not so far to move in forming this shed, as it has in the single-lift machine, the loom can be driven slightly faster. It will be obvious that in this case, with one half of the shed falling while the other is being raised, double the number of hooks used in a single-lift machine will be required, because each set of knives must have its

own set of hooks : and as there is only one set of needles, each needle must control two adjacent hooks, one for each griffe. These two hooks are connected together by means of two cords, or else by the newest arrangement for this purpose, one that is widely adopted, consisting of

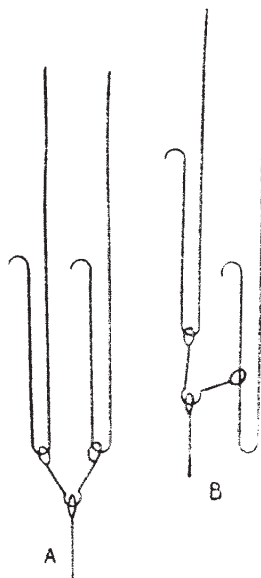


FIG. 15.

a patent link connection, as shown in fig. 15. A is the position of the link and hooks when the griffes are level ; B shows them when one griffe is up and the other down. The rising griffe picks one hook up at the centre of the shed while the other griffe is falling with the other hook, still lifting the same neck cord when necessary to form

the pattern. This connection has several advantages over the old system.

These double-lift machines are wrought either with one cylinder or with two cylinders. In the case of one cylinder only one row of needles is necessary, each needle being connected to two hooks. This method of weaving causes great pressure on the cards, which in consequence soon get worn out. The machines with one cylinder cannot be driven at the highest speed, so that for some purposes two cylinders are used. In this case they are driven by an eccentric from the tappet shaft. Both cylinders may be connected, one going out when the other is coming in, and one eccentric will drive both. These cylinders only move at half the speed of the single cylinders, at once saving the pattern cards and allowing the machine to be driven at a higher speed. All the hooks in a double-lift single cylinder point in one direction, but it will be noticed, in reference to fig. 16, that the hooks for a double-lift with double cylinder are differently arranged from those of the single cylinder. The hooks, of which only four instead of sixteen are shown in fig. 16, are still in pairs, one from each pair being controlled by the cylinder on the right, and the other from each pair controlled by the cylinder on the left. All hooks must point towards their own cylinder, and since the hooks are moved in opposite directions by their respective needles, one set of knives are inclined in the opposite direction to the other set, and the knives of each set, when lifting, take their particular hooks with them when the threads controlled by the hooks are required at the top of the shed.

The twilling Jacquard.—There are many machines made and used for special purposes. The twilling Jacquard is perhaps the best known of these. It is

intended to take the place of the loom used for pressure harness weaving. A considerable number of these machines, somewhat different in their construction, have been patented and put on the market, many of them good in their way no doubt, but all seeking to work out the same principle, namely, inserting the weaves for the ground and figure of the cloth without using a

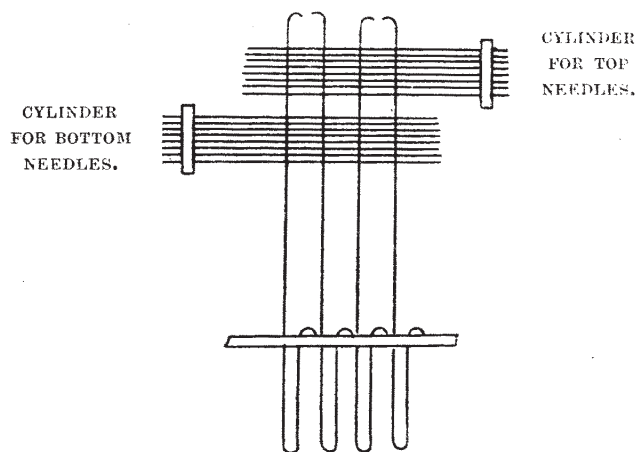


FIG. 16.

pressure mounting. The pressure mounting is a set of twilling shafts in front of the harness, with their threads passing through the harness. The twill forms the ground-work of the cloth, while the harness throws up the pattern. This system of weaving belongs to a time previous to the introduction of the Jacquard, and is practised still, to some extent, in parts of England where some of the finest fabrics are produced, both by hand and

power loom. It is to combine these two movements then that the twilling Jacquard machine has been introduced, thus dispensing altogether with the heddle leaves.

The construction of the twilling Jacquard is somewhat different from that of the ordinary Jacquard machine. It has the usual set of needles, but twelve in a row instead of eight, and they are much larger than the ordinary needles because they have to control two, three, or even four hooks each. Such a machine may therefore contain as many as forty-eight hooks in one row. In addition to these needles and hooks, there are some twilling needles or bars which control one-fifth or one-eighth of the knives, somewhat as illustrated in fig. 17, according to the kind of weaves which are to be

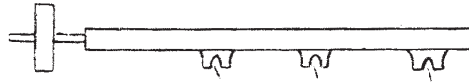


FIG. 17.

introduced in the cloth. The movement of the twilling bars is due to a small "barrel" fitted with studs according to the weave, and the notches which fit over the knives turn the latter out of the way of the hooks at the proper time. The action of the twilling Jacquard is the same as that of the single-lift machine. The griffe rises and falls every pick, and the cylinder, which is operated by a swan-neck, moves out and in, but does not turn until two or more impressions of the card are made. This latter, it will be at once understood, necessitates a different arrangement of the shears. They are placed in a position so that the cylinder will pass and repass without touching either. This is accomplished by

means of a tappet, as shown at fig. 18. The ratchet wheel A is attached to the tappet B on which the anti-friction roller C of the shears is resting. The shears, which are often made in two or more pieces, are fulcrumed at D. The ends of the griffe blocks are shown at E and F; the latter operates the swan-neck G as already described, while the former operates the rod H and lever J. Attached to the lever J is a pawl (shown

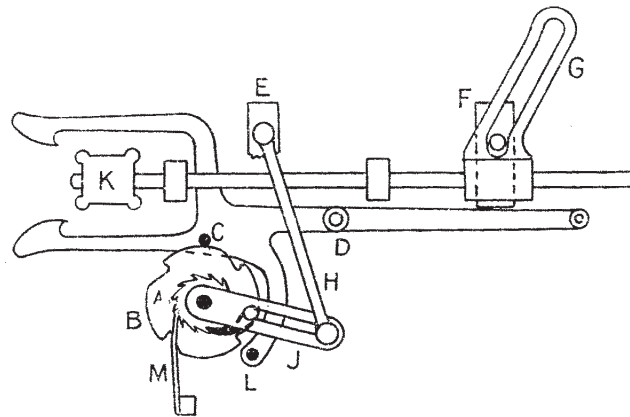


FIG. 18.

in solid black) held in contact with the teeth of the ratchet A by means of a light spring. As the griffe descends the pawl moves the ratchet A one tooth clockwise, and thus causes the cam B to make one revolution in twelve picks. The bowl C of the shears is on the thick part of the cam, and hence the cylinder K can move to the left without coming in contact with the catches of the shears. When, however, the bowl C drops into the recess of the cam B, the upper catch of

the shears will turn the cylinder K as the latter moves outwards to the left. The bowl on the end of L is for use when the lower catch is required to reverse the direction of rotation of the cylinder. The arrangement shown is for three picks to each card, the shears remaining where they are for two picks and then lowered to make a change after the third. Twelve teeth in ratchet A ÷ four divisions in cam B = three picks per card. The spring M serves as a retaining catch.*

Jacquard and tappet shedding compared.—Jacquard shedding, ingenious as it is in the way of producing patterns, has not nearly reached perfection. Tappet shedding, imperfect although it may be in unskilled hands, is the only method at present known by which a real substantial fabric can be produced. Take a heavy canvas for instance. This is almost as easily produced as a light calico by tappet shedding. The reason of this is that the crank is employed to close and open the Jacquard shed. A crank cannot be manipulated or altered to suit any circumstances, as there is little dwell on it. This is well known in the trade, and some have substituted box tappets for the crank, but the general way of driving Jacquards is by means of an ordinary crank or an eccentric. Sufficient dwell is usually obtained by either, and the movement to the harness is smooth. If the movement is jerky in any way, it causes breakages in threads and cords, and has thus a tendency to destroy the appearance of the cloth. The slower and more eccentric the movement given to the harness and heddles the better. In tappet shedding (as has been explained under the heading, "Beating up the

* For a complete description of this and other types of Jacquards, the reader is referred to pp. 204 to 315, "Jute and Linen Weaving: Mechanism," by T. Woodhouse and T. Milne.

shot") the shed must be as nearly as possible full open when the shot is beaten up, in order to put a good cover on the cloth. This is not so easily accomplished with the Jacquard machine, hence the lack of that firmness so necessary in all good cloth. It is the shedding movement that is mainly responsible for the quality of cloth in all sorts of weaving. Hence the necessity of being careful in the construction of all its details.

THE CONE PICK.

The unsatisfactory condition of the movement.—If the shedding movement is mainly responsible for the quality of cloth produced, it is the picking movement that is mainly responsible for a good or bad working loom. If the picking mechanism does not run smoothly it becomes very expensive in its upkeep. Being aware of the unsatisfactory condition of this movement still prevailing in some districts, we have gone anew into the whole subject with the assistance of an expert in order to find out what a really good working cone pick should be. After experimenting on the subject, we found that what we were really looking for was already in operation—a good working movement. We will endeavour to explain the principal features of this movement as we proceed.

Causes that lead to an unsatisfactory movement in the "cone" or "over" pick.—It will be as well first of all to point out the causes that lead to a bad working movement, and then proceed to show how they may be remedied. In some cases the tappet is either too long or too short. Judging from the various positions and lengths of the picking arm employed by different makers, its exact position and length has up till now been entirely

overlooked. This will be found to be a matter of some importance, and worth more consideration than has hitherto been bestowed on it. The cone or anti-friction roller on which the tappet acts in most cases is too small in diameter; it allows the point of the tappet to get almost under it, thus causing a jerky movement. The tapered sides of the roller or cone are in some cases too steep. When the tappet gets worn a little and is moved nearer to the frame, it acts on a smaller diameter of the cone or roller and alters the direction of the force. This causes a harsher working movement, which can only be remedied by renewing the tappet. The relative positions of the tappet and roller are often wrong. Sometimes sufficient provision is not made for the proper adjustment of the tappet and roller to each other in their vertical position, and in this case much of the force is sent in the wrong direction.

The length of tappet considered in relation to the length of picking arm.—The evils resulting from a tappet which is too short are so well known that we need not discuss them here, but it has been the tendency in some quarters for many years past to go to the other extreme and increase the length of the tappet, with a view, it is said, of smoothing its action. The length of the tappet should of course be sufficient for the force required, but the outline of that part which imparts the final movement to the picker and the shuttle should not be too much curved or hooked, otherwise a harsh pick results. That part of the tappet which draws forward the stick to tighten the strap, and that part from this position to the final movement should cause the stick to move smoothly, and gradually to increase its speed in order to minimise jerkiness. A smooth working pick will do much to reduce the great expense of the upkeep.

To obtain a smooth and satisfactory movement the height and length of the picking arm, and the actual point at which it is fulcrumed, must be determined with considerable nicety. The position of the upright spindle or axis on which the arm moves will be considered in the combining of the different movements of the loom. In the present connection, however, we notice that the point of this arm where it is connected to the picker will be in the centre of the lay's movement backward and forward immediately above the picker, and its height such as will give the least possible slack in any part of its movement. The position at which it is fulcrumed back in the loom, as we have already hinted, is determined by other considerations, which will be considered in the proper place, but its position in or outwith the end frame will be determined in great measure by the length of the shuttle box of the lay. The face of the tappet, as we have seen it, varies very little from that of a straight line. We may mention that we saw some looms working some time ago varying in breadth from one to two yards, with little or no slack at all in this movement. Some of them even did not possess the usual strap connecting the point of the arm with the picker; a wooden connection had been introduced into its place. Two views of this wooden connection are shown at A B (fig 19). There was no slack in the working of these looms.

How the force applied by the tappet should be transmitted to the shuttle.—Bearing in mind that the action in this movement partakes entirely of the character of a blow, the more direct this blow is given from the revolving tappet to the shuttle, the more effective will it be, and the less will be the expenditure of force; at the same time all the jerkiness common

in some looms is done away with. The force is transmitted through a two-armed lever, fig. 20, the short arm of which is the stud A to carry the anti-friction roller on which the tappet acts. B is the wooden arm, of which the extremity is attached to the picker by a strap or cord. This arm or lever is fulcrumed on the upright spindle. The length of that spindle is of no importance beyond that of raising the arm to its proper height, provided it is strong enough to resist the torsional strain

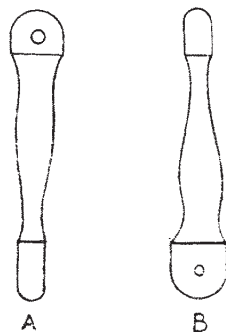


FIG. 19.

thrown upon it. The most important feature here, then, is the direction in which this force is applied to the short arm A, fig. 20. This should be done as nearly as possible at right angles to the axis of the upright spindle. What is meant by the direction of the force will be better understood with reference to figs. 21, 22, and 23. We can always start with this force at right angles, as shown at fig. 21. The direction of the force can always be determined by drawing a line D, fig. 22, tangent to the circumference of the anti-friction roller at

the point of contact with the tappet, then setting off a line E from this point of contact at right angles to the line D. This will give the direction of the force in relation to the axis or centre line of the upright picking shaft. It will be noticed that the direction of force is more or less upward in figs. 22 and 23, instead of being

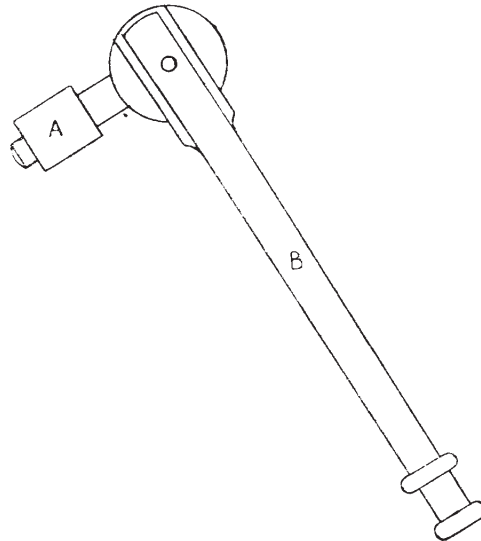


FIG. 20.

horizontal. It is impossible, under present conditions, to keep the direction of force horizontal, but the nearer it is to this the smoother will be the movement.

The method of constructing the picking cam.—To facilitate the proper adjustment of this cam it should be made up of three parts, as shown at figs. 24 and 25.

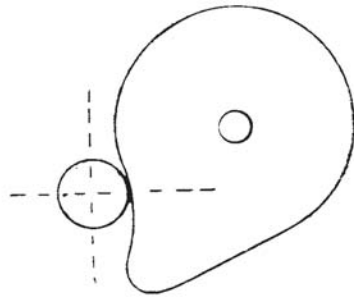


FIG. 21.

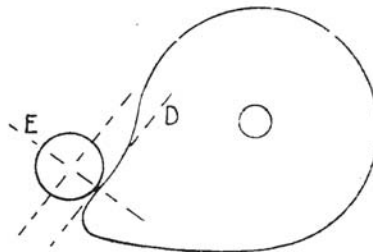


FIG. 22.

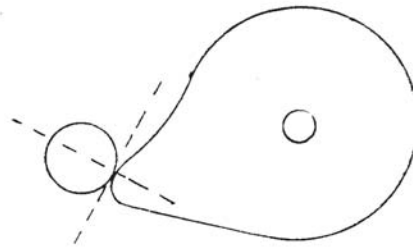


FIG. 23.

The socket or truck A is fixed to the shaft, with provision made so that it can be moved either to or from the fulcrumed centre of the picking lever (the upright picking shaft) in order to strengthen or weaken the force of the blow, as circumstances may require. The disc or plate B attached to the socket is made to move round in order that it may be minutely adjusted as to time. The tappet point C is a separate piece, so that it can easily be replaced when worn out.

The face of this tappet, and also the disc, should be

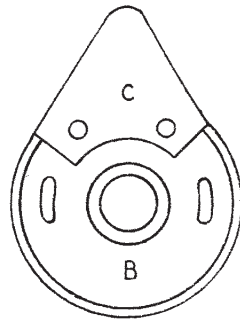


FIG. 24.

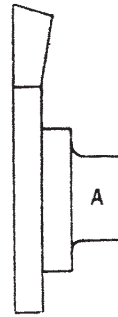


FIG. 25.

so shaped that they will have a proper bearing with the anti-friction roller during the whole of their revolution. The point of the tappet must also be well rounded, otherwise it will soon get worn out.

The vertical adjustment of the anti-friction roller.—This is a point of considerable importance—the height in the loom of the stud that carries the friction roller in relation to that of the picking cam. It is the relative

position of these two parts that in great measure determines the direction of the force. By the lowering of this stud in relation to that of the position of the cam we send the force more in a straight direction and thus soften the whole movement. This can be seen by a mere cursory observation. Now, in order to obtain the best results this must be determined to a nicety. There are many makers who, after determining the relative position in height as to stud and cam, make this stud a fixture. Opinions differ in relation to the fixed or movable stud for the cone. If looms of the same breadth and maker are examined it will be found that the smoothness or harshness of the working of these picks varies considerably, even the two movements on one loom sometimes vary to a considerable extent, and that too without any apparent cause. It would appear that the remedy for this is to place that stud in a slot in the upright picking shaft or spindle, so that a thorough adjustment can be made at the outset. And, moreover, during the working of the loom the tappets by and by get worn, and the cams have to be moved in to strengthen the force. It will then be found, by all who care to notice, that when this takes place with a cone-shaped roller this stud requires to be lowered in order to maintain the same smoothness in working—the same direction of the force. It must be lowered just in proportion to the amount of taper on the roller; with a parallel roller this may not be necessary. On the other hand, we know that where this slot is used there is a greater tendency for the stud to become loose in the process of working. If the stud can be securely fixed, and if those in charge know how to determine the proper position in the slot for the stud, the apparent advantages would become real ones.

Two methods of driving the loom.—The loom may be driven with the crank moving downwards as the reed is approaching the fell of the cloth, or it may be driven in the opposite way so that the crank is moving upwards as the reed approaches the cloth. Each system has its advocates, and there are advantages in both. With the former method or “downward beat,” the picking position is near the bottom centre, and the crank is up when the leaves for plain cloth are level; in the other or “upward beat” loom the picking position is at the top centre, and the crank is down when the two leaves are level. It will be seen that the latter method makes it easier for the weaver to repair broken warp threads; with the downward beat loom the crank sometimes falls to the bottom centre and the leaves are then full open; before the threads could be repaired easily the crank would have to be turned to the top centre.

The sum of the whole matter.—We can now summarise what constitutes a good working picking movement, and how to find it. The most important feature then is to get rid of all the slack, and make the tappet just of sufficient length to propel the shuttle. This is done by finding the exact pose, as we may call it, of the picking arm; that is, to put it in a position in the loom and make it of such a length that there will be very little slack at any part of the loom's movement. The other all-important consideration is how to apply the force of the blow in the right direction. This is accomplished by finding the correct relative positions of the cam and anti-friction roller on which it acts; and to insure the continuance of a good working movement, we must make arrangements for the readjustment of the movement under any conditions that may arise. We shall have something more to say about the pick in another connection.

THE UNDER PICK.

The under pick : its advantages over the cone pick.—

The principles that govern the under pick are the same as those which govern the over, or cone pick. The lever A, shown in figs. 26 and 27, is for practically the same purpose as that in fig. 20. In the under pick, however, the end of the stick is in close contact with the picker. The picking mechanism in figs. 26 and 27, without the framework, shows that the picking arm A is attached to a socket fulcrumed at B, a point on the rocking shaft, the arm A passing up through the lay. This arm, it will be noticed, is in turn acted upon by lever D, fig. 26, fulcrumed on the end frame at G. The end only of this lever D is shown in its slot in fig. 26, and in contact with the short metal arm projecting from the bracket B in and to which the lower end of the picking stick is fixed. Then comes the tappet E and anti-friction roller F. The anti-friction roller on the end of the cam shaft in this case acts on the tappet, whereas in the cone pick the tappet acts on the rollers. This tappet or plate E, as it is frequently called, very often takes the form of a small point. It is made movable on the lever D, and so also is the anti-friction roller on the socket attached on the cam shaft, to admit of adjustment as to time and strength.

The advantages of this movement over that of the cone pick are : first, it is more direct, making it more suitable for high speed looms running a light shuttle ; secondly, it is much cleaner than the over pick. The spindle on which the picker of the over pick moves requires to be oiled frequently. Sometimes too much oil is put on ; it is thrown about by the action of the pickers, and would be ruinous to some kinds of cloth. This does not occur in the under pick.

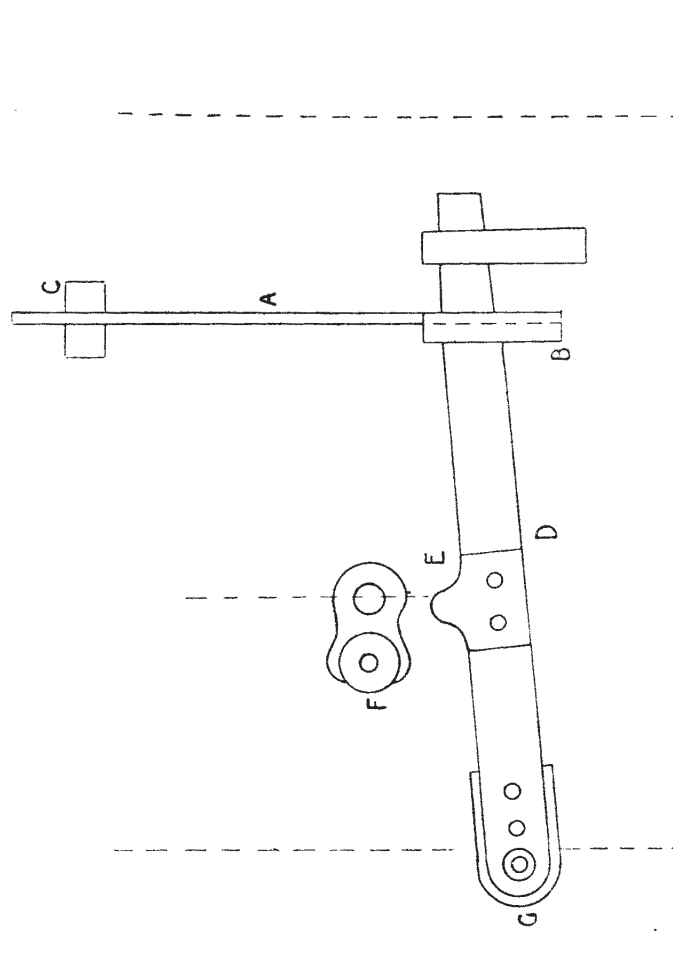


FIG. 26.

The disadvantages of the under pick and how they are being met.—The great defect of this movement is, that the top end of the picking “stick” A, figs. 26 and 27,

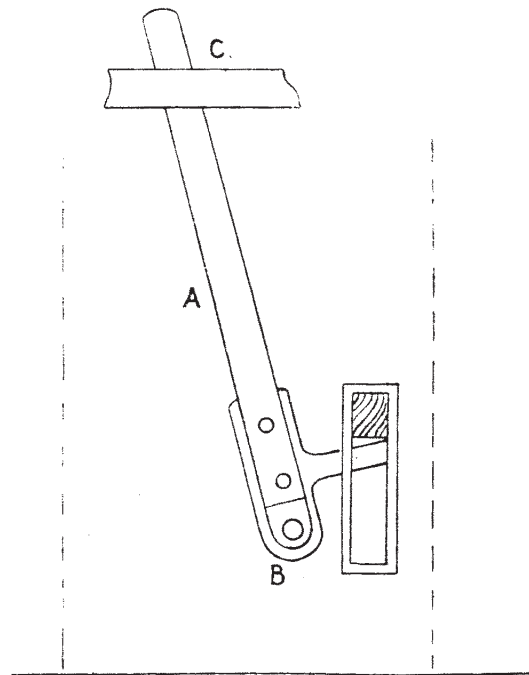


FIG. 27.

in the older type of looms moves in the arc of a circle instead of moving parallel to the box; the movement is therefore unsatisfactory as the sliding action of the stick inside the picker is apt to impart a faulty movement to

the picker and shuttle. In recent years the difficulty has been overcome, and a perfect horizontal movement of the end of the stick is obtained. A device which has been tried in at least one large factory, and which we have permission to describe, is illustrated in fig. 28. If it is of any practical value to our readers, a trial of it will cost little. The arrangement is shown at fig. 28. In



FIG. 28.

the picker, dropped over the end of the picking stick, there is a projection shown at A. This projection is made no deeper than what will cover the end of the shuttle in its movement along the box of the lay, and it is made with a curved face so that it will be in easy contact with the shuttle without disturbing its direct movement.

Why always buffalo hide for pickers?—We have frequently heard it asked, Why always buffalo hide for pickers? It is dear, and is always getting dearer. Is there no other material that can be used with more economy in the working of a loom? We have heard compressed paper mentioned as the substance of which

the picker of the future will be made ; or something made out of the same fibrous material compressed to a proper consistency might be used for the purpose.

BEATING UP THE SHOT.

What actually takes place in the making of cloth in the loom.—The three principal movements are shedding, picking, and beating up the shot. To understand exactly what is going on we must consider this latter movement in conjunction with the other movements of the loom. Beating up the shot is an expression borrowed from the hand-loom weaver, and in connection with power-loom weaving is used to signify the same process, namely: that of placing the warp threads in their proper position by the action of the reed. That action, for certain kinds of light cloths, should take place just at the moment the shed is full open, when the lower warp threads are held tight. In every case of this kind the conjunction of shedding and beating up as to time makes the best cloth ; but in many instances the yarn employed will not bear the full stress of weaving in this way, and in that case we must ease the shed perceptibly, so that it will not be so full open as the reed begins to recede from the fell of the cloth. In heavy work it is necessary that the shed be held tight when the shot is beaten up. There is a common saying amongst those employed on heavy work that with this conjunction of shedding and beating up “the cloth takes the weft much easier.” The explanation of this is that if the warp threads are not closed over the thread of weft just put in before the reed begins to leave it the weft has a tendency to spring back.

It is this shedding and beating up of the shot that draws the yarn from the beam, not entirely the take-up motion as some would suppose. The take-up motion commences to act just about when the tension is partially removed from the threads, and continues to act until the reed reaches the cloth; it will therefore help the shedding and beating-up to draw forward the yarn from the beam. We know that various automatic let-off movements have been put on the market, but as none of these has been adopted extensively on plain looms, we shall not consider them at present. The old friction let-off puts no more strain on the yarn than what is required in the process of weaving. Its defect is that it requires too much attention. As the yarn comes off the beam or roller the combined diameter of the beam and the yarn on it becomes less, consequently the friction must be eased at short intervals to keep the yarn at a uniform tension. That a simple automatic movement is required there is no doubt, but so far as we know that movement has not yet been evolved.

The beating up of the shot can take place only when the reed is on the front centre, but the other movements should be placed in time with it where such timing is possible.

We now see exactly what correct weaving should be. The shed is opened to take in the pick, and gradually closed over it while the reed is taking the weft forward to the fell of the cloth, these actions culminating, so to speak, in the warp threads gripping the weft and holding it at the fell of the cloth even after the reed leaves it. After the reed has left the cloth and travelled approximately half its stroke, the shuttle is sent across. Theoretically the shuttle should be half-way across when the reed reaches the back centre; immediately after this

the uptake motion commences to act, and continues to do so until the reed reaches the front centre again.

Now, how does the take-up come in to regulate the thickness of the cloth? It does so in connection with the let-off movement. It is known at what speed to drive the take-up roller to produce a certain number of shots per inch, and the let-off has to be weighted accordingly; the shed and beat-up will then only take what is necessary for the particular weave.

TO COMBINE AND HARMONISE THE THREE PRINCIPAL MOVEMENTS OF THE LOOM.

The relative position of the principal parts of the loom.—The combination of the various movements of the loom are about as varied as the makes of looms, and hence the difference in the working of the machine. It is a matter of astonishment that no fixed rules have hitherto been laid down for the guidance of makers in determining the relative position of these three movements. This is just of as much importance as the working out of the details of these movements. We attribute this laxness to the conservative nature of the manufacturer—"What has done good service in the past will do very well for the present." This state of things cannot go on, as we will show further on in the book. Taking the best practice in the country, we will endeavour to assist in establishing some rules whereby the relative position of these three movements can easily be ascertained.

We may put it down as a fixed rule, which, we think, no one will care to dispute, that the three principal centres, namely, the crank shaft, the tappet shaft, and

the rocking shaft, must be fixed centres. The same principles will guide us in determining these centres in working out machines, either for light, medium, or heavy work. The guiding principles are the same throughout. These centres when found will determine the shape and form of the end frame, differing only in strength to suit light or heavy work.

The rocking shaft, the swords, and the lay.—First, we take the pivoting point or fulcrum of the swords. The rocking shaft is placed low in the loom. For heavy work it is attached to the sole plate of the end frame, as the latter gives stability, and reduces to a minimum the radial movement of the lay (or slay). The length of the swords, and consequent height of the lay, will be determined by the height of the front top rail, or what is sometimes called the “breast beam.” With the cloth passing over this rail, the lay thrown back, and the shed opened, the lay should just touch the under half of the shed. Makers differ considerably in fixing the actual height, but we think no difficulty will be found in fixing the most convenient height for the weaver to attend to his or her duties; then by drawing a line representing the cloth and yarn, with the shed open, we can find the length of swords and depth of lay.

The forward position of the lay and swords, and consequently the rocking shaft, is a matter of no little importance. When the lay is forward—that is, when the shot is being beaten up—it should be as near to the front top rail as possible. Then from this point we will construct our swords so that their centre line will be in a vertical plane when the shot is being beaten up. This will determine the *fixed point* of the rocking shaft. In no case should the swords in their forward movement pass this vertical point, for if they do so their continually

passing and re-passing the centre of gravity gives them a certain amount of vibration which can very well be done without. We would also remark that at this point the reed should be perpendicular and about one inch behind the centre line of swords.

The cause of so much breakage in the swords, and its remedy.—Before leaving this subject we would like to try to find out the reason of so much breakage in the swords, and, if possible, to suggest a remedy. It is well known that they generally snap just above the rocking shaft, and in spite of all these warnings this point still remains the weakest. As these swords are still made, they are tapered up from the rocking shaft,

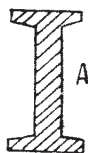


FIG. 29.

being weakest just at that point. Their cross section is shown at fig. 29. Now, as it is in the feather A that most of the strength lies, and as this feather is shortened as it reaches this point, the strength is thereby decreased. Moreover, as the impact given to the swords by the knock-off of the yarn protector, owing to the leverage of the swords, strikes this point, one would naturally suppose that this part would be the strongest. Various devices have been tried to remedy this. One of these is by making the swords of T-shaped malleable iron bolted to a flange wrought on the rocking shaft. The cure here is worse than the disease. The bolts get loose, the holes get worn, and all get shaky, with the lay out of

position. Cast malleable swords have also been tried, but being of a flexible nature they bend. There is therefore nothing left but to revert to true mechanical principles, maintaining the rigid cast iron, and giving strength where most required.

The position of the crank shaft in relation to the swords.—Seeing that the crank shaft is the prime moving factor in the loom, from which all the other movements take life, it might have been thought that in this connection we ought to have commenced with it first, but it will be already seen why we did not. The height of the end frame and the length of the swords are intimately connected. Having found that, we proceed to place the crank shaft in the proper position to give the lay the correct movement.

Since the shuttle is crossing the shed when the lay is approaching and leaving the back centre, the lay should travel at its slowest rate during this period. The very fact of the crank passing the back dead centre when the lay is full back results in a slow movement to the lay. This natural slow movement may be made slower still if the crank shaft is placed—as it always is—in a lower plane than the pin which holds the connecting arm to the lug of the sword. A diagram of the lay's movement is shown in fig. 30, and in this diagram the centre of the crank circle A is in a lower plane than usual, and the eccentricity, as it is called, is greater than it would be if the centre of A were raised a little. This circle is divided into twelve equal parts, and numbered; the corresponding numbers on the arc B, which represents the path of the connecting pin, indicate the positions of the pin when the crank occupies the corresponding positions on the circle A. The twelve points on the arc B are obtained by taking a length equal to the length of

the connecting arm, and with the point of the compasses at each position on the circle cut the arc B as shown. It will be found that the slowest movement of the lay is when the crank passes from point 6 to point 8. Fig. 31 will perhaps show this a little clearer. Let A B represent the path of the connecting pin; C, the centre of rocking shaft; and D, the circle of the crank. The distances between points 1 and 2 and between points 3 and 4 on this path are the same, but it will be observed that the

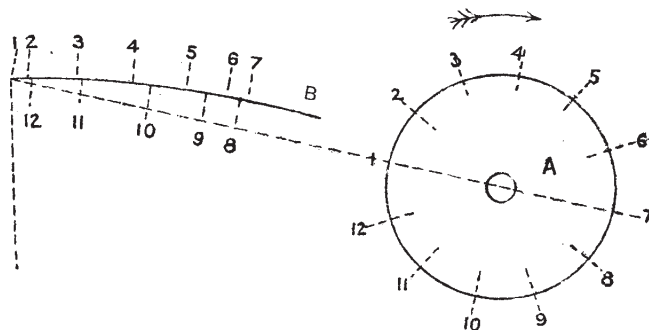


FIG. 30.

crank has moved through a larger space in the circle in moving the swords backwards and forwards between 3 and 4 than between points 1 and 2. Of course, the crank is always revolving at the same speed throughout the whole revolution, but owing to its position it gives the lay the eccentric movement shown at fig. 30.

We must, however, arrive at something more definite than this; we must find the exact position of the crank shaft. This eccentricity of the lay's movement can be varied according to requirements, broad looms requiring

a little more than narrow looms, as the shuttle has a greater distance to traverse and requires more time. This eccentricity will be in a direct ratio to the length of the connecting rod and the diameter of the circle described by the crank. The shorter the connecting rod and the larger the circle of the crank the greater this eccentricity will be, but it must not be increased beyond a certain limit. If this be done, the movement of the lay tends to become faulty, and a hesitancy takes place in the movement of the loom. Some of our readers may have in their mind's eye a make of loom with this particular defect, and they will readily understand how hopeless it is to find a remedy.

Makers are gradually approaching the following rules which we have laid down all along, no matter whether the machine be intended for light or heavy work. The throw of the crank should be no more than what is necessary to make the shed sufficiently large to allow the shuttle to pass through. When this is the case there will be less friction on the yarn in weaving, and we can drive the loom faster than with a larger throw. The centre of the crank shaft should be approximately half the diameter of the circle of the crank below the centre of the connecting pin in the sword. The reader may notice that looms that most nearly approach to this are the best working looms. The wypers should be so set that the leaves will be level, with the shed of course closed, when the crank is on the bottom centre when the loom rotates, as indicated by the arrow in fig. 31.

The position of the tappet shaft in relation to the crank shaft, the treadles, and the upright picking shaft or spindle.—In fixing this point there are three considerations we have to take into account. The first is its relative height in the loom to that of the crank

shaft. It will be remembered how we came to fix the height of the latter, the height of the swords being determined by the height of the breast beam and shed,

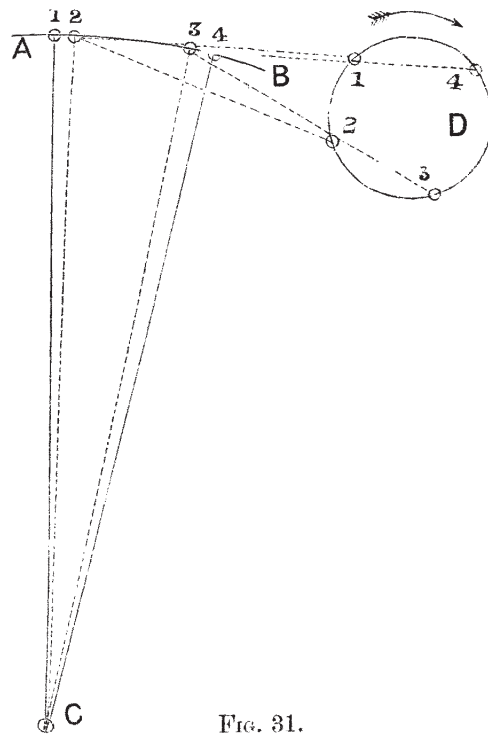


FIG. 31.

and the height of the crank in turn to give the correct movement to the lay. Then the crank and tappet shafts are connected by wheels, the number of teeth in each being as 1 is to 2. Now it sometimes happens that the

wheels are made too large in diameter. The combined momenta of these large wheels have a detrimental effect on the whole loom when spent on the knock-off movement, keys and screws are loosened, and swords and brackets are broken that otherwise could be saved, hence we see that this shaft must be brought up to a position which will give a reasonable diameter to these wheels. The same reasons apply when we say that the fly-wheel on the end of the crank shaft should be no more than a hand-wheel to turn the loom when necessary.

The horizontal position of this shaft becomes a little more complex. It is necessary to bring the shedding cams as far forward to the heddle leaves as possible, in order that we may get sufficient length of treadle to reduce its radial movement at that point. On the other hand, it is necessary to keep back considerably in order to get sufficient length of picking arm when the cone pick is employed. We must reconcile these two conflicting interests, so to speak, as best we may. It will be well to arrange for our picking centre first; then we can place the point at which the treadles are fulcrumed on a bracket considerably outside the loom, and in this way make up the length of the treadles.

The upright picking shaft.—This spindle must also be made a fixture on the end frame. In the case of the short picking tappets we have already described, it may be necessary to place the upright picking shaft on the inside of the frame, in order to find the proper place of the tappet on the short arm of the lever A, fig. 20. With long tappets and much slack to draw up, this spindle is often placed on the outside of the frame, as the arm is generally thrown excessively far back.

The distance of this upright spindle from the tappet

shaft will be as already indicated when considering the picking movement. To fix this distance, take half the

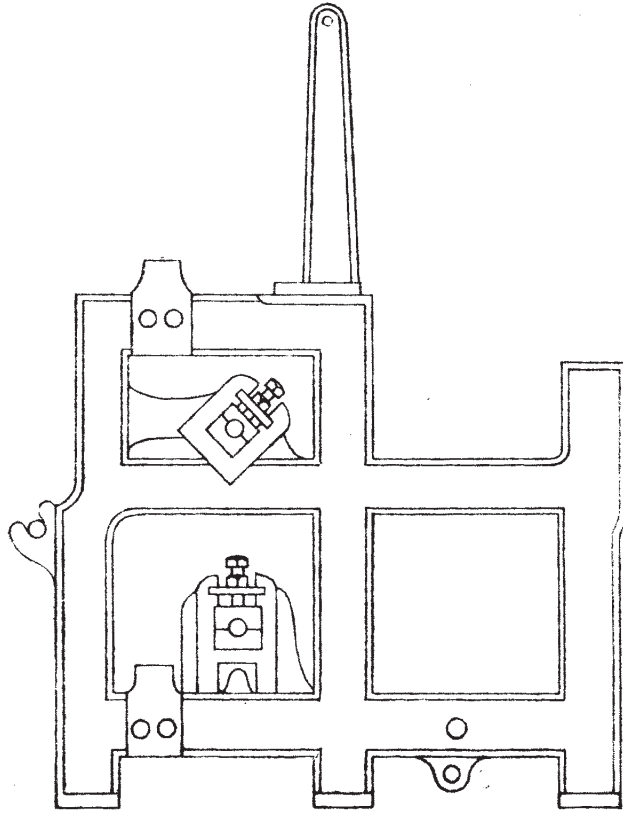


FIG. 32.

diameter of the disc of the picking cam, half the diameter of the anti-friction roller on which it acts, and half the

length of the tappet; the sum of these three will give the distance from centre of tappet or cam shaft to the

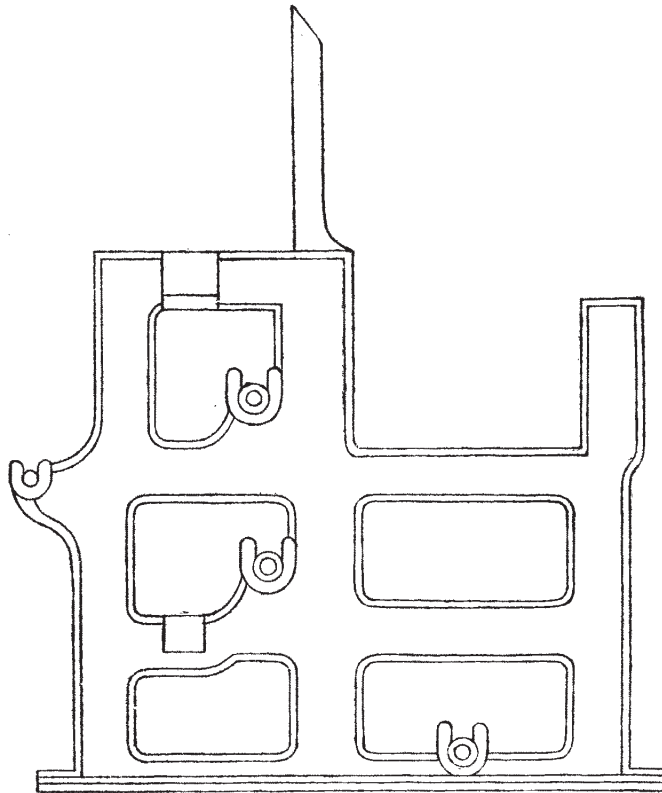


FIG. 33.

centre of the upright picking shaft. In broad looms, for the same class of work it is necessary to increase the

diameter of the disc of the picking tappet, consequently these centres will be proportionately farther apart.

The end frame.—Those who have followed our arguments will now be able to determine the exact relative positions of these centres, which now become the fixed centres in the end frame. What remains to be done is to fill in this part of the framework in a manner that will secure these centres in their proper places. Figs. 32 and 33 are reproduced here to show how this may be done for light or heavy work. The heavy sole plate on the latter gives stability, and on this can be fixed the rocking shaft.

THE POSITIVE TAKE-UP MOVEMENT.

Its action.—We have considered the three principal movements of the loom, and will now proceed to point out the noticeable features of the auxiliary movements. In doing this we shall neither occupy space nor tire the reader with lengthened descriptions of what may be learned at a glance in the workshop or factory, but simply point out and describe these features that cannot so easily be got at. It is the take-up movement in conjunction with the let-off movement that determines the number of shots of weft given to the inch or yard of cloth. As we have already dismissed the various positive let-off movements, it will be understood that we speak of the friction let-off so commonly in use. The circumference of the take-up roller being known in inches, it is only necessary to find the wheels suitable for the range of work to be produced. To begin with, the ratchet wheel may be made to take either one, two, or more teeth as may be required for the work in hand. The wheel attached to the ratchet and that on the roller

may be fixtures; the others should be made changeable. In general, however, the wheel or pinion on the same stud as the ratchet wheel is the only one that is changed to alter the number of shots per inch in the cloth. When the required number of shots has been settled, the let-off will be suitably weighted to keep the yarn at a proper tension, according to what the take-up movement may want.

The roller covering.—The cloth take-up roller is covered in various ways, giving just sufficient, and no more, frictional power to take hold of the particular fabric that is being woven. In light work a coating of emery or other similar substance may be all that is necessary. Various coverings have been patented from time to time, but when we come to heavy, coarse work, small hackle points are used. The object is to obtain a complete positive motion without injuring the cloth in any way. It is quite obvious that great care must be taken in selecting the covering of this roller just to suit the particular fabric in hand.

Driving the take-up movement.—The take-up generally takes its movement from the rocking shaft or swords. Some take it from the crank shaft and others from the cam shaft. We have seen it driven from the latter, taking away only every alternate shot. Needless to say, this latter method is detrimental even to the very coarsest cloth. It lacks that “evenness,” that “skin,” that “cover,” so desirable in all cloth. It is necessary, or at least desirable, to take away every shot. We have seen an effort made to weave “scrim” (these are thin open cloths with the threads and picks somewhat apart) with the movement taking away every alternate shot, but it proved a failure.

In these circumstances it is quite evident that the

rocking shaft and swords are not the proper places from which to take this movement, as, if so, it cannot be

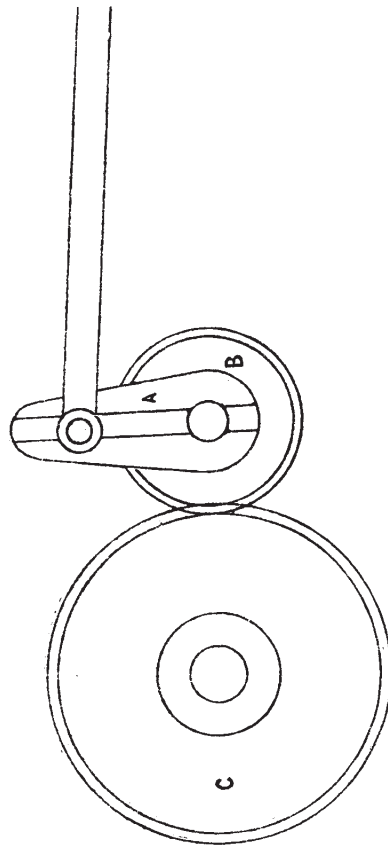


FIG. 34.

regulated as to time. The crank shaft is much better, but it is considered by some to stand too high in the

loom; consequently we are only left with the cam shaft for that purpose. This movement is taken from the cam shaft by a similar arrangement to that shown at fig. 34. A is a crank attached to wheel B, geared with wheel C, which is fixed to the cam shaft. This method will ensure taking away every pick, and will be easily adjustable as to time. Of course, the number of teeth in the two wheels will be as 1 is to 2, as two picks are made in one revolution of the cam shaft. It will be noticed that the connecting rod can be moved to or from the centre of the crank to give one or more teeth of the ratchet wheel as required.

The arrangement of the wheels in the take-up movement.—Fig. 35 shows one arrangement of these wheels that can be made to produce an almost endless variety of thicknesses of cloth. A the ratchet wheel is made with 40 to 50 teeth, and one, two, or more can be taken per pick as required. E is the roller wheel, and the dotted circle indicates the roller. The ratchet and roller wheels are, of course, at fixed points. C and D are the intermediate or change wheels, both of them attached to the same boss, and making the same number of revolutions in the same time. Arrangements, however, must be made in the loom for bringing C and D into gear with B and E, no matter what the diameters of C and D may be, as it is one or both of these wheels that is changed to a different number of teeth, and consequently a different diameter, to give a different number of shots per inch. As already mentioned, the only change wheel in many positive up-take motions is that represented by wheel B in fig. 35.

What we wish to point out more particularly in this connection is that with a proper arrangement of these wheels, and with the ratchet wheel of correct dimensions,

it is possible to take in a very wide range of "weaves" by changing one or both of the intermediate wheels, and changing from one tooth to more teeth of the ratchet wheel. Of course, it is necessary to construct the whole loom to suit the particular fabric to be produced, and this movement in particular. If this is well considered,

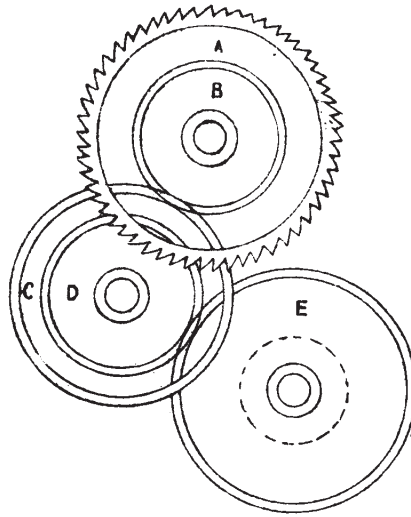


FIG. 35.

there will be no necessity for altering the conditions of the loom to suit the number of shots to be given, such as taking away only every second shot. The fault in the cloth woven by such a method of take-up—every second pick—is not so much noticed by the inexperienced if the cloth is thick, but an expert will notice it at once. It deteriorates the value of the cloth considerably. Some

think that any defect caused in this way may be remedied in the finishing. It may be hidden to some extent, but not remedied; the cloth is still of inferior quality.

A continuous positive movement not wanted.—Certain makers of looms have adopted a positive take-up movement, which gives a continuous pull to the yarn during the whole process of weaving. Whatever was the idea that prompted this we know not, but we have no hesitation in saying that the principle is altogether wrong for ordinary looms. All the movements of the loom are intermittent, and this one should be so also, and it must be made to come in at the proper time. This time we have already explained in the proper place.

THE NEGATIVE TAKE-UP MOVEMENT.

Purposes for which it is better adapted than the positive movement.—At one time the negative movement was the only one in use; but its defect, and a great defect it is, caused an outcry for a positive movement. The cloth being wound on the take-away roller, the latter with the cloth increases in diameter as the cloth goes on, and consequently requires constant attention to keep it at the regular "pace" to produce the number of shots required in any particular fabric in hand. There are some fabrics, however, for which the positive movement as we find it is not adapted. Canvas and similar cloth would require a take-away roller with hackle points, being heavily woven. Nothing else that we know of would be suitable. It will be easily understood that this would entirely destroy that class of cloth, hence the negative movement is the only known remedy for this great defect of the positive take-up movement. It will

be noticed then that both movements are really defective as we know them to-day, but we have no doubt that this being pointed out the remedy will soon be forthcoming.

THE LET-OFF MOVEMENT.

As it is, and might be.—This movement is so simple that little can be said about it which cannot be learned at a mere glance in the factory. We have already said in this connection that several makers have introduced “positive let-off movements”; these are probably quite suitable for the looms to which they are applied, but are too expensive and too complicated for simple plain looms. The defect in the negative let-off movement is the same as that in the negative take-up movement. The weight thrown on the yarn roller or beam must be such as to keep the yarn at a uniform tension, just in accordance with what the take-up wants; and as the yarn gradually moves off the beam the diameter of the yarn and beam gets smaller, and necessarily wants to move faster to give off the same amount of yarn at each pick. Consequently this friction requires constant attention, in order to keep an equable tension throughout the whole weave. There is no doubt whatever but that a suitable simple movement without much machinery about it is really wanted in this connection.

The proper tension of the yarn in the loom.—There must be a uniform tension throughout the breadth of the cloth in the loom as well as the length. This implies—and is worthy of notice here—that all the beams, rails, and rollers of the loom must be parallel to each other, and further, that the yarn must be wound on the beam with an equable tension throughout its whole breadth.

To the first of these we would direct the attention of the loom maker, and to the latter that of the factory worker. This tension may also be made unequal by the unequal trimming of the heddle leaves. Experience will also teach those who have to deal with it that the proper regulation of this tension will, in great measure, determine the quality or appearance of the cloth as it is formed in the loom.

The put-back motion.—The put-back movement in connection with the warp is of some importance. Sometimes a float or other similar cause may necessitate picking out some of the weft threads. Consequently the yarn beam must be rolled back until the fell of the cloth comes to the reed again before putting on the loom. Many looms are made with a movement of this sort, but sometimes it is very unhandy; it should be made so that the weaver can control it easy from the standpoint of the set handle of the loom.

Another cause which renders this movement almost useless is the practice of winding the friction rope (when that method is employed) several times round the friction roller of the yarn beam. It is not easy to loosen this by a touch of a lever, so that this method of tensioning should never be employed. This operation should be easily performed, and in as short a time as possible, by touching a lever to raise the weight, and by turning a small hand-wheel to put back the yarn roll. An iron brake, clothed with leather, passing about three-fourths round the friction roller on the yarn beam or roll, tightened by screws to suit the fabric to be produced, would be quite sufficient for the purpose.

THE YARN PROTECTOR—AUTOMATIC STOP
MOVEMENT.

Its threefold purpose.—At first sight this may be considered a simple and somewhat unimportant movement, but it is not so. If it be not constructed on proper principles it will cause disarrangement and breakage in almost every other part of the loom. This movement serves a threefold purpose. When the shuttle is thrown into the box it presses back the swell, lifting the protector weighted with a spring, thus steadying the movement of the shuttle and preventing its rebound. When the shuttle does not reach the box but stops in the shed, the protector is not raised, thus preventing the reed coming forward on the shuttle and breaking the yarn. At this point it also knocks off the loom. It is this knock-off that is the source of all the defects that arise from a malconstruction or faulty arrangement of this movement.

The momentum of its stroke.—It has already been noticed that this movement must be taken into account during the construction of the whole loom. The revolving parts of the loom accumulate a certain amount of force, which is all expended in the stroke of the protector when knocking-off the loom and bringing it to a sudden stop. The greater this force the greater the damage done by its reaction in the other parts of the loom. The only deduction we can draw here then is that the main wheels and the hand-wheel on the crank should be as light and as small in diameter as is consistent with strength and the arrangement of the other parts of the loom. Of course this implies that all the other movements of the loom are working

smoothly, as they ought to be, and requiring little accumulated force to steady their movements.

Its construction and arrangement.—In the early editions of this book we pointed out an objectionable method that was almost universally adopted—and is to some extent still—that of placing the protector on the lay. With this arrangement the full force of the

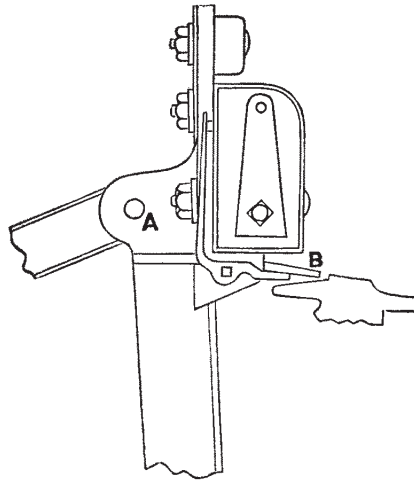


FIG. 36.

stroke is thrown on the lay, drawing it out of its proper position, distorting it, severing the fibres of the wood, and ultimately destroying it; all the while causing a bad working loom. This stroke should be thrown on the swords. Fig. 36 shows an arrangement of this sort that suits the purposes both of strength and lightness. A small bracket is cast on each sword carrying a small

“tongue” or protector. A light rod is passed between these brackets, and on it is fixed a double finger, one point going below the protector, the other reaching to the back of the swell. This arrangement is fully shown in the fig. at B.

The length of the protector.—The length of the protector should be no greater than what is absolutely necessary. If too long it will be too far forward, and will catch the buffer before the shuttle has time to raise the protector. It should just be long enough to prevent the shuttle pressing on the yarn and no more.

The fly-reed protector.—The only noticeable point about this movement is that it is only suitable for very light work. For heavy or even medium work the reed is not secure enough to resist the beating up of the shot. One advantage of the fly-reed or “loose-reed” motion is that the lay is not stopped suddenly as in the ordinary loom. The lay moves full forward as usual, but the reed is pushed back from its supports.

STOP MOVEMENTS WHEN A WARP OR WEFT THREAD BREAKS.

When they become necessary.—There is no necessity to overcrowd a machine with automatic movements that are of little or no value. These movements only become necessary when the weaver attends to a considerable number of looms. When the weaver’s attention is concentrated on one loom there might happen in one of the others something that if allowed to go on might cause considerable trouble—such as a float caused by a broken warp thread, or the loom running with an empty shuttle. The full value of these movements will be seen further on, when we come to consider the Northrop loom.

THE SHUTTLE RELIEF MOVEMENT.

What experience has taught about it.—Now that this movement has been in use for a considerable number of years we can rate it at its true value. The point is this, that for narrow, fast-running looms there is not enough time given for its action. The protector, when raised a little to relieve the shuttle as it is being thrown out of the box, is not down in time to catch it on entering the other box, but for broader looms the movement may be better.

Its purpose.—When the utmost has been done to render the pick easy in its movements there is still a considerable drag on the movement of the shuttle, caused by the weight of the protector pressing on the back of the swell. Now, this weight pressing on the swell (or something else) is necessary to stay the rebound of the shuttle when it is being thrown into the box, but the effect is injurious when the shuttle is being thrown out again. Besides causing much tear and wear to shuttles, picker, straps, etc., it gives to the shuttle an uncertain, jerky movement, causing it often to be thrown out of the loom altogether, and giving to the pick a much harsher movement than it otherwise would have. And, moreover, when cops are used it has a tendency to break them and bring out the ends in a “lump” before they are quite run down. This, indeed, takes place to a greater or lesser extent in every loom, but it was to remedy this that we suggested the shuttle relief movement.

What the movement is.—Fig. 37 shows the arrangement to relieve the weight of the protector just at the moment the shuttle is being thrown out. A is a cam fixed on the end of the crank shaft, B a small lever attached to the end of the protector rod, while C is a lever by which the motion is communicated. The

sketch shows the relative positions of the parts at the moment when the pick has commenced.

We reproduce this fig. as we received it from one who has put it in operation, but we are convinced that too

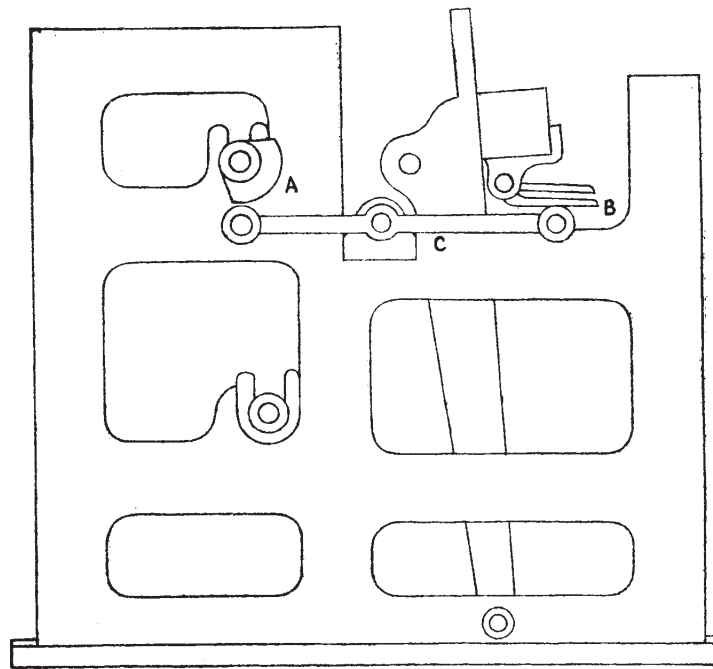


FIG. 37.

much dwell is given to cam A. If it were reduced to a point and properly timed it might be of some use, but the fact that there are very few of such motions on looms, in spite of the great number of ideas for the purpose, seems to indicate that the advantages claimed are not realised.

THE NORTHROP LOOM.

There are two distinct methods at present being employed to increase the amount of work produced by machinery.—A treatise on the construction of the power-loom would be incomplete without some notice of the Northrop loom, which is intended to accomplish this. Through the courtesy of one of the directors of the company, we are enabled to give a description—so far as our space will allow—of some of the most prominent features of this wonderful machine. The object of all the improvements in machinery going on at the present time is of course to cheapen production. Two distinct methods are being followed to secure this end. One is to make a machine that will run at a much higher speed than usual without in any way injuring the material dealt with or causing any extra breakage in the machine itself. The second method is to find a machine that will deal with the material in hand in a manner that will require less attention from the parties in charge, thus enabling them to attend to more of the machines than formerly. It is this method that the inventors of the Northrop loom have adopted, and it has been carried out by the introduction of various new automatic movements, besides the improvement of other movements, by which they claim that a weaver can attend to at least three times the number of looms they could with the old system, and with almost the same amount of production from each.

The principal feature in the "new loom."—The principal feature in this new loom is what is termed the weft changer. To make this movement clearly understood we may mention the fact that other inventors are introducing a shuttle changing movement so that when the weft runs down in one shuttle another takes its

place, with the loom still running. This is done somewhat on the principle of the check-loom. The distinguishing feature of the Northrop loom is that it has only one shuttle, which is never changed. When the weft thread runs down the bobbin on which it was wound (or if it is a cop, the spindle that held it in the shuttle) is knocked out, and a full one put in its place while the loom is at full speed. The full bobbin or cop is pressed into the shuttle by means of a hammer-shaped lever, and in doing so presses out the empty one. This is done just before the yarn is completely run out, so that no broken pick may occur in the cloth, as in most fabrics this would spoil the cloth at that part. Fig. 38 shows this movement in action with the other parts of the loom removed. The bobbin is being placed in the shuttle; the empty bobbin is falling into the box.

The weft changer considered in relation to the other automatic movements.—The weft changing movement alone would not give so great advantages economically, but it has necessitated a whole host of automatic movements and alterations in various parts of the loom (all patented) in order that the full benefit of this particular movement may be got. The idea is, as already hinted, that if anything goes wrong amongst the yarn, or in the loom itself, the machine stops at once. The weaver being engaged at any one of the looms need not be anxious about the others, being quite sure that nothing far wrong will take place. This is the sort of loom where the warp and weft stop movements become necessary; not in the ordinary loom, where in many cases tenters think they cause too much trouble.

This shows us quite clearly the distinction between the two methods that are being followed in the economical improvement of machinery.

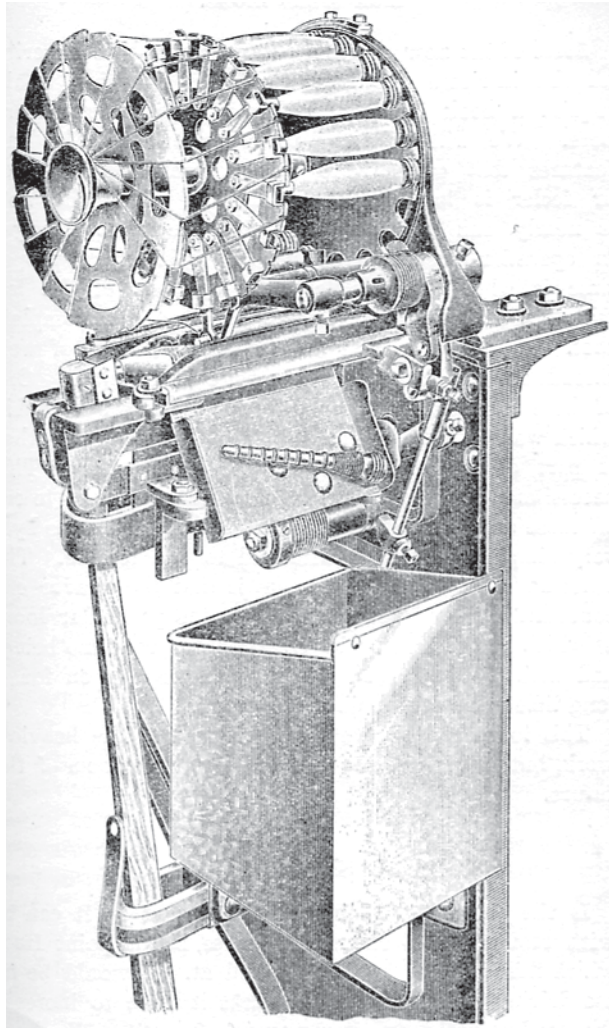


FIG. 38.

Some of the new automatic movements.—To describe all the intricate movements of this machine would require a book for itself. This will not be necessary here. We will only try to bring out the leading features that govern the whole machine. A finger or feeler is introduced to find out when the weft is nearly run down, and it puts the weft changer in operation just at the proper time. That proper time is when the shuttle is in the box of the lay with not sufficient weft left to make another complete shot. As this operation takes place two ends of weft threads are left dangling at the edge of the cloth. One of these threads is the piece of weft in the spent bobbin which was not sufficient to make another pick; the other is part of the weft that has just been put in. This necessitates the introduction of another movement to cut off these ends as the cloth moves along. It is done by a very simple contrivance attached to the temple. The outcome of all these movements is that the weaver can concentrate his or her attention on the particular loom at which he or she may be engaged, for the time being, and with the weft changer the loom may go on for a long time without stopping.

This loom has not yet been adapted to the heaviest work, but experts are agreed that it is the loom of the future.

HIGH SPEED LOOMS.

Is the power-loom being driven as fast as it can be with economy?—Economy, of course, is the point from which this problem is to be looked at. It would be no use driving machinery faster unless it were to increase the product with a greater margin of profit. We have

frequently heard the question asked of those who were particularly interested in the matter; and the answer invariably was—"Our looms are being driven as fast as the yarn will admit." But this can easily be met by the remark that the yarn is little better than it should be for the treatment it gets in the loom. Those who are constantly employed in a power-loom factory will often hear the remark that "this loom is much worse to the yarn than that." And still both looms are apparently the same, and both are from the same maker. This indicates that something is inherently wrong somewhere. To be particular, we must, of course, take into account the different fabrics to be produced. The light, narrow loom for producing light cotton work runs at a far higher speed than that employed in the jute and linen trade; but if we take the power-loom as a whole we shall find that it is a machine of very rude construction, and capable of great improvement even at the present time. The yarn itself in its preparation for the loom is not all that could be desired. At the present moment experiments are being made to improve this, so that with an improved machine and better yarn we may look for a higher speed loom and a greater production at less cost.

What is necessary in a high-speed loom.—In a high-speed loom it is needful that all the different movements be so constructed and arranged that they may work in the smoothest manner possible, and especially the pick and shedding movements. In chapters dealing with these movements we have shown how this can be done. All the revolving parts should be as evenly balanced as possible, and the whole made as light as can be, adding strength only at points where strength is absolutely necessary. Experience in a power-loom factory will

show where these strong points are needful. The intermittent movements of the loom will always be against the loom attaining to so high a speed as some other machines that could be mentioned. Still a great deal more could be made of the power-loom if constructed on thoroughly scientific principles.

A practical hint as to increasing the speed of looms employed in the jute trade and the making of other coarse fabrics.—It is the custom to make the shuttles in these looms as large as possible, so that they may contain a large amount of yarn and so require fewer stoppages to change the shuttle. We have shown in previous chapters that the larger the shuttle is the heavier must the machine be, with a greater throw of the crank, &c., and this all necessitates a slower speed. If the shuttle were reduced to a minimum, and a shuttle-changing movement introduced (several of those on the market at present could be made suitable for that class of work), it would be possible to make a high-speed loom for the class of work referred to. With the yarn better prepared for the loom the speed could be increased.

MAKING THE LOOM.

How a well designed loom can be spoiled in the making.—A badly designed loom, badly put together, is a source of great worry to those who have to deal with it, and it is only by extraordinary exertion on the part of the workers that anything approaching the output of a good loom can be obtained. Some may doubt that such a loom exists at the present time, but such is the case. How these looms continue to find purchasers may not be so easily answered. A loom properly designed in all its

details and well suited to the work to be produced may be entirely spoiled if not properly put together. This work is often given to boys and men unfamiliar with that class of machinery, and the foreman is quite satisfied if the looms are turned out to time. This is done in the race for cheapness, but it is not at all commendable.

How the frame-work should be fitted.—The frame-work of a loom should be carefully fitted, not merely bolted together, as in a good many instances. Where the rails join the end frame these parts should be planed, the rails or beams cut in length to gauge and fitted between “feathers” or strips cast on the end frame for that purpose. This will give stability to the loom as a whole, and we may also add that less metal will be required. We know of a few makers who have adopted this method of fitting the end frame, and it makes a great improvement on the whole loom.

Gauge and jig.—Every part of the loom down to the smallest detail should be made and fitted to gauge. We may be told that this is already done, but it is a well-known fact amongst mechanics who know the subject that in many cases this is only a sorry pretence. We must understand that the loom is a comparatively fast-running machine, and that the gauges must be thoroughly made, the one to fit the other as to diameter. Length gauges are also necessary in every case. In drilling holes the jig in every case should be used. The gauge and jig in the hands of a skilful foreman means a greater amount of work turned out, and of a far better quality than otherwise could be. Not only that, but this method of making looms (as well as machinery of all descriptions) saves a great amount of expense and labour in the weaving mill or factory. When the parts

that are likely to be wanted are properly made to gauge and jig it becomes a very easy matter to replace them in the loom when required. Besides, the machine does not require to stand a long time for repair. In most cases this is a matter of considerable importance to the mill-owner, for the resultant is a considerable saving in working expenses. The loom is always producing, while otherwise it might be at a standstill for a considerable time. This is a vital matter, and we are glad to notice that it receives more attention than when we first drew attention to the subject.

THE WEAVING SHED.

The model loom factory.—Fig. 39 shows a section of a modern loom shed. This is said to be a model power-loom factory, where all the operations can be conducted on one floor, thus reducing the expense of the whole operation to a minimum. The only drawback is the prohibitive price of ground in some places. The height of the roof will, of course, be determined by sanitary considerations. It will be noticed that the angles of the roof are different at C and D. The more upright angle at C, facing north, is the one in which the lights are placed.

The columns.—These columns in most cases serve a threefold purpose: they support the roof, carry the shafting, and as they are hollow they serve as conductors to carry off the rain water. Their distance apart in this fig. will be such as will allow of two rows of looms, with the necessary passages between each row. This allows of two rows being driven from one line of shafting. Space enough should be left behind the looms to bring up a barrow with the yarn beam, and if the place be

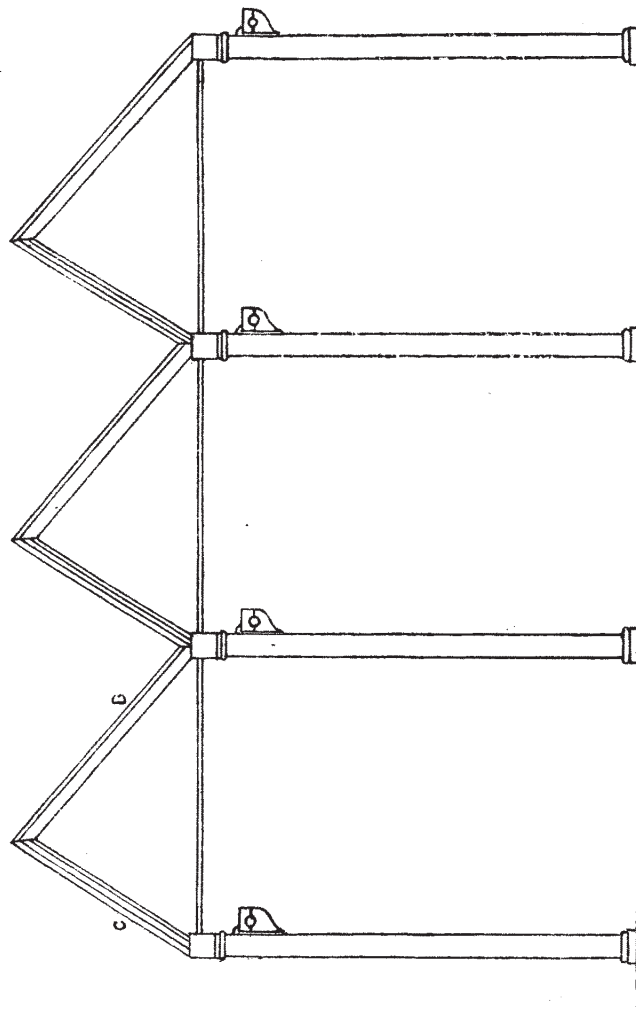


FIG. 89.

large there ought to be room enough to allow two barrows to pass each other. The space in front will be such as will allow the weavers to attend to the looms.

With the shafting underground.—The best method of all is where the shafting is placed in tunnels under the floor. In this case the columns will only have the roof to support, and one-half of the number indicated may be sufficient for that purpose, thereby saving floor space to a considerable extent. If we place the columns amongst the looms we leave an entirely open passage; in the other case the columns are to some extent in the way.

DRIVING THE POWER-LOOM.

The distribution of power from the generating station to the loom.—With the general question of the distribution of power we have got nothing to do, this is a large subject altogether apart. It is with its application to the power-loom that we have to deal. In this particular machine there are peculiarities which do not occur in any other machine that we know. The power-loom, to work well and make good cloth, must run at an even, steady movement all through. No matter what its speed may be, it must maintain that speed and nothing more. There must be no running fast and slow by times, and no jerkiness about it. Those who are experienced in the trade know very well that an uneven movement of the loom transmits itself to the cloth in an uneven fabric, and, moreover, the loom itself works very badly under the circumstances, and is the occasion of more expense in upkeep than would be the case if run at a uniform speed. We will now go into detail with this matter of distribution and application of power to the power-loom, and note what has been done in the past, what is now

being done, and what may be done in the future to realise the object in view.

What has been done in the past to get a steady movement for the power-loom.—In some large factories that we know the endeavour has been made to put the looms into groups, so that they may be under better control from the power centre. Steam has been carried long distances in pipes to engines set up in apparently convenient positions; but as this has proved a most expensive and inconvenient practice we may dismiss it without further remark.

At fig. 40 we have a scheme of underground shafting (which, of course, can be multiplied to any extent) which answered the purpose of getting a steady drive for the looms. The main shaft A and the counter shafts B C and D E were made of cast-iron, very strong. The line shafts, of course, were short and had little vibration, but the drawbacks were the initial expense and the great amount of friction to be overcome in running, which necessitated a greater amount of power from the generating centre. The system consequently proved too expensive.

We now come to fig. 41, which shows one method of driving power-looms, and this method is well known to all those employed in the trade. The main shaft runs out from the engine, usually supported by brackets attached to the end wall of the factory. The line shafting is driven by bevel wheels at right angles to the main shaft. The line shafts, of course, run the whole length of the factory. It is this long line shaft which is the root cause of much mischief. It usually measures two-and-a-half inches in diameter, and it is well known that in a long shaft of this thickness a great amount of vibration takes place. The farther we move outward

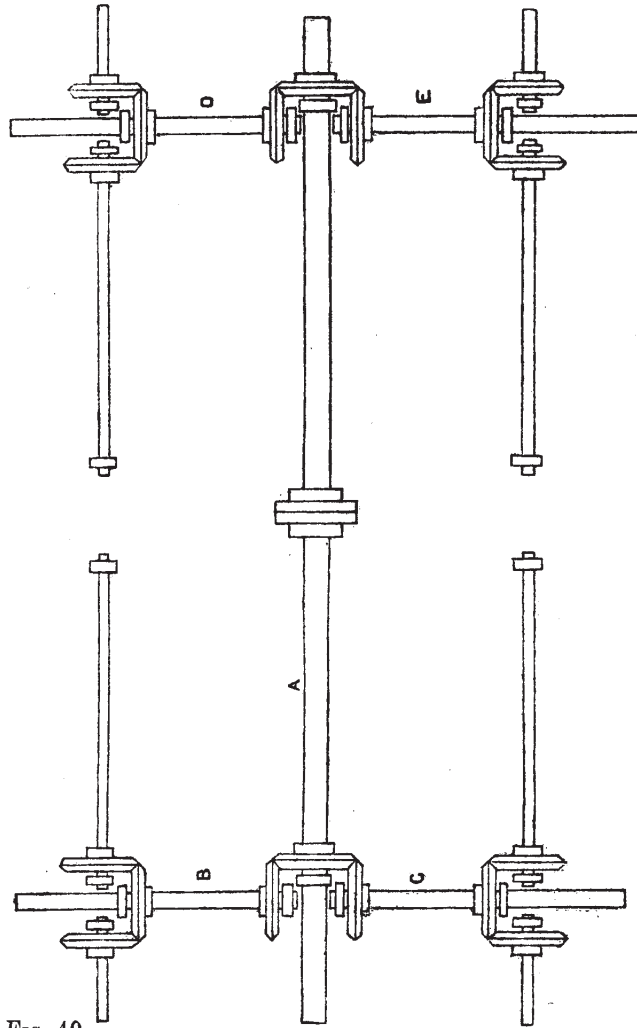


FIG. 40.

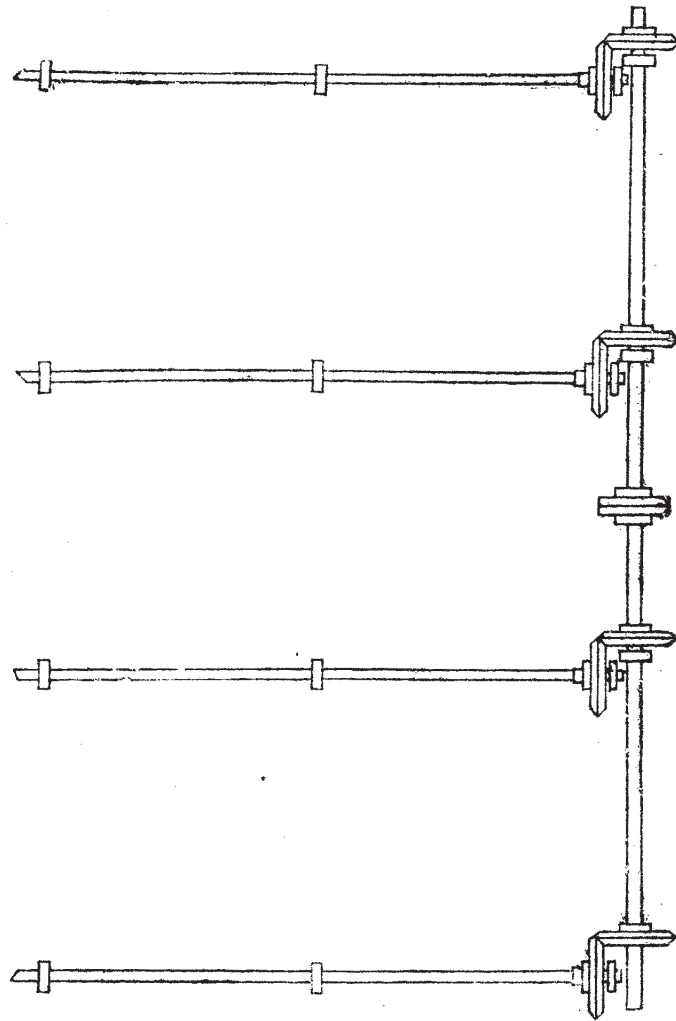


FIG. 41.

along the shaft the greater is this vibration. As a matter of course the vibration is transmitted to the loom, thus resulting in a bad working machine and an inferior quality of cloth.

If we look particularly into this we see that the looms driven from the line shaft near its connection with the main shaft and those all along the shaft work fairly well while the whole of the looms are kept running; but where there is a number of looms it often happens that many of them may be off at one time. When this is the case, if those driven from the out end of the shaft are put on first, they simply knock off, or they go on in a jerky manner, making bad cloth. This is going on in many places every day.

What is being done and what may be done to lessen this vibration on the line shaft.—A few years ago this subject was taken up by “experts,” much discussion took place, and the result was that a series of fly-wheels were to be placed on this line shaft, graduated as they went out to the end of the shaft; that is to say, they got heavier and larger in diameter as they reached the extreme end. This remedied the evil to a considerable extent. The mechanical principle involved here is well known: these wheels revolving with the shaft accumulate a certain amount of force, which carries the shaft with them always in the same direction, so preventing any backward movement or vibration.

What is altogether preferable for the driving of power-looms is electricity. The simple “line” can be brought from anywhere to the motor. These motors can be set up to drive groups in any conceivable manner. Although it is not our province to teach electricity, we would like to say that the motor must be one which will not be affected by load, but will have a steady movement

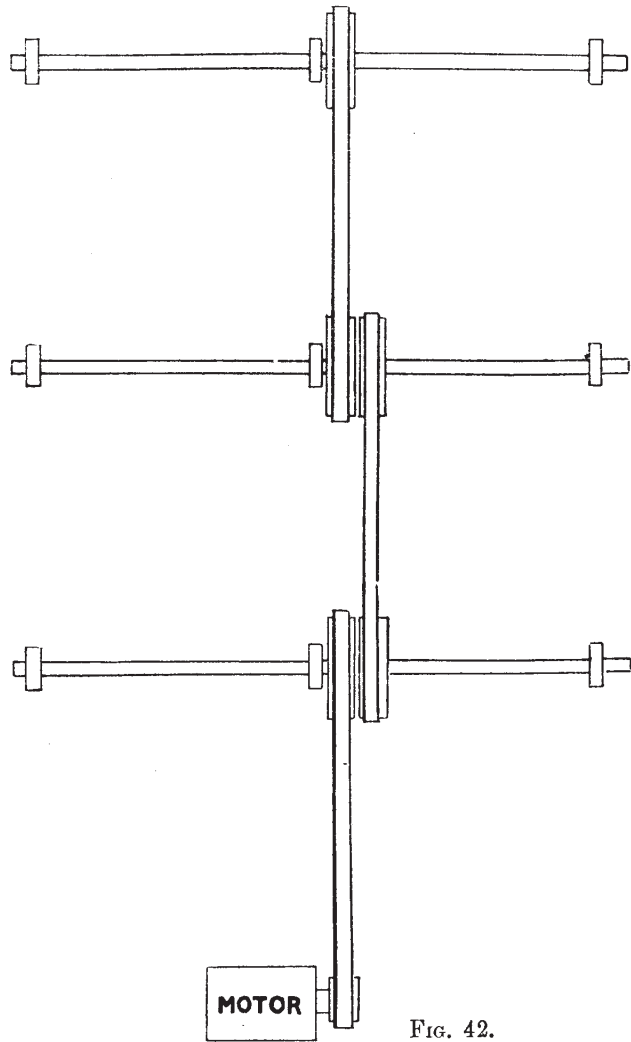


FIG. 42.

under any circumstances. Where electric driving has been adopted, the looms are generally driven in groups, but there are now several driven individually by small motors. The shafts for the line drives are comparatively short, and are driven from the centre. It is not advisable to have too many of these shafts driven the one from the other. In fig. 42 we have shown a plan of shafting now in use in one of the best factories in the country. We may also add that instead of belts driving from one shaft to another, ropes are more in favour. Their action is more reliable, with a steadier drive at all times and under all circumstances.

The ideal method of driving power-looms.—Whatever may be said of electricity as a motive power, either as to its expense or adaptability to the various industries of this country, there is no doubt whatever but that it is the long-felt something that was awaiting in the driving of power-looms. The steady even movement so necessary to that machine can be obtained through it. To obtain the ideal method of driving we ought to have a motor for each machine. That time has not yet arrived, although, as just stated, there are several driven in this way. The motor must still be cheapened, and every element of danger taken from it. Then the power-loom, so far as driving is concerned, will be on a level with other machines which require extreme regularity in their movement.

SHAFTING, PULLEYS, LEATHER BELTS, AND ROPES.

Driving power-looms.—As the ideal method of driving power-looms just referred to has not yet been reached, we are left with no other alternative but to erect

shafting. The erection of shafting in an ordinary weaving shed is so simple that it requires but little explanation; but then as our young students require some coaching, we will go briefly through the ordinary process with them.

Fixing the main shaft brackets.—Let us take for our present example a medium sized weaving shed with a main shaft driven directly from the engine, while the line shaft is driven at right angles to the main shaft by bevel or mitre wheels, as shown at fig. 41. As to the strength of shafting to be employed, that will be found in any book of engineering formula. Suffice it to say that in a case such as this the driving shaft is usually three inches diameter and the line shaft two and a half inches. The columns will have been already erected in lines at right angles to the wall which is to carry the main shaft. The columns are made with facets to carry the brackets which support the usual pillow blocks. On the wall which is to carry the main shaft there will be erected brackets to carry the pillow blocks there. These brackets will be according to the ideas of the party who designed them, and will be bolted to the wall. If the wall is not too strong these bolts will go right through, supported on the outside by large cast-iron washers. If the wall is strong enough it will be quite sufficient to let them in about nine inches, with large square washers under their heads, cementing them there (grouting them in). No matter whether the wall is of brick or of stone this is the best method.

Erecting the shafting.—The first thing that requires our attention on entering the factory for the erection of the shafting is our centre line. This will be found from the drawings supplied. Then with straight-edge and

level we must draw it along the wall, and, from that along the columns in some permanent way, so that it will not be easily rubbed out. At the same time, we must find out if all the bearings are correct. From this line, then, we can calculate the positions of the brackets, and in doing so we should allow for at least half an inch of wood between the pillow block and bracket, as this is the best way of levelling these—by planing the wood to suit. We know there are some who adopt a very rude method of placing hard to hard, as they call it, chipping a piece off here, and perhaps putting a piece in there, but we prefer to stick to the old-established custom, which has not yet been improved upon, not even by all the patent or proprietary bearings that have been put on the market.

Levelling the pillow blocks.—After all this has been done we have only to level up our pillow blocks. There are two methods of doing this. The one is by placing half-centre pieces in the blocks, then testing them by the straight-edge and level, testing each block separately to see if it is level in itself. The other is to use a fine-edged steel straight-edge in the bottom of the bearing; by this we can notice if each block is level in itself, and if both with one another. When this is done, all that remains is to put in the shafts and fix on the wheels.

Drums or pulleys.—We now come to the drums or pulleys, as they are variously called. It is usual to make these in halves, boring out the holes a fraction less than the shaft. If this be properly done, when bolted together they hold better than with the usual key; but when they have much to do most makers put in a key also just to make sure.

To find the unknown quantity in pulleys.—The unknown quantity in pulleys is found in the following manner:—

To find the diameter of the driving pulley on the line shaft, the diameter of the loom pulley and the revolutions per minute of both being given.

Rule.—Multiply the diameter of the loom pulley by the number of its revolutions per minute, and divide the product by the number of revolutions per minute of the driving pulley; the quotient will be the diameter of the driving pulley.

To find the number of revolutions given by the driving pulley per minute, its diameter and the diameter and number of revolutions per minute of the loom pulley being given.

Rule.—Multiply the diameter of the loom pulley by the number of its revolutions per minute, and divide the product by the diameter of the driving pulley; the quotient will be the number of revolutions per minute of driving pulley. The same rule applies to the loom pulley.

From the foregoing rules it will be noticed that the unknown quantity in these pulleys can always be found by an easy method, namely, by multiplying together the two numbers that belong to the same pulley and dividing by the third number; the result is the term required.

To find the circumferential velocity of pulleys.—To find the circumferential velocity of a pulley, its circumference and the number of revolutions per minute being given.

Rule.—Multiply the circumference by the number of revolutions per minute and the product will be the space passed through per minute.

The fast and loose pulleys and the friction pulleys—where each can be employed with most advantage.—There are two sorts of pulleys used on power-looms, the

fast and loose pulleys, which allow for the belt being shifted from one to the other in starting and stopping the loom, and the friction pulley. Where a sufficiently long belt can be obtained, as in the case of those driven from above, perhaps the former is the best. In this case the face of both driven and driving pulleys should be straight, of the same diameter throughout, and parallel with each other. For short belts employed in driving looms from below the floor the friction pulley is the most effective. Short belts require to be much tighter than those of greater length, and are not so easily moved from one pulley to another.

The convexity of pulleys.—When friction pulleys are used there is no belt fork to keep the belt in its place, consequently the face of the pulley is made convex. This convexity should be at the rate of a $\frac{1}{4}$ in. to the foot. The reason of this convexity is that belts always incline to run on to the greatest diameter. All pulleys where the belts do not require to be moved about upon them should be made convex for that reason. The belt will remain central on the pulley.

Belts—their width and thickness.—Notwithstanding the advances of electricity and the increase in rope driving, leather belts are still used as conveyers of power, hence the necessity for knowing something of their proper management. Belts should never be so broad as the pulleys on which they run. It is a decided waste to make them so. First of all, the width of belt required should be determined and pulleys sufficiently wide made for them. The width of loom belts varies according to the width of loom and weight of cloth to be produced—from 2 in. to 3 in., and in some cases $3\frac{1}{2}$ in. The ordinary thickness for 2 in. is $\frac{3}{16}$ in.; over 2 in., $\frac{1}{4}$ in.

How the lap-jointed belts should run—the length of lap.—The two principal methods of joining belts are by the lap and the butt joints. Beltmakers generally use the former in joining the lengths together, and when putting belts on the pulleys we must see that this lap-joint runs with the pulleys and not against them. In running against the pulleys this lap-joint soon gets torn up and destroyed. Fig. 43 shows how the lap-joint is

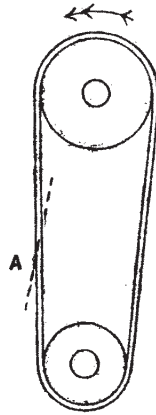


FIG. 43.

formed at A, and the arrow shows the direction in which it and the pulleys are running. In ordinary loom belts the length of lap should be twice the breadth of the belt. In narrow belts from 1 in. to $1\frac{1}{2}$ in. brass hooks and other fastenings are used.

A belt clamp.—In the case of heavy belts, such as those for main driving, a stretching clamp is necessary to bring the ends together when splicing it, as it is

altogether too heavy to handle without some such appliance. Fig. 44 shows one of very simple construction now in use which recommends itself for lightness and handiness, and can be made either of wood or iron.

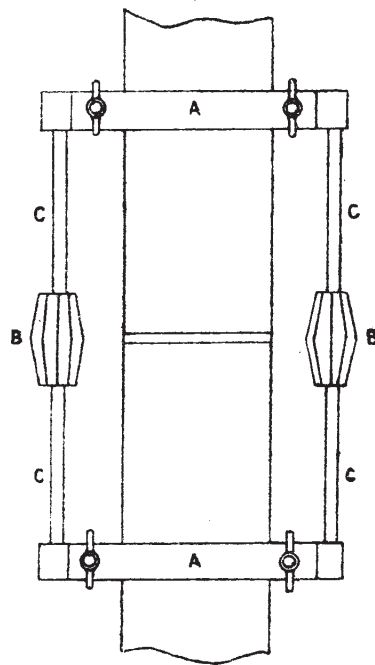


FIG. 44.

The clamps A A are drawn together by bolts tightened by hand screws. Right and left hand screwed bolts C C are fixed into the ends of the clamps and drawn together by nuts B B; also with right and left hand screws to

suit the bolts. When the belt is put on the pulleys and the two parts of the joint drawn together in this way they can be cemented and riveted or stitched together with the utmost ease at the proper tension.

The necessity of squaring the ends of a butt-jointed belt.—In making a butt joint we must be very careful to see that the ends which come together are cut square to the edge of the belt, otherwise we shall make one side of the belt tighter than the other. As we have already explained, belts always incline to run on to the greatest diameter of the pulley. So if we make one

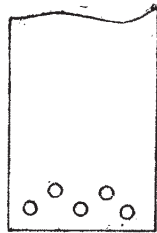


FIG. 45.

edge of the belt tighter than the other it will run off to the tight side, and very soon destroy the belt.

How a butt-jointed belt should be laced.—We will now show the most approved method of lacing butt-jointed belts, and we may remark in passing that this is by far the best and most lasting method of joining loom belts from two inches and upwards. In fig. 45 we have pierced a line of three holes, keeping half an inch from the end of the belt; and another two holes half an inch farther back, but opposite the spaces in the line of three holes. Of course the exact number of holes will depend

on the breadth of the belt. Now draw the lace through the centre holes on either side of the joint, leaving equal lengths on what is to be the outside of the belt. Then lace out to the edges and back to the centre, fixing the ends there so that it will not slip; always keeping the lace straight to the inside of the belt, as shown at fig. 46; it will then be crossed on the outside as shown at fig. 47. It is a common practice to cross the lace on

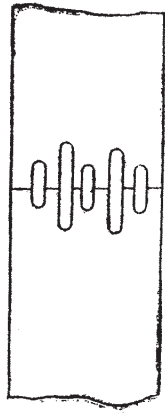


FIG. 46.

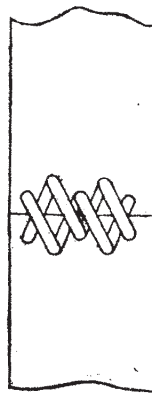


FIG. 47.

the inside in order to have it straight on the outside of the belt, as it looks much better, but it does not wear nearly so long when laced in this way, as the friction is much greater on the crossed lace when passing over the pulleys.

The management of belts.—The life of a belt or the length of time it will run is always a matter of considerable importance, and will depend to a great extent on

the manner in which it is kept. In all well regulated factories a man is appointed to this particular job; not only for the main belts, but for all the machine belts as well. Being constantly employed amongst them, he soon becomes familiar with every one of them individually, and knows what each requires. A belt should never be made too tight; it should rather be allowed to sag slightly. As a belt transmits the power by its frictional contact with the pulleys, a short time suffices to make the inside smooth and inclined to slip. Do not be in any hurry to take it in or shorten it, nor put rosin on it; both acts are equally detrimental under certain circumstances. There are various solutions used for the purpose; find out which is the most suitable for the particular work and apply just a very little. Keep all belts clean, and allow no oil to escape upon them.

How to get the most power out of belts—the direction in which they should run.—One of the most important details in connection with belt driving is the direction in which they run in relation to the driving and driven pulleys. This is a matter that has to form part of the calculations in designing the method of driving a factory—which way should the belt run here? If the belts run horizontally or slanting to any extent it is always more economical to make the under side of the pulleys the driving side, when the sag of the belt will be on the top side, thus gripping a greater part of the circumference of the pulleys.

The construction of rope pulleys.—Rope driving is now much more extensively used than formerly. It is more economical under certain circumstances than belts, especially for long distances. The information in regard to rope driving was not very extensive when it was mentioned first in this work, but there is now

much reliable data to be had on the subject. It is a recognised fact that a multiplication of smaller sized ropes is much more convenient than a few large ones—of course this is where a considerable amount of power is to be transmitted. A very important consideration in connection with rope driving is the construction of the pulleys. The friction on the rope should be sideways, while the angle of the grooves of the pulley should be such as will prevent the rope being jammed.

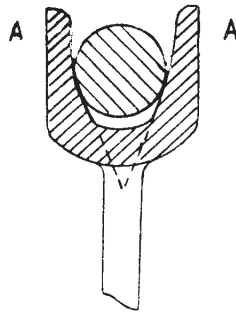


FIG. 48.

Experience has proved that the best form of groove is that when the sides are at an angle of 45° to each other. Fig. 48 is a section of a single rope pulley, showing this, with the flanges A A extending beyond the groove to prevent the rope from coming off. Another advantage that rope driving has is that it is not necessary that the pulleys be exactly in line, as those for belts must be.

ERECTING AND FIXING LOOMS IN THE
FACTORY.

How the parts of the loom should be marked.—When looms arrive from the makers to be erected in the factory sometimes a difficulty arises if the parts are not properly marked. Of course, the man who is to put them up is supposed to know where each part should go; but then, as there are always two or more parts of the same thing, perhaps fitted with keys or holes bored to suit them, the question arises, which is which, to which side of the loom should this go? etc. Now, there is a certain rule that should be adhered to in marking the parts of looms when taken to pieces to be conveyed to the factory. The rule is simply this—Take for example the two picking cams with their keys, the one next to the driving end should be marked 1, the other 2. The same with all the other parts, always beginning with those next the driving end as No. 1. If the small parts of a number of looms are to be sent together, those of one loom will be marked 1, 2, etc., the next 1A, 2A, and so on, adding a particular letter to the figure, which will make each set of parts easily distinguishable from the other.

How the main wheels should come into gear.—In putting the looms together care must be taken that the main wheels (the crank and wyper shaft wheels) are put in gear correctly, as this may save a considerable amount of labour afterwards. The exact rule for this is to turn round the cam shaft until the picking point presses out the cone to its full extent, then turn back the crank until it forms an angle of 45° with a horizontal line drawn through its centre. We do not require any scientific scale for this purpose. Good workmen make a study of this when “setting” their pick, and know by sight when it is right. Fig. 49 is a skeleton diagram

showing the picking point full out on the roller A with the crank shaft B standing at an angle of 45° with a horizontal line drawn through its centre on its movement backwards. Put the wheels in gear when the two shafts are in that position.

The arrangement of the looms.—In arranging looms in the factory those in authority should have a well-devised plan to give to the workmen. The two main

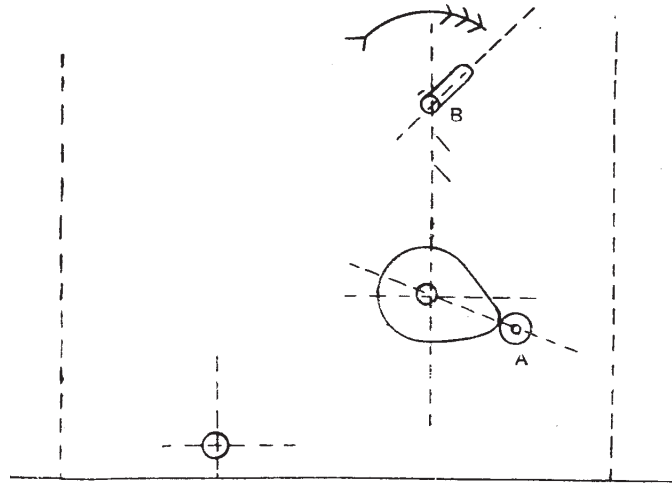


FIG. 49.

features in this plan will be—first, that the broadest looms or those adapted for the heaviest work will be driven from the line shaft nearest its driving point (that point of the line shaft nearest its connection with the main shaft); or, if driven by electricity, that point nearest its connection with the motor. The lighter looms will be farther out. This arrangement will reduce the torsional

strain thrown on the line shafts. The second point is—that in order to have some regularity and to economise space the looms should be grouped in fours. Fig. 50

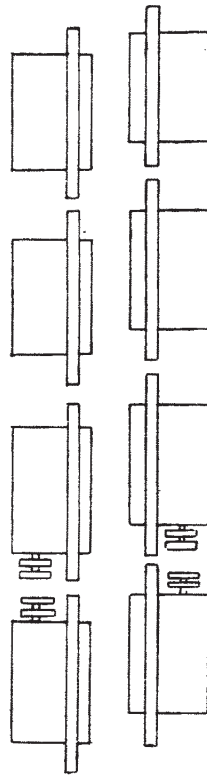


FIG. 50.

shows this arrangement, with all the four belts grouped together, leaving sufficient passages around the looms for the work to be performed.

The main points to be observed in fixing looms to the floor.—We can now proceed to fix the looms to the floor. The two points to be considered here are that the crank shaft of the loom runs parallel with the driving shaft, and that the loom be thoroughly bedded on the floor, with all its parts level. Then drop a plumb-line from the driving shaft at two points sufficiently apart to secure accuracy. Through these points draw a line on the floor, and, if necessary, draw it in with some sharp instrument so that it will not be easily rubbed out for

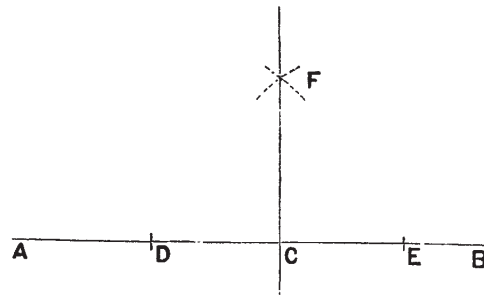


FIG. 51.

the time being. We have now another line to draw at right angles to this one, so that the ends of the looms—one out and one in—may be square to the passes before and behind the looms. To find this line and draw it exactly square to the one we have already got is simply an ordinary geometrical problem, and can be done in two ways. Let the line A B (fig. 51) represent the line already drawn on the floor and C the point from which we are to set off the line at right angles to it. Take a pair of beam compasses or trammels long enough to

secure accuracy, then on point C with any convenient radius mark off points D and E. Then with these points as centre with the same or any other convenient radius describe two arcs until they cut each other in point F. Through points C and F draw a line in the way we have already described, extending it as far as it may be necessary.

Another method.—The line C F in fig. 51 in some cases may be near the wall or some other obstruction that may not allow of our working out the foregoing

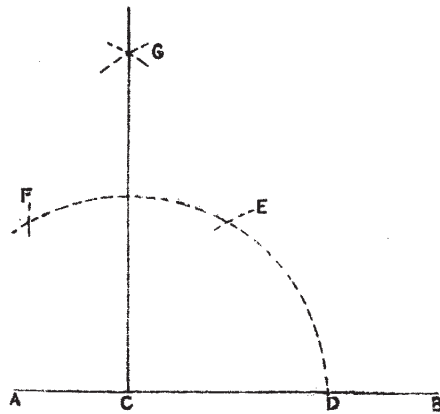


FIG. 52.

problem freely—not having space enough. Then we can apply this problem. Let the line A B (fig. 52) be the line already found, and C the point from which we want the line at right angles extended. Then take C as centre, and with any convenient radius describe an arc cutting the line A B in point D. From point D as centre with the same radius mark off point E, and from point E as centre with the same radius mark off point F. Then

from points E and F with the same or any other convenient radius describe arcs till they cut each other in point G. Through points C and G draw the line required.

A template necessary for this work.—We have now got all the lines drawn, and may proceed to put in the holding-down bolts to fix the looms to the floor. In order to save a deal of time and hard work moving about heavy looms on the floor, first putting them in

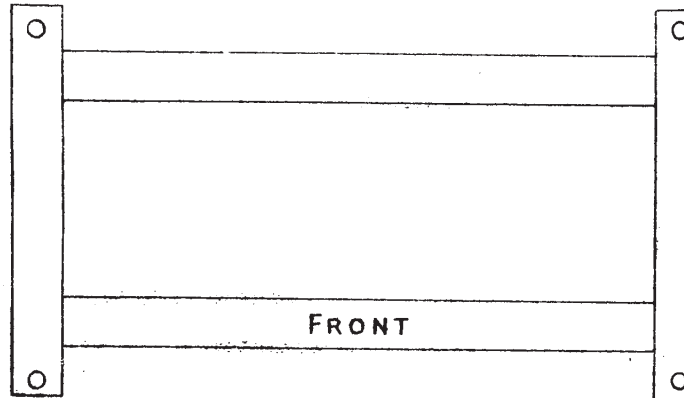


FIG. 53.

position and marking off the holes, then moving them out of the way to get the holes made and then moving them back again, a template becomes necessary. Even should we have come in advance of the looms, and cannot take the positions from the actual machines, with the aid of a template we can still proceed. Fig. 53 is a representation of it. It can be made of pieces of wood nailed together with the holding-down bolt holes in it, with a centre line representing the centre line of the

crank shaft, and for accuracy, of course, the front of the loom is marked on it. We have simply to lay down this template, with the centre line parallel to the line already drawn on the floor, and arrange it to the line drawn at right angles as required. We may then mark off the holes and have the bolts put in.

To find a proper bearing for the loom.—To obtain a proper bearing for the feet of the loom, and facilitate the process of levelling, pieces of wood should be fitted below the end frame. When the loom has been placed on these pieces of wood, try the spirit level along the lay, and try to lift the loom at each of the four corners with a small crowbar to see if there is any rocking movement about it. If so, take out the piece of wood that is too high and dress it down as required. Repeat this as often as necessary until the machine has been brought to a proper bearing and quite level. In heavy sole plates, as that indicated in fig. 33, it is always better to take a rough cut off the sole plate in the planing machine.

Points necessary to be noticed before starting the loom.—Adjust the various parts of the loom, such as the cams, the shuttle boxes, etc. Be careful to see that all the bolts and keys are quite tight. Oil the moving parts, put on the belt as already described, and give the loom a run to see that all is right. Then it is ready for the yarn.

WORKING THE LOOM.

THE MECHANICAL DEPARTMENT.

Some practical points worth noticing.—The “up-keep” in the mechanical department of a power-loom factory sometimes entails inordinate expense; indeed, in many factories there is an unaccountable waste going on

in this department; besides this the looms are never in a condition to give the best results. In some factories we visited lately we were surprised to see the condition to which the machinery was reduced; indeed, it was only fit for the scrap heap. We remarked to one manager who was showing us round that his machinery seemed to be in very bad condition. "It ought not," was the reply; "the money expended on repairs runs up to rather a big sum at the year's end." We may also mention a large establishment that we know where the machinery was so much run down, and the expense of keeping the place going ran up so high, that the proprietors came to the conclusion that it would be much better and cheaper in the end to clear out the whole factory and fill it with new machinery, which they did. These facts are well known to those who are conversant with the subject.

Now, there are two questions that at once arise here. What is the cause of this? and How is it to be remedied? In answer to the first question, we would say that the main cause is owing to the fact that the man who has the last word, or perhaps the first word in the management of this department, the manager or foreman of the weaving shed, may not know sufficient about the intricacies of mechanical work. It is rare indeed that we find in the same individual a knowledge of the intricacies of the art of weaving associated with a knowledge of the capabilities of machinery. The answer to the second question—the remedy—is this: There ought to be a thorough division of labour in the factory. The mechanical department, which we have under consideration at present, should be under the superintendence of an expert in that particular line, one thoroughly trained to the work in his early youth. We say early

youth advisedly, for we know from considerable observation that very few indeed will ever be experts in any mechanical pursuit if they have not studied and practised it in their early youth.

We would also remark that the training in most of the technical schools on this particular subject is often at fault. In most cases the machinery is not of the best description, and, as a rule, the teacher lacks the practical experience necessary. The teachers of these technical classes, to be of any value, should really be practical experts in the particular branch they seek to teach.

To the young student.—To the young man entering the power-loom factory (mechanical department) prepared to adopt this as a profession at which to earn a livelihood through life, we would at once say there is ample scope in it for the exercise of mental abilities. We know of no other branch in the mechanical line which is a better training school for making a good, all-round mechanic. You are necessarily left to your own resources to a considerable extent as to what is best to be done under the circumstances that may occur, and the better you exercise your judgment and apply it to your work, the more you will be left to exercise it under proper control. But to master it you have to throw your whole energy into it. There are secrets to be found out that no one else can thoroughly explain to you. Whatever may happen you must inquire into the cause of it. We do not mean that you are to ask your neighbour or anyone else about it; you must reason it out for yourself. By working on this principle you train the mind, and will ultimately become an expert mechanic, lifting your work out of the mere rut of drudgery and placing it on a scientific basis. One of the principal things to be noted here in repairing and keeping

machinery in order is, whatever you do, do it thoroughly. If some part gets broken or gets worn out unnecessarily, this must have been caused by a defect somewhere. Do not be satisfied by merely replacing the broken or worn part; find out what has been the cause, and make sure as far as possible that that will not occur again. This method of procedure will lighten your labour and will also greatly lessen expense.

Spare parts should always be kept ready where they may be expected to be required. This will shorten the time the loom will be stopped for repairs, but if any particular part requires frequent replacing, you may be sure that there is a defect in that particular part, and you must have it remedied, and perhaps strengthen the part at its weak point.

The loom "knocking off"—to find the cause.—We will now go into detail with the "fitter," hoping to make it plain enough for him to follow us through the various intricacies of his trade. What is perhaps the most difficult, or, perhaps, the most annoying thing to a beginner is the loom "knocking off." The loom may stop when a warp thread breaks, or when the weft thread breaks or gets entangled in any way. These stoppages do not call for the mechanic's attention, but in many cases the loom stops or "knocks off" without any apparent cause. This indicates that something is wrong with the machinery of the loom, and in this case the loom mechanic should be called in. The merest trifle may put it right or something may be radically wrong. The following are easy methods of getting at the bottom of it all through a little practice. If the loom will work a short time before stopping put your hand on the top of the picking shaft (if a cone pick), taking a firm hold of the arm just at that place, and in a very short time you

will be able to interpret the meaning of all the various vibrations you feel there. Or, by taking the end of the lay in your hand firmly while in motion, you will soon learn the meaning of the vibrations to be felt there, and you will thus be enabled to go straight to the particular place requiring attention.

The causes that make the loom "knock off."—Now, what are these causes that make the loom "knock off"? After careful consideration we have classed them under three heads. It may be from a want of power to throw the shuttle across the loom in time to raise the protector before it strikes the buffer, or it may be from an obstruction retarding the action or stopping the progress of the shuttle across the loom. Or something may be wrong with the knock-off movement itself, causing the loom to stop while it is otherwise all right. It is evident that if a sufficient force—no more—is properly applied to the shuttle it will reach the opposite box all right if it meet with no obstruction by the way, and, with the protector in good working order, little cause will be left for the loom knocking off. We will now go over these distinctive features in detail, and show the various causes from which they arise, and the symptoms (so to speak) that appear in the loom, by a knowledge of which we may be enabled to apply the proper remedy.

When the loom knocks off from a deficiency of power.—When the loom knocks off from a deficiency of power it may arise from the belt being too slack and slipping on the pulleys; or if it be a loose and fast pulley some derangement of the belt fork may prevent the belt from getting full on to the fast pulley. If they are friction pulleys they may not be locked quite tight enough, or some oil may have got between the bearing surfaces, causing them to slip. Or the picking point may be worn

out; or the whole picking cam may not be set in position to give enough force—it may be a little too early or much too late. The picking straps may have stretched until they are a little too long; the arm may be a notch or two too far back. The defects of the belt and pulleys may be seen in a tendency of the loom to go slower at times. If the defect is in the loom itself, you will feel it from the end of the lay in the manner we have already indicated. If the cause is in the pick, you will be able with a little practice “to spot” the exact deficiency and put it right.

When the loom knocks off from an obstruction to the shuttle.—In the case of obstructions to the shuttle, it is not always easy for the beginner to find the fault, but with practice the touch of the hand on the picking movement and the lay gets keener. The most deceptive of these obstructions is perhaps when the picking strap or cord is too tight. This may be caused by an inexperienced tuner or tenter. In this case the loom seems as if the power were wanting altogether. The friction of the picker on the spindle absorbs the force communicated to it, which is thus not transferred to the shuttle; consequently the power is wanting when it comes that length, and the shuttle may not be thrown more than half-way across the loom. An obstruction may be caused by the cording of the heddle leaves stretching and causing the shed to be too small, not giving the shuttle a clear shed. The pick may take place too soon, throwing the shuttle into the shed before it is quite open to receive it; or the pick may be too late, when the shed will overtake it before it is quite clear; or the shedding itself may be too late or too soon. These obstructions not only retard the movements of the shuttle, but also cause considerable breakage amongst the yarn.

When the protector is at fault.—When the protector alone is out of order it will not communicate itself to the picking spindle or to the end of the lay, where the vibrations tell of many other defects. There seems to be no apparent cause at all for knocking off. The shuttle may be going up at both sides with a steady movement, and then stop at a time when we least expect it. This in itself is enough to cause suspicion that the defect is in the protector or something pertaining to it, and lead us to examine that movement and its connections. The fault may be occasioned by the swells being worn and not lifting the protector high enough; or the boxes may be too wide for the shuttle, which will have the same effect; or the lifters of the protector may be broken or worn or bent. Any of these defects can be ascertained on examination, and at once put right.

The value of the ear in detecting what is wrong.—We have already explained that by the sense of touch, by placing our hand on certain parts of the loom while it is working, we can detect the exact point where any defect may be; but a well-trained ear is perhaps of as much importance. We have known individuals who, on going amongst the looms they had to attend to, and with which they were familiar, could detect at once the jarring sound of a loom out of order, and immediately find the fault. If nothing more, there is a want of that sharp, steady “click, click” with which all are familiar.

Causes that throw the shuttle out of the loom.—In some places shuttle guards are used on the looms. These shuttle guards prevent the shuttle from flying upwards when it leaves the shed from any cause, and thus a flying shuttle is not so dangerous as it would be in the case of a loom without a shuttle guard. The higher the speed of a loom, the more the necessity for a shuttle

guard. The cause of a flying shuttle may be the lay getting bent or twisted, or being thrown off the proper level. If the picker spindle is not in line with the back box and reed, or the shuttle box too wide at the entrance, the same thing may happen. The reed should always be kept straight; a single split protruding into the course of the shuttle will throw it out of its course. Dust gathered about the box or race of the lay, or an obstruction caused by a broken thread, will bring about the same result, more especially if the loom is not otherwise in good working order. The shuttles themselves, and also the swells, get worn, and should be dressed occasionally to keep them in good working order. When the pick is too strong, or the shuttle is jammed in the box, very little obstruction will throw it out, and perhaps this may occur without any obstruction at all. A little experience and a little care will to a great extent prevent these evils.

The main principle that should guide the mechanic.—

In all well regulated factories the mechanic has a certain number of looms to attend to and keep in good working order. He should not wait until he is called for, but should be constantly engaged finding out the weak points in each and putting them right, remembering the old adage that a stitch in time saves nine. We know of no situation in which this is more applicable than amongst running machinery, and more especially power-looms. Indeed, the attendant mechanic should thoroughly know each loom, and when opportunity presents itself take any defective one in hand for repairs.

Some things to be guarded against.—There are some things we would specially guard the loom attendant against if he wishes to keep a good working loom. Do not re-dress the picking tappets unless absolutely un-

avoidable; they should be so arranged at the start that they will go on till quite worn out, and then be replaced by new ones. If this cannot be done we may be sure something is wrong with the construction of that movement. Do not work with the shuttle jammed, or even any way tight in the box; it should be quite free, the check strap being there to prevent its rebound. If the pick is too strong reduce it in force by moving the cam farther out on the anti-friction roller. Do not work with belts, straps, or cords too tight; there is nothing more damaging to the loom than this. Tight belts, straps, and cording soon get worn out and broken, and cause a great deal of obstruction while working, as well as unnecessary expense.

WORKING THE LOOM.

THE TENTING, TACKLING, OR TUNING DEPARTMENT.

The power-loom tenter's work.—The workman and his work with which we have to do in this chapter go under different designations in different localities; but it will be easily understood that the words tenter, tackler, or tuner, and sometimes foreman, have the same significance. It is the mechanic's duty to keep the machinery working and in good order; it is the tenter's duty to make the cloth; and, moreover, this has to be done with his own hand quite independent of the mechanic or the weaver who attends the loom. To summarise his duties, we would say that he has to fix up the warp in the loom; adjust the heddle-leaves to give the proper movement, and the let-off movement to give the proper tension necessary to the particular fabric in hand; adjust the wheels of the take-up movement to give the required number of shots per inch; and to see that this

is all done in the best possible manner, so that the cloth turned out may be the best that could be produced in the circumstances. He has also to attend to the repair of straps and cords (not necessarily the driving strap or belt), and generally to attune the loom to the work in hand; also to superintend the weavers under his charge. To do all this and to do it well a great many details have to be learned and thoroughly digested, so to speak, before the tenter can be said to be a competent workman. These details we shall now go into, remarking that there are so many different classes of weaving (or perhaps we should have said weaves, which is the word in some places) that what may be necessary in one district amongst one class of weaving may be unnecessary or altogether unknown in another; but we will endeavour to explain the principles that underlie all weaving, and that must be understood before cloth of any description can be made.

Tackling.—The tackler derives his name from the process of “looming the web” and putting the tackle in order. The roller with the warp yarn is put into its place in the loom, the heddle leaves hung up as nearly as possible in their place, and the reed put loosely in its place in the lay. The treadles are now attached to the heddle leaves, as they can be more readily got at before the warp is tied up. The treadles must also be adjusted at this stage as nearly as possible. The “pace” or tension cords are now put on the yarn “beam” or roller, and the weights attached to the levers (if any levers are necessary) for the make of cloth. A piece of cloth is now brought up from the cloth roller, and the ends of the warp thread tied on to it. In doing this it must be seen that all the slack threads are drawn in, and when necessary a brush may be employed for this purpose.

It must also be seen that an equal tension is preserved on each "tie up." The exact position of the reed can now be ascertained, and it may be fixed in its proper place in the lay. The lease rods are put in, raising the back leaf of heddles for the first one, and the front leaf for the second, then placed at their proper distance apart from the heddle leaves as the particular fabric may require. (The lease rods will be dealt with in a separate paragraph.) The wheels necessary to give the number of shots required per inch can be ascertained in the manner described in another chapter, and put on. All the different parts of the tackle can now be adjusted to a nicety, and a few shots thrown with the hand to make sure that all is right before putting on the loom.

The most important point in clothmaking—To make good cloth.—The technical phrase for this in some places is "to put cover on the cloth"; in other places, "to put a skin on it"; while others are content with the phrase, "spreading the warp threads." The idea comprehended in them all is the making of good cloth in contradistinction to bad cloth, no matter what the material may be of which it is made. If unsatisfactory, it is said to have a "raw" appearance. Slight defects in weaving can be remedied to some extent or perhaps hidden in the finishing; but the cloth is more valuable when properly made in the loom. To be able to know when the proper standard is being reached in the loom requires experience; and to produce it a combination of circumstances is necessary, and these we will now proceed to notice in detail.

Spreading the warp threads—What actually takes place amongst the yarn to cause the threads to spread—How it is done.—In conjunction with other arrangements which we will notice, perhaps the main factor is

the lowering of the warp line at the heddles. In plain cloth, for instance, where two threads are drawn through the same split of the reed together, they are made to stand out equidistant from each other, and at the same time give a "made-like" appearance to the cloth. What actually takes place amongst the yarn in the process of weaving to bring this about is shown at fig. 54. This fig. shows the shed full open. The line B C E is the line of the warp threads before the shed is formed. It will be noticed that when the shed is formed one half of the yarn has risen as far from the centre C as the other half has sunk, but if we measure accurately

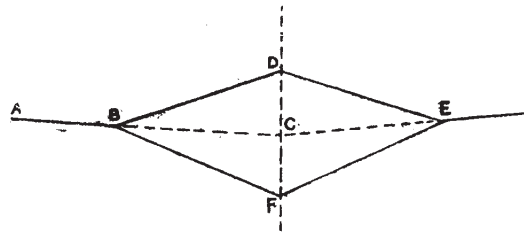


FIG. 54.

the distance B D E and the distance B F E, we shall find that the latter is somewhat longer than the former. What follows from this is that the upper half of the shed remains somewhat loose, while the under half is held tight. Consequently the two threads that pass through the same split, instead of running together, are spread apart just in proportion to the lowering or raising of this warp line. Each half of the shed as it comes up repeats the same thing. Where the shedding cams or wipers are properly constructed and adjusted, with the lease

rods in their proper place in the yarn, and all the straps and cordings correctly attuned, the warp line requires to be lowered very little—in some fabrics of cloth less than in others—to produce the required result; but in every case where good cloth is made this is done to a greater or less extent. Some fabrics are so flimsy that they would not stand this process, but then these are not good cloth. In some places this cover is obtained by raising the back beam alone to an inordinate height. This practice should never be resorted to; it is a very harsh way of working, and is very bad for the yarn. By raising both front and back beams just a little out of the straight warp line will be quite sufficient to produce the required result without overstraining the yarn.

What part the shedding cams or wipers play in making good cloth.—In the first instance, the cams should be properly constructed on the principles we have described under that heading. Of course, this does not come under the cognisance of the tenter, but it is well for him to notice this. What he has more intimately to do with is their proper adjustment as to time. In theory the proper time is nearly full shed just at the moment the shot is being beaten up, but this is not always practicable. Sometimes the yarn will not stand the full pressure being put upon it. Tenters of experience know well the effect that a very slight movement of the wipers has upon both the yarn and the cloth, and they must adjust them to the particular needs of the case in hand. If we depart from the theory, and make the action of the wipers a little late, we save the yarn but we detrimentally affect the cloth.

The lease rods—the important part they play in making good cloth.—The primary purpose of the lease rods, as their name indicates, is to keep the lease—that

is, to allow each alternate thread to go up and down in its proper place; and when a thread may be broken, to find its proper place at once. The most important part they play, however, in the making of the cloth, is in putting a "cover" or "skin" on it; or, in other words, in spreading the warp threads properly. Their distance apart from the heddle leaves, in conjunction with the lowering of the warp line and the time of treading, affects both the yarn and the cloth in a very material manner. When they are placed too far from the heddles the yarn has a tendency to get chafed, and thus weakened. On the other hand, when too near the heddle leaves, too great a stress is thrown on the yarn, although a superior quality of cloth may be produced. Consequently the tenter must find a proper medium for their place in relation to the quality of the yarn and the cloth to be made. If we refer again to fig. 54 we shall at once see how all this comes about. Point E is the position of the lease rod; now, if we move that point either to or from the heddles we alter the angle of the shed altogether, and thus either lessen or add to the difference in tension of the two halves of the shed, thus making a material difference in the quality of the cloth, and perhaps overstraining the yarn at the same time. Very little experience will be required to find the proper position of the lease rods, but without that knowledge it is useless to go on.

The tension at which the yarn is held, and the adjustment of straps and cords.—We may know all that has already been said about the making of cloth, and still mar it all by putting on the wrong tension. In handloom weaving this tension is carefully adjusted by hand every time the cloth is drawn forward, but as the powerloom automatically takes away the cloth every shot, the

tension must be such as to give just what is required and still maintain the same tension for the next. Of course, the yarn beam or roller will be weighted according to the particular fabric in hand. It will at once be noticed that there is a vast difference in this between a light calico and a heavy canvas. The particular point to notice is that an equal tension is thrown on each shed as it is formed. This is secured by a proper adjustment of the straps and cordings of the heddle leaves and their connection with the treadles. To ascertain whether this is being correctly done, place the hand on the flange of the yarn beam while the loom is in motion and feel if each tread and beat-up of the shot has the same effect; if it has not, tighten up the cordings of that leaf which has the weakest movement, or loosen that which has the strongest, as may be necessary, always noticing that each shed as it comes down just touches the lay and no more (when the latter is full back). Repeat this until you have adjusted the whole to a nicety. Such, then, are the main features to be noted by the tenter in the making of cloth; but there are other details that crop up that should be known by all workers among looms. These we will notice under that heading.

JACQUARD WEAVING.

Shedding with the Jacquard machine.—The foregoing remarks on tackling, tenting, etc., are not all applicable to Jacquard weaving. The method of shedding, for instance, in Jacquard weaving is altogether different from that of tappet weaving. In another chapter we have explained this in connection with the particular subject we were dealing with; but now in connection

with the tackling we have to deal with it again. In tappet weaving we have a considerable pause after the shed is full open and closed over the pick or warp thread; and, moreover, this time of closing the shed over the warp thread can be regulated as the demands of the case require, but not so in Jacquard weaving; other considerations come in here that have to be taken into account. In the Jacquard machine the griffe, which raises the hooks and opens the shed, is acted upon by a crank, consequently most of the actual pause disappears altogether. It is true that the crank gives a slower movement towards both ends of its stroke, but there is no real pause. Sometimes a tappet is employed for this purpose, but the crank is more suitable, for the reason that as much time as possible must be given to the rising and falling of the hooks. The graduated movement of the crank just suits this. When jerkiness in any part of the movement takes place it shakes the harness to such an extent that it affects the cloth. Now this is where the skill of the tackler tells—he puts as much cover on the cloth as possible without giving a shock to the harness.

Setting the machine to the comber-board.—Where only one Jacquard machine is required for one loom it is often placed on the top of the loom itself. This is effected by making the end frames of the loom high enough to carry it. In most factories made for this class of weaving, the Jacquard machines are carried on beams attached to the roof or columns supporting the roof, and made movable so that they can be adjusted to any fabric that may be in hand. When in the proper position the centre hook of the machine is exactly plumb with the centre hole of the comber-board. This can be ascertained by the aid of a plumb line.

The comber-board itself is made of some hard wood, framed for strength, and fixed to the loom by brackets, having a hole opposite each hook through which the

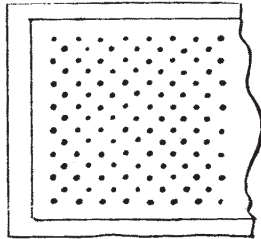


FIG. 55.

neck cords pass. Fig. 55 shows how these comber-boards are made. Sometimes what is called a heck and sometimes a reed is employed for the same purpose, but the

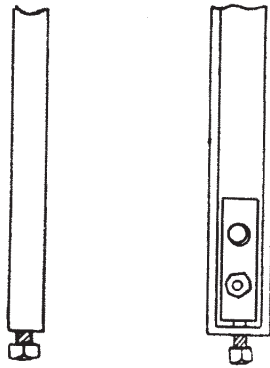


FIG. 56.

comber-board is generally used. It should be adjusted to the Jacquard machine and duly levelled.

Setting the cylinder.—The tackler will adjust the card cylinder to the needles—that is, when the card comes forward it will be properly adjusted to take the needles so that they go fair into the holes. There is an attachment in all well-made machines for that purpose. Fig. 56 shows two views of what may be described as the simplest of these. The tackler will touch the points of the needles with some substance which will mark the card when he brings it forward; he will see how they touch the cards, and adjust them accordingly. Most machines are fitted with the put-back movement we have described in another chapter, so that the whole thing can be managed without delay.

Mounting the harness.—There is such a variety of methods employed in mounting harness that it would be impossible to give a detailed description of them all. We will confine ourselves to a summary of procedure mostly employed in the full harness, where any pattern whatever can be produced. Each hook is attached to a single mail carrying a single thread, consequently any single thread can be raised independently of the others. This is called the single tie. In this case the harness cords are connected directly with each hook.

Preparing the lingoos.—The lingoos are weights used to bring down the mails when the griffe leaves the hooks. They are made of pieces of round wire of various kinds and sizes, according to the weight required. Sometimes they are made of lead, but this depends entirely on the fabric to be produced. The mails are strung on a piece of wire, which is hung up in some convenient position. The lingoos with a small hole in the end are also placed handy; also the twines in bunches, cut to the lengths necessary. The twine is wound round two pins at the necessary distance apart, then cut. Having now our

mails, lingoes, and twine, take a piece of the latter, put it through an end hole of the mail, then put both ends of the twine through the hole in the end of the lingoe, and cast a knot on them. Proceed in like manner with the others as quickly as possible.

Levelling the mails is perhaps the most important point in Jacquard mounting. Not only the machine itself, but also the mails, must be levelled, and that in a perfectly straight line, otherwise the shed will not be properly formed. This is done by means of a levelling frame or slabstock, which is fixed to the end frames by brackets. To this frame the heddles are secured in a perfectly straight line, and at the proper height in the loom to allow of the correct shed to be formed, just in the same way as in tappet weaving, only in this case it should be done in the mounting. Some machines are made so that they can be raised or lowered a little, but the right plan is to make the mounting correct at once. We may now attach our cords to the hooks, finding their length in the same way as that of the lingoes. Pass them through the comber-board in their regular order, and so to the mails.

SOME DETAILS THAT SHOULD BE KNOWN BY ALL CONNECTED WITH WEAVING.

A peculiarity in the construction of the shuttle, and the reason for it.—In considering the design of the loom we gave reasons for the height, breadth, length, and weight of the shuttle; but there is a peculiarity about its construction which more particularly affects the working of the loom, and which should be well known by all concerned. That is, the position of the point A

shown at fig. 57. This point should be considerably below the centre line of the shuttle B. The reason is, that when an obstruction occurs in the shed, such as may be caused by a broken thread, if this point or tip is too high it may lead the shuttle over the top and cause it to be thrown out of the loom altogether. But if this point is low enough it will guide the shuttle under the obstruction, and the worst that will happen is that the loom may knock-off, which in this case would be an advantage. This point or tip of the shuttle should not be too low, however, as in that case it might catch any little obstacle on the lower half of the shed. Every effort should be made to guard against the shuttle being thrown out of the loom by seeing that the loom itself is

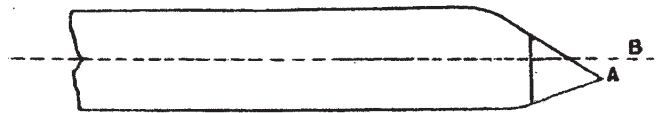


FIG. 57.

in thorough working order. All fast-running looms are fitted with shuttle guards, which in *some* cases are of considerable advantage.

Management of the picking movement.—A bad working pick is the source of a great deal of unnecessary expense and waste in the power-loom factory. Its proper adjustment, therefore, ought to be thoroughly understood by all concerned. If “too hard” the shuttle will be broken; this is what should not occur at all except on very rare occasions of accident. The cops or bobbins will be “broken,” causing too much waste of the yarn. The pickers, straps, etc., may not wear nearly so long as they ought to. Besides, with the continual

breakages and stoppages of the loom, its output is reduced. In other sections of the book we have shown how all this can be avoided. It is of prime importance that we begin with a properly constructed movement, and keep it properly adjusted throughout in all its relations with other parts of the loom.

The use of the check-strap.—The check-strap, or martingale as it is named in some parts, is used to stay the rebound of the shuttle when thrown into the box of the lay, and to prevent it from reaching the extreme end of the box. Fig. 58 shows an arrangement of this attachment as used in some places. It consists of an iron rod A, say $\frac{3}{16}$ or $\frac{1}{4}$ inch diameter, running along the lay, with short straps attached to each end of it. It must be attached to the lay in such a manner that its action will be perfectly free, and the length of its traverse regulated by the lace or cord B to suit the requirements of the particular case in hand.

This little attachment is not always cared for as it should be. Sometimes when the shuttle seems inclined to rebound, instead of adjusting the check-strap, knocking the front of the box of the lay with a spanner is resorted to by the tenter. This is often the first step in the making of a bad working loom.

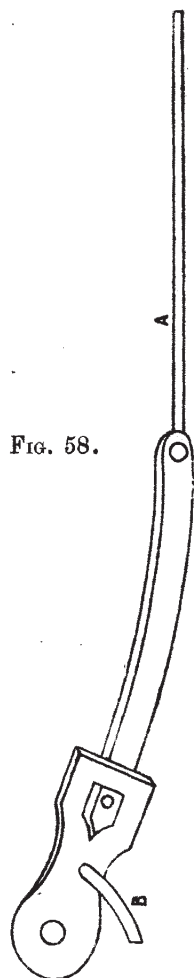


FIG. 58.

In some narrow, light, fast running looms the check-strap is not used. To prevent the picker striking the end of the box, and so causing the shuttle to rebound, a small wooden arm is introduced instead of the usual picker strap, so adjusted that the picker cannot quite reach the end of the box. This arrangement is shown at fig. 19.

The intermediate or patent selvage—How it is formed.—The devices used for the formation of the intermediate selvage are so simple that we need not describe them here, but simply state how the threads that form this selvage are manipulated; the method is not so easily understood by a beginner. We will illustrate this to make it more easily understood. The patent selvage is formed by three threads somewhat stronger than the thread in the cloth, or it may be three double threads. One thread is drawn through an eye on the front leaf of heddles, and another on the back leaf; then the “looping” or “flying” heddle is attached to the front leaf, through which a thread is drawn named the “looping thread.” This looping thread, which binds the other two together with the weft threads, is also drawn through a heddle on the back leaf. Fig. 59 shows the exact relative position of these threads with the front leaf down, and fig. 60 shows their position with the back leaf sunk. Fig. 61 is an enlarged view of the selvage itself, showing how the threads are interlocked.

It will be noticed that the looping thread just rises to about the middle of the shed in both figures. This will be quite evident on examining its position in fig. 61. It is always above the weft threads, and passes under the other two selvage threads in the process of shedding.

The length of the flying heddle is adjusted so as to make the most of both sheds. The only difficulty in this connection, then, is to find its proper length. When

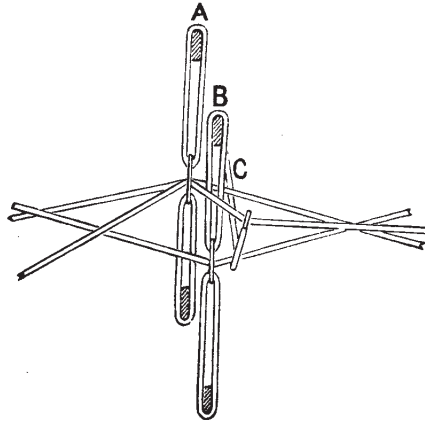


FIG. 59.

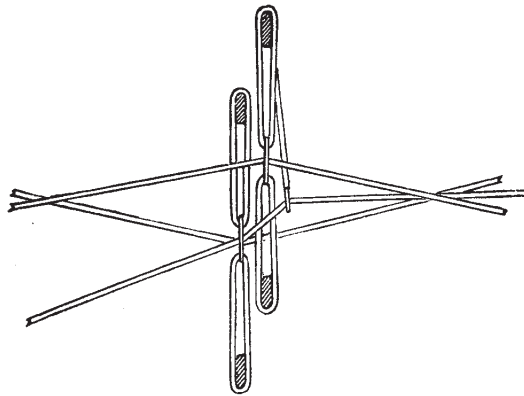


FIG. 60.

this looping heddle is not the proper length an unequal tension is thrown on the thread in the two sheds, and the selvage is spoiled, or the thread or the heddle may be broken.

The "mail" or ring through which the thread passes on the looping heddle should be as small as can be wrought with, and at the same time large enough to prevent its being entangled in the reed.

It will be noticed that the looping thread is not taken by the lease rods, but comes direct to the heddles from

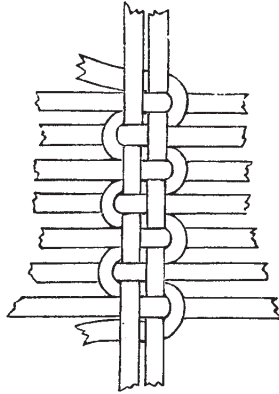


FIG. 61.

the bobbin on which it is wound. This bobbin is weighted sufficiently to keep the thread at the proper tension. The tighter this thread can be wrought the stronger will be the selvage. By a careful examination of these diagrams showing how the threads are interwoven and drawn together by the looping thread the whole process of forming the intermediate selvage will be quite easily understood.

HOW THE PATTERNS ARE PRODUCED.

Tappet, Dobby, and Jacquard shedding.—It is by the order and succession in which the warp threads are raised and depressed to be interwoven with the weft threads, in conjunction with the order in which these threads are drawn through the heddles or healds, that the different patterns of cloth are produced. This is the point from which we must start, and we must follow it up through many different sorts of cloth manufactured, in order to get a thorough knowledge of our subject.

In tappet weaving the patterns are necessarily small in size, because a large number of treads cannot be given in one “repeat” of the pattern. These patterns are also confined to a certain class, which we will illustrate as we proceed.

When we wish to extend these patterns and they become too complicated for the tappet loom we employ the Dobby machine; but the patterns are somewhat of the same class as that produced by tappets, as it is still heddle leaves with which we are producing the pattern. But by the Dobby machine these patterns can be greatly enlarged and varied, as a greater number of leaves can be employed, and there is practically no limit to the number of repeats that can be made in the formation of one pattern. As we have explained in another chapter, the Dobby is simply a small Jacquard machine, and is acted upon by cards in the same way. It will at once be seen how this variety and size of pattern is obtained.

Then, passing on to Jacquard weaving pure and simple, we leave our heddle leaves behind and employ the harness in their place. We have already seen what the harness is. The pattern will then depend upon the “tie” or mounting of the harness cords; how many of

them are attached to each hook; how these hooks are acted upon by the needles to be raised or let down; and how the needles in turn are acted upon by the pattern cards. We notice the limits of the tappet and Dobby machine, but there is practically no limit to the patterns that can be produced by the Jacquard machine.

Plain cloth.—To begin at the beginning, we must have a look into the construction of plain cloth, where the warp and weft threads are interwoven alternately. There are a few details it may be as well to know. In seeking to produce the different patterns of cloth we must not lose sight of the fact that in each case the cloth must be well made. The conjunction of the various

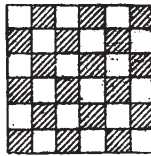


FIG. 62.

movements of the loom and the necessary adjustment of the same to that end having been explained throughout the book, we may sum it up here with the one word "cover." This is not so easily done in some cases as in others, but we must always make the most of the circumstances.

A representation of plain cloth on paper would take the form of that shown at fig. 62, the black squares, say, representing the weft, and the white squares the warp threads. This will be understood with reference to all the other figs.

Sometimes in plain weaving four leaves of heddles are employed, each two being fixed together and raised and depressed as one. This is done to prevent the heddles being overcrowded on the shaft. Fig. 63 shows this arrangement, and the order in which the threads are generally drawn through the heddles. The figures 1, 2, 3, 4 on the right indicate the leaves of heddles. No. 1 is the leaf next to the lay. 1 and 2 rise and sink together, as also do 3 and 4. The figures on the heddle leaves show the order in which the threads are drawn.

Setting the heddles to the reed.—The reed is always fitted to the fabric of cloth to be woven, but it is not always necessary that the heddle leaves should be so. Any fabric of a less sett or porter than the heddle leaves

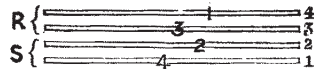


FIG. 63.

can be wrought in them by leaving out (at regular intervals) the extra heddles. Let us take for our example those reckoned by the "porter." If we have a 30 porter reed and our heddle shafts count 36 porter, then we leave these extra 6 porters of heddles empty, dividing them in such a way that they will not be inconvenient. No matter what the porters of reed and heddles may be, we have just to subtract the porter of the reed from that of the heddles, and the difference will be the number of porters to be set in 37 inches. The simplest way to get at it is this: Take the difference between the porter of the reed and heddle shafts—in this case 6—divide the count of the reed by it; the quotient

will be 5. This shows us that we are to fill five heddles on each leaf, then set the sixth, or, in other words, leave one empty on each leaf.

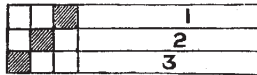


FIG. 64.

Regular twills.—The twill differs from that of plain cloth in this, that the warp and weft threads are not interwoven with each other every shot, but are “flushed”

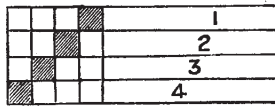


FIG. 65.

either on one side of the cloth or the other, to form the pattern required. What are termed the regular twills are those where the warp threads are flushed and inter-

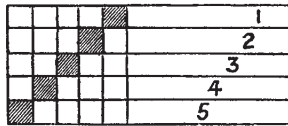


FIG. 66.

woven at regular intervals. The commonest of these, the three, four, and five leaf, etc., are shown at figs. 64, 65, and 66. The draughts are in the same order as the treading is performed—beginning on the back leaf, then

each succeeding one until all the leaves are gone over, then going back over them again in the same order. The squares in the figs. show the order of the treading, and the figures 1, 2, etc., show the order of draughting.

The same twill with the draughts reversed.—This is a very common pattern, and may be seen in almost every household. It is named the herring-bone twill. It derives its name from its resemblance in the cloth to the backbone of that native of the deep. This is shown as a four-leaf at fig. 67, but can be made with any number of leaves. The treading is straight across, beginning with the back leaf as No. 1, the same as the three previous examples; but the draughting is that shown by

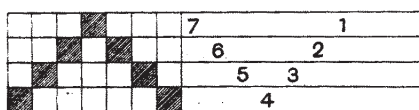


FIG. 67.

the numbers in the fig. In the cloth the twill will be seen to run first in one direction, then in the opposite direction, the pattern being enlarged according to the number of leaves employed, and to the number of threads drawn before the draught is reversed in direction.

How the pattern should be turned.—It will be noticed that in the foregoing example of a four-leaf herring-bone twill the draughts run from the back leaf to the front one, then beginning on the second front leaf and running back. When the back leaf is reached the same order is repeated. This is what is called turning the pattern on a single thread. It makes the neatest pattern. These remarks are equally applicable to all classes of patterns; for the most part they are all twills.

Take a piece of damask cloth, for example—the pattern is simply twilled first on one side of the cloth, then on the other. No matter what class of pattern it may be, for the sake of neatness it should always be turned on one thread.

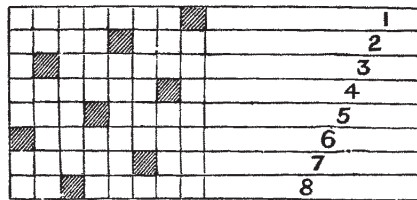


FIG. 68.

Irregular twills.—There are other twills than those we have just described. They are made by altering the order of treading instead of the draughting. Take, for example, an eight-leaf of this description as shown at fig. 68. It will be noticed that the draughting is straight across, but not the treading. If we call the back leaf 1



FIG. 69.

the treading begins there, and is as follows:—1, 4, 7, 2, 5, 8, 3, 6. This is an eight-thread sateen or satin, and is one of the weaves used extensively for linen, cotton, and silk damasks; it is also used in the worsted trade.

Common twills that are equally flushed on both sides of the cloth.—This twill is used also in the woollen branches of the trade. The cloth is called serge. It can

be wrought with any number of leaves. Figs. 69 and 70 show four and eight leaf twills of this sort. In the four-leaf the warp threads are flushed for two picks on the one side, then two picks on the other. The eight-leaf is flushed four times on the one side, then four times on the other. The draughts are on each alternate leaf, as indicated by the figures.

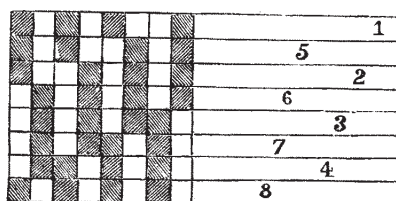


FIG. 70.

The combination of common twill and plain cloth.—

This class of weaving is mostly used to show to more effect the colours in a stripe, the plain body of the cloth being relieved by a bright stripe in colours. Fig. 71 shows how they are combined. Two sets of

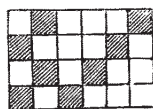


FIG. 71.

heddle leaves are employed for this purpose, one of them being spaced to allow the threads of the other to pass. Their action is simultaneous, and passing through the same reed their junction is thus complete.

How the draughts and treading form the patterns in the cloth.—Take a six-leaf twill, for example, of which the draughts and treading are shown at fig. 72. If we make a piece of cloth with the draughts and treading as indicated in the fig.—supposing the warp to be

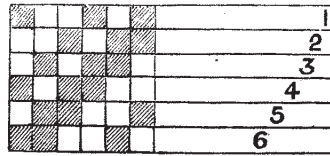


FIG. 72.

white and the weft black—it would have the appearance of that shown at fig. 73. Now, if we keep the treading as it is, but reverse the draughting in a similar manner to that shown at fig. 67, the appearance of the

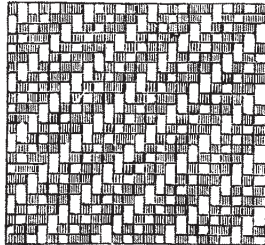


FIG. 73.

pattern will be changed to that shown at fig. 74. Then, if we keep the draughts straight, as shown at fig. 72, and reverse the treading—that is, go over the leaves in the order arranged on, and then go over them again in

the opposite direction, and repeat—we have the pattern shown at fig. 75. Then, if we reverse both draughts and treading in the manner indicated, the pattern shown

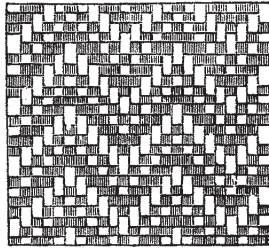


FIG. 74.

at fig. 76 is formed. This is what is called the diaper pattern, and shows the principle that is involved in producing patterns by tappet weaving. They can be

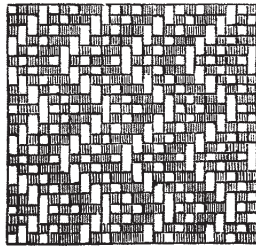


FIG. 75.

enlarged and varied considerably; but by and by the pattern becomes too complicated for tappets, then the Dobby and Jacquard machines are employed for that purpose.

How the patterns are produced by the Jacquard machine.—We have already shown in another chapter that the Dobby machine is simply a small Jacquard machine working heddle leaves instead of the harness employed in the ordinary Jacquard loom. Although the Dobby is confined to the same class of patterns as that produced by tappets, these patterns can be greatly enlarged, as a greater number of leaves can be employed. Besides, the leaves can be gone over in any conceivable manner. Still, the principle on which these patterns are wrought out is the same as that employed in tappet

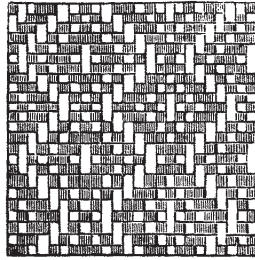


FIG. 76.

weaving; but the method is altogether different. The same method is employed for lifting a heddle leaf or shaft as is used in the Jacquard to lift single threads.

When we come to Jacquard patterns the case is quite different. Instead of raising and depressing the warp threads by leaves of heddles to form the pattern, any particular thread or threads can be raised or kept up as long as may be necessary. A great amount of artistic skill, combined with a good knowledge of weaving, is required in order to be able to design these patterns and

prepare them for the cardcutter.* Knowledge and capability, however, are not always to be found in the same individual, hence the necessity for a division of labour, so to speak, in this particular branch of the textile industry.

There are designing establishments in all centres of this industry, where sketches for patterns can be bought or wrought out for the particular fabric to be produced,

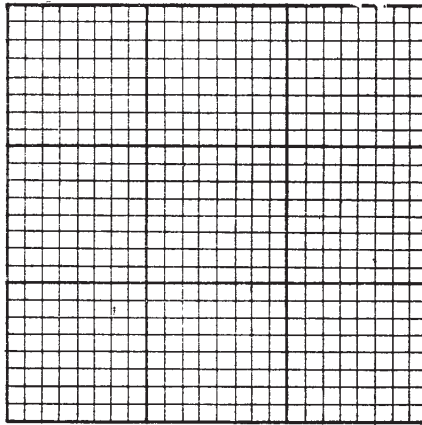


FIG. 77.

and where the cards are cut ready for the loom. The method of procedure is as follows:—We have first of all to find the drawing of the design—coloured, if necessary—suitable for the fabric to be produced. Then this sketch will be put upon design paper. Fig. 77 shows

* For a full description of the designing of a great variety of textile fabrics, see "Textile Design: Pure and Applied," by T. Woodhouse and T. Milne.

how one type of design paper is ruled. This is called 8×8 paper, each of the large squares containing 64 smaller ones. It also indicates that the warp and weft will be equal. For each eight threads of warp there will be eight picks. The upright spaces between the lines represent a thread of warp, and the horizontal spaces that of the weft. Fig. 78 shows a small sketch on design paper. As the spaces between the lines simply

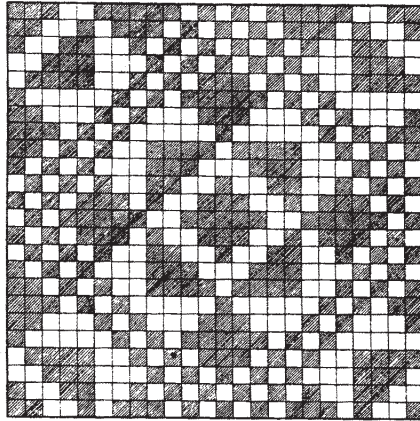


FIG. 78.

represent enlarged threads, it will at once be seen how the pattern is formed.

How the cards are found and cut from these sketches.
—If each space between the upright lines represent a warp thread it will also represent a needle in the Jacquard machine, and as the cross spaces represent a shot of weft it will also represent one card of the pattern.

Then we have simply to note what threads, and consequently what hooks, are to be raised for each succeeding pick of the pattern, and perforate the cards opposite the needles whose hooks require to be raised. This, in brief, is the principle that runs through it all. When our young student gets impressed with this idea all the other intricacies may be mastered in time.

A striking peculiarity in linen damask cloth.—There is a striking peculiarity in linen damask cloth that we do not think has yet been fully explained. Suppose the warp and weft before being woven are exactly the same colour, say white. Now, when they are in the cloth they seem to be of a different shade altogether. We know it has been said that the one class of threads casts a shadow on the other. This does not seem to us to explain the matter fully. It seems rather to be the play of light on the individual thread according to the position that thread is held to the light. No matter what pressure may be employed in finishing the cloth, it does not altogether do away with the roundness of the threads (a little observation will show this), consequently when we hold them across the light it has a different effect on them than if we hold them in a line with it. This play of light brings out the pattern with fine effect.

TEXTILE CALCULATIONS.

The different standards or bases of calculations used in different localities.—In previous editions of this book we have noticed the difficulty that presents itself at the very outset of this subject. It is evident that to find the quantity of warp and weft to make a certain piece of cloth, the fineness of the reed in which it is to be

wrought, the weight per yard or piece at which it will come out of the loom, and the actual cost of material—we must have some standard on which to base our calculations. These standards are nearly as numerous as the localities in which textile manufacture is carried on; besides, so many different names are applied to the same thing that they are apt to muddle the learner. There are those who advocate the adoption of a universal basis for the calculation of yarns of all descriptions. This is scarcely practicable, neither is it necessary. What in common have the jute manufacturers of the north-east of Scotland with the silk weavers of Spitalfields? What is necessary is that there be a recognised basis of calculations throughout the whole country in connection with each distinct fibre of which yarn is made—such as cotton, flax, silk, etc. Yarns are used for other purposes than that of making cloth. For instance, a large quantity of yarns of all descriptions are used for covering lines and cables for conveying electricity. If there were a recognised basis of the different fibres it would be easier to get at the required weight. There is not so much difficulty, however, as would appear at first sight; it is just taking slightly different roads to the same place. Moreover, it is not necessary for the student to acquire a knowledge of the different bases of calculations; it is only necessary to learn that which he is to use. It will be seen, however, as we proceed that the same principle runs through them all—they all produce the same result; so that after we learn one system properly it will be an easy matter to acquire them all if necessary. It is this underlying principle that we now intend to explain.

The “setts” or “porters” of the reed.—The number of splits—in some districts called dents—per inch or any number of inches of the reed indicates the fineness of

the reed, and consequently the fineness of the cloth to be woven. What is perhaps the most reasonable method is that adopted in some places, the calculating on the number of splits or dents per inch. Of late this basis of calculation for the reed is being more generally used. It is simpler by far than any other method in use. In most districts in Scotland the fineness of the reed is indicated by the number of porters in 37 inches. The porter contains twenty splits or dents, consequently the fineness of the cloth depends upon the number of times twenty splits occur in 37 inches. For example, if it occurs eighteen times it is called eighteen porter cloth. The equivalent to the Scotch porter is the English "beer." In most districts the beer contains twenty dents, but in other districts it differs somewhat; for instance, in some parts of Yorkshire it only contains nineteen dents. Then, again, the basis of this calculation is varied by the number of inches that contain these beers. In some places it is the 37 inch standard or the number of beers contained in 37 inches or in 30 inches, and so on with great diversity. These are the principal porters or setts of the reed on which the calculations are based. Our example will show clearly the principle on which they all run—two threads making a split if not otherwise mentioned.

Take the porter of twenty splits calculated on the basis of the number of times it is found in 37 inches. Then, to find the number of threads or ends in any width of cloth in inches, multiply the count of the reed (the number of porters in 37 inches) by 40 (the number of threads in a porter). Then multiply the product by the width in inches and divide by 37, which will give the number of ends. Divide this by 2 to give the number of splits or dents.

The same rule applies to the beer systems, no matter what basis they have.*

Those calculated on the inch basis simply resolve themselves into a question of proportion; thus, if one inch contains so many splits or threads, how many splits or threads will be in any given number of inches?

The calculation of warp yarns.—Almost all the calculations of yarn are based upon the number of “cuts,” “leas,” “hanks,” or “skeins,” etc., that go to make one pound weight, or the number of pounds one spyndle weighs. The hanks, etc., are made up by winding the yarn on a reel of a given diameter (which varies in different districts), giving a certain length of thread. The cotton hank, for example, measures 840 yards, which, by the way, is determined by Act of Parliament. In linen yarn the lea measures 300 yards. Then the number of hanks or leas that go to make up one pound weight constitutes the “count” of the yarn. In many cases the yarn is not sent out in this form, but is wound in balls or cops. The basis of calculation, however, is the same—a certain length of thread weighing a given amount gives the count of the yarn. Thus, if 20 hanks or leas weigh one pound, it is spoken of as 20’s; or if 30 hanks make one pound, it is 30’s, etc. In the coarser yarns, reckoned by the spyndle of 14,400 yards, if the spyndle weighs, say, 6 lbs., it is termed 6-lb. yarn, etc. This spyndle also varies in length in different districts, but the foregoing remarks will show the principle on which the following calculations are made. These can only approximate to the general practice, but the examples given may be helpful:—

* See “Healds and Reeds for Weaving: Setts and Porters,” by T. Woodhouse.

MOST COTTON YARNS.

54 inches	=	1 thread	=	1½ yards.
80 threads	=	1 cut or lea	=	120 „
7 cuts	=	1 hank	=	840 „

SOME LINEN YARNS.

90 inches	=	1 thread	=	2½ yards.
120 threads	=	1 lea	=	300 „
10 leas	=	1 hank	=	3,000 „

COARSE LINEN AND JUTE YARNS.

Some Woollen Yarns are also reckoned by this table.

90 inches	=	1 thread	=	2½ yards.
120 threads	=	1 cut	=	300 „
2 cuts	=	1 heer	=	600 „
6 heers	=	1 hasp	=	3,600 „
4 hasps	=	1 spyndle	=	14,400 „

To find the quantity of warp necessary to make a given piece of cloth we have simply to multiply the number of threads in the width by the length of the piece in yards. This will give us the number of yards of yarn contained in the piece. Then divide by the number of yards in the denomination to which it belongs, 300 for leas, 840 for hanks, 14,400 for spyndles. The result will be expressed in the denomination to which it belongs.

To find the weft.—The process of finding the quantity of weft necessary for any given piece of cloth is somewhat similar to that for finding the warp. For example, we can multiply the number of picks per inch of cloth by the width occupied by the threads in the reed in inches. The product will be the number of inches of weft yarn

contained in one inch of cloth. Turn this into yards, then multiply by the number of yards in the length of the piece; the product will be the number of yards of weft thread in the piece. Then divide by the denomination required, as has been done with the warp, to find the number of hanks, leas, spyndles, etc.

We may mention that the skein is calculated under so many different denominations that it would only be bewildering to introduce it here; and as this system of calculation is gradually giving place to the simpler methods there is no need to revive it here.

An example showing how to find the quantity of warp and weft in any given piece of cloth of any material.—It will be observed from the foregoing rules that the method of finding the number of splits or threads and the quantity of warp and weft in any given piece of cloth is the same in every case, no matter whether it is cotton, linen, or any other material. It is also extremely simple. The only thing to be noted is the different scales by which reeds and heddles are reckoned, and the different tables for the computation of yarns.

Let us take, for example, a piece of jute cloth 100 yards long, 18 porter, made from 108 yards of warp, 48 inches wide in the reed, and 22 shots per inch in the finished cloth. Then:—

$$\frac{18 \times 20 \times 48}{37} = 467.01 \text{ splits.}$$

Now if we take these 467 splits and multiply them by 2 we have the number of threads or ends in the piece. Multiply this by 108 and we have the number of yards of warp thread in the piece. Now if we look up the table for the denomination we wish to bring it to, say

spyndles, each 14,400 yards long, if we divide the yards of thread by that number we get the spyndles required. It may be stated thus :—

$$\frac{467 \times 2 \times 108}{14,400} = 7 \text{ spyndles.}$$

Then to find the quantity of weft on the same piece with 22 picks to the inch, multiply the 22 by 36, giving the number of picks per yard ; and by the length of the piece in yards (100), which will give the number of picks on the piece. Then multiply the number of picks on the piece by 48, the width, and divide by 36, which will give the number of yards ; then by 14,400, to bring it to spyndles. As we have a multiplier and a divisor of the same denomination in this question—namely, 36—we may cancel these and briefly state it thus—

$$\frac{22 \times 48 \times 100}{14,400} = 7\frac{1}{3} \text{ spyndles.}$$

To find the weight and cost of yarns.—As we already know how to find the quantity of yarn necessary to make any given piece of cloth, very little more is required to enable us to find the weight and the actual cost of it. We know how many hanks, cuts, etc., it takes to make up the piece ; then all that is necessary is to divide the number of hanks, etc., by the count of the yarn and we have its weight at once. Thus if 20 leas or hanks weigh one pound, how many pounds will 50 hanks weigh ? It is simply a question of proportion.

So is it with the cost. If the yarn be sold by weight, so much per pound, it is simply a question of proportion again ; and if the yarn be sold by bundle, the cost of one bundle is multiplied by the number of bundles.

Considerations that must be taken into account in determining the price of cloth from that of the yarn.— There is the cost of labour and the upkeep of the establishment, which may vary in different localities. Then there is the waste that takes place in the manufacture of cloth. In winding, warping, beaming, and finishing, as well as weaving, the waste is considerable, and must be allowed for in any calculation as to the weight of cloth to be produced from any given weight of yarn. This in every case will vary with the quality of yarn used. The worse the quality the more waste will be produced. Then there is the shrinkage that takes place in the loom, and the alteration that takes place in the process of finishing. All this must be learned by experience in the factory. Most manufacturers or managers of works have formulated data for their own use in connection with the particular fabrics they produce and the conditions on which works are run. If this is not already done, a very good plan that is adopted by some managers is to take note of each movement as it passes along, and under varying conditions, if any, and at various times, and from these notes compile data for their own use.

We have endeavoured to describe and illustrate the various parts as briefly as possible so that the matter may be easily understood by the young student. After he has mastered what appears in this volume, he will perhaps be inclined to study each branch more deeply; he will have no difficulty in finding text-books on each branch of the weaving industry.

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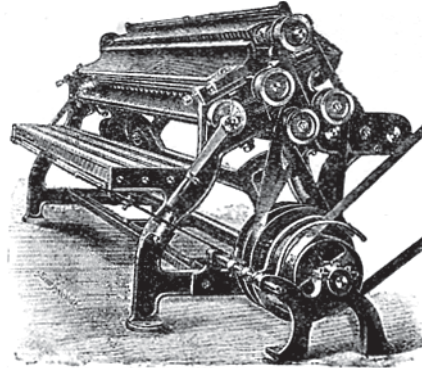
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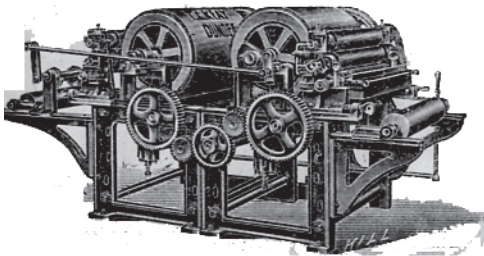
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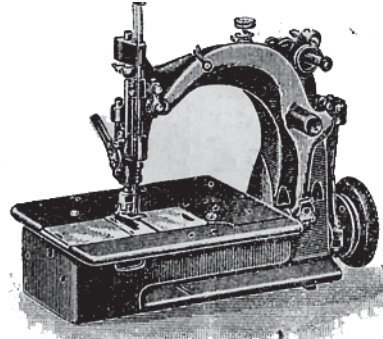
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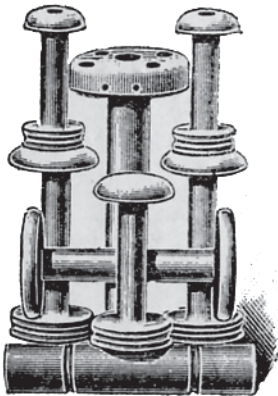


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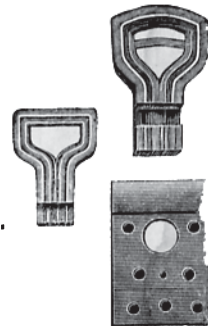
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