Dobbies and Other Head Motions

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What This Text Covers . . .

This table of contents will help you to plan your studies. You can check off each section as you complete it – then you will know exactly where you were when you pick up your text again. You may also use this table later, when you want to review certain parts of the text.

1. Purpose and Operation . . . . Pages 1 to 11
You'll find that many words used to describe the various parts of the dobby have meanings quite different from those found in a dictionary. You'll also learn how the information for weaving specific fabrics is "coded," so that the dobby will "know" exactly what has to be done.

2. Dobby Parts and Their Operation . . . . Pages 12 to 18
The main parts of the dobby are covered in detail in this section. When you complete your study of this section, you should have a clear understanding of the various functions of the dobby.

3. Dobby Maintenance . . . . Pages 19 to 24
This section covers the care and maintenance of the dobby. Particular emphasis is placed on the checking and repairs that are needed for a dobby.

4. Dobby and Harness Attachments . . . . Pages 25 to 33
A dobby can function perfectly, yet do no more than an automobile engine when the transmission is worn out. The purpose of the dobby is to move the harnesses. Here, then, you'll learn how the dobby is connected to the harness to achieve its purpose.

5. Timing the Dobby . . . . Pages 34 to 37
To obtain optimum results in weaving, the dobby must work in harmony with the other motions of the loom. This section will show you how this is accomplished.

6. Variations in Dobby Design . . . . Pages 38 to 44
There are many variations in dobbies and head motions. The general principles common to all of them are covered here. You'll learn how dobbies can be modified to function better for certain purposes. You'll also learn about an inexpensive dobby substitute that can be used under certain conditions.

7. Head Motions . . . . Pages 45 to 53
This final part of the text covers a head motion that is designed specifically to do heavy-duty work not normally expected of the regular dobby.

Dobbies and Other Head Motions

Purpose and Operation

Use of Dobbies

1. As you have learned from your study of looms, cam looms are suitable for weaving relatively plain fabrics. While it is possible to use cams for up to ten harnesses on a loom, seldom are more than six harnesses ever used. Thus, if a mill intends to weave nothing but plain, simple twill, basket, satins in medium constructions, and similar weaves, cam looms are generally used. However, such weaves as spots, fancy twills, satins in fine constructions, combination weaves, pile fabrics, and similar weaves are beyond the range and capability of cam motions. Some of these weaves often require as many as 16, 20, and 24 harnesses, and so are often called dobby weaves.

Still more complex weaves, such as brocade, damask, and the large flower designs often found in household fabrics, are beyond anything that can be produced with harnesses. These weaves require jacquards.

In this text we will cover only the dobbies or other head motions that are used to control the movement of harnesses. You have already studied cam motions; jacquards are covered in a separate text.

Origin of Terms

2. Some of the terms used in various trades started as nicknames. For example, a printer's apprentice was called a printer's devil, because he was often covered with black ink. Of course, everyone is familiar with the trick-playing little people of fairy-tale fame – gnomes, gremlins, leprechauns, and particularly the dobbies of Scotland.

As you know, the harnesses of a handloom or cam loom are normally raised and lowered by treadles under the loom. In the days of the handloom, the weaver had to make special arrangements whenever fabrics requiring a large number of harnesses were to be woven. A helper, usually a young boy, was hired and placed on a seat either above or at the head of the loom. His job was to raise and lower the harnesses as needed or called for by the weaver. This boy was called a dobby, dobby boy, or head boy. Thus the mechanism that eventually replaced the boy was called a dobby or head motion.

Different terms are often used to describe an item or mechanism, depending upon the type of mill or its location. For example, a harness may be called a shaft in mills weaving silk or synthetic fabrics. The term harness will be used in this text. Likewise, the term dobby, dobby head, or head motion will be used, depending upon the term used by the manufacturer of a particular mechanism. Even if a different term is used in the mill where you work, you should have no

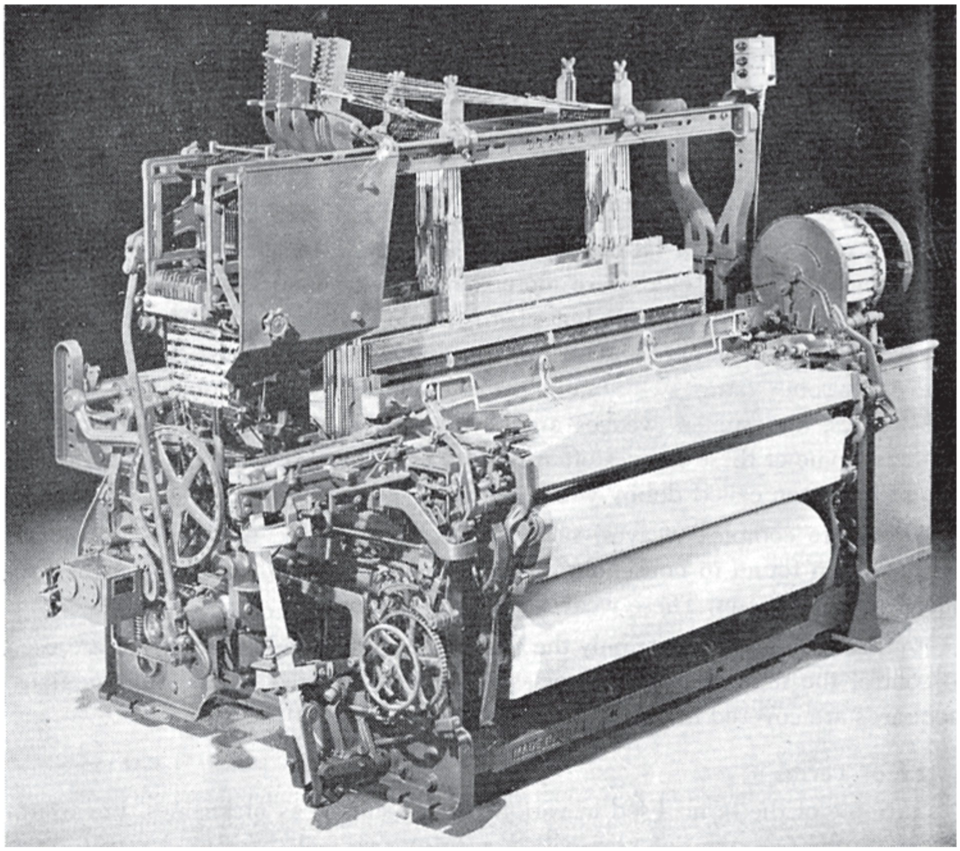


FIG. 1. DRAPER X-3 MODEL LOOM WITH CROMPTON & KNOWLES DOBBY

trouble recognizing the mechanism being discussed, either through the description given or the illustrations used.

Economics of Dobbies

3. Looms equipped with a dobby can be used for simple weaves, as well as for dobby weaves. When weaves can be produced on the same harness draft, it takes only a few minutes to change from one weave to another. The major advantage of a dobby, therefore, is its great flexibility for producing a wide range of different weaves.

You may be wondering why cam looms are used so extensively, if looms with dobbies are so versatile. There are many reasons why dobbies have not fully replaced cam motions. First, the initial cost of a dobby is quite high. Second, maintenance costs are much higher than those of cam motions, even when the dobby is used to produce simple weaves. These points must be carefully considered by mill management.

In the past, looms with dobbies could not be run at the speeds which could be obtained with cam looms. However, modern dobbies and head motions are constructed so as to operate at high loom speeds.

Looms and Dobbies

4. Most of the looms found in American mills are manufactured by either the Draper Corporation or the Crompton & Knowles Corporation. While Draper looms are manufactured basically as cam looms, they can be easily modified for use with dobbies. Such a loom is shown in Fig. 1. Crompton & Knowles looms are normally manufactured for use with dobbies, other head motions, or jacquards.

The terms cam loom, dobby loom, and jacquard loom are commonly used to identify a loom with the particular motion indicated by the name. However, these terms are misleading, in that the particular mechanism is delivered as specified by the mill. Actually, most looms can be readily changed to accommodate one type of harness motion or another. The harness motion is optional, just like the manual or automatic shift of an automobile.

Capacity of Dobbies

5. Dobbies and other head motions are built to operate a number of harnesses. The greatest number of harnesses a dobby can operate is called its capacity. This may range from 16 to as many as 32 harnesses. A 20-harness capacity is the most common.

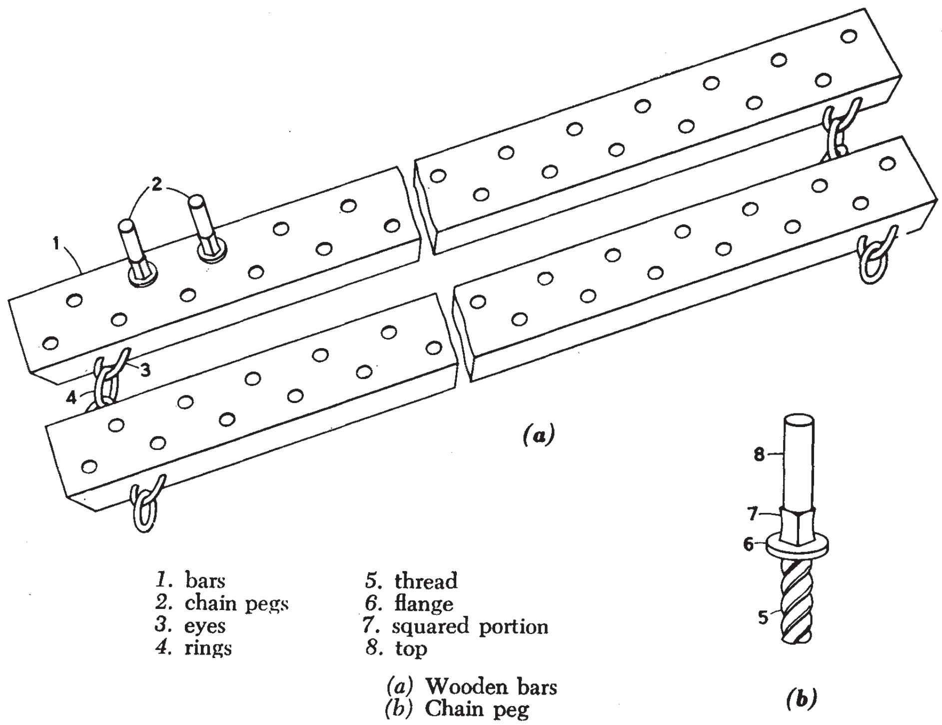
There are factors, not considering the dobby, which determine the maximum number of harnesses which can be used. The space within the framework of the loom is of the utmost importance. The front harness can be no farther forward than the lay when the lay is in its back position. The back harness can be no farther back than the crankshaft of the loom.

The warp yarn to be woven must also be considered. As you know, the farther back the harness is, the greater the distance it must travel in its up and down movements. At some point, depedening upon the yarn, the strain on the yarn becomes so great that excessive broken ends render weaving unsuitable or impracticable.

You must clearly understand that no mechanical reason prevents you from running only 2, 3, 4, 5, or 6 harnesses on a dobby or head motion capable of moving 16 or more harnesses. In other words, a dobby or head motion can handle any number of harnesses up to its capacity.

Harness Chains and Chain Drafts

6. The purpose of a dobby is to raise the harnesses in a given order. This purpose is achieved by using a harness chain, which is fed into the dobby. As you will see, the harness chain does not look like an ordinary chain, as you might think. Depending upon the construction of the dobby, the harness chain may be



1. bars
2. chain pegs
3. eyes
4. rings
5. thread
6. flange
7. squared portion
8. top

(a) Wooden bars
(b) Chain peg

FIG. 2. WOODEN DOBBY CHAIN

made with wooden bars, steel rods, or even thin sheets of paper, metal, or plastic. In any case, its purpose is to make the dobby raise the harnesses in the prescribed order.

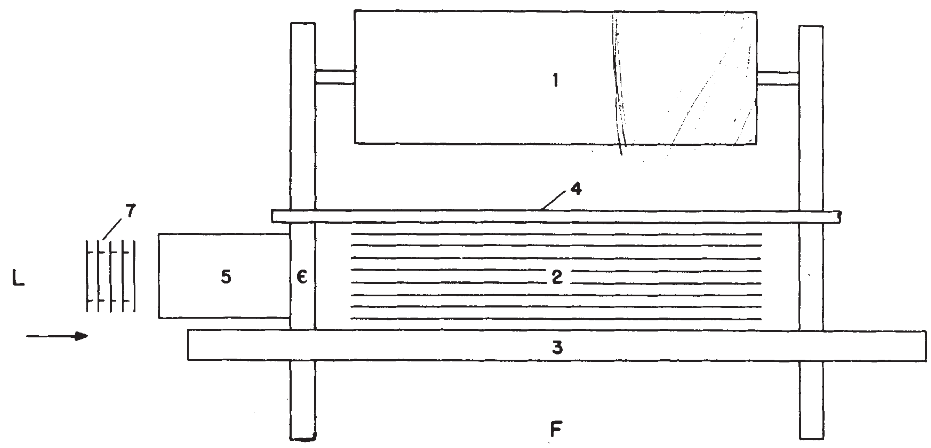
The order in which the harnesses are to be raised is indicated on a piece of paper by the designer, the paper being called the chain draft. Although chain drafts for dobbies will be covered somewhat in this text, the manner of making chain drafts is thoroughly covered in another text.

Harness chains are generally prepared by an employee who has been specifically trained to do this. It can be either a full-time or a part-time job, depending on the size of the mill and the frequency with which style changes are made. However, the weave room supervisors and loom fixers should know enough about chain drafts to be able to check the accuracy of a harness chain.

Bars for Harness Chains

7. Most dobbies are operated with chains made with wooden bars, such as those shown in Fig. 2(*a*). As you can see, the bars *1* contain two rows of holes, into which are inserted the chain pegs *2*. Steel eyes *3* and rings *4* connect the bars together. The rings are split, and can be opened or closed with long-nosed pliers to disconnect or connect the bars, as the case may be.

A chain peg is shown enlarged in view (*b*). The bottom of the peg is threaded,



1. warp beam
2. harnesses
3. lay
4. crankshaft
5. dobby
6. left loomside
7. harness chain

FIG. 3. SKETCH OF LOOM, SHOWING LOCATION OF DOBBY

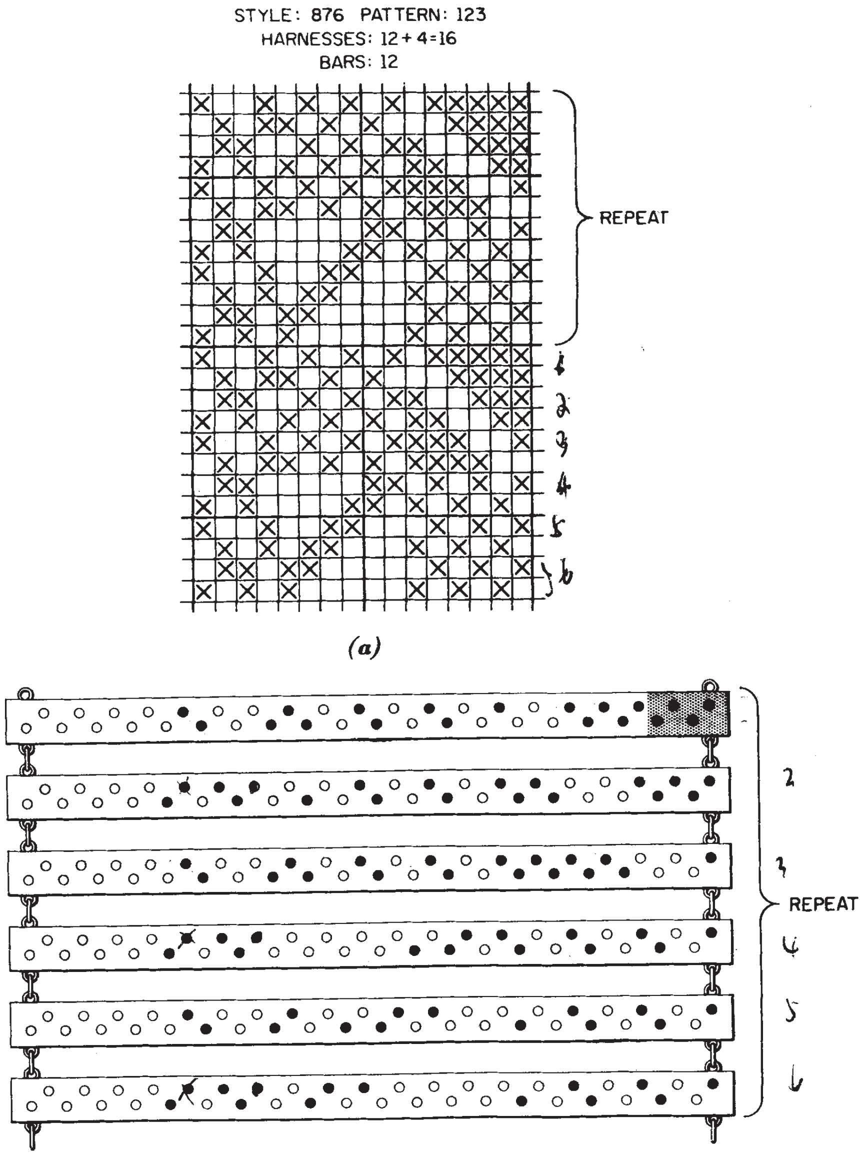
as at *5*, so that it may be lodged in a hole of the bar. The flange *6* of the peg will be flush with the face of the bar when the peg is fully inserted into the hole. The squared portion *7* fits into a square hole of the peg puller, a simple tool used to insert or remove the pegs. The top *8* of the peg is round; it is this part that causes the dobby to raise the harness or keep the harness in the raised position.

A peg in a hole of the bar simply means that a harness will either go up or remain up at this point. On the other hand, an empty hole means that a harness will either go down or remain down.

Location of Dobby

8. Most dobbies are installed on the left side of a loom. Look at Fig. 3, which is a simplified sketch of a loom. The warp beam *1* is at the back of the loom. Now, suppose you stand in front of the loom; this position is indicated by the F in the illustration. In this position you'll see the harnesses *2* between the lay *3* and the crankshaft *4*. The dobby *5* will be attached to the arch on top of the left loomside *6*.

The harness next to the lay is called the front, or 1st, harness. Then, counting from front to back, the harnesses are called 2nd, 3rd, 4th, and so on. The harness chain *7* is fed into the dobby as indicated by the arrow. You must remember all of these points, for only in this way will you be able to understand how harness chains are made up. The one point you must remember right now is that the ***right*** side of the harness chain regulates the movement of the *front*, or *1st*, harness. This point may be easier to understand if you stand at the left side of the loom, as indicated by the L in Fig. 3. Turn the illustration sideways, if you don't have a chance to look at a loom, and you'll get the idea.



(a)

(b)

(a) Chain draft
(b) Harness chain

FIG. 4. CHAIN DRAFT AND CORRESPONDING WOODEN CHAIN

Chain Draft and Harness Chain

9. A chain draft, as prepared by the designer, is shown in Fig. 4(*a*). The style and pattern numbers on top are assigned by the mill to identify the type of fabric (style) and the specific weave, or variation (pattern). In this case the dobby has a 20-harness capacity. However, only 16 harnesses are to be used. The first 12 harnesses will weave the body of the fabric, while the next 4 harnesses will weave the selvage.

Although you may go from left to right in building a harness chain, it is best to go from right to left. As you will remember, the peg on the right side of the chain will move the front, or 1st, harness. Now look at the top row of squares of the chain draft. Going from right to left, you'll see marks in the first five squares. Looking at the sketch of the harness chain in (*b*), you'll see pegs (indicated by filled-in circles) in the first five holes of the top row. The next square of the top row of the chain draft in empty; therefore, no peg is inserted in the chain (indicated by the blank circle). You should be able to follow the remainder of the top row of squares in the chain draft without any difficulty; compare it to the top row of holes in the harness chain.

10. Now, going from top to bottom, look at the second row of squares of the chain draft and compare it to the second row of holes in the top bar of the chain. You'll note that the second row of holes in the bar is offset to the left of the top row. In other words, the first peg in the second row is not directly below the first peg in the first row. As you'll soon learn, this arrangement is due to the construction of the dobby. While it is easy to read only one row of the chain draft at a time, the arrangement makes it difficult for the beginner to compare the entire chain draft to the entire harness chain at a glance.

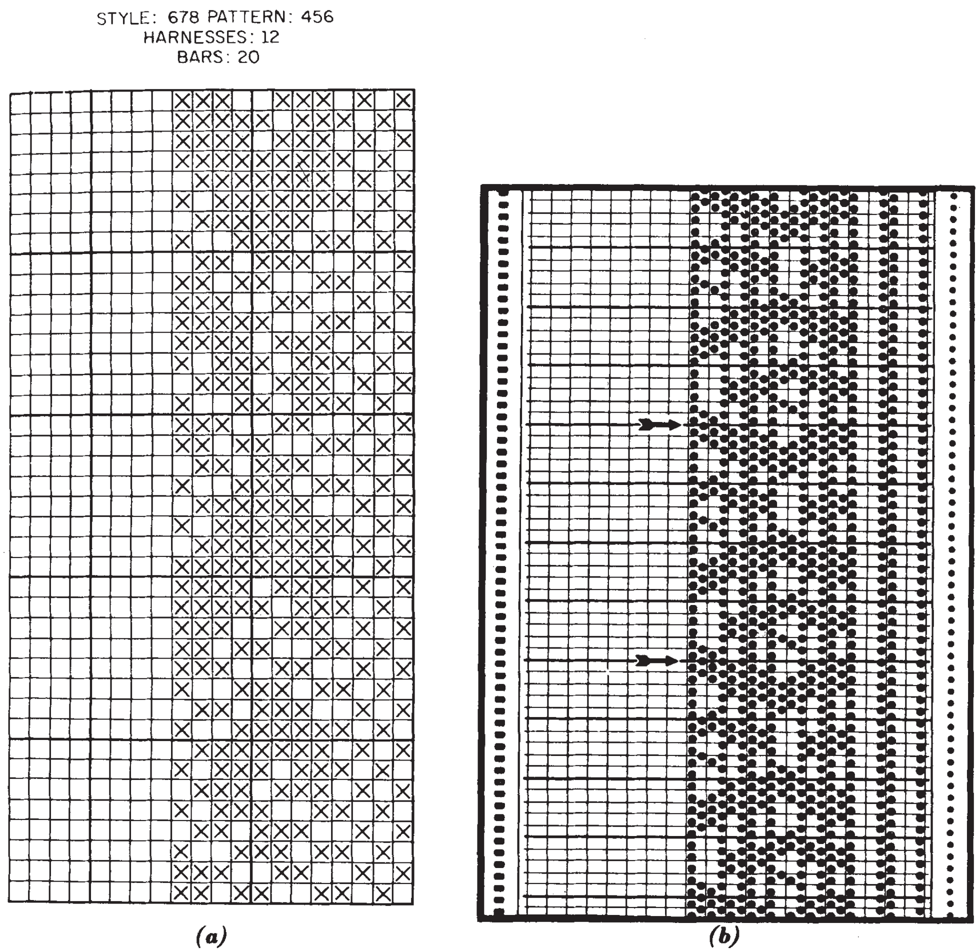
When the first two rows have been pegged, the first bar of the harness chain is completed. The third and fourth rows then go on the second bar, the fifth and sixth on the third, and so on. The chain draft shown in Fig. 4(*a*) repeats after 12 picks, or 6 bars, and only six bars are shown in (*b*). The seventh bar would be exactly like the first, the eighth like the second, and so on.

The chain cylinder of the dobby requires at least eight bars. It is obvious therefore that, with a repeat of six bars, the harness chain for the draft shown in Fig. 4(*a*) must contain 12 bars. You cannot stop after eight or 10 bars; to do so would result in partial patterns being woven into the fabric.

When the harness chain is completed, it is good practice to identify the first bar in some way. In our example, the first bar is marked with paint, as indicated by the shading at the right end of the bar. Such marks simplify things when the chain must be taken off the loom to be checked or stored.

Variations in Drafts and Chains

11. The harness chain shown in Fig. 4(*b*) is for a left-hand, double-index dobby, and it is the type most commonly found in mills. A harness chain for a



(a) Chain draft
(b) Paper chain

FIG. 5. CHAIN DRAFT AND CORRESPONDING PAPER CHAIN

single-index dobby has only one row of holes per bar. Such a chain is much easier to understand, and thus should give you no trouble.

It is also possible to put the dobby on the right side of the loom, but this is seldom done. If you should encounter this arrangement, you need only remember that the harness chain would be pegged from left to right instead of from right to left.

Let's look at a special situation, one that you may run into, particularly if the designer is located at the sales office or headquarters of a group of mills. The chain draft submitted to the mill may be upside down, or may even be suitable for a right-hand dobby. Some mills make it a practice to hand the draft to the chain builder, requiring him to make the necessary changes. As can be expected, the chain builder will often make mistakes in pegging the harness chain. For this reason, the designer should always arrange the chain draft exactly as it is to be pegged on the harness chain. The methods used for properly preparing chain drafts are covered in the text *Basic Textile Design and Weave Analysis.* If you are interested in learning these methods, and if the text mentioned is not part of your course, you should ask your instructor to have it added.

Paper Chains

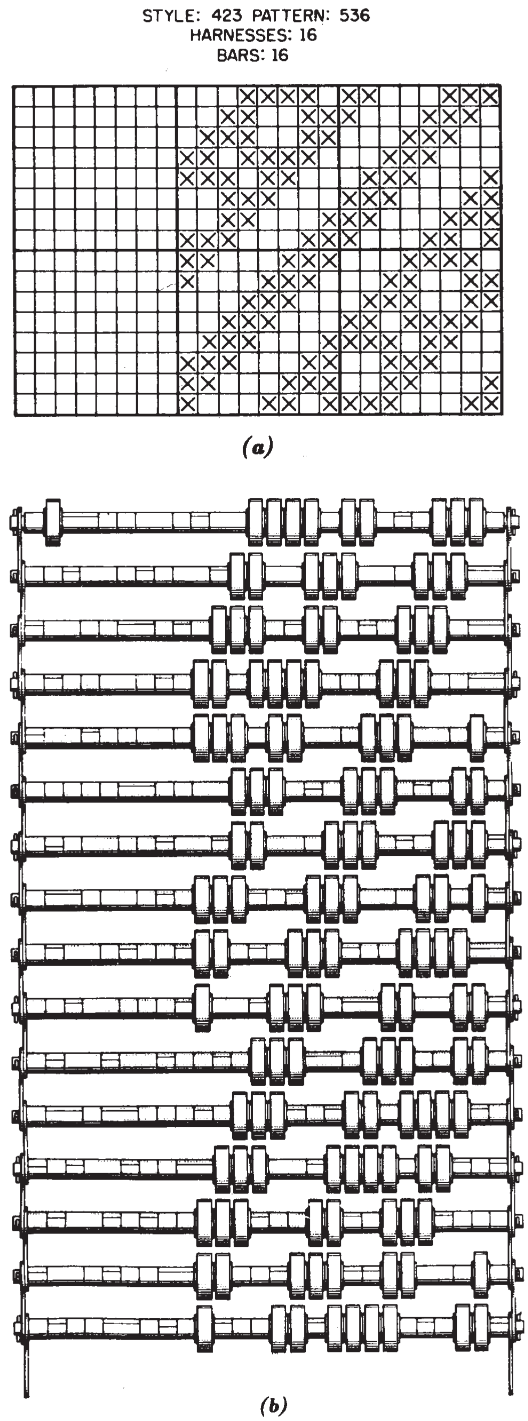
12. While harness chains with wooden bars are the most common, some dobbies use chains made of paper. The chain draft, Fig. 5(*a*), is prepared just like any other draft, regardless of the type of chain that is to be used. As shown at the top of the draft, the weave is to be woven with 12 harnesses and with a 20-harness dobby.

The corresponding paper chain is shown in Fig. 5(*b*). The chain contains reinforced strips along both edges. The strip on the right contains small holes, whereas that on the left carries elongated holes. The holes in these strips fit pins in the chain cylinder of the dobby, much like the holes at the sides of a movie film fit the projector. The difference in the shapes of the holes prevents the chain from being put on the loom upside down.

13. Look at the paper chain in Fig. 5(*b*) very carefully. The space between each horizontal line is equivalent to one bar; that is, it compares to two rows of squares in the chain draft. The space between each vertical line represents one harness. A hole punched into the paper chain will cause the harness to be raised or made to remain in the top shed.

Now, look at the top row of squares in the chain draft, and then compare that row to the first row of holes in the paper chain, the row being indicated by the top arrow. Reading the chain draft from right to left you'll see a mark in the first square of the top row. Now, look at the paper chain and you'll see that the first square on the right, directly under the heavy line indicated by the top arrow, has a hole punched in its upper right-hand corner. The next square on the top row of the draft is blank. The corresponding space of the paper chain is also blank in the upper right-hand corner. If the hole in the lower left-hand corner of this space confuses you, take a piece of paper and cover up the holes in the lower half of the space. Remember that each space between the horizontal lines is the same as one wooden bar. Thus, the top half represent one row of squares of the chain draft, and the bottom half another row of squares.

If you compare the first row of holes in the paper chain to the top row of squares in the draft, you'll see that the holes correspond exactly to the marked squares. Now move your paper down and even with the next horizontal line on the paper chain. Looking at the chain draft, the first square on the right of the second row is blank, whereas the second square is marked. The first space on the corresponding line of the paper chain is also blank, but the second space has a hole at the left. Like the wooden bar, the holes of the paper chain are offset. In other



(a) Chain draft *(b)* Roller chain

FIG. 6. CHAIN DRAFT AND CORRESPONDING ROLLER CHAIN

words, the holes for the first row of squares in the chain draft will be at the right of their spaces in the paper chain. Likewise, the holes for the second row of squares will be at the left of their spaces.

14. When you understand the basic principles involved, you'll have little trouble comparing the paper chain in Fig. 5(*b*) with the draft in (*a*), and seeing exactly how the chain is punched. A machine similar to a typewriter is used to punch the holes in the paper chain. The 20 spaces between the arrows of the paper chain shown in the illustration represent one repeat of the chain draft. The 20 spaces above and below the arrows are extra repeats. Thus the chain is made long enough to fit easily around the chain cylinder of the dobby. You'll also find the first two rows of holes repeated at the bottom of the paper chain. This section of the chain will be glued over the first two holes at the top. The chain is thus formed into a loop and can revolve around the cylinder of the dobby.

Paper chains may also be made of plastic or thin metal. The material used has no effect on the operation of the dobby; rather, its use is dependent upon its cost and durability.

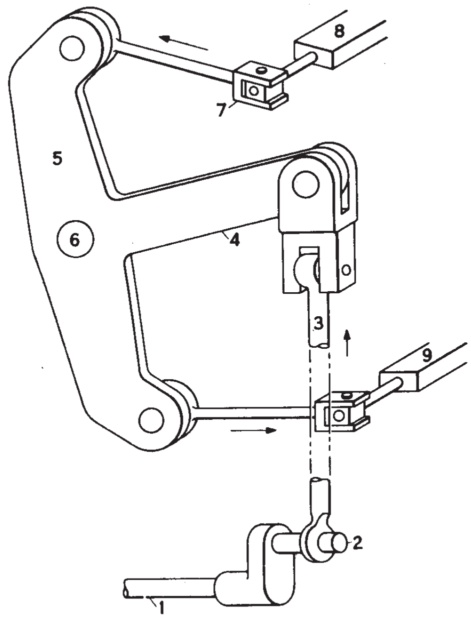
Roller Chains

15. When wide looms are used to weave heavy fabrics, heavy-duty head motions are needed. The most common of these head motions is the Crompton & Knowles head motion. One early type of this motion was called the Gem Head. Thus you'll find terms like "C & K Head" or "Gem Head" used to describe this type of head motion.

The C & K head motion uses chains of steel bars which are connected by links. Each steel bar in the chain controls the harnesses for one pick. Rollers on the bars cause the harnesses to be either raised or made to remain in the raised position. Washers on the bars cause the harnesses to be either lowered down or made to remain in the lowered position.

In Fig. 6(*a*) you'll see a chain draft for 16 harnesses. In (*b*) is the corresponding chain for a C & K head motion with a 24-harness capacity. As shown in the illustration, an extra roller has been added at the left of the first bar to identify this bar as the first bar in the chain. This procedure can be used when the full capacity of the head motion is not being utilized. If all of the harnesses were to be used, a short piece of string could be tied to the first bar for identification.

If you study the chain draft and the chain very carefully, you should have little trouble understanding how the rollers are arranged. In a roller chain there is a bar for each pick and thus no confusing offsetting of the rollers, as is encountered with wooden bars and paper chains.



1. camshaft
2. crank arm
3. connecting rod
4. rocker arm
5. rocker
6. rocker shaft
7. pin-and-swivel connector
8. top knife
9. bottom knife

FIG. 7. DRIVE FOR DOBBY KNIVES

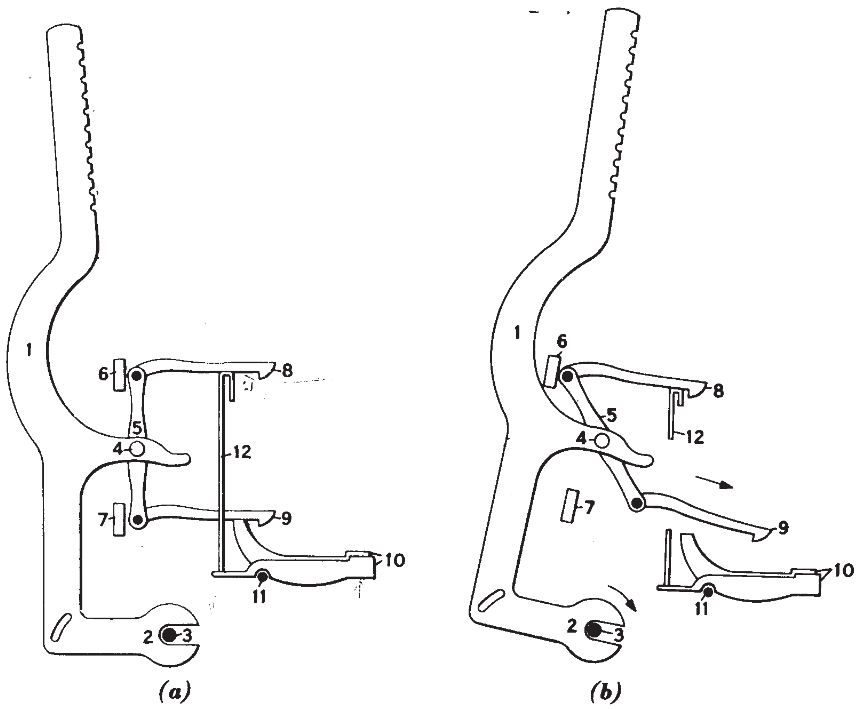
Dobby Parts and Their Operation

Drive of Dobby Knives

16. If you have ever seen visitors in a weave room that uses dobbies, you undoubtedly have noticed how they watch a dobby for a while, shake their heads in amazement, and then walk away. There are so many different parts in a dobby, all moving in different directions at the same time, that you can't understand how it works just by looking at it. In discussing the various parts of the dobby, some of the illustrations will be simplified and distorted wherever necessary so that you may better understand the motions involved.

The drive for the dobby knives, as seen from the back of the loom, is shown in Fig. 7. On the outside of the camshaft *1* is a crank arm *2*, which moves the upright connecting rod *3*. Actually, the connections are made by swivels, but these have been omitted from the illustration for simplification. The top of the connecting rod is attached to the rocker arm *4*. The rocker *5* is fast to and fulcrumed on the rocker shaft *6*. There is another rocker, which is made fast to the front end of the rocker shaft; this rocker is not shown in the sketch. The front rocker has no rocker arm. However, it moves exactly like the rocker shown in the illustration, since both are made fast to the same shaft.

A pin-and-swivel connector *7* connects the top of the rocker to the top knife *8*. The bottom knife *9* is fastened to the bottom of the rocker in the same manner. These knives slide in slots in the dobby, allowing them to move back and forth,



1. jack
2. slot
3. jack pin
4. boss
5. jack-back
6. top girt
7. bottom girt
8. top hook
9. bottom hook
10. fingers
11. finger rod
12. needle

(a) Both hooks raised; jack remains in back position
(b) Jack is moved by action of bottom hook being lowered

FIG. 8. JACKS, HOOKS, AND FINGERS

but not up or down. As the camshaft rotates, the crank arm and rocker arm move up, causing the top knife to go in and the bottom knife to go out. All of these movements are indicated by the arrows in the illustration. As the camshaft continues to rotate, the crank arm moves over the top and down on the other side, causing the actions of the rocker arm and knives to be reversed. In other words, these parts will now move in the directions opposite to those indicated by the arrows in the illustration. Since the camshaft rotates once for every two picks, the bottom knife will be out on one pick and the top knife will be out on the next pick.

Dobby Jacks

17. Now that you understand how the dobby knives work, let's look at the dobby jacks, one of which is shown in Fig. 8. Here again, the parts have been simplified and distorted somewhat so that you will understand their function

and operation more clearly. There is a dobby jack for every harness that the dobby is capable of operating. For instance, if the dobby has a capacity of 22 harnesses, there will be 22 dobby jacks.

In the lower end of the dobby jack *1* is a slot *2* which fits over a rod, or jack pin *3*, that is supported on the dobby sides. The jack pin is the fulcrum of the jack; that is, the whole jack moves around this pin. A boss *4* on the jack projects into the jack-back *5*. In the position shown in Fig. 8(*a*), the upper arm of the jack-back rests against the top girt *6*, while the lower arm rests against the bottom girt *7*. The girts are steel bars which are made fast to the sides of the dobby. In this position the jack is as far to the left as it can go. As you will see later, the harness connected to the jack will be in the bottom shed.

Hooks and Fingers

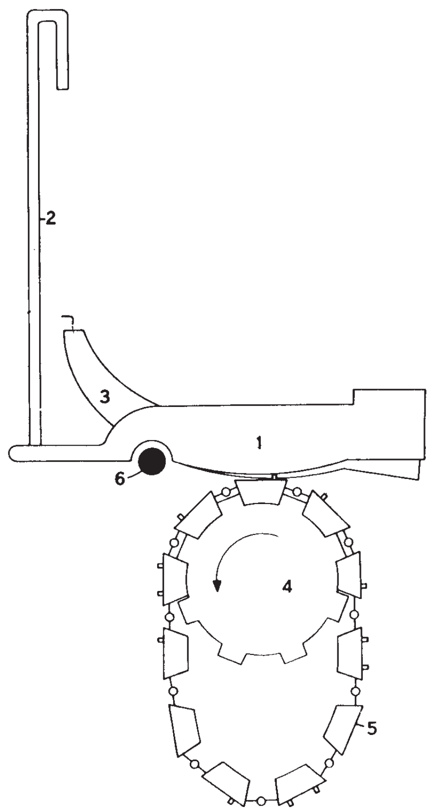
18. As shown in Fig. 8(*a*), the top hook *8* is connected to the top of the jack-back, and the bottom hook *9* is connected to the bottom of the jack-back. Below the knives are the fingers *10*. The finger shown in the front in the illustration is fulcrumed on the finger rod *11*. On the left tip of the finger is a wire *12*, called a needle, which contacts the top hook. The back finger is bent upward at its left end and contacts the bottom hook. Like the front finger, this finger is also fulcrumed on the finger rod.

As you will learn in more detail later, the fingers are raised by the pins in the harness chain. When the right side of a finger is raised, the left side is lowered. When the left side of the finger goes down, the hook which rests on the finger will also go down. It doesn't matter whether the hook rests directly on the finger, as the bottom hook does, or whether it rests on the top of the needle, which in turn rests on the finger, just as the top hook does.

Jack Movement

19. The hooks are located just above the dobby knives. Thus, if a hook is lowered, it will catch on the edge of the dobby knife and be carried along with it. On the other hand, if a hook is raised, the dobby knife will pass under the hook. If both hooks are raised, the movement of the dobby knives will not affect the dobby jack at all, allowing the jack to remain in the position shown in Fig. 8(*a*).

When the bottom hook is lowered, it will be carried along by the motion of the bottom knife. This position is illustrated in Fig. 8(*b*), in which the center portion of the needle has been left out to show the other parts more clearly. In the illustration, the bottom knife has carried the bottom hook to the right. The hook, made fast to the jack-back, carries the bottom part of the jack-back along. And because the jack-back is fulcrumed on the boss in the jack, the top part of the jack-back attempts to go in the opposite direction. However, it cannot do so, because it leans against the top girt. Consequently, the hook drags the jack over to the right with it, as shown.



1. front finger
2. needle
3. back finger
4. chain cylinder
5. harness chain
6. finger rod

FIG. 9. DOBBY FINGERS AND HARNESS CHAIN

You must understand that the top hook would drag the jack along, just as the bottom hook does, if it were in position to be carried along by the top knife. Briefly, then, the jack follows either the top hook, or the bottom hook, depending upon which is in position to be carried along by its respective knife.

Movement of Dobby Fingers

20. You have seen how the dobby fingers work. For a clearer understanding of the operation of the fingers, look at Fig. 9, which shows the fingers enlarged. Again, the view is from the back of the loom. The front finger *1* moves the top hook by means of the needle *2*, whereas the back finger *3* moves the bottom hook with its raised end. Directly below the fingers are the chain cylinder *4* and harness chain *5*. As can be seen in the illustration, one of the pegs on the harness chain is raising the front finger. Since the finger is fulcrumed on the finger rod *6*, the left end of the finger will be lowered when the right end is raised. This action

will cause the needle to be lowered and the top hook to be caught by the knife as it moves outward.

If a peg were under the finger for the bottom hook, the bottom hook would be moved in the same manner as described for the top hook. In other words, when there is a peg for one of the fingers, the hook that is moved by this finger will be in position to be carried along with the knife. When there is no peg, the right side of the finger will be down and the left side will be up. The hook will then be in the raised position, and the dobby knife will pass under the hook without touching it.

Movement of Dobby Jacks

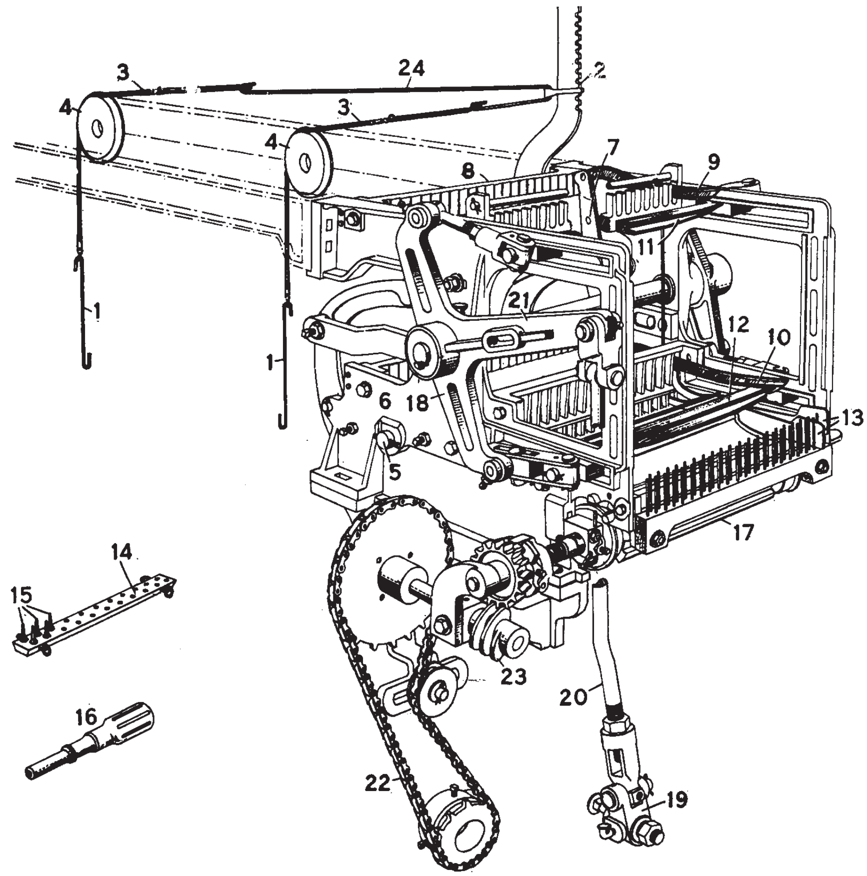
21. It will be well for you to visualize and understand the motions of the dobby jacks under all possible conditions. As you know, the top knife moves out on one pick; we'll call this pick the first pick. As the top knife moves out on the first pick, the bottom knife moves in. On the second pick, the top knife moves in and the bottom knife moves out. This is a two-pick cycle that is repeated over and over again. Now let's look at conditions that can exist during this two-pick cycle.

Condition No. 1. Let's assume that the chain has pegs for both picks. In this case, both the top and bottom hooks are lowered and carried along with the knives. As the top knife moves out on the first pick, the jack will be carried along. Similarly, as the top knife moves back in on the second pick, the jack would also come back if it were not for the fact that the bottom knife is moving out at the same rate that the top knife is moving in. Thus, if the bottom hook is carried along, the raising action of the bottom knife equalizes the lowering action of the top knife. As a result of this equalizing action, the jack and harness stay in place, the harness remaining in the top shed position.

Condition No. 2. Here we'll assume that the chain has a peg for the first pick, but not for the second pick. In this case the top hook will be lowered and the top knife will carry the jack along on its outward movement, causing the harness to be raised. Since there is no peg on the second pick, the bottom hook will be raised and the bottom knife will not touch it. Then, as the top knife moves back in, there is nothing to keep the jack from returning to its back position, causing the harness to be lowered.

Condition No. 3. Let's assume that pegs are not used for either pick. As a result, both the bottom and top hooks will be raised and will not be affected by the movement of the knives, causing the harness to remain in the bottom shed.

Condition No. 4. Finally, let's assume that the chain has a peg for the second pick, but not for the first pick. In this case the top hook will be raised. However, when the top knife moves out on the first pick, the jack will not move if it is in the bottom shed to begin with. If it is in the top shed, it will be lowered. On the second pick, the bottom knife will move out, and, since the bottom hook is lowered, the hook will be carried along, causing the jack to raise the harness.



1. wire hooks	*13.* fingers
2. jack	*14.* wooden bar
3. harness cords	*15.* pegs
4. sheaves	*16.* peg puller
5. jack pin	*17.* chain cylinder
6. dobby side	*18.* rocker
7. jack-back	*19.* swivel
8. top girt	*20.* connecting rod
9. top hook	*21.* rocker arm
10. bottom hook	*22.* cylinder drive chain
11. top knife	*23.* worm
12. bottom knife	*24.* mount wire

FIG. 10. C & K DOUBLE-INDEX, SINGLE-CYLINDER, OPEN-SHED DOBBY

Review of the Dobby

22. Now that you understand the major parts of the dobby and how these parts function, let's look at the dobby again as a whole unit. Then you'll know where each part is located, and its relation to the other parts involved.

The dobby shown in Fig. 10 is built by Crompton & Knowles and is technically known as a double-index, single-cylinder, open-shed dobby. "Double-index" simply means that each harness jack is influenced for a cycle of two picks. "Single-cylinder" means that the dobby has only one chain cylinder and one harness chain. "Open-shed" means that when there is no change the harness remains in the top shed or the bottom shed, as the case may be. Most dobbies in use today are of this type.

The harness, though not shown in Fig. 10, is supported by the wire hooks *1*. Strings with slipknots are used instead of the wire hooks when weaving synthetics and other fine fabrics. The strings allow for finer adjustments in the shed. The jack *2* is made to move up and down by the harness cords *3* running over the sheaves *4*. As you know, the jacks are fulcrumed on the jack pin *5*, which is held in the dobby side *6*. Actually, the dobby shown has a capacity of 22 harnesses, but only one jack is shown so as to not cover up the other parts.

As shown in the illustration, the top of the jack-back *7* rests against the top girt *8*, and the top hook *9* is raised and the bottom hook *10* is lowered. Also, the top knife *11* is shown in the "in" position, whereas the bottom knife *12* is shown in the "out" position. The bottom hook, being lowered, has been carried along with the bottom knife. The movements of the hooks, as you know, are transmitted by the fingers *13* on the harness chain.

23. Because the harness chain is not shown in Fig. 10, one of the wooden bars *14* with its pegs *15* is shown to the left of the dobby. A peg puller *16* is also shown beside the bar. The lower edge of the chain cylinder *17* is barely visible below the dobby.

The motion for the rocker *18* is transmitted from the camshaft of the loom by the swivel *19*, and through the connecting rod *20* to another swivel on the rocker arm *21*. The first swivel and lower part of the connecting rod are located down along the loom side, but have been moved up in the illustration so that they could be seen and identified. The chain cylinder is driven by a chain *22* from a sprocket on the crankshaft to another sprocket on the worm shaft. On the other end of the worm shaft is the worm *23*, which meshes with a worm gear on the cylinder shaft. All of the parts mentioned, as well as the mount wire *24*, which connects the jack to the harness cords, will be mentioned again in further discussions of the dobby. It is therefore important for you to remember what each part looks like and where it is located. Refer again to Fig. 10 whenever it is necessary for you to properly identify or locate a particular part.

Dobby Maintenance

Cleaning the Dobby

24. When a warp runs out, the whole loom should be cleaned. This is particularly true of the dobby. Although you may find that the instructions given here differ somewhat from the practices in some mills, the fact remains that the dobby should be inspected thoroughly by a qualified loom fixer or supervisor when a warp runs out. Above all, the dobby cannot be inspected, or even function properly, if it is not clean. Some mills have a dobby completely dismantled for cleaning and inspection whenever a warp runs out. In most cases, however, this practice is not economical.

The loom cleaner must remove all lint or fly that has gotten into the dobby. Although filament yarns do not produce lint, pieces of nylon fibers, which are very strong, and glass fibers, which are extremely abrasive, will quickly ruin a dobby if not removed. Therefore, any waste matter that clogs the oil holes and the moving parts of the dobby must be removed. The loom cleaner should wipe all lint and fiber accumulations from inside and around the dobby with a suitable cleaning brush.

If a mill is equipped with compressed-air cleaners, the entire dobby assembly can be blown down. In that case, a good cleaning solvent can first be sprayed into the dobby and allowed to soak into the assembly for a few minutes. After soaking, additional solvent should be sprayed into the dobby, and, while the solvent is dripping off the various parts, the entire dobby should be cleaned out with the air cleaner. Clogged surfaces in deeper recesses of the dobby can be cleaned with a long wire. All excess dirt and oil should then be cleaned off with a solvent-soaked cloth.

Oiling the Dobby

25. As you know, the dobby has many small moving parts. Some of these parts just slide past each other, while others rotate under considerable pressure. If those parts that slide, or barely touch each other, are oiled excessively, the oil will tend to thicken, and, when mixed with dust, sizing, or lint, will form an abrasive paste. On the other hand, if those parts that move tightly under pressure are not oiled sufficiently, they will wear rapidly. Consequently, proper oiling of the dobby requires more care and know-how than oiling of the loom.

Most parts of the dobby should be oiled or greased. However, oil and grease should never be used on the needles and fingers. The needles should be allowed to run dry, even where they pass through the comb and may wear. A light touch of grease can be placed underneath the hooks to prevent their wearing through while running. This touch of grease must be very light, so as to prevent the hooks from sticking and becoming a source of mispicks. A very light oil should be used on the sharp edges of both knives to prevent unnecessary wear as the hooks drop and rise over the edges of the knives. Do not use grease on these edges.

26. New dobbies will seldom cause trouble, and they may not need adjusting for many years if they are oiled and greased properly at regular intervals. The jack-backs (or combinations), knife runs, swivels, and bearings should be lubricated each week. One of the preferred methods is to use a nonfluid oil one week, and a light-viscosity oil the next. The heavy oil sticks on flat or round surfaces, such as the girt face and between combinations, while the light oil flows into the bearings and prevents gumming and clogging.

Positive oiling is accomplished by holding the oil spout downward above the top hook connections, and then squirting oil into the bosses or buttons while the loom is running. With the loom still running, the spout should then be inserted between the dobby needles and oil squirted into the jack buttons and combinations. The spout should not be forced against a needle, or the needle will be bent and cause cloth defects. The bottom hook connections can be oiled by inserting the spout just below the bottom girt, and then squirting the oil back and forth into the connections. Much of the oil at the top will gradually drain down into the center holes and the bottom hook button holes.

Inspecting the Dobby

27. After the dobby has been cleaned and lubricated, it should be thoroughly inspected. Depending upon the job layout of the mill, the inspection may be carried out by a loom fixer, the supervisor, or any other technically qualified person.

The first inspection step is to make sure that the oiling and greasing have been carried out satisfactorily and properly. Next, the dobby must be carefully checked for worn parts, which, if sufficiently worn, should be replaced. Inspection of the dobby can be carried out more accurately and quickly when the person performing the job knows just what to look for. Usually, experienced fixers can quickly determine when certain parts need to be replaced.

Checking the Dobby Jacks

28. If you look at a dobby closely, you'll note that all of the jacks are at a slight angle, from left to back. However, all of the jacks are in perfect alignment, from the front jack to the back jack. If wear is present, some jacks will be out of line or will hang low. Low-hanging jacks should be replaced.

If some of the jacks are out of line, remove the jack-backs and check them for wear. The boss in the jack and the center hole in the jack-back usually wear off on a slight pitch, thus allowing the jacks to slip free during weaving. This action causes harness skips, since the harness or harnesses will remain down and not be raised on the pattern call when the jacks are supposed to move upward. The loom may continue to weave the fabric for several inches or yards, or until the unwoven end or ends sag low enough for the drop wires to stop the loom. Of course, the weaver may notice the defect in sufficient time to prevent the loom from running too long.

The hooks can be checked for play by taking hold of the hook tips on the upper row and moving them in and out. If wear is present, the hook will move for some distance without moving the jack-back. The length of the free movement will indicate the amount of wear. The bottom row of hooks should be checked in the same way.

If the amount of free movement is very slight — about $\frac{1}{64}$ in. (inch) — the hook should be replaced. However, if the hook moves $\frac{1}{8}$ in. or more, the entire combination (hooks and jack-backs) should be removed, and the top and lower holes and hook buttons should be checked. All defective hooks and jack-backs should be discarded.

Checking Dobby Knives

29. If the sharp edges of the dobby knives have become rounded or grooved, the hooks are likely to slip free during movement. Worn knives should be replaced with new ones. The worn parts can be filled in later by welding, and then ground to their original shape. Such salvage operations by the maintenance shop can greatly reduce the cost of new parts.

When a hook slips off a defective knife, an occasional single skip or harness mark will be caused. On one-harness lifts, the filling will lie across the cloth, and when sheared will leave a harness mark across the fabric. On lifts of two or more harnesses, the filling will be woven into the fabric, but the defect will appear as a mispick. Good knives and hooks prevent many imperfections. An ounce of prevention is worth a pound of cure insofar as knives and hooks are concerned.

Checking Racks and Fingers

30. After the knives have been taken care of, the top and bottom combs and racks should be checked for broken reeds. Damaged combs should be replaced. The reeds separate the hooks from each other, thus preventing the hooks from slipping between the moving cylinder fingers. After the combs have been checked, the fingers should be checked; broken fingers should be replaced.

When all of the parts have been checked and are either replaced or otherwise known to be in good condition, grasp the cylinder with your right hand and start turning it clockwise. While the cylinder is turning, watch the upper row of hooks to make sure that they rise and drop properly as the pegs move under and away from the fingers. If the upper row of hooks is satisfactory, check the bottom row in the same manner. All fingers must move freely, without binding.

Dismantling the Dobby

31. While it is not often necessary to dismantle the dobby, there are occasions when the entire assembly must be dismantled, repaired, and cleaned. If the dobby frame is broken and needs to be replaced, the jacks and other parts will often need to be dismantled also. If some jacks are broken off above the lower jack notches, or if many show wear and slip, all jacks must be removed.

Before the dobby is dismantled, get a bucket of cleaning solvent and a large piece of cardboard. Place the cardboard on the floor at the head end of the loom, keeping the solvent close by. A helper should be assigned to assist in the project.

As each part is removed from the dobby it should be checked very carefully for wear. Discard all worn parts, replacing them with new ones. Check the jacks first, retaining those without worn buttons. Jack-backs that show no wear at the hook connections or within the center hole should also be retained. All retained parts should first be washed in the solvent; all hardened scale should be scraped off with a suitable instrument. After being thoroughly washed and cleaned, all parts should be wiped clean.

32. After the jacks and jack-backs have been cleaned, inspect the girts for the jack-backs. The offset arrangement of the girts prevents the combinations from shifting sideways when hooks from the opposite girt are called for by the pattern chain. For example, as the bottom hook moves out, pressure is exerted on the top girt. As this pressure is applied, the back of the combination has a tendency to slip sideways. Unless it is prevented by the girts, when the hooks move back and are released, the sideways movement will bring the resting back under the adjacent back that would be moving into the resting position; this action could cause jamming. In addition to being a source of cloth imperfections, jamming also causes breakage of parts within the dobby.

When girts are worn smooth, they should be discarded as soon as the smoothness is detected. The top girt usually wears along the bottom edge, whereas the bottom girt shows most wear along the top edge. Girts worn along one edge may be interchanged and thus made serviceable again.

Planning for Dobby Assembly

33. You can speed up the job of reassembling the dobby by planning in advance. Because it is uneconomical to keep a loom stopped for a period of time, the job of reassembling the dobby is usually considered as a rush job. So it is best to be prepared for it. Get new jacks and combinations to replace those that were discarded in the cleaning operation. Put all different parts in a separate pile, so you won't have to hunt for them when you need them. Grease each jack boss and the center hole of each combination. These grease applications are important, since they will prevent wear at the fulcrum.

Squirt a medium grade of oil on both connections of the combination hook. In large weaving operations the assembling of dobbies is often assigned to a specialist. In these cases a pan of oil is used, and each part is dipped into the oil instead of being squirted. This procedure helps to speed things up considerably, thus saving valuable loom downtime.

Assembling the Dobby

34. Start assembling the dobby by putting about one third of the combinations

into position, starting at the back of the dobby and working toward the front. Still working from back to front, insert the lower hook of the first combination into the comb between the reeds at the back, and push the upper hook into the top comb. Continue in this manner until all of the combinations you previously inserted are in place. Check the combinations; they should move easily, without binding.

Now start putting the jacks in place, still working from back to front. Push each jack into position, making sure that the jack slot fits over the jack pin. Raise each combination and place it on the jack button. Continue in this manner until you have a jack on each combination already in the dobby. The reason for inserting only one third of the combinations at a time is to prevent the removal of a large number of parts, if, upon checking, one of the combinations is found to be binding or sticking.

Finish inserting the combinations and jacks, following the same procedures. However, do not insert the last combination or jack, since those require special attention, as you will learn.

35. The front jack is the "kingpin," so to speak, that holds the whole assembly in place. Put this jack into place before putting in its related combination. Then, as you put the combination in place, push the lower hook in. As you move the combination into position, reach between the dobby sides from the front with your left hand, and grasp the hook tip and pull on it. At the same time, push the combination from the back with your right hand. In so doing, move the hook as close as possible to the bottom comb. Now grasp the top hook firmly and put it into the top comb, using the same pulling and pushing technique that was used for the bottom hook. You will then find it fairly easy to slip the center hole over the jack button by guiding it with your right hand near the center of the jack-back.

With all of the jacks resting on the jack-backs and the combinations resting on both the top and bottom girts, stand in front of the dobby, facing the dobby needles, and study the position of the loosely held jacks. Jacks are never in an exact vertical line, but lean slightly toward the back of the loom. If necessary, be guided by looking into the dobby of a correctly adjusted loom. When properly adjusted, insert the small lock-rod.

To shift the jacks to the desired position, reach up from the back or front of the loom and shove the jacks to the desired slant with your hand. Screw in the positioning studs against the jack guides to tighten the jacks; occasionally, reach to the top of different jacks and pull them as if they were in regular movement during weaving, permitting the jacks to slip free and fall back into position. When the jacks appear slow in falling, loosen the adjusting screw slightly. Jacks should fall freely, but must be tight enough to prevent them from slipping from the combinations after the harness tension has been applied.

Checking and Straightening Hooks

36. When cleaning the dobby hooks, it is very likely that some of the hooks may become slightly bent. Thus, upon completing the assembly of the dobby, you may find that some of the hooks bind against the dobby reeds instead of falling freely as they should. These hooks should be straightened as much as possible.

A special tool is used to straighten bent hooks, so that they may fall freely in operation. The hook straightener is an indispensable tool, one that should be in every loom fixer's toolbox.

If a bottom hook binds against one of the reeds in the comb, insert the straightening tool between the wires and jack-backs, fitting the slotted end down over the bottom hook. If a top hook is causing trouble, it is easy to reach. In either case, carefully bend the hook in such a manner that it bends toward the binding point, not away from it. Then lift the point of the hook and let it drop; it should fall freely. If necessary, bend the hook a little more. Be careful not to bend the hook too far, as this could cause the hook to be seriously damaged. Always bend just a little at a time. Once again, check to make sure that the hook falls freely; if it slides down slowly, it is likely to bind later on, or it may even miss the knife and cause imperfections in the cloth.

37. Now check the height of the hook over the knife. If the hook is too low, the knife will slide over it when a peg is in the chain. In time, the point of the hook will wear off, and a groove may be worn into the knife. Knives with grooves worn in them are a sure sign of negligence in dobby maintenance and inspection. If the hook is too high, the knife may fail to catch the hook squarely in the notch when there is no peg in the chain. Then the point in front of the notch will become worn and the hook will slip off the knife, once again causing cloth imperfections. If the hook is too high or too low, it can easily be bent with the hook straightener.

Occasionally some fixers prefer not to bother with the srtaightening tool, but rather will hit the hook with a hammer in order to bend it. This practice should not be allowed, because the bending cannot be controlled. Above all, to use a hammer in this way is likely to damage other parts of the dobby.

After all of the hooks are in perfect alignment, check the wires also. Make sure that all wires move freely. Some could possibly have been bent while you were working on the bottom hooks.

Dobby and Harness Attachments

Dobby Sheaves

38. The dobby sheaves, or grooved pulleys, are located between the loom arches and above the harnesses. Shown in Fig. 11, the sheaves *1* vary in size from $2\frac{1}{2}$ to 4 in. in diameter, depending upon the type of loom. When various types of looms are found in the weave room, it is likely that various types and sizes of sheaves will also be found. For this reason, sheave replacement should be made with care. Fortunately, however, sheaves that are properly cared for last a long time.

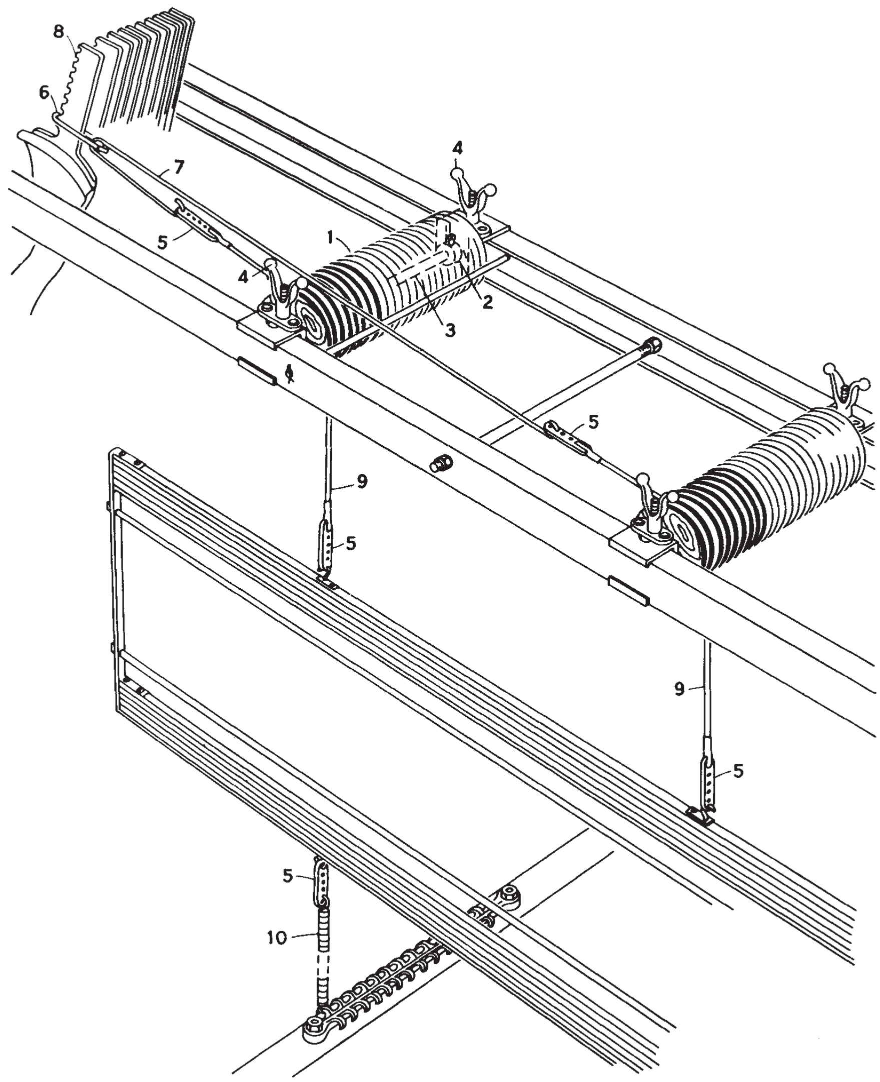
Dobby sheaves may be composed of wood, steel, wood with bronze or oil-impregnated press-wood bushing, or various plastic compositions. They may even be made of hardened rubber. Many millmen prefer the wooden type, in spite of the fact that this type tends to splinter around its outer rim. It is claimed that wooden sheaves last longer and actually give less trouble than the steel type or the wooden type with bronze bearing. Although the cost of the sheaves must be considered, one of the main reasons why wooden sheaves are preferred is the fact that the metal or plastic types permit fine dust to sift down onto the warp yarns. This powdery dirt is often the cause of streaks in the fabric.

Checking and Adjusting Sheaves

39. The dobby sheaves on new looms should be carefully inspected. It is not necessary to oil wooden sheaves on new looms. However, the sheave units may have to be taken down and adjusted so that the sheaves will turn freely during weaving.

Most modern looms have a dirt pan directly beneath the sheave units. This pan must be removed whenever adjustments are to be made. To adjust the sheaves, move the adjusting collar *2*, Fig. 11, on the sheave shaft *3* so that the sheaves have just enough play to allow them to turn freely. After being adjusted, the sheave unit should be placed in proper operating position and the dirt pan replaced. Be sure that the harness cords are centered in the slots of the dirt pan; otherwise, the cords will rub on the edges of the slots and become frayed.

All sheaves and sheave shafts should be thoroughly checked once a year. Worn sheaves can be detected by observing whether any abnormal shifting occurs in operation. In other words, they tend to wobble when the loom is running. When a sheave appears low on the shaft, the center hole is often worn eggshaped. If a sheave tilts sideways, the hole is likely to be worn on an angle. Occasionally, when the wear is minor and a limited number of harnesses are being used, the worn sheaves can be moved to the back of the shaft and unworn ones moved forward. In this way the unit can be made serviceable again. When all of the sheaves are badly worn, it is usually necessary to change the shaft also. On high-speed looms, the steel shafts often wear out before the wooden sheaves.



1. sheaves
2. adjusting collar
3. sheave shaft
4. wing nuts
5. harness strap connectors
6. jack eye
7. mount wire
8. jack
9. harness straps
10. pulldown spring

FIG. 11. DOBBY AND HARNESS ATTACHMENTS

40. When replacing a sheave, put some grease into the center hole with your finger before placing the sheave on the shaft. This will assure that the sheave will turn readily and freely, and will also prevent the harness straps from wearing out quickly.

The sheave assembly is placed between the loom arches and held in adjustable stands. By turning the wing nuts *4*, Fig. 11, the shaft can be raised or lowered as desired. After being adjusted, the sheave shaft should be set in the low position. If it becomes necessary later, one or both ends can be raised to the desired height.

Inexperienced fixers often try to adjust the loom shedding by adjusting the height of the sheave stands. This practice is unnecessary, since the individual harnesses or the entire harness unit can be raised or lowered by adjusting the harness strap connectors *5*, raising the jack eye *6* on the mount wire *7* to a higher notch on the jack *8*, or by other means which will be described later in the text.

Mounting a New Warp

41. The methods used to mount a new warp in a loom will vary from mill to mill, and will often depend on the type of loom being serviced. Usually, a new warp is placed on a dolly equipped with a bracket that carries the reed, the set of harnesses, and the banks of drop wires. The dolly is then rolled to the loom, where the warp beam is set in its bearings. The harness set, with the reed tied to it, is swung over into the loom between the crankshaft and the lay, with the lay being positioned at front center.

After the harnesses are in place, they are hooked to the harness straps *9*, Fig. 11. Harness strap connectors should be used at all of the places indicated in Fig. 11. If the steel eye of the harness strap is hooked directly to the mount wire, the eye and mount wire will wear rapidly and cause harness drops, spoiled cloth, and needless expenses.

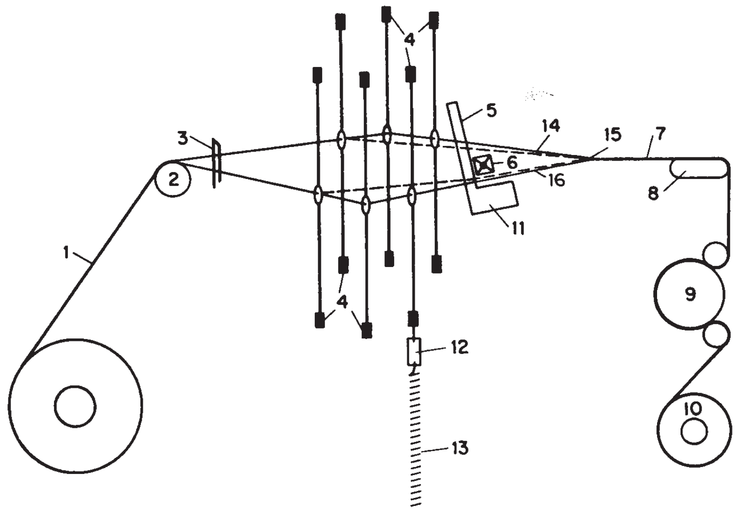
The reed is then removed from the bracket and put into position, as are the banks of drop wires.

42. A canvas apron, or leader cloth, is placed around the take-up roll so that the warp can be laced into the loom prior to weaving. One end of the apron reaches down near the cloth take-up roll, and the end for lacing just hangs over the breast beam. The warp yarns are then pulled forward in bunches to within an inch or so of the apron. The warp beam is secured to the let-off to prevent further forward movement of the yarn during lacing. When tying the warp yarn to the apron, all of the bunches should be tied evenly so that the yarn has an even tension from one selvage to the other before the take-up is started. The let-off is then released slightly as the take-up ratchet is pulled forward to draw the laced section down and around the take-up roll.

In drawing the warp around the take-up roll, avoid excessive tension. Otherwise, ends will break and the heddles will be strained unnecessarily. Now align the reed with the box plates on each side and tighten the reed cap. Then, apply warp tension gradually, until the yarn is fairly even and firm. Unwoven yarn will now be down over the breast beam and around the take-up roll.

Pulldown Springs

43. With the harnesses connected to the dobby jacks, the action of the dobby will pull each harness into the top shed whenever called for by the pegs of the



1. warp yarn
2. whip roll
3. drop wires
4. harnesses
5. reed
6. shuttle
7. woven cloth
8. breast beam
9. take-up roll
10. cloth roll
11. lay
12. harness strap connector
13. pulldown spring
14. top shed
15. fell
16. bottom shed

FIG. 12. SHEDDING

pattern chain. A pulldown spring *10*, Fig. 11, is used to promptly pull the harness back down when it is supposed to be in the bottom shed. In plain weave, the harnesses change at every pick. In $\frac{2}{2}$ twill, the change takes place after every two picks. Changes for other weaves depend upon the design of the weave.

On dobby looms, it is usually better to weave warp satins and other similar weaves face down, as though they were filling satins. This is done for a number of reasons, including these: 1) a greater number of pulldown springs will be in the down position; 2) there will be less strain on the dobby; and 3) better weaving conditions will prevail.

Usually, one spring on each side of the harness will be sufficient to pull the harness down into the desired position. For heavy, dense weaves, it may be necessary to use two springs on each side of the harness. Occasionally, three springs may be required. In any case, you should always start with the least amount of spring tension necessary and then add springs as needed. Once certain weaves have become standard in the mill, the tension requirements will be known and all future warp mountings for these weaves can be treated accordingly. Records of all spring requirements should be kept and used for reference.

Shedding

44. The diagram in Fig. 12 was prepared to help you understand how to properly adjust the shedding motion. The illustration shows the lay at back center position, and the shuttle moving through the shed. The warp yarn *1* passes over the whip roll *2* and through the drop wires *3*, harnesses *4*, and reed *5*. The shed, or the opening for the shuttle *6* to insert the picks, is formed by the harnesses being raised and lowered in a given order. After the picks are inserted, the woven cloth *7* passes over the breast beam *8*, goes around pressure rolls and the take-up roll *9*, and passes down and winds around the cloth roll *10*. The take-up arrangement varies on different types of looms, but does not influence the principles of shedding.

When the shed is properly formed, the yarn should be about $\frac{1}{16}$ in. above the race plate on the lay *11*. The harness strap connector *12*, which is attached to the pulldown spring *13*, may be used to decrease spring tension. The shuttle should clear the top shed *14* by about $\frac{1}{4}$ inch. As the pick is beaten into the fell *15* of the cloth, the lay should be at front center, and the harnesses that are changing should all be at equal height.

If the harnesses are not positioned correctly, the bottom shed *16* will be off the race plate, and the top shed will be too low, touching the top of the shuttle. This is indicated by the dotted lines in the illustration.

Checking the Springs

45. When there is insufficient spring tension, the harnesses will not be pulled all the way down as the shuttle moves through the shed. This condition may cause frayed ends; if serious enough, the condition may cause the shuttle to fly out of the loom and possibly injure someone. There are two causes for insufficient tension: 1) too much tension on the warp; and 2) not enough tension on the spring. When the warp is at fault, the let-off must be adjusted. If the spring is at fault, you can use a heavier spring or shorten the harness strap connector. In cases of extremely dense or heavy warps, you may have to use two or even three springs instead of one.

There should be just enough spring tension to pull the harnesses down rapidly and completely. On the other hand, there should not be so much tension that the harnesses are pulled down with a sharp snap. Excessive tension could also cause the harness frames to become distorted. Even when warps require heavy tensioning and harnesses require additional pulldown springs, it is best to use light springs on the two or four selvage harnesses, if any are used. When spring tension is too strong, it has a tendency to lock the heddles as lifting takes place, and chop out warp or selvage yarn. Quite often, when a fixer is puzzled as to the reason for unusual warp yarn breaks near the heddle eyes, lessening the pulldown spring tension may overcome the trouble.

Spring tension is usually tested by lifting each harness by the harness straps, or by grasping the edge of the harness and lifting it. This is a matter of practice and experience. If scientific methods are used, the proper spring tension can be determined for each style of fabric, and a simple spring scale can be used to check the exact amount of down pull. However, these are time-consuming methods, and they are not practical in general mill operation.

Observe the loom while it is running. If the harness straps tend to buckle or sag when the harness is in the bottom shed, you can assume that there is insufficient spring tension. If the harnesses come down with a sharp snap, you have too much spring tension.

Adjusting the Springs

46. For very light fabrics, especially those made with very fine yarns, even one light spring on each side of the harness may be too much, if the full tension of the spring is used. In such cases the harness strap connector must enter the picture. Traditionally, short leather straps with holes punched into them were used as connectors. When the connector was not needed to reduce the spring tension, the spring was usually hooked directly to the harness eye. This practice is not very efficient with modern high-speed looms. Metal rubbing against metal causes rapid wear. The use of leather for connectors has also decreased, primarily because leather is expensive and not always uniformly strong. Today, short straps made of nylon or suitable plastic materials are used at all connecting points.

Remember the various ways to increase or reduce spring tension. If less tension is desired, you can use a lighter spring, a spring that has been used for some time on a heavier harness and has lost some of its strength, or a longer connector between the spring and harness. The latter method is especially good for the selvage harnesses, the up-and-down movements of which are relatively short. The light or weakened spring methods are best for the light harnesses in the back, the up-and-down movements of which are rather long. If more tension is desired, you can use a heavier spring or a shorter connector, or, in extreme cases, you can add springs as needed.

Mount Wires

47. The mount wires 7, Fig. 11, are often referred to as leader wires in some mills. You will recall that the back harnesses must be raised and lowered considerably higher and lower than the front harnesses, in order to get a properly opened shed. Now, if you look at the dobby jacks shown in the various illustrations of this text, you will notice a series of notches in the top part of each jack. Each mount wire is hooked into one of these notches by the jack eye, or hairpin-shaped connector. The jack eye may be called dobby loop or by some other name, depending upon the mill. The points at which the jack eye is connected to the mount wire and dobby jack are places where steel again rubs against steel. This, of course, often causes the jack eye to wear rapidly. For this reason, modern jack eyes contain a protective layer of nylon, or are equipped with nylon bushings.

The main point you want to learn and remember now is into which notch of the dobby jack each harness mount wire must be hooked. For average fabrics, the first two jack eyes — that is, those that move the two front harnesses — are hooked into the lowest notch. The next two jack eyes are hooked into the next notch. This procedure is continued, moving up one notch for each two jack eyes and harnesses, until all of the harnesses have been connected. This should be easy to remember. After all, the dobby jack is nothing but a lever, and the farther you get way from the fulcrum, the greater will be the movement.

Harness Straps

48. Often the name used for a given part varies from mill to mill, if for no other reason but force of habit. If you find that another name is used for a given part in this text, use that name; the illustration in the text will always show you just which part is being referred to. Thus the harness straps 9, Fig. 11, may be called dobby cords, harness cords, or by some other name in your mill. However, Fig. 11 clearly shows which part is being covered as you read.

The harness strap is simply a strong piece of rope with a steel eye at each end. Some looms are equipped with flat sheaves; thus, the harness strap may be a flat nylon strap. However, the principle remains the same.

Using a level, make sure that all of the harness straps are perfectly vertical, from the sheaves down to the harness eyes. If necessary, move the sheaves. If a single harness is out of line, move the position of the eye on the harness. When the looms are equipped with dirt pans, make sure that the straps do not rub against the edges of the slots in the pan; rubbing straps will wear through very quickly.

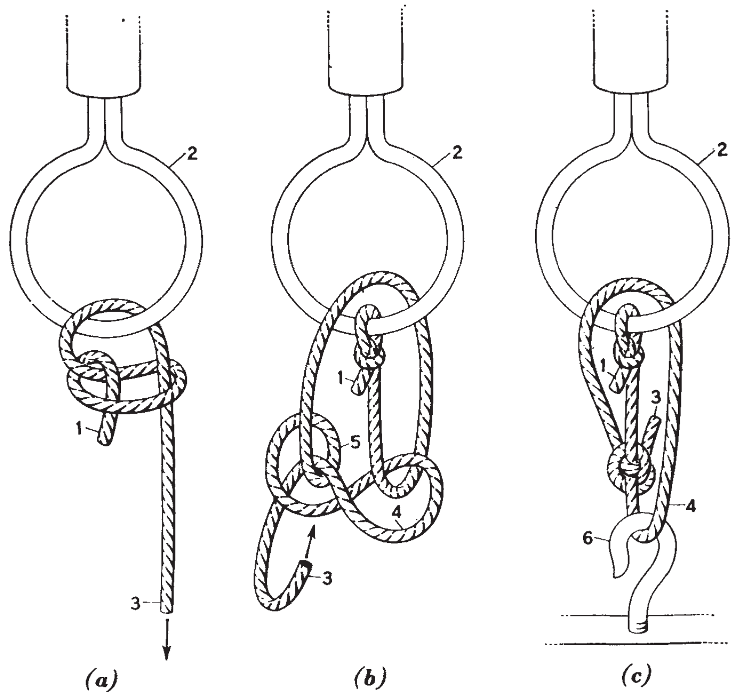
Harness Height

49. When starting a new warp, the harness height should be adjusted so that, when all harnesses are up, there remains a slight pitch from the front harness to the back harness. Each harness, from front to back, should be $\frac{1}{64}$ in. higher than the next harness in the set. On a 16-harness mount, the first harness would be at least $\frac{1}{4}$ in. higher than the last harness.

A good method of checking the harness height is to lower each harness so that the warp yarn touches the race plate. When the loom is moved by hand and some of the harnesses are raised, the lowered harnesses will have a tendency to rise slightly above the race plate and come to the desired height of about $\frac{1}{16}$ in. above the race plate.

On a new warp, turn the lay over one pick by hand so that the new lift is made, and set the shuttle so that the top shed is approximately $\frac{1}{4}$ in. above the front shuttle wall. Mark a white chalk line on the reed at the top shedding position. Remove the shuttle and check the subsequent lifts until the full set has been inspected, making the height in each case even with the chalk mark.

Once the entire set has been properly adjusted, weaving can start for one



1. short end
2. strap eye
3. long end
4. large loop
5. small loop
6. harness hook

(a) Short end passed through strap eye and knot tied
(b) Loops formed
(c) Knot completed

FIG. 13. SLIPKNOT

pick at a time until a heading has been formed and further precautions have been taken to start the new warp with a minimum of warp end breaks.

Adjustable Connections

50. There must be some sort of connection between the harness strap and the hook eye on top of the harness. In order to allow the harness height to be set properly, this connection must be one that can be shortened or lengthened as required. Several methods are used; some of the most common will be described.

On some looms, short sections of leather or nylon straps, containing holes into which the wire is hooked, connect the two wire hooks — one on the dobby cord and one on the harness. To raise or lower the harness, it is only necessary to hook the wire into a different hole, the holes being spaced through the length of the strap.

On other looms, an adjustable metal connector is hooked to the dobby cord and harness hook eye. On both sides of the connector slide are holes through which the ends of a V-shaped wire protrude. By pushing the ends into the slide, the wire part can be raised or lowered as needed. Other connectors work on the same principle as a turnbuckle.

Still another method of adjusting the harnesses, one often used when weaving delicate synthetic yarns, is to use a waxed, braided cotton cord with a slipknot. As shown in Fig. 13(*a*), the short end *1* of the cord is inserted through the harness strap eye *2* and a knot is tied. The long end *3* is then pulled down to tighten the knot, as indicated by the arrow. Then, as shown in view (*b*), the long end is passed through the eye. Using the right hand, the end is passed through the large loop *4* thus formed, and using the left hand, the center is twisted into a small loop *5*. With the small loop in the left hand, the end is passed through it with the right hand. The end is then brought up and passed through the small loop once more, as indicated by the arrow in view (*b*). The bottom of the large loop is then pulled down with the right hand until the slipknot is tight. The harness hook *6* is then put into this loop, as shown in view (*c*). By pushing the slipknot up, the harness may be lowered; by pushing the slipknot down, the harness may be raised.

Evaluation of Adjusters

51. Each of the various adjusters has certain faults. Slipknots, if not carefully made, may get loose and slip out of place. However, the knot shown in Fig. 13, once it is mastered, becomes quick to tie and it is easy to adjust. This is a single-strand slipknot tie, suitable for medium work. On heavy material, such as duck, a double strand of cord can be used. Follow the same details, merely doubling the strand. To master this knot and a few others that are handy for weaving and fixing, the student should practice tying at all available moments. Even after several weeks, it is a good plan to make a few ties to keep in practice. After frequent use the technique is never forgotten.

Leather straps used as harness adjusters tend to fly about during weaving and may be the cause of harness skips. Metal adjuster units can cause wear on the harness strap eyelets and harness hooks; metal dust may soil the warp yarn. The kind of material woven in each mill should be considered when deciding on the type of device to be used.

Inspection of Parts for Wear

52. After looms have been in operation for several years, all mount wires should be inspected at each new warp remount. Check each wire at the jack eye and each looped end at the harness straps. If any of the wires or strap ends shows wear, replace the faulty part. During regular work an occasional break will occur. Such breaks may be due to a worn jack eye, a worn mount wire, a worn harness strap, or a torn tie-up cord. It is not advisable to replace an entire unit and discard the old unit when the old unit can be repaired. Replace the broken jack eye with a new one. If the wire is broken, discard it but remove the harness straps

if they are still serviceable. Replace broken straps and retie torn tie-up cords. Serviceable parts can be kept at the workbench and used to replace damaged parts.

Timing the Dobby

Directions for Specific Dobbies

53. There are many varieties of dobbies in use in mills today. Each make and model requires slightly different settings, timing, and maintenance. Thus, the instructions in this text are general in nature, but they do provide a basic understanding of the principles involved.

Information on the specific dobbies you may be working with can usually be obtained. If no channels have been set up for getting the information, simply write to the manufacturer. Use your company letterhead if at all possible. Or just let the manufacturer know what company you work for, and the model and age of the dobby with which you are working. Most of the dobbies in the United States are manufactured by Crompton & Knowles Corporation, Worcester, Massachusetts. The most common make of imported dobby is the Staubli dobby, which is manufactured in Switzerland. Information on the Staubli can be obtained from H. J. Theiler Corporation, Spartanburg, South Carolina. Perhaps the simplest way to get the information you may need is to see the purchasing agent or supply room supervisor in the mill. He can tell you where the dobby was purchased, and where he gets the spare parts.

Timing the Dobby Drive

54. The exact timing instructions for various dobbies differ somewhat, but they are alike in principle. The following instructions, determined for a simple, conventional, single-index dobby, will give you the fundamental principles of dobby timing.

As the chain moves, the pegs lift the indicating fingers, which raise the harnesses as required by the pattern. The dobby knives and chain must be timed to work in unison. The connector drive rod is fastened to the slotted portion of the dobby crank gear and is adjustable for lift by moving the stud. Moving the stud toward the gear center will shorten the throw and lessen the harness lift. Moving the stud outward toward the gear rim increases the throw and gives more opening to the shed. Timing the single-index dobby is quite simple. The drive is continuous and will require only 1) timing the pegs beneath the fingers, 2) timing the knives and sweep, and 3) timing the opening and closing of the shed and the size of the shed opening.

For timing, turn the lay forward until the crankshaft is in front center, with the reed set against the cloth. Check the top and the bottom knives; both should be in the same position. The harnesses moving upward and the harnesses moving downward should be on a level at this point. For instance, on a plain weave, where all harnesses change position at every pick, all harnesses should be in line if the timing is right.

Adjustments to Allow for Wear

55. If the harnesses are not level when the lay is at front center, loosen the crankshaft gear. Block the two meshing gears and turn the lay backward or forward, without moving the head motion, until the harnesses are even. Tighten the gear lightly and remove the block; then turn the lay over and pick and check the timing on the next pick.

Dobbies in service for ten years or more will be rather shopworn, and loose play will have thrown many original adjustments off a trifle. Knife edges may be worn round, shafts grooved, hooks smooth, girts unevenly worn, bearings loose, and other surfaces worn off. The damage at each point of wear may be negligible, but the total may throw the timing off considerably. As the harnesses are equalized from the top, the bottom may be off as much as $\frac{1}{2}$ in. or more. If the top knife is timed to equalize the shafts at front center on one pick, the bottom knife will be out on the next. Here is one of the finer points in timing: check the harness level on both picks.

Adjustments for Double-Index Dobby

56. As you'll recall, there are two picks on each bar of a double-index dobby. To time both picks, move the lay to front center for checking time. If the top knife levels the crossing harnesses satisfactorily, turn the lay over to check the bottom knife. The bottom, let us say, is still $\frac{1}{4}$ in. away from front center. The upward-going harnesses and the downward-going harnesses are level, but the lay can still be moved farther. Remove the cotter pin in the top connection holding the driving rod, and loosen the nut holding the driving rod in the swivel. This permits the driving rod to be turned. Remove the top swivel from the stud on the rocker arm, disconnecting the upper end of the driving rod.

Now move the lay toward front center about halfway between the present position and the desired position. This movement will either increase or decrease the height of the driving rod. Now screw upward or downward on the rod so that it can be slipped back onto the stud without forcing. Replace the cotter key temporarily, but do not tighten it, because you may have to move it again. Next, check the level once more from each side. If this is satisfactory, tighten all connections firmly.

57. When necessary, slight adjustments can be made on the knife connectors. Hooks should show a clearance of not more than $\frac{1}{4}$ in. nor less than $\frac{1}{8}$ in. between hook and knife when the hook is down and the lay is at back center. But where the wear is great, clearance may be more. By moving the knife forward, timing is that much earlier and the lift is that much greater. When making any dobby adjustment, always be positive that the knife does not jam into the front or back

end of the slot. When the knives are adjusted, turn the connectors to the desired position very lightly until the required throw has been arrived at.

There is also a slot in the dobby crank arm to adjust the shed and harnesses. But during the years of use it is best to keep the connector or adjusting swivel as near the inside end of the slot as possible. By moving the stud outward, more throw is given to one shed and less throw to the opposite shed. However, using this adjustment will often bring the lower end of the driving rod up against the large drive-gear guard and will wear the driving shaft through or cause binding. Generally, it is best to forget about this adjustment, as on most dobbies all adjustments can be satisfactorily made by other means.

Adjusting the Shed Opening

58. In order to adjust the opening of the shed, move the drive-gear stud inward or outward. Various weaves may require changes in the shedding. A satin weave may require a wider opening; so move the stud outward in the slot. A taffeta or leno weave may require less opening; so move the stud inward toward the gear center in the slot. Make small movements and check. Continue making further adjustments until a satisfactory opening has been made.

Never make a pick or more under power directly after making any dobby adjustment. Check the adjustment by turning the lay by hand. If at any time there appears to be a tight binding feel when turning by hand, do not force further movement. Stop, check, and recheck. Locate the binding point and make further adjustments. Only when you are absolutely positive that the dobby works freely, and only then, should you make a pick or two by pulling the starting handle. Smashes and wrecked dobbies will result if these necessary precautions are not taken.

Timing the Chain Cylinder

59. When the shedding has been equalized and the proper harness lift obtained, it becomes necessary to time the pattern chain cylinder. Move the lay so that the crank arms are exactly back center. Take hold of the cylinder handwheel and turn it so that the small steel pegs of the chain are under the indicating finger runs at the highest point of their rise. If the clutch gives way and does not place the pegs beneath the indicating fingers at their highest point, the chain is out of time. Rock the chain back and forth slightly by turning the wheel, and be very sure that the chain is in the right position beneath the indicating fingers. Now loosen the setscrew fastening the clutch sleeve to the cylinder shaft, and turn the handwheel so that the peg is backed $\frac{1}{16}$ in.; then tighten the setscrew. Turn the lay over by hand and check the pegs for the lift from the opposite side. The pegs should now be just going into the high-rise position.

When timing the single-index dobby in the foregoing manner. The hooks should drop just as the knife enters into the back position, thus assuring a positive action. When the pegs move out, following the pattern, the hooks should snap off the knife in a lively manner. If hooks or needles tend to drag, an occasional mis-pick may result. Check the hooks passing through the comb, and prevent binding by bending sticking hooks to the right or the left as needed, to give more freedom of action. If all hooks appear to be pressing one side of the comb, the comb should be adjusted sideways.

Practical Observations

60. By now it should be clear that dobbies are carefully built, intricate mechanisms comparable to a fine watch or to an electric typewriter. You should, if at all possible, observe a dobby on a loom while trying to understand how it works. If you are interested in loom fixing, remember that it will take years of practice before you will be able to adjust a dobby properly. However, the instructions given in this text will enable you to avoid much time-wasting guesswork.

If you are doing designing work, observe dobbies with different chains. A good designer can often save much work for the fixers and expense for the company by arranging pattern chains that cause a minimum of wear on the dobbies and harnesses. If you get permission to visit a weave shed, remember that a fixer in the process of setting or repairing a dobby is a very busy man. Do not disturb him. Just stand where you are not in the way and observe as much as you can. Later, review the material you have studied.

Variations in Dobby Design

Reasons for Varied Design

61. If you were to visit a museum of machinery, you would note that technical developments often do not move in a straight line. For example, let's take a look at the bicycle. The first bicycle looked much like a modern bicycle, but did not have a chain drive. The next step was to speed things up. This was done by making the front wheel larger and larger, until the bicycle became a monstrosity and required an acrobat to ride it. Finally, some bright young mind thought of chain transmission, and things got back to normal again.

Much the same has been true of dobby design. The original idea was to build a simplified jacquard. As things were speeded up, the paper cards and needles of the jacquard could not take the strain, and wooden bars with steel pegs became popular. In our modern age, with business machines reviving the punching of paper cards, we find punched pattern chains quite popular again. But these punched chains are not necessarily made of paper; they may be made of plastic film or thin metal foil.

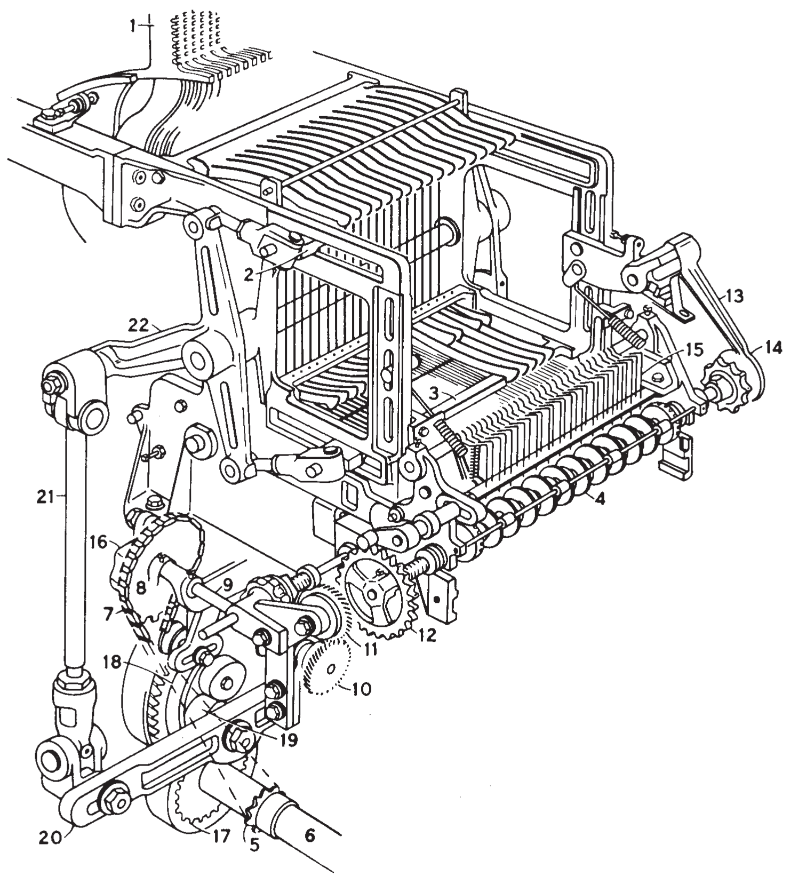
Some of the variations in dobbies are just a matter of fad and fashion. Others, like the C & K head motion you'll study later, are manufactured for special purposes. Bear in mind, however, that in every case the purpose is to lift and lower the harnesses to form an even shed, with ample space for the shuttle or other filling carrier to pass through. Above all, the lifting and lowering of the harnesses must be done smoothly so as not to injure the warp yarn. You will find that the principles you have already learned apply to any dobby, and that all you will have to learn in addition are the specific methods of adjustment needed to accomplish the desired end results.

Punched Pattern Dobby

62. The dobby shown in Fig. 14 is manufactured by Crompton & Knowles. You undoubtedly will recognize most of the parts, and you are already familiar with their function. For example, you will need no further instruction on the dobby jacks *1*, the top knife *2*, the bottom knife *3*, and many of the other parts. So, let's look at some of the differences that do exist.

The pattern cylinder *4* is fitted with round disks which are suitable for supporting a paper chain. A sprocket *5* on the crankshaft *6*, by means of the chain *7*, drives a second sprocket *8* on the small cross shaft *9*. This drive should be familiar to you. However, on the other end of the small cross shaft is a helical gear *10*, which meshes with and drives a second helical gear *11* on a stud. The whole drive is calculated so that the helical gear on the stud makes one revolution for every two picks. A small pin, or dog, behind this gear turns the cylinder wheel *12*. This cylinder wheel is technically a star gear, and thus will move one tooth for every revolution of the helical gear on the stud.

A holding pawl *13* catches in a ratchet *14* on the other side of the cylinder



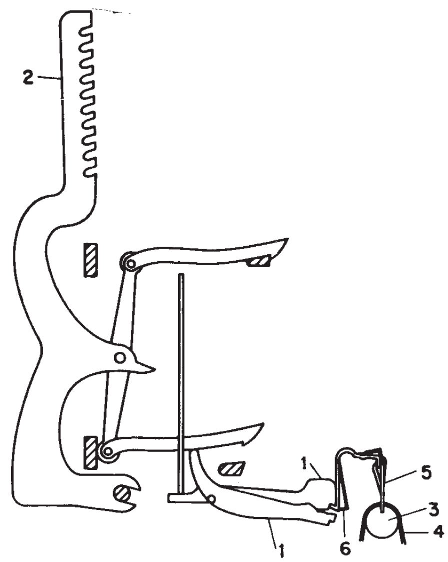
1. jacks
2. top knife
3. bottom knife
4. pattern cylinder
5. driving sprocket
6. crankshaft
7. chain
8. driven sprocket
9. cross shaft
10. driving helical gear
11. driven helical gear
12. cylinder wheel
13. holding pawl
14. ratchet
15. bank of needles
16. cam for lifter blade
17. gear on crankshaft
18. cam gear
19. roller
20. lifter arm
21. connecting rod
22. rocker arm

FIG. 14. DOBBY FOR PUNCHED PATTERN CHAIN

shaft, thus preventing the cylinder from turning back after the cylinder wheel has moved it. Looking closely at the illustration, you'll notice a bank of needles *15* above the cylinder. The function of these needles will be new to you, and so we'll look at them in more detail.

Indicator Needles

63. When you look at Fig. 15, you'll recognize most of the parts shown, and you should know how they function. You should be familiar with the indicator



1. indicator fingers
2. jack
3. chain cylinder
4. punched pattern chain
5. indicator needle
6. needle hook

FIG. 15. DETAILS OF PUNCHED PATTERN INDICATION

fingers *1,* and the manner in which they actuate the jack *2.* If you are not familiar with this function, you'd better go back right now and review those sections of the text which describe the function. You learned previously that the fingers are lifted by the pegs in the chain. The fingers shown in Fig. 15, however, are lifted by a special lifter blade in the punched pattern dobby. Motion for the lifter blade is obtained from the cam *16,* Fig. 14, on the small cross shaft.

Looking at Fig. 15 again, you'll see the chain cylinder *3,* which carries the punched pattern chain *4.* Now let's see how the indicator needles work. If there is no hole in the pattern chain, the indicator needle *5* cannot drop down, and the needle hook *6,* shown solid black in the illustration, will remain away from the finger. This action will allow the right side of the finger to drop and the left side to rise. In other words, you'll get the same result that you would get if a wooden chain were used and there were no peg to actuate the finger.

When there is a hole in the pattern chain, the needle drops down and the needle hook engages the notch on the end of the finger. If you look at the illustration carefully, you'll see the needle hook engaged in the notch of the back finger. The hook is shown in outline form. As a result of this action, the left side of the finger will be lowered, producing the same result you would get if you had a peg in a wooden chain. Bear in mind, of course, that only one needle hook is shown in Fig. 15. You must also remember that this hook assumes the position shown in solid black when there is no hole in the chain, whereas the same hook will assume the position shown in outline when there is a hole in the chain. It's as simple as that.

Dobby Drive

64. At this time, let's go back to Fig. 14 and study the dobby drive shown. This particular drive is certainly not confined to punched paper chain dobbies; you may well find it used on dobbies with wooden chains. However, it does differ somewhat from the dobby drive you studied earlier in this text.

As shown in the illustration, the drive originates with the gear *17* on the crankshaft. This gear meshes with the cam gear *18*, which is compounded with a cam. The cam moves the roller *19* on the lifter arm *20*, which is connected to the vertical connecting rod *21*, which, in turn, is connected to the rocker arm *22*. Thus the only difference between this dobby drive and the one covered earlier in this text is the manner in which the up-and-down motion of the rocker arm is obtained. If you study the text carefully, such minor differences in construction should not puzzle you.

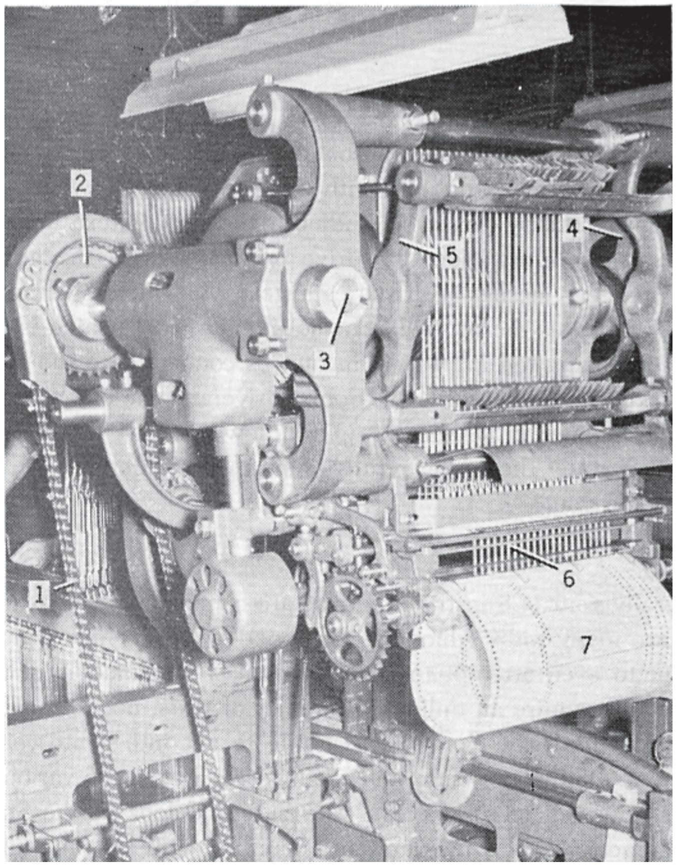
Staubli Dobby

65. Generally your ICS instruction texts are confined to American equipment. True, there are many mills which are equipped with machinery made in other countries. But to even attempt to cover all makes and models of any piece of equipment would require an unlimited number of texts, not to mention the time needed to study the texts. Nor is it desirable to get into controversy as to the respective merits of the precision and engineering details of various looms and attachments. However, let's break the rule here and look at the Staubli dobby, which is manufactured in Switzerland and may be found in many mills.

Shown in Fig. 16, the dobby is called the Staubli American Standard Head by the manufacturer. At first glance it may appear to be quite different from the dobbies already covered in this text. The differences, however, are mostly in engineering details. As you will learn, the unit is similar in most respects to other dobbies; its function is exactly the same, that is, to raise and lower the harnesses as required.

Drive Details

66. As you look at the illustration of the Staubli dobby, the first thing you'll probably notice is the lack of a vertical connecting rod, such as is used to move the rocker arm of other dobbies. The Staubli dobby is driven by a strong roller chain *1*, Fig. 16, which is in turn driven by a sprocket on the crankshaft. This chain drives a sprocket *2* on the cross shaft *3*. A small bevel gear on the cross shaft drives a large bevel gear on a second shaft that goes clear through to the other side of the dobby. A cam *4* on that side of the dobby moves the rocker *5* that carries the top and bottom knives. As you can see, the drive for the dobby originates at the crankshaft, just as it does for the C & K dobby. In this case,



Courtesy of H. J. Theiler Corporation

1. roller chain
2. sprocket
3. cross shaft
4. cam
5. rocker
6. indicator needles
7. punched paper chain

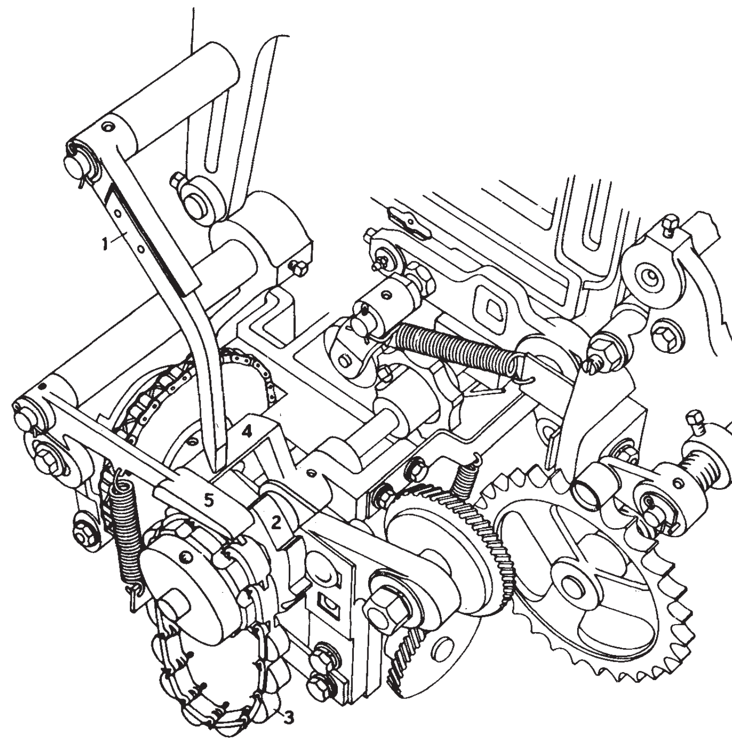
FIG. 16. STAUBLI DOBBY

however, the cam that is used to move the rockers is located right on the dobby head, instead of underneath the dobby. The operation of the indicator needles *6* and punched paper chain *7* remains the same as for other dobbies.

Briefly, then, the principles and function of a dobby are always the same; only the engineering details vary from make to make and model to model. The main thing for you to keep in mind is that the dobby is a precision-built piece of machinery which will give trouble-free service only if it is properly lubricated and maintained. Negligence can be very costly.

Multiplier Attachment

67. Some fabrics, such as tablecloths, are woven with a satin or other similar

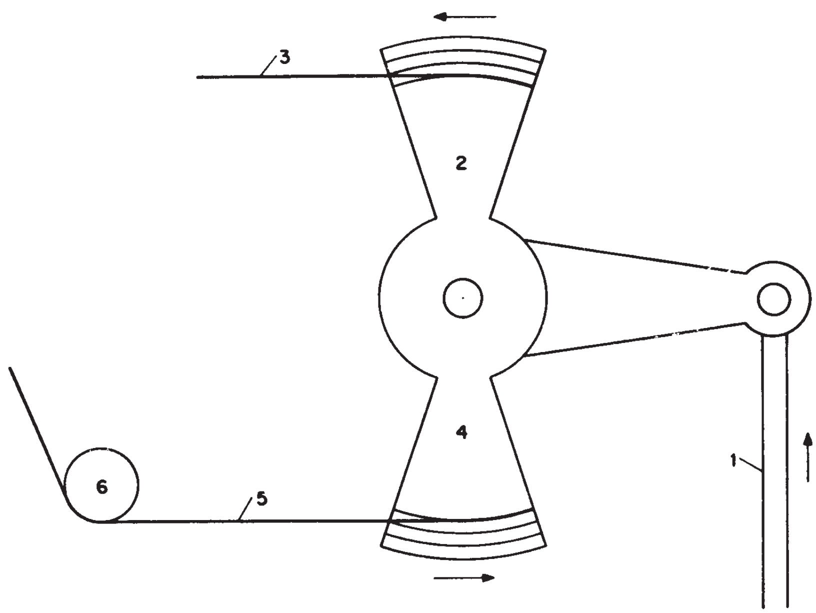


1. pawl
2. ratchet
3. multiplier chain
4. shield
5. indicator finger

FIG. 17. MULTIPLIER ATTACHMENT

weave at each end, and plain weave in the body. There may be several thousand picks of plain weave before the satin or other weave comes up again. To build a pattern chain for several thousand picks long would be extremely troublesome, not to mention the trouble that the chain could cause when running on the loom. A multiplier attachment is used to overcome these problems. Such an attachment is shown in Fig. 17.

The multiplier gets its motion from the long pawl *1*, which is attached to the dobby rocker arm. When the pawl engages the ratchet *2*, it advances the multiplier chain *3*. The shield *4* is operated by the last line of holes in the punched pattern chain. When there is no hole in the pattern chain, the shield prevents the pawl from moving the ratchet, thus causing the pattern chain to weave as usual. When there is a hole in the pattern chain, the shield is held down, the pawl moves the ratchet, and the multiplier chain advances. High links on the chain will lift the lever, or indicator finger *5*, which disengages a clutch on the pattern chain cylinder drive, causing the pattern chain to stop until a low link on the multiplier chain comes up.



1. connecting rod
2. top wing
3. top strap
4. bottom wing
5. bottom strap
6. sheave

FIG. 18. BUTTERFLY MOTION

The multiplier attachment does not affect the settings of the dobby in any way. It is simply a device for eliminating long, cumbersome pattern chains.

Butterfly Motion

68. The harness motion shown in Fig. 18 is called the butterfly motion because of its wings. A simple motion, it was considered obsolete for some time. As shown in the illustration, it consists basically of a piece of cast iron with two wings. It is driven from the crankshaft by the vertical connecting rod *1*. Thus the entire butterfly motion moves exactly like the rocker arm in a dobby.

Now let's assume that the connecting rod moves up, as indicated by the arrow in the illustration. This action will cause the top wing *2* of the butterfly motion to move to the left. The top strap *3*, which is bolted to the wing, is connected to the first harness. As the wing moves to the left, then, the harness will be lowered. At the same time, the bottom wing *4* will move to the right. The bottom strap *5*, which is bolted to the bottom wing, passes over a sheave *6* and is connected to the second harness. The movement of the bottom wing will thus cause the second harness to be raised. As the crankshaft turns, the motion of the butterfly is reversed of course, causing the harnesses to move up and down at each change of direction.

As you know, the back harnesses need to be raised and lowered a greater distance than the front harnesses. This is accomplished by steps in the wings of the motion. The straps in Fig. 18 are bolted to the inner steps of the wings.

69. The butterfly motion has one distinct disadvantage, in that it cannot be used for anything except the plain weave. You may well ask why anyone would want to use a harness motion that can produce nothing but plain weave. The answer is simple economics.

Printing, dyeing, and finishing have been perfected to a very high degree, increasing the demand for plain gray goods. Wages and the cost of spare parts have also gone up. Thus a mill manager may well find himself saddened by costly dobby maintenance on looms that are used to weave nothing but plain fabrics year after year.

A butterfly motion costs but a small fraction of the price of a dobby. Above all, it needs little maintenance other than occasional lubrication. Therefore, the motion which was considered obsolete is now back in favor in many mills. It is so simple that you will have no trouble with it should you encounter it in your work.

Head Motions

Principle of Head Motions

70. In every head motion or dobby you have studied so far, the harnesses were pulled up and then returned to the bottom shed by springs. For very heavy looms, such as woolen and worsted looms, a positive down motion is desirable. The C & K head motion has jacks that pull the harnesses down as well as up, thus providing complete control of the harnesses.

As was explained before, terminology varies from mill to mill. You may hear the C & K head motion referred to as a "Gem Head," a term derived from an early version of the head motion. Also, just as with dobbies, you will find that technology just doesn't stand still. Improvements and changes are made constantly. For this reason you should always get the exact instructions from the manufacturer whenever there is any doubt as to what should be done. Usually, however, you'll have little trouble understanding any variations of the principles covered in this text.

Gearing Inside Head Motion

71. The sections of the head motion shown in Fig. 19 have been simplified so as to make them easier to understand. The harness *1* has been made very small, simply to make it fit into the illustration. Only one jack and harness is shown; the others, of course, work in the same way.

There is a separate, thin vibrator gear *2* for each harness. The top cylinder gear *3* and bottom cylinder gear *4* are located above and below the vibrator gears, respectively, and extend all the way across the head motion. All of these gears are technically known as mutilated gears, since they have teeth only on parts of

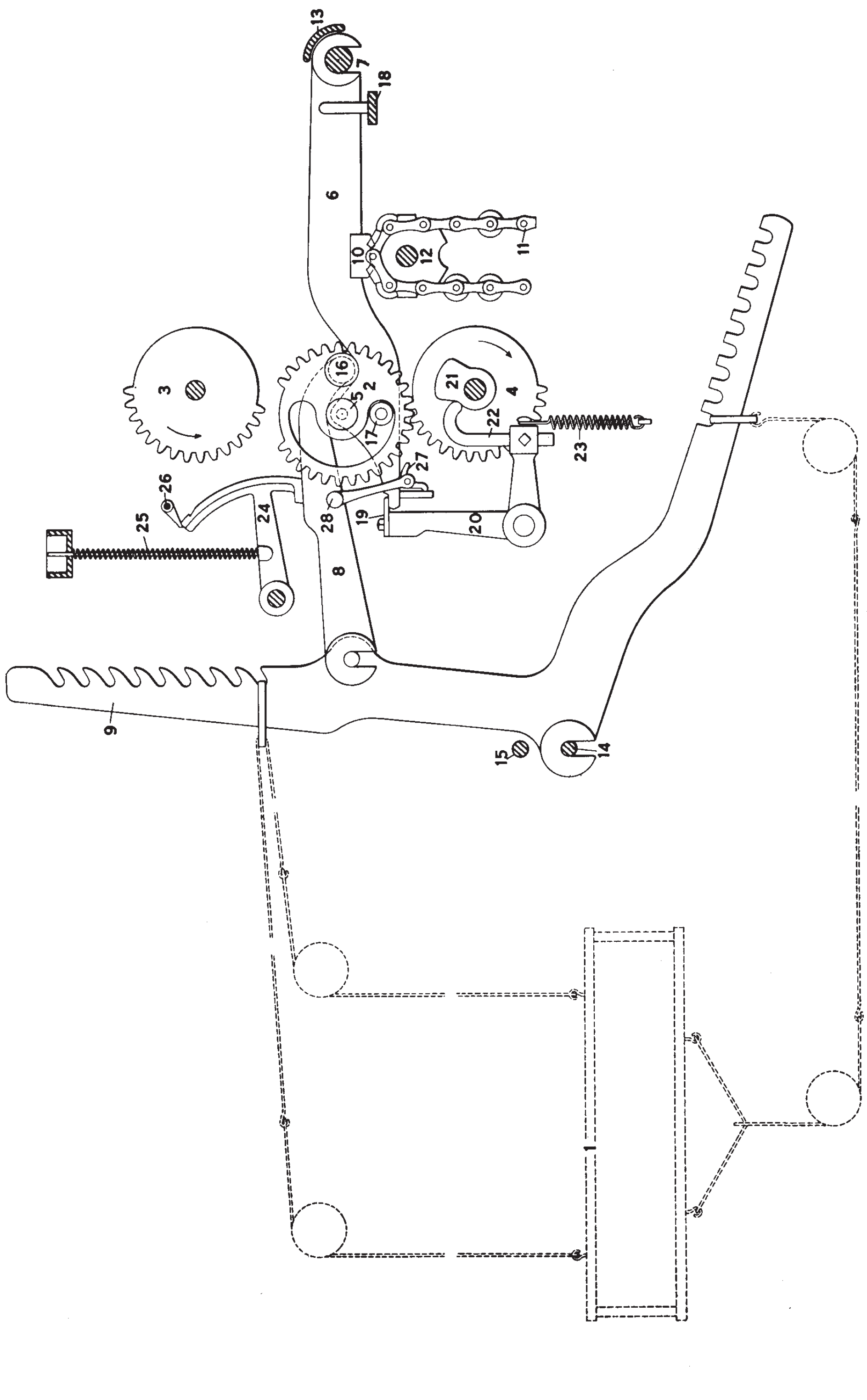


FIG. 19. GEARING INSIDE HEAD MOTION

LEGEND FOR FIG. 19

1. harness
2. vibrator gear
3. top cylinder gear
4. bottom cylinder gear
5. vibrator pin
6. vibrator lever
7. heel pin
8. connector
9. harness jack
10. run
11. pattern chain
12. chain cylinder
13. heel shell
14. jack rod
15. holding rod
16. connector pin
17. steadying boss
18. heel comb
19. lock knife
20. frame
21. cam
22. cam follower
23. spring
24. drop weight
25. drop-weight spring
26. pawl
27. eccentric bar
28. handle

their surfaces, as is clearly illustrated. The cylinder gears turn in the directions indicated by the arrows.

One one side of the vibrator gear there is a blank space of one tooth; on the other side, shown at the top of the gear in the illustration, three teeth are left out. The vibrator gear is free to turn on the vibrator pin *5* at the end of the vibrator lever *6*, with this lever being fulcrumed on the heel pin *7*. A connector *8*, which is pivoted at a point near the outside edge of the vibrator gear, connects to the harness jack *9*. Note that the jack is shaped like a boomerang.

A steel run *10* on the vibrator lever contacts the steel pattern chain *11* on the chain cylinder *12*. You are already familiar with pattern chains, and thus can visualize that a roller on the chain raises the vibrator lever. When this happens, the vibrator gear on that lever will be raised and mesh with the rotating top cylinder gear. The cylinder gear will then give a half turn to the vibrator gear. The side of the vibrator gear to which the connector is fastened will move from its position on the left of the gear to the right; that is, the gear will move to the position shown in the illustration. This movement is transmitted to the jack by the connector, pulling the harness up. The harness will remain up as long as rollers continue to come under the run.

When a tube, or sinker, comes under the run, the vibrator gear is allowed to drop down, coming into contact with the bottom cylinder gear. This gear will give the vibrator gear another half turn, pulling the harness down. The harness will stay down as long as sinkers continue to come up on the pattern chain. The illustration shows the vibrator gear just as the bottom cylinder gear is meshing with it to lower the harness to the bottom shed.

Auxiliary Parts of Motion

72. Other parts are needed to make the head motion work properly. The heel shell *13*, Fig. 19, keeps the vibrator lever on the heel pin. The jack rod *14* forms the fulcrum for the jacks, which are held down by the holding rod *15*. The connector pin *16* holds the connector to the vibrator gear. The steadying boss *17*

engages in a slot in the vibrator gear, and thus governs the distance of the half circle through which it can move.

The vibrator levers are kept in place by the heel comb *18*, and by another comb near the toe end. This second comb is not shown in the illustration. The lock knife *19* locks the vibrator levers into position while the vibrator gears are being turned. The lock knife, which is attached to the frame *20*, is made to move away from the vibrator levers by the cam *21* acting through the cam follower *22*. A spring *23* holds the cam follower against the cam.

Timing the Lock Knife

73. The timing of the lock knife is important; for, if the knife were to remain in contact with the vibrator levers when a riser is forced under the run, the levers or the lock knife would be bent or broken. The knife should be set so as to be just moving from contact with the vibrator levers when a new bar of the chain is forced under the runs. When the cylinder gear engages the first tooth of the vibrator gear, the lock knife should have engaged with the ends of the vibrator levers.

On older looms the cam is fastened to the shaft with a pin and is not movable; but by moving the cam follower in its casting, an adjustment sufficient for timing the lock knife may be obtained. If the cam follower is lowered, the lock knife will be timed earlier, and if the follower is raised, the knife will commence to move later. The cam that moves the lock knife on modern looms is adjustable. It is designed to impart an easy motion to the frame. If harness cylinder gears are advanced or retarded, the adjustment of the cam should be checked.

Drop Weights and Leveling

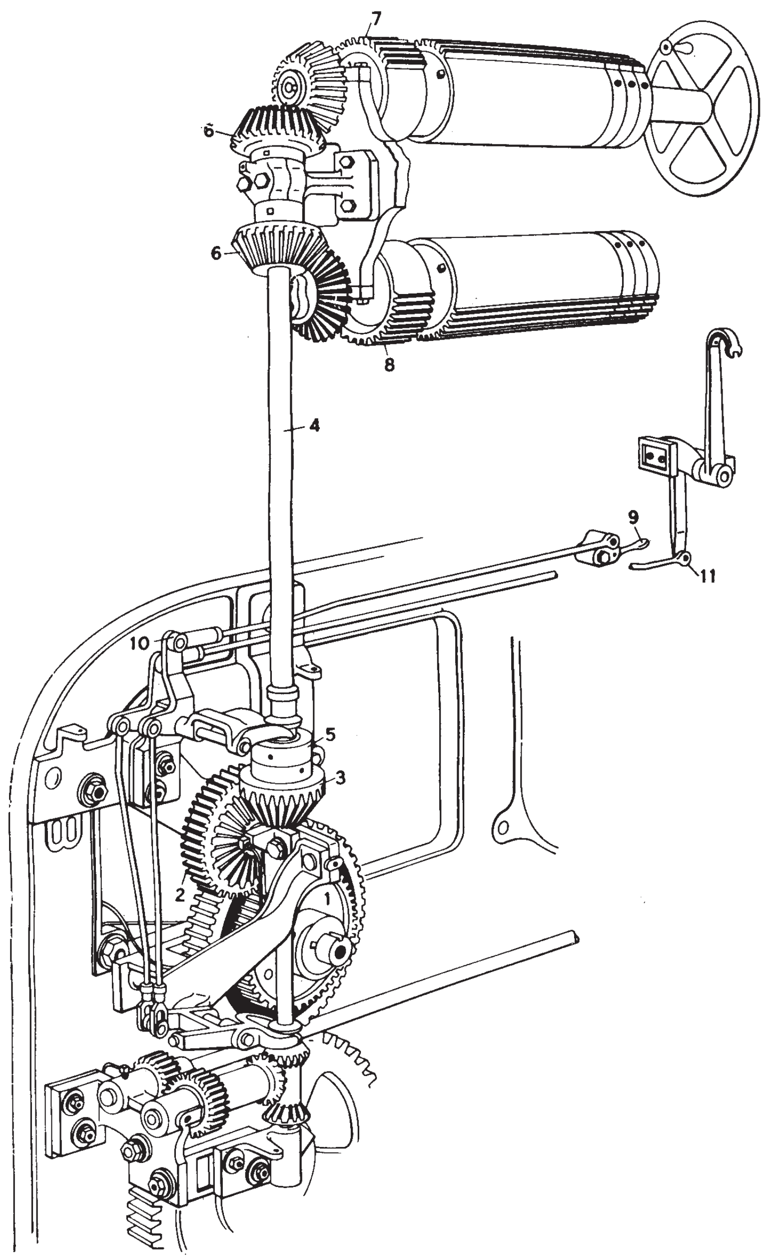
74. As the head motion runs, the vibrator gears may tend to rebound. The gears are prevented from rebounding by being held in place by a drop weight *24*, Fig. 19, which is kept from bouncing by the drop-weight spring *25*. A small pawl *26* is used to hold the drop weight out of the way when a vibrator is removed for repair. Also, if you have a 20-harness dobby and you are using only eight harnesses, the idle drop weights can be held out of the way by their respective pawls.

The eccentric bar *27* can be moved by the handle *28* to level the harnesses. This is sometimes done to allow the warp to be checked or broken ends to be drawn in.

Drive for Head Motion

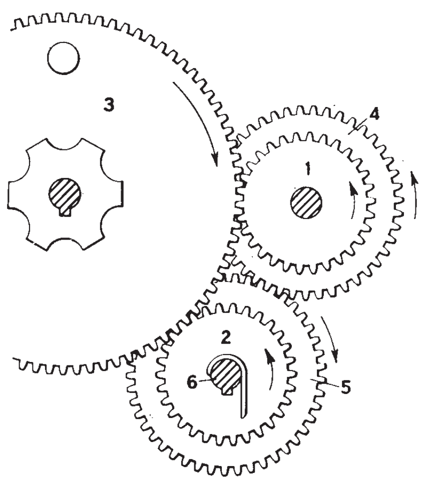
75. The exact arrangement of the drive for the head motion depends upon the model of the loom. You'll be given a general description of the drive here; you can always get detailed information on any specific model by writing to the manufacturer. The major parts of the drive are shown in Fig. 20.

An eccentric gear *1* on the crankshaft of the loom meshes with and drives a second eccentric compound gear *2*. The beveled surface of the compound gear



1. drive gear
2. driven compound gear
3. driven bevel gear
4. upright shaft
5. pin clutch
6. driving bevel gears
7. top cylinder gear
8. bottom cylinder gear
9. handle
10. shipper for head motion
11. shipper for take-up motion

FIG. 20. DRIVE FOR HEAD MOTION



1. upper small gear
2. lower small gear
3. chain-cylinder gear
4. upper large gear
5. lower large gear
6. key

FIG. 21. DRIVE FOR CHAIN CYLINDER

meshes with and drives a bevel gear *3.* This bevel gear is free to turn on the upright shaft *4,* and also acts as the lower member of the pin clutch *5.* The eccentric gears can be set so as to favor the harness motion; or they can be set so as to favor the box motion, if one is used. Some looms have the drive from the camshaft; in which case the drive gear is an elliptic gear with twice as many teeth as the driven gear. However, the result is the same in both arrangements.

Two bevel gears *6* on the upper end of the upright shaft mesh with and drive the top cylinder gear *7* and the bottom cylinder gear *8.* You are already familiar with the function of the cylinder gears. The segments to the right of the cylinder gears are for the box motions, whereas the long cylinders to the right of the segments are for the harness motion. At the extreme right you'll notice small sections; these sections make it possible to vary the timing for the first eight harnesses, when this is desired for certain fabrics.

Engaging the Head Motion

76. The central member of the pin clutch *5*, Fig. 20, is keyed to the upright shaft, but the top member is free to move. This top member carries a pin that can extend through a hole in the central member and into a hole in the driven bevel gear *3.* The exact arrangement of this clutch varies with different models of looms, but the principle is not hard to understand.

The handle *9,* which works through the shipper *10* for the head motion, is used when you want to disengage the motion. The other shipper *11* goes to the take-up motion, and is used to reverse the take-up when turning the head motion back during pick-outs. You must understand that this has nothing to do directly with the head motion; it is shown here so you can tell which is which when you look at a loom.

Drive for Chain Cylinder

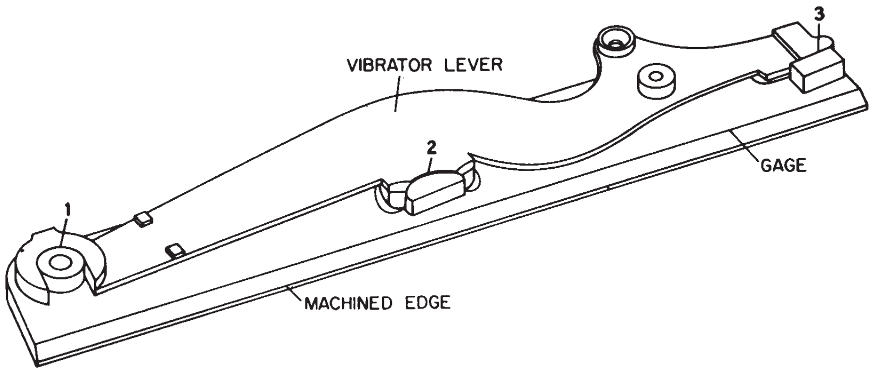
77. Now that you know how the entire head motion is driven, let's see how the chain cylinder is driven. The drive comes from the shaft of the bottom cylinder gear. The gearing arrangement is shown in Fig. 21. As shown in the illustration, the upper small gear *1* and lower small gear *2* mesh with the chain-cylinder gear *3*. The upper large gear *4* and lower large gear *5* are in front of the other three gears and mesh with each other, but not with any of the other three gears. Gears *1* and *4* are bolted together and both run loose on a stud. Gears *2* and *5* run loose on the bottom cylinder-gear shaft, but a key *6* set into the center of the shaft, has a projection that may be moved in a slot in the two gears. This key, according to its position, locks one or the other gear to the shaft. Gears *1* and *2* are equal, having 16 teeth each. Gears *4* and *5* are also equal, having 20 teeth each. The chain-cylinder gear has 96 teeth. The sizes of the gears may vary in different loom models, but the gear ratio must be the same. The chain cylinder has 6 grooves for the pattern chain, and a new chain bar must be forced into the head motion at each pick; therefore, the drive gear must compare with the chain-cylinder gear in the ratio of 1 to 6.

The action of the gears in actual operation will make the purpose of this arrangement clear. When the loom runs, the key is all the way in, leaving gear *5* loose and locking gear *2*. Now gear *2* will act as driver, the other gears running loose, as indicated by the arrows. When it is desired to change a pattern or harness chain, the first step is to disconnect the head motion. The key is pulled halfway out, leaving all gears loose. Then the chain cylinder may be turned freely, by using the handle, into any position desired. Suppose it is desirable to reverse the head motion to find a broken pick. In this case the key is pulled forward as far as it will go by means of its lever. The lower part of this lever will reverse the take-up roll, as mentioned. In this position the key will leave gear *2* loose, but lock gear *5*. When the head motion is now turned by means of the big handwheel on the upper cylinder-gear shaft, gear *5* will turn in the same direction as the bottom cylinder-gear shaft. Since it meshes with gear *4*, which is locked to *1*, gear *1* will now be the driving gear and all gears will turn in directions opposite to the arrows in the illustration.

Maintenance of Head Motion

78. On new C & K looms the various gears are fitted with timing pins on one gear and corresponding notches on the matching gears. This prevents mistakes in timing, even by inexperienced loom fixers. When working with older looms, or when you want to make an exception to the normal timing, you should write to C & K for specifiec instructions.

The vibrator levers wear out most readily and should be checked from time



1, 2, 3. touching points

FIG. 22. CHECKING VIBRATOR LEVER WITH GAGE

to time. In Fig. 22 is shown a vibrator lever being checked with a special gage, which can be obtained from C & K. The lever should touch the gage at points *1, 2,* and *3.* If the lever does not touch at any one of the points, tap the lever with a mallet until it is properly aligned. The lower edge of the gage is machined and can be used as a straightedge.

Troubleshooting

79. While inspecting the head motion you may sometimes find worn teeth on the vibrator gears. If the chain cylinder is not properly set, the first tooth of the vibrator gears may wear out fast. Check this out with a full bar of risers under the vibrator levers. The vibrator gears should now mesh with the cylinder gear, and there should be $\frac{1}{32}$-in. clearance between the top of the tooth on the vibrator gears and the blank surface of the cylinder.

Harness skips may be caused by bent vibrator levers. Check the levers with the gage, as you have already learned to do. Another common cause of harness skips is loose or worn risers on the pattern chains. Rings are available which can be inserted between risers or sinkers to take the excessive play out of the chain. Inspect the chains from time to time.

Summary on Dobbies and Head Motions

80. In dealing with dobbies and other head motions, bear in mind that they are complex and expensive mechanisms. Your greatest problems will probably arise when looms have been run on plain or other similar simple weaves for a long time and with only a few harnesses. Fixers and oilers often forget about the head motions during such periods. Worst of all, the fixers will often use the good parts from the back of the head motion to replace worn parts at the front. Then, when the loom is suddenly needed for a complex weave, the head motion has to be practically rebuilt.

Remember also that when you are assigned to a different job, or when your employer changes loom models, you should always try to get all of the maintenance instructions you can from the manufacturer. Study these instructions carefully. From your study of this text you have already learned the principles you need. More important, you have learned to follow and understand written instructions. This knowledge will prove of great value to you when you work with dobbies or other head motions.

Dobbies and Other Head Motions

Serial 5503 Edition 1

Examination Questions

Notice to Students.—Study this instruction text thoroughly before you answer the following questions. Read each question carefully and be sure you understand it; then write the best answer you can. You will profit most if you answer the questions in your own words. When you complete your work, examine it closely, correct all the errors you can find, and see that every question is answered; then mail your work to us. DO NOT HOLD IT until another examination is ready.

1. The management of your mill is making a drive to reduce the cost of spare parts used on dobbies. While preventive maintenance is the ultimate answer, what two things can you, as a loom fixer, do immediately to reduce the cost of new dobby knives and girts?

2. You have a dobby with a wooden chain. Suppose one of the steel pegs loosens and falls out. What effect will the missing peg have on the harness it controls?

3. On your answer paper, draw the first bar of a wooden chain, such as that shown in Fig. 4(*b*). Leave the holes blank. It doesn't have to be a fancy drawing; just draw a simple rectangle to represent the bar and 40 small circles to represent the holes. Now look at the chain draft shown in Fig. 6(*a*). By filling in the appropriate circles of the bar you have drawn, show how you would insert pegs for the first two picks of the pattern in that draft.

4. Upon checking a jack-back, you find $\frac{3}{16}$-in. play or free movement. What must you do?

5. A new mill is to be equipped with modern Draper looms. What type of harness motion would you specify if the looms are to be used for
   a) plain print goods and twills only?
   b) a variety of small or medium-sized patterns, such as fancy twills and satin strips on plain ground?
   c) plain-weave poplin only, so far as present plans are concerned?
   d) fancy tablecloths, such as damask; bedspreads with large woven flower designs; and similar fabrics?
   e) fabrics in which long stretches of plain weave alternate with short areas of combination weaves or bands of satin weaves?

6. *a*) What happens when the tip of the dobby hook hangs too low?
   b) What should you do to remedy the trouble?

7. Your mill wants to try out a new type of shuttle, one which is slightly larger

than the type currently being used. In order to use the new shuttle, you must make the shed opening a little larger. How would you do this?

8. New looms with dobbies manufactured in Belgium, England, and Japan have been installed in the mill. What two steps can you take to make sure that you will be able to cope with and repair the new dobbies?

9. What major difference is there between a C & K dobby and a C & K head motion?

10. There are two likely causes for harness skips on looms equipped with C & K head motions. What two parts of the head motion would you check, and what steps would you take to stop the harness skips?