THE NORTHROP LOOM

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THE NORTHROP LOOM
(PART 1)

Serial 1764 A _____ Edition 1

CONSTRUCTION AND OPERATION

AUTOMATIC WEAVING

1. In power looms of ordinary construction, the principal motions of weaving, namely, shedding, picking, and beating up, are accomplished by mechanisms that, to a great extent, operate automatically. The auxiliary motions of the usual loom, including the let-off and take-up mechanisms, the protector and filling stop-motions, etc., also are automatic in operation. In all such looms, however, it is necessary that the supply of filling be replenished by hand whenever it breaks or the cop, or bobbin, in the shuttle becomes exhausted. To accomplish this the loom must be stopped, usually by the filling stop-motion, and the weaver, after immediately giving the loom proper attention, must again place it in operation. Automatic weaving, therefore, refers, strictly, to the production of woven fabrics with looms in which the filling yarn is automatically renewed in the event of breakage or exhaustion, and without stopping the loom or requiring the attention of the weaver. Looms in which this principal object of automatic weaving is attained are included in the general class designated as automatic looms.

2. Advantages and Results.—The reduction of the element of labor in weaving with automatic looms is well illustrated by considering the ordinary duties of the weaver

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in giving proper attention to a power loom of non-automatic construction. Whenever the filling runs out, for instance, on an ordinary plain loom, the weaver first must release the loom brake and push back the lay. Next, the shuttle is removed from the box and the spare shuttle taken from the hook or receptacle, usually on the arch of the loom, and placed in the box. The weaver then starts the loom by pulling on the shipper handle, and often assists the loom on the first pick by pulling the lay forwards as the power is applied. When weaving cloth of light weight it also is often necessary to rub down the cloth below the breast beam in order that a good start may be made and no thin place formed in the cloth.

The loom having been started, the weaver picks up the shuttle removed from the shuttle box and raises the spindle out of the shuttle to a convenient angle so that the empty bobbin or cop tube can be removed. A filled bobbin or a fresh cop is now placed on the shuttle spindle and, after a sufficient length of filling is pulled off, the spindle is snapped back into place. It now is necessary to thread the shuttle and, while in most cases hand-threading shuttles are now used or a shuttle-threading instrument is employed, in some instances the weaver thrusts the filling into the forward part of the shuttle and then sucks it through the shuttle eye. This latter operation is dangerous and unsanitary, as there is liability of infection, and the sucking of shuttles, repeated from seven hundred to one thousand times a day by each weaver, tends to fill the lungs and respiratory passages with cotton fiber and lint. The practice without doubt has injured the health and shortened the lives of many weavers and in many states is prohibited by law.

The shuttle now is placed in the proper place for the spare shuttle and the weaver's duty to that loom, for the time being, is ended. If the filling is not exhausted, but is merely broken, it, of course, is not necessary to replace the bobbin or cop in the shuttle with a new one, but otherwise practically the same operations must be performed as when the filling runs out.

3. A cop, or a bobbin, of filling will run from 1 minute, or even less, to 15 or 20 minutes before it is exhausted, depending

on the size of the cop, or bobbin, the counts of the filling yarn, and the width and speed of the loom. In addition, with even the best of filling yarn, there will be each day probably from four to ten or more breaks of the filling per loom. Possibly 6 or 7 minutes represents the average interval of time during which one loom will continue in operation without being stopped by the filling stop-motion. If, therefore, a weaver operates, say, eight looms, it is clearly evident that the sequence of operations required in order that a loom again may be placed in operation, after having been stopped for want of filling, must be performed by the weaver more frequently than once a minute. This portion of a weaver's work, consequently, constitutes his most important duty and, although he has other tasks, it consumes the greater part of his working time.

When, however, automatic looms are employed, the weaver can supply them with large quantities of filling at convenient intervals, and this can be accomplished with but little labor. As the looms are automatically supplied with fresh filling whenever the supply in the shuttle breaks or becomes exhausted, the duties of a weaver are greatly lightened. Because of this fact, it is possible for each weaver to attend to a much larger number of automatic looms than is possible when common looms are employed. The number of the latter that one weaver can run varies with the character of the fabric being woven, the width of the loom, etc. On some work only four non-automatic cotton looms can be operated; in other cases, six looms can be run, while on plain narrow cotton looms, it is customary for each weaver to attend to eight looms.

4. The number of automatic looms that can be attended by one weaver doubtless will average fully three times as many as in the case of common looms. In some mills only sixteen or twenty automatic looms are assigned to one weaver; in other mills each weaver operates twenty-four or twenty-eight and, in some cases, even thirty-two looms. As a matter of fact, two hundred automatic looms have been run in actual mill service by only five weavers without the assistance of boys or learners to supply the looms with filling.

As a result of the increase in the productive capacity of weavers through the installation of automatic looms, the cost of weaving is greatly reduced. Savings of from 40 to 50 per cent. have been made in many cases, and under favorable conditions the gain is even greater. The cost of weaving is commonly considered to be approximately one-half of the labor cost of manufacturing a cotton fabric, hence the value of large economies in the weave room is readily apparent. There is no increase in the labor of weaving on automatic looms as compared with common looms, and in many respects the work is less fatiguing. Nevertheless, because of the increased production of the weaver, it is possible, and the general custom is, to grant him greater compensation.

As automatic looms have reduced the cost of weaving, they have revolutionized the production of many of the simple types of cotton fabrics, and the tendency, as the development warrants, is to use them not only for more elaborate cotton cloths but also for the production of woolen, worsted, silk, and linen fabrics.

5. Types of Automatic Looms.—Automatic looms are of two principal types, namely, filling-changing looms and shuttle-changing looms. A **filling-changing loom** is one in which, when the filling becomes broken or exhausted, the bobbin, or the cop, is ejected from the shuttle and another with a fresh supply of filling is inserted. A **shuttle-changing loom** is one in which the shuttle itself is ejected and another inserted when a filling failure occurs. In both machines, the operation of supplying fresh filling is entirely automatic. There is, of course, a vast difference in the construction and operation of looms of each of the two classes.

6. Development of the Northrop Loom.—The Northrop automatic loom, illustrated in Fig. 1, is of the filling-changing type and is a widely used loom that has been developed to a point of great efficiency. The loom is the original invention of James H. Northrop, who first developed a shuttle-changing automatic loom, and later, in 1889, conceived the basic principle of the present filling-changing loom bearing his
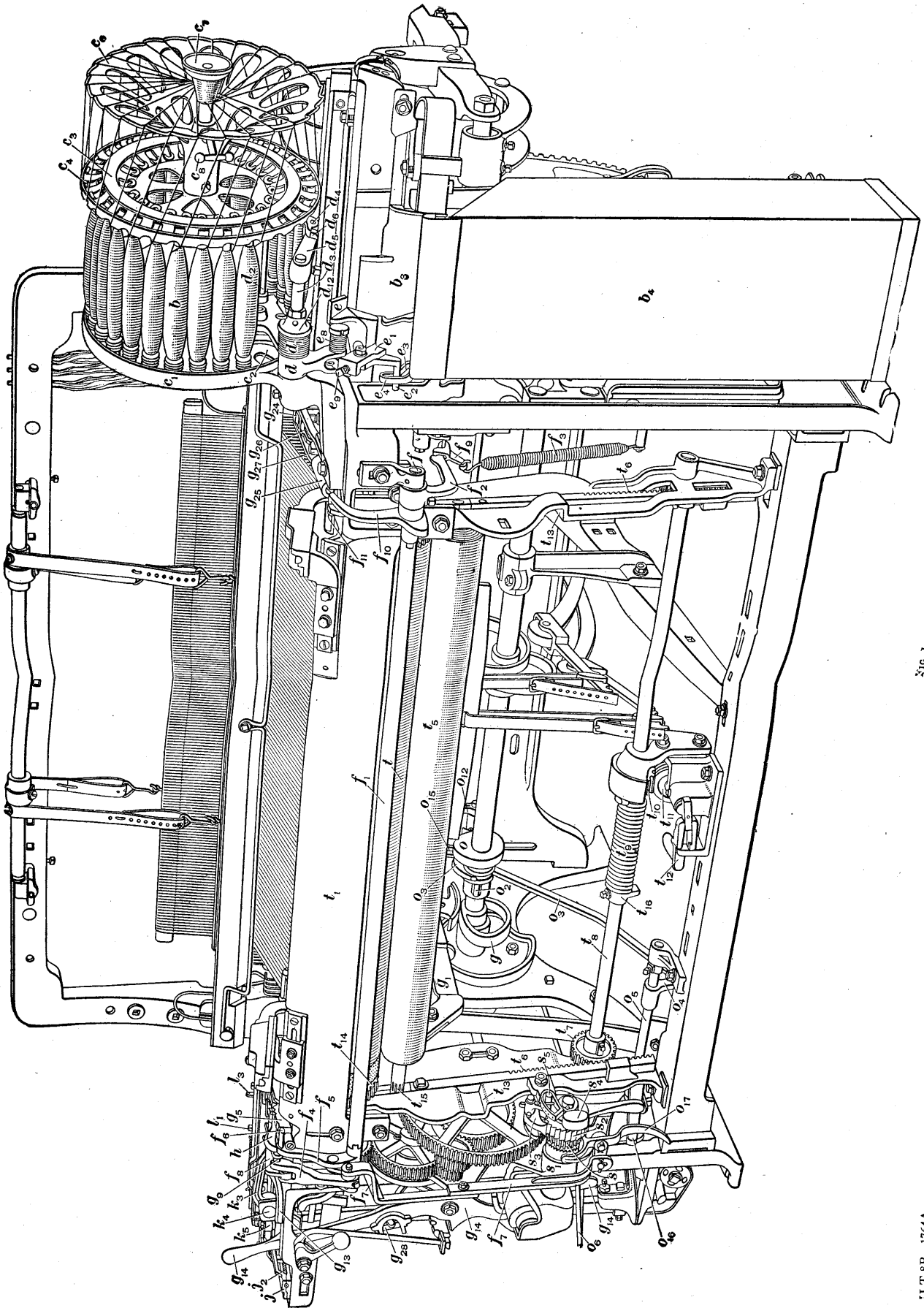
Fig. 1

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name. By 1890 the loom was sufficiently perfected to be in actual operation in a Fall River, Massachusetts, cotton mill, but the real date of the introduction of the Northrop loom was 1895, when looms were supplied on a commercial basis to a number of textile mills. Since that time, numerous improvements in the mechanism have been made and new devices added, but the primary principle has remained unaltered. The Northrop loom is often, but somewhat incorrectly, called the Draper loom, from the name of the manufacturer.

7. References to Views.—In all of the views given of the Northrop loom, the same reference letters have been used to designate the same or similar parts. This method of lettering will give the reader great aid in becoming familiar with the different parts of the machine, and frequent reference should be made to the general illustrations showing considerable portions of the mechanism, in order to observe the relative positions of the parts in the loom.

FILLING-CHANGING MECHANISMS

SINGLE-FORK FILLING-CHANGING DEVICE

8. The principal feature of the Northrop loom is, of course, its possession of various mechanisms designed to automatically replenish the filling. The simplest arrangement of these devices is known as the single-fork filling-changing mechanism, and this combination commonly is employed for weaving cloth of simple character, such as print cloth, sheetings, etc. In such fabrics it is not always of extreme importance that the pick be matched; that is, it is not essential that there be absolutely no partial repeats of the weave, broken picks, and similar defects. The single-fork filling-changer in its simplest form is adapted, therefore, to the production of these fabrics, and looms thus equipped are employed to a large extent.

The complete arrangement of the working parts of this mechanism is shown in the perspective view in Fig. 2, which
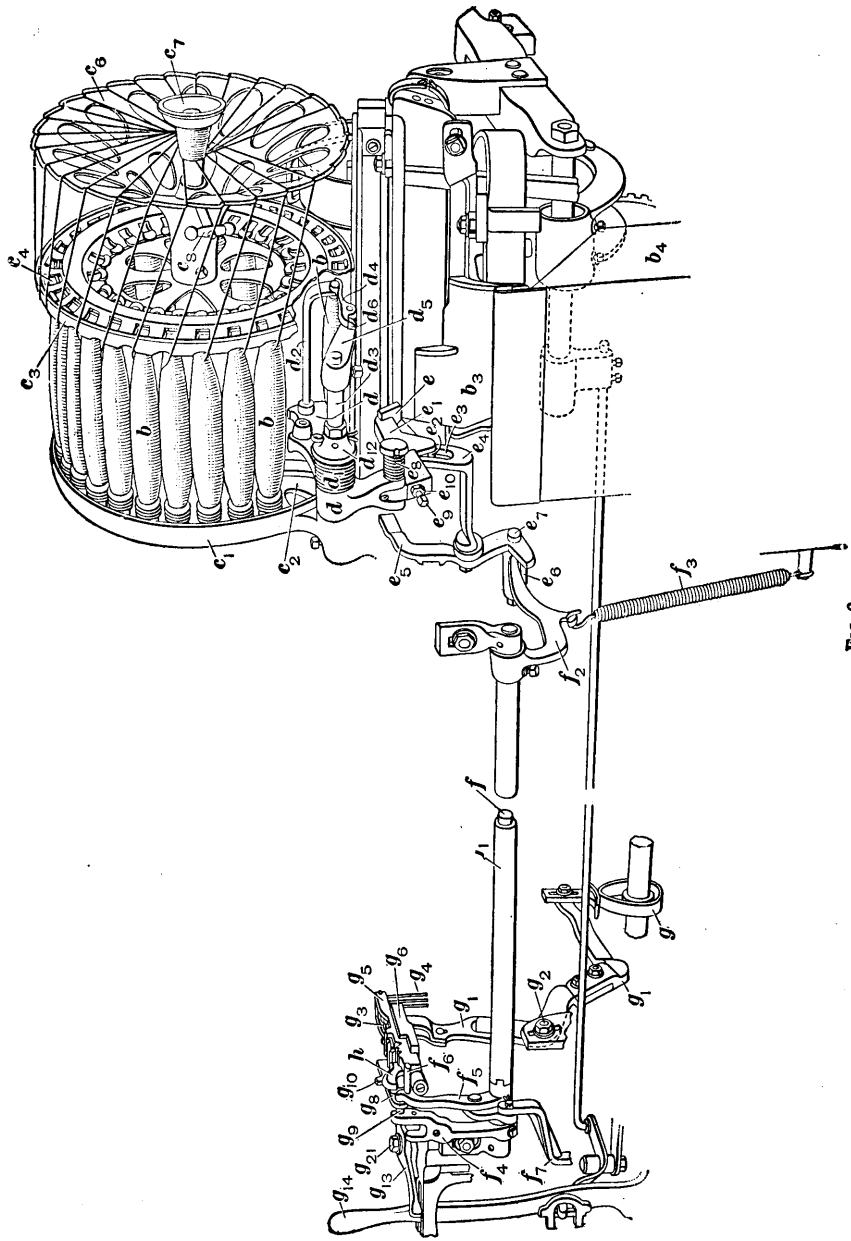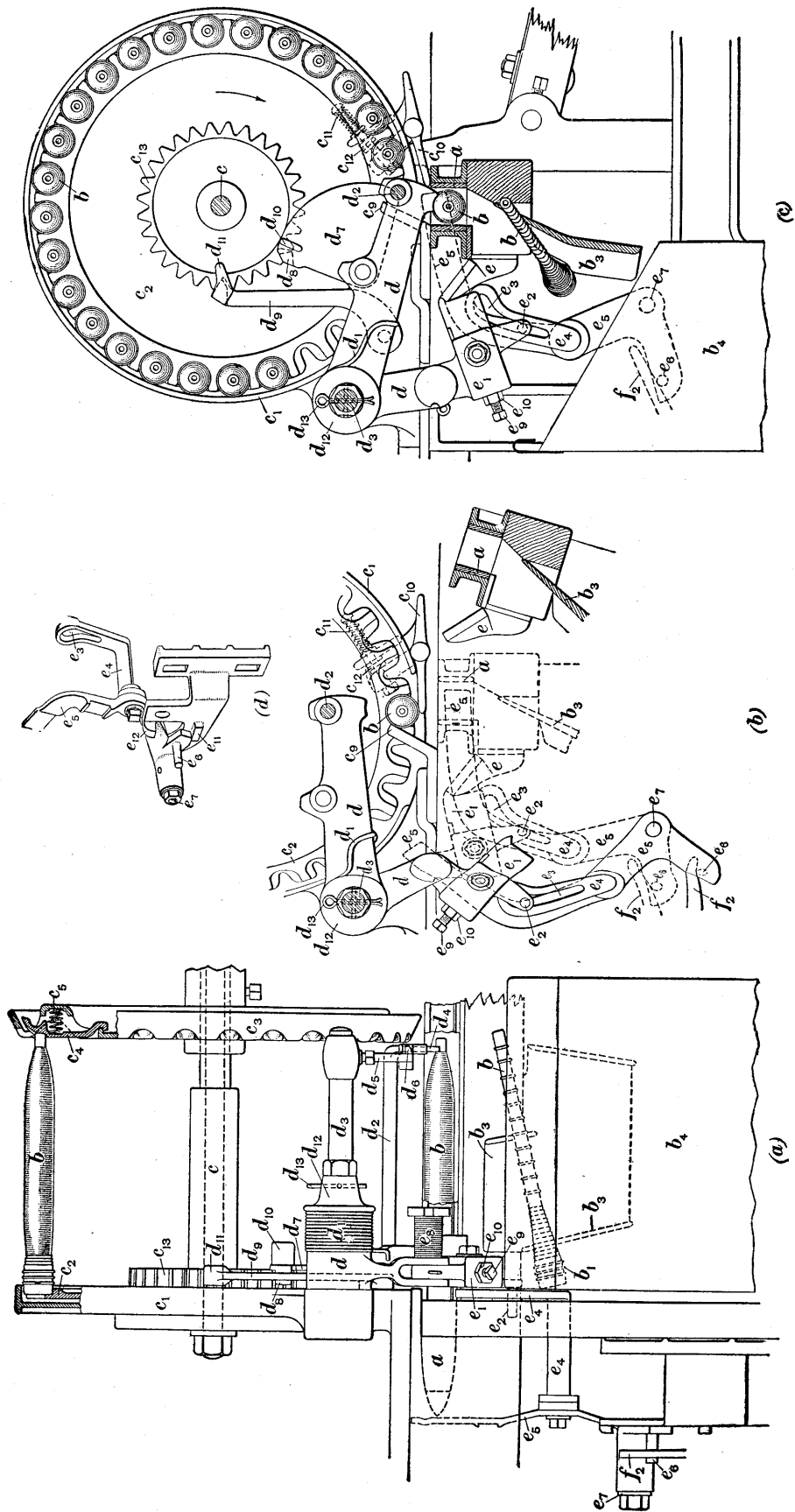
Fig. 2

FIG. 3

(a)   (b)   (c)   (d)

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illustrates the battery, comprising a hopper, in which the supply of filling for replenishing the shuttle is carried, and mechanism for transferring the bobbins; also devices for controlling the transfer of filling when required.

9. Hopper, or Magazine.—In Fig. 3 (a) is shown a front elevation of the battery, including the hopper, or magazine, and the transferring mechanism; in (b) is shown a partial right-side elevation·of these parts; (c) illustrates a full right-side elevation; and (d) gives a detailed view of the shuttle feeler—a part of the transferring mechanism. The bobbins b on which the filling yarn is wound with the usual filling-wind are carried in the revolving hopper, which is capable of being rotated on the axis c. This hopper is always on the right-hand side of the loom and consists of a stationary flanged end plate c_1 that carries the support on which the circular disks c_2 and c_3 rotate. The bobbin heel disk c_2 contains a number of recesses in which the heels of the bobbins b are inserted and in part retained by the flange of the stationary plate c_1. The bobbin tip disk c_3 contains a number of clips c_4 that corresponds with the number of recesses in the disk c_1. These clips are retained in the disk c_3 and the bobbin held firmly in both c_2 and c_3 by a small coil spring c_5.

10. In filling the hopper, the weaver first unwinds a foot or so of filling from the bobbin, places the heel of the bobbin in the recess in the disk c_2, and presses the tip of the bobbin firmly into the clip c_4 in the disk c_3. The end of filling yarn is then passed over a notched disk c_6, Fig. 2, that holds the yarn in proper position to be threaded in the shuttle, as will be explained, and is secured by being wound several times around the stud c_7.

Skilled weavers do not place the bobbins in the hopper singly, but at one operation grasp a handful of bobbins in the left hand and with the right hand free the end from each bobbin, so that as the bobbins are slipped into the hopper, the ends may be wound around the stud c_7 together. Some weavers in this manner can fill the entire hopper in considerably less than two minutes.

In filling hoppers, gaps, or empty spaces, should not be left, as this sometimes causes trouble when the transfer of filling to the shuttle is made. Also, weavers should economize effort and not attempt to place one or two bobbins in the hopper. Instead, they should wait until the hopper is at least one-half empty, and then fill it. The adoption of this method will enable a weaver easily to attend to a large number of looms, as battery replenishment is required by each loom only at comparatively long intervals, depending on the character of the fabric being woven.

From time to time the stud c_7 becomes choked with the accumulation of filling yarn wound upon it. It may be loosened easily by means of the hand wrench c_8 and removed for cleaning.

The number of bobbins contained in the hopper varies in looms of different models; most looms are equipped with what is known as the 25-bobbin hopper, which contains twenty-eight spaces for bobbins.

11. Transferring Mechanism.—It will be noted by referring to Fig. 3 that the hopper is free to revolve until the bobbin that is next to be transferred to the shuttle comes in contact with a stop and guide c_9. This stop is so located that it will check the bobbin to be transferred in the correct position for it to be forced out of the hopper and into the shuttle a. The flange on the lower part of the plate c_1, moreover, is cut out so that the bobbin will have free passage from the hopper to the shuttle, the nose of the bobbin being easily released from the clip c_4 in the bobbin tip plate c_3.

To hold in place the bobbin to be transferred and to help guide it into the shuttle during the transfer, a guide c_{10} is employed. The spring c_{11} causes this guide to press lightly on the bobbin, its normal position being fixed by the washers c_{12}, but as the transfer takes place the guide swings downwards, releasing the bobbin and assisting to guide it into the shuttle.

12. The actual transfer of the bobbin is effected by the transferrer d and transferrer fork d_2, which, by the motion of the lay of the loom, are forced downwards for a short dis-

tance, swinging on the stud d_3, and thus pushing the bobbin out of the hopper and into the shuttle. The tip of the bobbin, it will be noticed in Fig. 2, is supported by a spring-retained finger d_4 carried by an arm d_5 attached to the stud d_3. The stop d_6 retains the finger d_4 in the position shown in Fig. 2 and prevents the coil spring (not shown) that operates it from expending its force. The finger, however, is free to swing downwards and release the tip of the bobbin when the latter is forced down by the transferrer fork d_2.

The head of the transferrer engages with the heel of the bobbin in the hopper and the transferrer fork comes in contact with the tip of the bobbin. The filled bobbin, in being pressed into the top of the shuttle, forces the empty bobbin out through the bottom of the specially designed shuttle, which has no spindle, and it passes through an opening in the bottom of shuttle box, over the guide b_3 and into the sheet-metal receptacle b_4.

13. The operation of the transferrer and attached mechanism is governed by the starting rod f, Fig. 2. Normally, the shuttle-feeler finger f_2, which is setscrewed to the starting rod, is held in its lowest position by the spring f_3. The finger presses down on the stud e_6 (also, see Fig. 3), holding the shuttle feeler e_5, which swings on the stud e_7, away from the lay and, by means of the slot e_3 and stud e_2, causing the latch depresser e_4 to hold the latch finger e_1 in a depressed position, where it will not be in the path of a bunter e attached to the lay. Whenever the filling is missing, however, a partial revolution is given to the starting rod f and the finger f_2 is raised against the tension of the spring f_3. When this takes place, the shuttle-feeler finger releases its pressure on the stud e_6 and the spring e_8 raises the latch finger e_1 into an operative position so that it will be struck by the bunter e on the lay and forced toward the front of the loom for a short distance as the lay moves forwards. The movement of the latch finger imparted by the motion of the lay causes the transferrer d and transferrer fork d_2 to be forced downwards, transferring the bobbin from the hopper to the shuttle.

In Fig. 3 (*b*), the transferrer, latch finger, and other parts are shown in normal position by means of full lines. The dotted lines indicate the positions of these parts after the latch finger is raised to its operative position and just as the bunter on the lay engages with it. Fig. 3 (*a*) and Fig. 3(*c*) indicate the positions of these parts after the bunter has engaged the latch finger and forced it forwards to the full extent of its movement, thus causing the transferrer to assume its lowest position, placing the bobbin in the shuttle as shown. Fig. 2 shows the parts in nearly the positions indicated by the dotted lines in Fig. 3 (*b*).

14. Shuttle Feeler.—If the transfer of a bobbin from the hopper to the shuttle were to take place with the shuttle in such a position as not to receive the bobbin properly, it is very probable that parts of the transferring mechanism or the shuttle, etc. would be broken. This is especially true in those cases in which the shuttle does not receive sufficient momentum from the picking motion to enter properly the box on the battery side of the loom or in which the shuttle is rebounding in the box for any reason, in which cases it will project from the shuttle box. To prevent the transfer of the bobbin under this condition, the shuttle feeler e_5, shown in detail in Fig. 3 (*d*), is employed. As the spring e_8 causes the latch finger e_1 to rise into its operative position, the stud e_2, which is on an extended arm of the latch finger, operates the shuttle feeler e_5 by means of the latch depressor e_4. The stud e_2 engages with the slot e_3 in the latch depressor and the upward movement of the latch finger causes the latch depressor to swing the shuttle feeler on the stud e_7 so that its upper end passes directly in front of the shuttle box until it nearly reaches the back plate of the box.

If the shuttle a is not far enough in the box for the transfer of a bobbin to take place properly, the tip of the shuttle will project from the box and the end of the shuttle feeler will come in contact with it as the lay comes forwards. When this occurs the shuttle feeler will be pushed forwards by the shuttle and, by means of the latch depressor and stud e_2, will

depress the latch finger so that it will not engage with the bunter e on the lay. Instead, the upper rounded corner of the latch finger will engage with the inclined under surface of the bunter and, as the lay moves forwards, the latch finger, shuttle feeler, and other parts will be thrown downwards into the positions that they occupy during the normal operation of the loom, as indicated by the full lines in Fig. 3 (b). Under this condition the transfer of a bobbin from the hopper to the shuttle, of course, cannot take place and the loom will be stopped in the ordinary manner for want of filling. As shown in Fig. 3 (d), the movement of the shuttle feeler in its extreme positions is limited by the stops e_{11} and e_{12} cast on the bracket bolted to the frame for the purpose of supporting this device.

15. Rotation of Hopper.—The manner in which the hopper is rotated on its axis c to bring the next bobbin in contact with the stop c_9 after the preceding bobbin has been inserted in the shuttle may be understood by referring to Fig. 3 (a) and Fig. 3 (c), especially the latter. A ratchet gear c_{13}, cast integral with the bobbin heel plate c_2, is operated by a pawl d_7 having a projection, or tooth, d_8 engaging with the teeth of the ratchet. The pawl is swiveled on a stud in the transferrer d and is large and heavy so that when the transferrer is thrown down by the bunter on the lay engaging the latch finger, the tooth d_8 will become disengaged from the ratchet and the pawl will fall forwards and downwards. This causes the tooth d_8 to take up a tooth on the ratchet and when the bunter releases the latch finger and the coil spring d_1 raises the transferrer and pawl, the ratchet and hopper will be turned in the direction indicated by the arrow in Fig. 3 (c) until the next bobbin in the hopper strikes the stop c_9. A stop pawl d_9 attached to the frame also engages with the ratchet c_{13} and serves to hold the hopper securely in position.

A projection d_{10} on the operating pawl enables the operating and stop pawls to be disengaged easily from the ratchet when it is desired to turn the hopper back by hand, as when inserting fresh bobbins. Projection d_{11} prevents the stop pawl from falling out of contact with the ratchet. The hopper, being

balanced to all practical intent and carrying no operating mechanism, is free to turn on its axis very easily.

16. Lay Guide.—To prevent the lay from having any transverse movement, which, of course, would interfere with the proper transfer of a bobbin from the hopper to the shuttle, a guide for the lay is usually applied to the loom. As illustrated in Fig. 4, this guide consists of a grooved block a_{10} clamped to the lay sword, which engages a similar grooved plate a_{11} secured to the frame of the loom.

This device does not interfere with the free reciprocating movement of the lay as required to beat up the filling but prevents side sway and transverse vibration even after the lay has become worn and shaky.
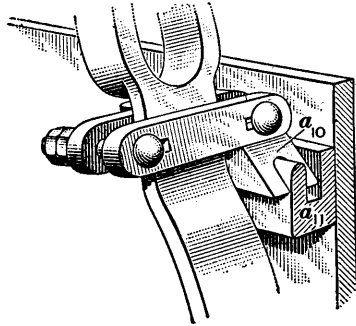
FIG. 4

17. Shuttles.—The shuttle required by the Northrop loom is of the self-threading type and is designed to utilize filling yarn supplied on bobbins or in cop form. Two of these shuttles, having different forms of self-threading eyes, are illustrated in Fig. 5 (a) and (b).

The shuttle a is open on the bottom, and is formed to receive a bobbin or a cop of filling from the top and eject it through the opening in the bottom. It does not contain the usual spindle; instead, a shuttle spring a_1, made in the form of a fork with its tines extending on each side of the shuttle, is placed in the end opposite the eye. The shuttle spring contains notches designed to engage with metal rings b_1 securely placed on the heel of the bobbin b. When the transferrer forces a fresh bobbin from the hopper into the shuttle, the heel of the bobbin is forced between the tines of the shuttle spring, and the notches in the latter, by engaging with the rings placed on the bobbin, securely hold the bobbin in its proper position in the shuttle. At the same time the new bobbin, by striking on top of
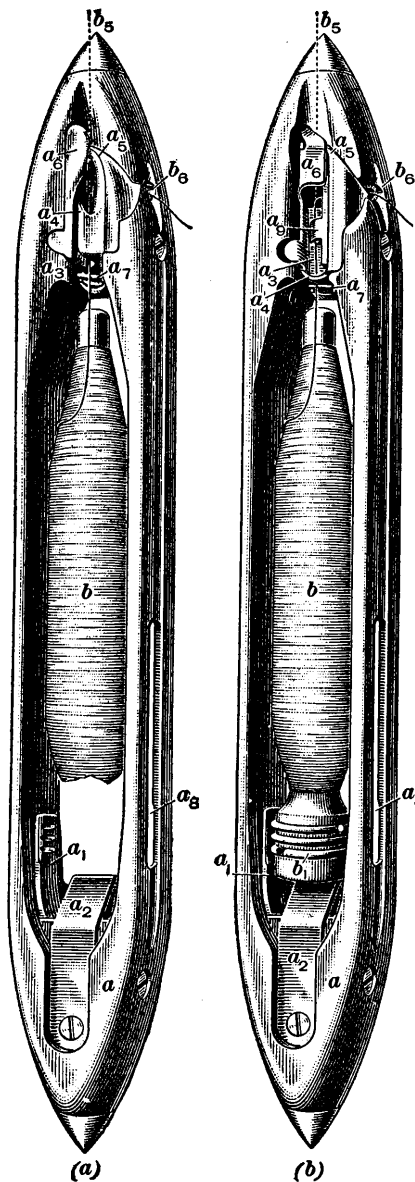
FIG. 5

the bobbin already in the shuttle, forces the latter out of the shuttle spring so that it falls through the openings in the bottom of the shuttle and in the lay, into the empty-bobbin can.

If the shuttle should happen to be a trifle too far in the box when the transfer takes place, the heel of the bobbin will strike the bent and inclined shuttle-spring cover a_2, which, by either forcing the shuttle in one direction or the bobbin in the other, or both, will guide the bobbin into the shuttle so that the rings on the former will be properly gripped by the shuttle spring.

18. The manner in which the self-threading feature of the shuttle operates may be described as follows: When a fresh bobbin is transferred from the hopper to the shuttle, the end of the filling yarn is held by being wound around the stud c_7, Fig. 2, and as it is placed in the proper notch in the plate c_6 when the hopper is filled, the filling thread

will be held in exact line with the shuttle, as shown by the dotted line at b_5, Fig. 5 (a), when the latter is picked across the loom. On the first pick after the transfer and as the shuttle moves away from the battery side of the loom, therefore, the filling will fall into the longitudinal slot a_3, in the shuttle-eye casting and pass beneath the horns, or projections, a_4, a_5, and a_6, which are shaped to allow the thread to have an easy entrance but to prevent it from flying out of the slot a_3. On the next pick as the shuttle is driven back toward the battery side of the loom, the filling will be held by the selvage of the cloth on the left and will be drawn down under the horn a_5 and another projection of the shuttle-eye casting, not shown in the illustration, into the eye b_6 as indicated.

As indicated in Fig. 2, when the hopper is filled, the end of filling is not passed from the smooth depression in the plate c_3 to the corresponding, or opposite, notch in the plate c_6; instead, it is placed one notch backwards with reference to the direction of rotation of the hopper. The reason for this is that when the bobbin is transferred from the hopper to the shuttle, the loom is on the front center and the lay occupies its extreme forward position. Before the loom commences to pick, however, the crank-shaft has passed to the top center and before the shuttle leaves the box, the lay has receded. By having the filling placed back one notch in the plate c_6, therefore, the end of filling held by the stud c_7 is brought in line with the passage of the shuttle as the latter inserts the pick succeeding the transfer of fresh filling. This tends to prevent misthreading and the breaking of the filling on the first pick after the transfer.

The form of the various parts of the eye is such that after the shuttle is threaded the filling cannot be thrown out of the shuttle eye by the subsequent operation of the loom. A hardened pin inserted in the shuttle-eye brass casting for the filling to turn around, at the point where its direction of movement is altered, prevents undue wear. A similar pin or a suitable pot-eye is inserted in the wooden part of the shuttle to form a shuttle eye that will wear well. Pieces of flannel a_7 inserted in a transverse slot in the eye casting impart sufficient friction to

prevent the filling from passing too freely through the shuttle eye.

19. The shuttle-eye device of the shuttle illustrated in Fig. 5 (a) is a one-piece brass or bronze casting, but that of the shuttle shown in Fig. 5 (b) is made in the form of a steel sheet-metal stamping that encloses a small cast-iron piece. The self-threading feature is very similar in either case, and in the shuttle illustrated in Fig. 5 (b) the thread is first drawn straight through the groove, or trough, a_3, as shown by the dotted line at b_5. As this takes place, the yarn slips under the retaining horns, or projections, a_4, a_5, and a_6 of the sheet-metal stamping and also beneath the projection a_9 of a small cast-iron piece. As the shuttle is driven back toward the battery side of the loom, the threading is completed and the end is drawn through the eye b_6 as indicated. A projection (not shown) on the casting carrying the projection a_9 prevents the filling from being thrown out of the shuttle eye when the shuttle is checked in the box during the ordinary operation of the loom. The customary friction flannel is inserted at a_7 to control the running of the filling.

20. Bobbins and Skewers.—A common type of the special bobbin required for the Northrop loom is shown in Fig. 6 (a). The novel feature of this bobbin is the three steel rings b_1 clinched around its base for the purpose of engaging the notches in the shuttle spring, thus holding the bobbin in weaving position in the shuttle. Under variable atmospheric conditions, the wood of which the bobbin is made will swell or shrink, and especially will the bobbin swell if the filling is dampened. To allow for this expansion and contraction, the rings are split, and as they are necessarily somewhat elliptical they are applied to the bobbin with the openings equally spaced around its head. The bobbin, therefore, will always fit perfectly in the shuttle spring.

The bobbin shown in Fig. 6 (a) is of the ordinary "coned" type of filling bobbin but these special Northrop loom bobbins are made in many sizes and types for fine or coarse filling yarn and for special work. To insure the successful operation of

the loom, bobbins should be kept in good condition. Damaged and warped bobbins should be discarded and when necessary the bobbins should be reamed. It is very important, also, that the rings be kept tight, as otherwise the bobbin will not be securely held in the shuttle.

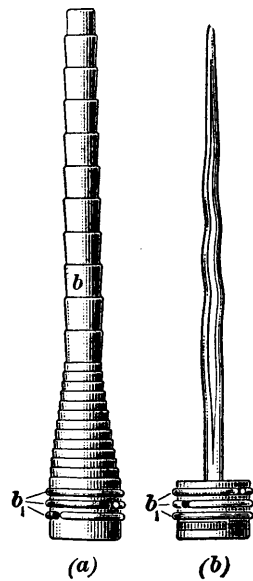When filling yarn is supplied in the form of cops, a skewer as shown at Fig. 6 (b) is employed. This skewer is designed with a head containing grooves in which rings are placed, so that it can be gripped by the shuttle spring and held in position in the shuttle in a manner exactly similar to that employed in the case of a bobbin. The weaver is supplied with a number of these skewers and after the cops are thrust upon them, the hopper is filled with skewers exactly as when the filling yarn is wound on the bobbins. Some skewers have a perfectly uniform exterior, but skewers having the wavy contour shown in Fig. 6 (b) give better satisfaction and tend to reduce the amount of cop waste in weaving.

(a)   (b)

Fig. 6

21. Temple Thread Cutter. When the hopper is filled, the end of filling yarn from each bobbin or cop is secured by being wound around the stud on the outside of the hopper. Consequently, whenever fresh filling is transferred to the shuttle there will be a length of filling yarn extending from the hopper stud to the selvage of the cloth. This end, of course, would ultimately be broken and do no practical harm, but loose ends depending from the selvage detract from the appearance of the cloth if allowed to remain. The temple on the right-hand, or battery, side of the loom, therefore, is supplied with a device known as a temple thread cutter, the object of which is to sever the ends of filling referred to, close to the selvage. The right-hand selvage, in consequence, will have a neat appearance.

As illustrated in Fig. 7, this cutter consists of a movable knife i, which, when forced downwards and forwards, cuts the end of filling, extending from the selvage to the hopper stud, by engaging with a knife i_1 held in a fixed position in the temple. The cutter is thrown down and pushed forwards with the lay by means of a projection i_2, which is operated by being struck by a piece of leather fastened to the lay. When the lay reverses its motion, the knife i is returned again by means of the spring i_3. The piece of leather attached to the lay also engages the heel i_4 of the temple so that the cutting device is not made to bear the strain of moving the temple at each pick of the loom. The thread to be severed is supported in the correct position to be engaged by the movable knife by a notch i_5 in the temple.

The temple thread cutter, while it operates close to the selvage, is designed to sever only the end of the filling extending from the selvage to the hopper stud. It will not always trim the edge of the cloth when loose threads of filling yarn are left, because of the filling breaking or running out just as the shuttle enters the box on the battery side of the loom. The thread-cutting device is incorporated into many different styles of temples suitable for various classes of work.
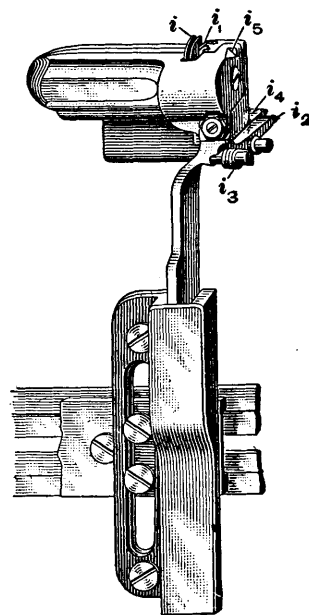

FIG. 7

22. Filling Motion.—The filling motion of the Northrop loom, which is of peculiar and original construction, serves a dual purpose. On account of the objects to be accomplished by an automatic loom, it is necessary that the transferring mechanism be placed in operation and a fresh supply of filling inserted in the shuttle whenever the filling breaks or runs out.

If, however, the transfer fails to take place for any reason, it is evident that the filling motion must be made to operate after the manner of an ordinary filling stop-motion and stop the loom. In the first case, the filling motion must be arranged to impart motion to the starting rod and shuttle-feeler finger which control the operation of the transferring mechanism, and in the second case, it must be devised in such a manner as to throw the shipper handle of the loom from its retaining notch in the event of a failure to transfer.

By referring to Fig. 2, it will be seen that a filling cam g of the usual type is attached to the cam, or bottom, shaft of the loom and imparts an oscillating movement to a filling-cam follower g_1 centered on a stud g_2 attached to the frame of the loom. Instead of engaging directly with the filling fork g_4, as is usual, the filling-cam follower in this case carries at its upper end a hook g_3 for this purpose. This is more clearly indicated in Fig. 8, which, in several views, shows the assembled and detailed parts of the filling motion. Fig. 8 (a) is a perspective view of the device, (b) is a plan view, and (c), (d), and (e) are sectional views.

The fork g_4 operates in conjunction with the usual grate, or grid, attached to the lay and is swiveled on a filling-fork slide g_5, which is carried by and slides in a guide, or bed, plate g_6 secured to the breast beam of the loom. A spring g_7, attached at one end by a screw to the fork slide, is fastened at the other end to a pin placed in the guide plate. This spring moves the fork slide into its normal position after it has been operated upon by the filling-cam-follower hook g_3.

A dog g_8, commonly called the straddle-bug and shown in detail in Fig. 8 (f), is carried by a stud g_{12} attached to the fork slide g_5, the stud engaging with a slot in the dog and the rear end of the latter being supported by the boss g_{11}. A stud g_9 at the front end of the dog engages the upper end of an arm f_4, which is secured to the starting rod f, Fig. 2.

A device known as a filling-motion trip h, shown in detail in Fig. 8 (g), is loosely supported in the filling-fork slide g_5, being retained in position by the projection h_4 rising behind a bridge g_{15} of the fork slide. The trip is steadied in its action

(a)

(b)

(c)

(d)

(e)

(f)

(g)
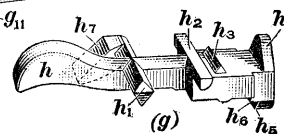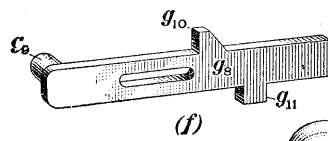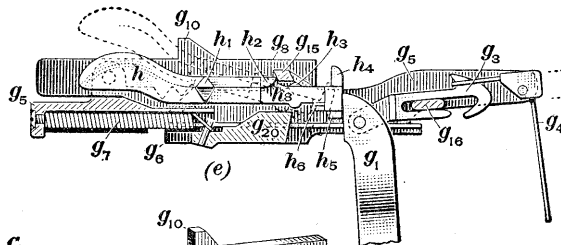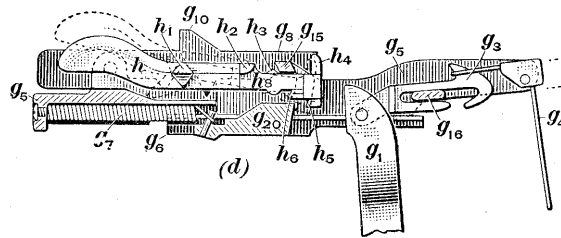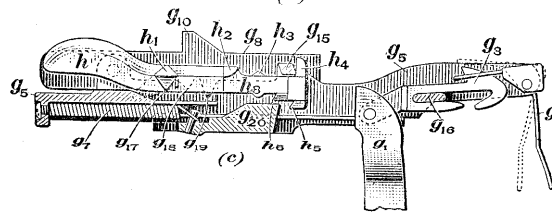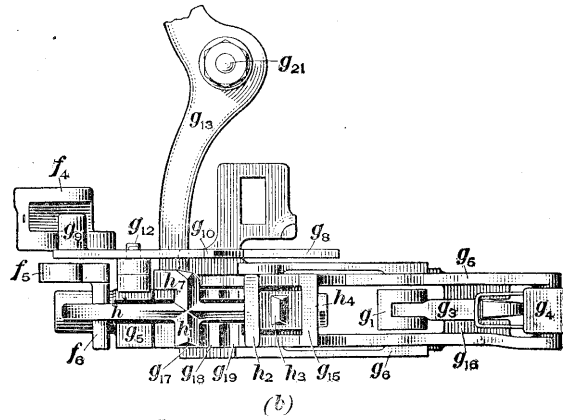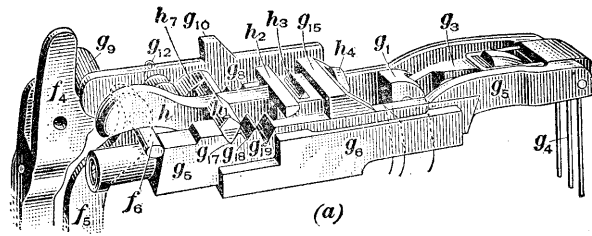
by a rocking bar h_2 and, as its principal features, carries a dog h_7 designed to engage the lever g_{13}; an angular bar h_1 that, under certain conditions, engages the slots g_{17}, g_{18}, and g_{19} in the fork slide; and two notches h_5 and h_6 arranged to engage an angular boss g_{20}, which is part of the guide plate g_6.

23. The action of the filling-motion mechanism in controlling the transferring device and the stopping of the loom may be described as follows: The rotation of the filling cam on the cam-shaft of the loom causes the cam-follower g_1 to move the follower hook g_3 toward the front of the loom on every alternate pick, that is, every time that the shuttle comes to rest in the box on the left-hand side of the loom. The hook is supported by and slides on a bridge g_{16} in the fork slide and is designed to engage with the filling fork g_4. Whenever a pick of filling is left in the shed, as in the normal operation of the loom, the filling fork will not enter the grate on the lay and will be tilted as shown by the dotted lines in Fig. 8 (c) so that it will escape being caught by the hook g_3 as the latter is moved toward the front of the loom. Assuming, however, that the filling becomes broken or exhausted, then, as the shuttle enters the box on the left of the loom, it will leave behind it no pick of filling and the filling fork g_4 will not be tilted to escape the follower hook g_3. Under this condition, as the hook moves toward the front of the loom, it will engage the filling fork and draw it and the fork slide g_5 forwards against the tension of the spring g_7. As this takes place, the stud g_9 on the dog g_8, which is attached to the fork slide, will operate the arm f_4, causing the starting rod f, Fig. 2, to make a partial revolution, raising the shuttle-feeler finger f_2 and allowing the transferring mechanism on the next pick and with the shuttle on the battery side of the loom to operate, as has been previously described.

By referring again to the several views shown in Fig. 8, it will be noted that as the filling-fork slide g_5 is forced forwards by the follower hook g_3, the notch h_5 in the filling-motion trip will engage with the boss g_{20} of the guide plate g_6. The fork slide in being moved forwards, therefore, will cause the angu-

lar bar h_1 of the filling-motion trip to rise out of the notch g_{17} in the fork slide, in which it normally is at rest, as shown in Fig. 8 (c), and fall into the slot g_{18}. This will alter the relative positions of the filling-motion trip and fork slide, causing them to assume the positions shown in Fig. 8 (d).

24. As the motion of the filling-cam follower g_1 moves the hook g_8 in the opposite direction, the fork slide is brought back to its normal position by the spring g_7. Suppose that the transfer to the shuttle of a fresh supply of filling was successfully accomplished, when the transferring mechanism was thrown into operation. Under this condition, the shuttle will leave a pick of filling in the shed when it again enters the box on the left of the loom and the filling fork will be tilted so that the follower hook will not engage with it and the transferring mechanism will not again be put into operation. Moreover, in moving forwards the head of the filling-cam follower g_1 will strike the end of the filling-motion trip and replace it in its normal position, with the bar h engaging the notch g_{17}, as shown in Fig. 8 (c). On the other hand, assume that for some reason the transfer of fresh filling to the shuttle was not properly accomplished and the shuttle is again driven into the box on the left-hand side of the loom without leaving behind it a pick of filling. In this case, the filling fork will again fail to be disturbed and will be engaged by the follower hook g_3, the filling-fork slide being forced forwards for the second time and again operating the arm f_4 so as to turn the starting rod and again throw the transferring device into operation.

25. As the filling-fork slide is moved forwards the second time, the notch h_6 of the filling-motion trip will engage with the fixed boss g_{20} and the fork slide in moving forwards will cause the angular bar h_1 of the trip to rise out of the notch g_{18} of the fork slide and fall into the notch g_{19}, making these parts assume the positions shown in Fig. 8 (c). It will be noticed that the notch g_{19}, in addition to being farther back than the notches g_{17} and g_{18}, is much deeper. Thus, when the bar h_1 of the filling-motion trip is engaged with this notch, the

dog h_7 of the filling-motion trip is placed in a position directly back of the end of the lever g_{13}.

If the second attempt to transfer fresh filling to the shuttle fails and the shuttle again enters the left-hand box without leaving a pick filling in the shed, the filling fork will again engage the cam-follower hook and the fork slide will be brought forwards for the third time. In this case, however, the filling-motion trip has already assumed its extreme position relative to the filling-fork slide, as shown in Fig. 8 (e), and therefore it will, in this case, be moved forwards with the slide. Since the dog h_7 of the trip is now engaged with the end of the lever g_{13}, the latter will be moved about its center g_{21} a sufficient amount to cause the other end of the lever to force the shipper handle from its retaining notch and stop the loom. It will be noted, however, that if the second attempt to transfer fresh filling to the shuttle is successful, the pick of filling left by the shuttle as it enters the box will cause the filling fork to miss the filling-cam-follower hook and the fork slide will not be moved forwards. The head of the cam-follower g_1, however, will replace the filling-motion trip in the position shown in Fig. 8 (c), as previously described. It will be noted from the foregoing description that, in the event of the filling breaking or running out, this device will cause the loom to make two distinct attempts to replenish the filling and, in the event of consecutive failure, will stop the loom.

The bosses h_3 and h_8 come in contact with the bridge g_{15} of the filling-fork slide and the boss g_{20} of the guide plate, respectively, thus guiding and checking the filling-motion trip in performing the movements described.

26. Whenever the filling breaks, even if fresh filling is supplied by the transferring mechanism and the loom continues in motion, there will be at least one shed, and possibly more than one shed, in which no filling yarn will be placed. To prevent the formation of a crack or thin place in the cloth, therefore, a mechanism is supplied to let back the take-up gears a slight amount, whenever the transferring mechanism is operated or the loom stopped by the filling motion. This

device is operated by an arm f_5 carried loosely on the starting rod. A stud f_6 on this arm rests against the end of the filling-fork slide so that every time the latter is moved forwards a rod f_7, Fig. 2, connected to the arm f_5 will be lowered. This movement of the rod f_7 temporarily disconnects a toothed clutch in the train of take-up gears and lets the take-up roll move back a slight distance to slacken the cloth and warp so that no crack will appear in the fabric.

FEELER FILLING-CHANGING DEVICE

27. When the transfer of filling is controlled by a filling fork and the customary grate, or grid, it is evident that the transferring mechanism will not be placed in operation until the fork has detected the absence of filling, due either to breakage or exhaustion. Since the transfer of fresh filling cannot take place instantaneously, but at least one shed must be left empty and very likely only a portion of a pick inserted in another shed, a mispick will be made in the cloth. Moreover, whenever the very last end of the filling yarn is woven from the bobbin, a bunch is liable to be formed in the cloth on account of the last few turns of yarn on the bobbin slipping off at once and being woven into the cloth in a lump.

Since the transferring mechanism is operated much more frequently because of the exhaustion of the filling than on account of the filling becoming broken, it is evident that a large number of mispicks and other defects in the cloth—in fact, the bulk of them—will be prevented if the transferring mechanism is set in operation just before the filling in the shuttle becomes exhausted. This, therefore, is the object of the feeler filling-changing mechanism, sometimes called the mispick preventer, and its use renders entirely practicable the weaving of perfect cloth on an automatic loom.

This mechanism is not necessary for, nor is it ordinarily applied to, looms used for weaving plain fabrics, such as print cloths, sheeting, etc., because in such fabrics the few mispicks made by an automatic loom are not seriously objectionable. Also, it often is not used when three-harness work, such as

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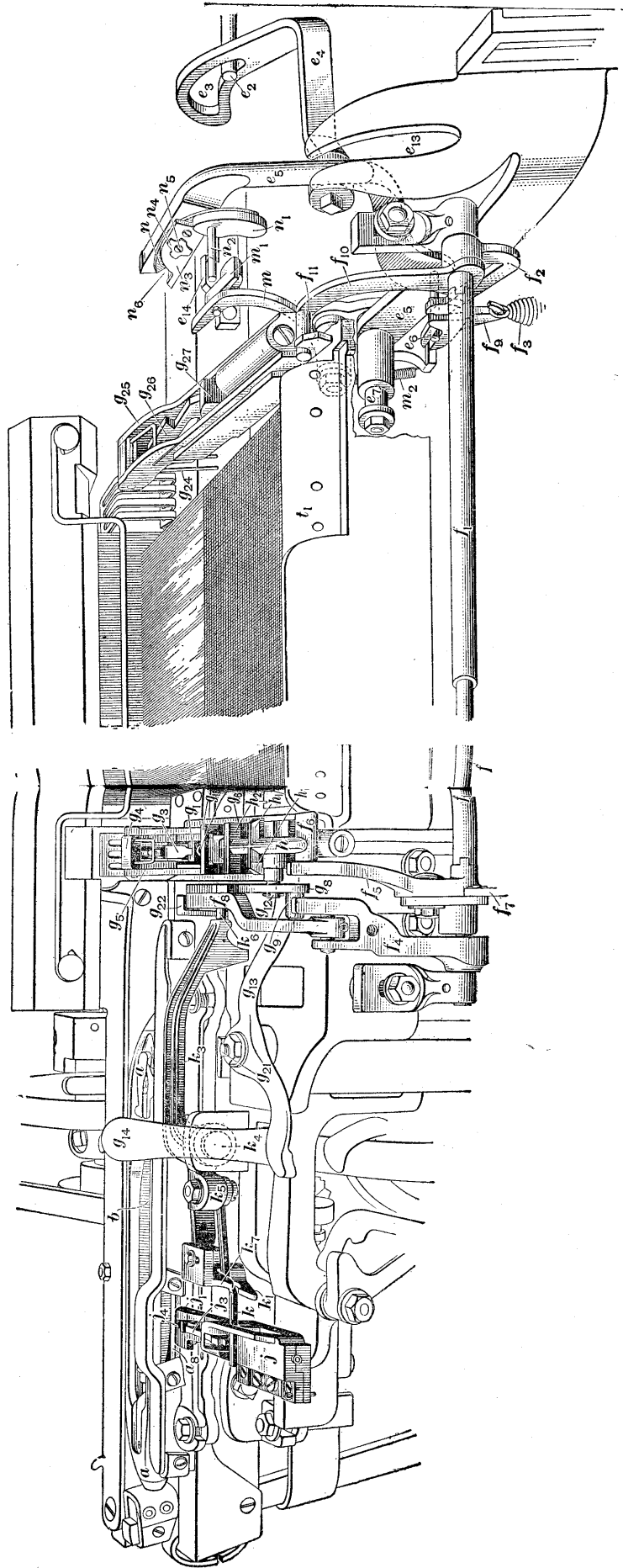
drills and similar three-harness fabrics, is being produced. The reason for this is the peculiar action of the automatic loom, the interval between the detection of the absence of filling, and the operation of the transferring mechanism being such that, in a great majority of cases, the loom will replenish the filling just in time to insert it in the proper shed of three-harness weaves, so that no mispick results.

When fabrics involving the use of more harnesses, including fancy fabrics in which the weaves are produced by dobby or jacquard shedding mechanisms, are woven, however, mispicks are of serious consequence and the loom should be equipped with the feeler filling-changing mechanism. This device also is of great worth in the production of napped goods, in which mispicks are very apparent and constitute a serious defect. A general perspective view of this mechanism, together with its connection with the transferring mechanism, is given in Fig. 9.

28. Filling-Feeler Mechanism.—The control of the feeler filling-changing mechanism is invested in the filling-feeler device, the object of which is to detect the point of approaching exhaustion of the filling in the shuttle and cause the transferring mechanism to operate and supply fresh filling just before the filling runs out. A perspective view of the device is shown separately in Fig. 10 (a), and two sectional views of the feeler, shuttle, and bobbin are shown in (b) and (c).

A bracket j, formed in two pieces, is attached to the framework of the loom and supports the filling feeler j_1 which slides freely in the bracket j but is kept pressed back by a light coil spring j_2. A filling-feeler trip j_3 is swiveled to the feeler j_1 and carries a screw j_4 immovably secured by a locknut j_5. The trip is held in a raised position, higher than the lever k, by a spring-actuated plunger j_6 inserted in the casting j, as shown in Fig. 10 (b). The filling feeler projects through an opening in the front box plate of the box on the left-hand side of the loom, and also through a long slot a_8, Fig. 5, cut in the side of the shuttle a. Each time that the lay comes forwards with the shuttle at rest in the left-hand box, the filling feeler j_1 will
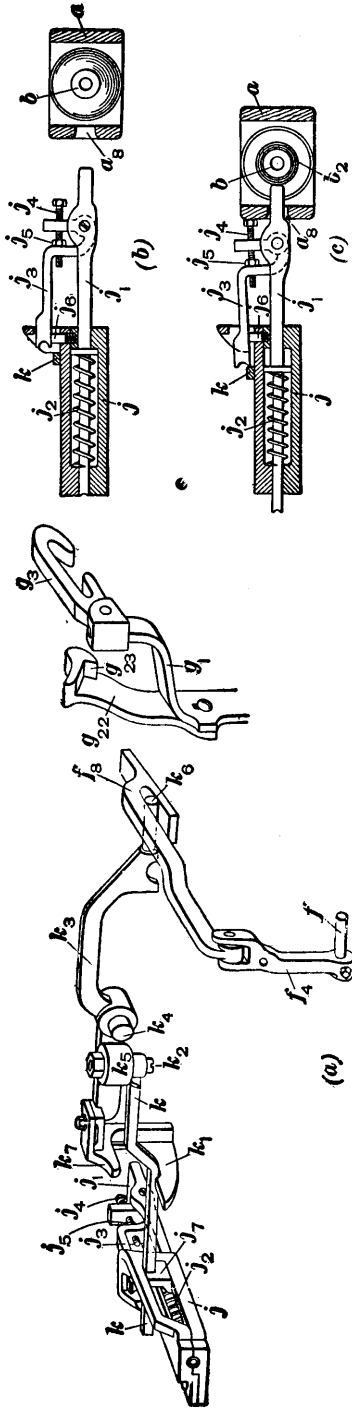
Fig. 10

come in contact with the yarn wound on the bobbin b and be pushed forwards, compressing the spring j_2. At the same time, the filling-feeler trip j_3 passes above the lever k without engaging it. As the lay recedes, spring j_2 will return the filling feeler j_1 to its normal position and this action continues as long as the bobbin contains an adequate supply of filling yarn.

As the yarn on the bobbin is woven off, however, the diameter decreases so that the filling feeler will project farther and farther into the shuttle, and the head of the screw j_4 will approach the side of the shuttle. When the filling becomes nearly exhausted and only a layer, or so, of yarn remains on the bobbin, the feeler j_1 will project so far into the shuttle that the head of the screw j_4, carried by the trip j_3, will come in contact with the side of the shuttle. This will cause the front end of the trip to be lowered and, as the filling feeler and trip are forced forwards, the latter will engage and operate the lever k, as indicated in Fig. 10 (c). The lever k swings on the center k_2, Fig. 10 (a), and is held in its normal backward position by a coil spring contained in the case k_5. Its opposite end is engaged in a small sliding piece j_7 that assists in returning the lever k to its normal position and that aids in its support.

A lever k_3, fulcrumed on a stud k_4, carries a cam k_1 at one end and a pin k_6 at the other, the latter supporting a casting f_8, which, when the filling-feeler device is employed, is connected to the arm f_4 on the starting rod f. A filling-cam-follower trip g_{22}, secured to the filling-cam follower g_1, is formed with a notch g_{23}, and by virtue of the filling-motion cam on the bottom, or cam, shaft of the loom, is brought forwards each time that the shuttle is checked on the left-hand side of the loom. The casting f_8, known as a feeler slide, ordinarily is held in such a position that its end does not engage the notch g_{23}. When, however, the near exhaustion of the filling causes the feeler trip j_3 to engage and force forwards the lever k, the latter, operating on the cam k_1, will lower the left end of the lever k_3 and raise its right end. The pin k_6 will thus raise the feeler slide f_8 into such a position that its end will engage the notch g_{23} as the filling-motion cam brings the cam

follower g_1 and the filling-cam-follower trip g_{22} forwards. As this takes place, the feeler slide also will be forced forwards, operating the arm f_4 and turning the starting rod f. The latter will operate the transferring mechanism in the manner previously described, so that a fresh supply of filling will be inserted in the shuttle, just previous to the total exhaustion of the existing supply. The projection k_7 contains a locking notch, or surface, that holds the lever k_3 in its normal position during the ordinary operation of the loom.

29. Special Bobbin Winding.—It is evident that when the filling-feeler device is employed, the ordinary coned-base
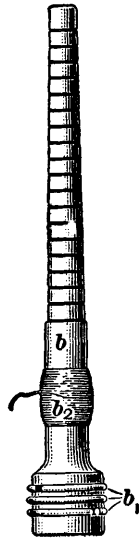
Fig. 11

filling bobbin, shown in Fig. 6 (a), cannot be employed, because it would interfere with the action of the feeler, preventing the latter from projecting into the shuttle far enough to insure the action of the feeler trip. Moreover, when the filling feeler is used, the best results are obtained and the amount of filling left on the bobbin as waste, when the latter is ejected from the shuttle, is reduced to a minimum if a special form of filling winding is utilized. As illustrated in Fig. 11, this special winding consists of first forming on the bobbin a small bunch b_2, over which the filling yarn is afterwards wound with the ordinary filling wind.

These bunches are formed by a special attachment furnished for the spinning frame which first starts the winding with a short traverse that is gradually increased until the regular traverse is attained, after which the winding proceeds in the ordinary manner. This attachment is automatic in its action, and a large bunch is produced in such a manner that the yarn will not be broken in weaving off the bunch. Attention should be paid to this bunch-building feature, as bunches that are too small, although they reduce the amount of waste, sometimes cause the feeler mechanism to fail to operate before the filling is exhausted, causing a defect in certain fabrics.

30. Dual Function of Straddle Bug.—The straddle bug g_8, Fig. 8, is so designed as to be placed on its stud g_{12} in two positions, that is, with the stud g_9 at the left, engaging with the arm f_4 on the starting rod, or with the stud at the right, in which position it will not engage with the arm f_4. When the straddle bug is placed in the former position, as illustrated in Fig. 8, the transferring mechanism will be set in operation by the filling motion when the filling breaks or becomes exhausted, since the stud g_9 will operate the arm f_4 and turn the starting rod, as has been explained.

When the filling-feeler device is applied to the loom the filling, of course, will not become exhausted, as the loom is caused to transfer just before the bobbin in the shuttle becomes empty. As on many fabrics the possible mispicks from a comparatively few breakages of the filling are not of vital importance, the straddle bug is often placed in the position shown in Fig. 8 on many looms equipped with the filling-feeler attachment. That is, the latter device prevents the majority of defects, and a few mispicks, caused by the breaking of the filling, are tolerated in order to preserve fully the automatic features of the loom.

When, however, fabrics are woven in which it is absolutely necessary that the pick be matched, as in fancy weave effects, fine napped goods, etc., the straddle bug is removed from stud g_{12} and replaced with the stud g_9 at the right. In this position the stud g_9 will not engage the arm f_4, and the projection g_{10} will rest directly behind the lever g_{13} which throws the shipper handle from its retaining notch and stops the loom. Thus, whenever the filling breaks, the loom will not transfer, as stud g_9 will not operate arm f_4 and the starting rod, but instead the loom will be stopped as in the case of common looms, the movement of the filling-fork slide causing the projection g_{10} of the straddle bug to operate lever g_{13} and release the shipper handle. The weaver now matches the pick and again starts the loom in the ordinary manner.

This device enables absolutely perfect cloth to be woven and yet the automatic feature of the loom is largely retained, because the filling-feeler device replenishes the filling just

prior to exhaustion and this operation, of course, is required a great deal more frequently than filling replenishment because of filling breakage.

31. Pick Finder.—When matching, or finding, the pick the weaver removes the shuttle and turns over the loom by hand to find the correct shed. To prevent the protector mechanism of the loom from interfering with this operation, an attachment known as the pick finder, is applied to looms equipped with the filling-feeler device.

As indicated in Fig. 12, this consists of a slide l operated by a projection l_1 and retained in position by a spring l_2. A notch at the end of the slide is designed to engage with the
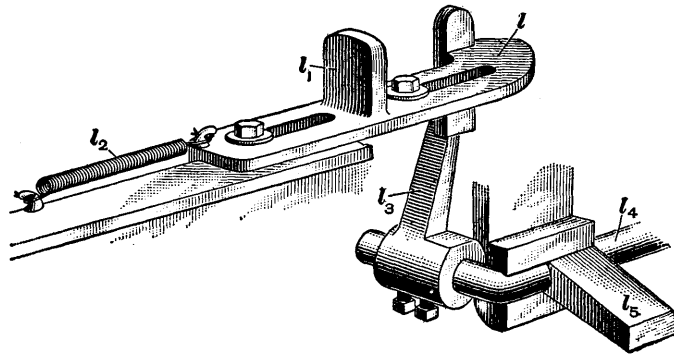
FIG. 12

finger l_3 attached to the protector rod l_4 and, when so engaged, the finger l_3 is held back so that the dagger l_5 on the protector rod will be raised and fail to engage with its knock-off frog. When pushed to the right, the slide l, by virtue of its wedge-shaped end, forces the finger l_3 back so that it will engage the notch in the slide and, when the shuttle is inserted in the box, the slide will be released and the spring l_2 will return it to its normal position. Pushing back the finger l_3 will release the slide at any time.

32. Shuttle-Feeler Thread Cutter.—An attachment known as a shuttle-feeler thread cutter, often referred to simply as the feeler thread cutter, is necessary on all looms

equipped with the filling-feeler device for operating the transferring mechanism. Whenever the latter mechanism is placed in operation by the filling-feeler motion, and not by the breaking of the filling as detected by the filling motion, a thread of filling extends from the selvage of the cloth through the shuttle eye to the bobbin contained in the shuttle. When the fresh bobbin of filling is inserted in the shuttle, not only must the old bobbin be removed but the shuttle eye must be cleared to allow the yarn from the new bobbin to be properly threaded in the eye. To accomplish this the thread extending from the selvage of the cloth must be cut as closely as possible to the shuttle so that the old bobbin, in being ejected, will draw the short length of yarn, left extending from the shuttle, through the shuttle eye, leaving the latter entirely clear and free.

The temple thread cutter alone cannot accomplish this result, as it cuts the thread at too great a distance from the shuttle eye and it does not positively operate at the correct time. The object is attained by means of a thread cutter, mounted on the shuttle feeler, which not only severs the filling yarn close to the shuttle at the time of the transfer of filling, but also clamps and holds the end extending to the cloth so that the temple thread cutter will again cut the yarn close to the selvage in the ordinary manner.

FIG. 13

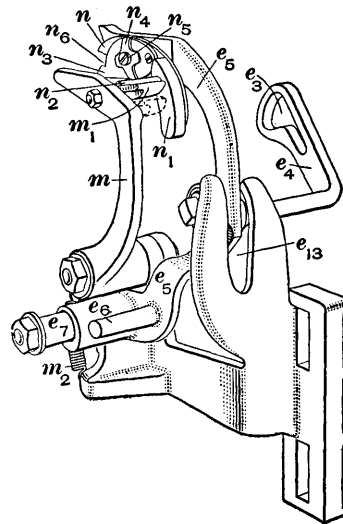**33.** The feeler thread cutter is shown at the right in Fig. 9 and in detail in the perspective view given in Fig. 13. It consists essentially of a movable cutting knife n mounted on the shuttle feeler e_5 and having securely attached a heel piece n_1

that supports a pin n_2. One edge of the movable knife oper-
ates in connection with a stationary knife which is really a
part of the shuttle feeler, while the other edge works in con-
junction with a clamping piece n_3, the latter being kept pressed
firmly against the side of the knife by a spring n_4. These parts
are retained in position by the adjusting bolt n_5 on which the
movable knife is centered.

When the transferring mechanism is set in operation, the
shuttle feeler e_5 is thrown up in front of the shuttle box in the
usual manner and, if the transfer has been occasioned by
the filling-feeler device, the thread of filling extending from the
selvage of the cloth to the shuttle enters the opening n_6. As
the lay moves forwards, however, the bunter e_{14} attached to
the lay, strikes the heel n_1 of the movable knife and thus
the knife is closed. As the filling is then in the opening n_6, it
will be neatly severed, the portion attached to the shuttle being
entirely freed and the portion attached to the selvage of the
cloth being securely held by being pinched between the
movable knife and the clamping piece n_3.

As the transfer takes place and the exhausted bobbin is
forced from the shuttle, it will, in falling into the can or recep-
tacle provided, draw the end of the filling out of the shuttle
eye and clear of the shuttle. Sometimes short cans placed on
the side of the loom are provided for the reception of empty
bobbins when ejected from the shuttle, but when looms are
equipped with the filling-feeler device and the shuttle-feeler
thread cutter a long can extending to the floor, as shown at b_4,
Fig. 1, should be used. This allows the ejected bobbin to fall
a sufficient distance to draw the end of filling entirely clear of
the shuttle eye and for this reason, also, these cans should not
be allowed to become filled with empty bobbins, which, of
course, would cause the object of the deep can to be defeated.

34. As the shuttle feeler e_5, Figs. 9 and 13, is returned to
its normal position, coincident with the transfer of fresh fill-
ing, it carries with it the end of the length of filling attached
to the selvage of the cloth, which is held by being clamped in
the feeler thread cutter as explained. This thread must be

held tight until cut by the temple thread cutter, but in order not to break the yarn, or cause it to become disengaged from the feeler thread cutter, a cam-shaped slot e_{13} is provided in the bracket supporting the various parts of this mechanism, for the purpose of moving the shuttle feeler e_5 to the left as it returns into its normal position. This is made possible by supporting the shuttle feeler on a long stud e_7, which allows a certain amount of transverse movement. The result of this lateral motion, when combined with the movement of the shuttle feeler in returning to its normal position, is to cause the feeler thread cutter to move in the arc of a circle having the point of attachment of the thread to the selvage as a center. The length of filling yarn is thus held tight, so that it can be cut by the temple thread cutter, but it is not strained and broken.

An arm m, which is allowed a certain amount of freedom of motion and is held in a normal position by a spring m_2, supports a cam-shaped piece m_1, known as the thread-cutter trip. The latter is designed to engage with the pin n_2 attached to the heel n_1 of the movable knife n. The trip m_1 is allowed to move within certain limits as indicated by the dotted lines in Fig. 13 but is normally held in the raised position shown by the full lines in Fig. 13 by a small coil spring contained in a recess of the trip, not shown in the illustration. As the shuttle feeler e_5 is thrown up in front of the shuttle box, the pin n_2 attached to the heel of the movable knife engages with the under side of the cam m_1. This action causes the movable knife to be raised, forming the opening n_6 for the reception of the filling thread. As the shuttle feeler returns to its normal position, the pin n_2 strikes the upper surface of the cam m_1 and in passing over it forces it down into the position shown by the dotted lines.

If the shuttle is trapped in the shed, or "weaves in," in such a position as to interfere with the feeler thread-cutting mechanism, the end of the arm m will come in contact with the shuttle and the arm will be pushed forwards against the tension of the spring m_2, thus preventing any possible damage to the shuttle or other parts.

35. If the shuttle is projecting from the box when the transferring mechanism is placed in operation, the end of the shuttle feeler will engage the shuttle and the latch will be depressed so as to prevent the transfer of fresh filling in the manner explained. If the transferring mechanism has been placed in operation by the filling-feeler device, it is very important that the filling shall not be cut, as this would cause a defect in the cloth, the running filling being severed and the transfer of fresh filling being prevented. However, the filling will not be cut in this case even if the shuttle feeler in moving slightly to the left should slip from the point of the shuttle. The reason for this is that the latch is not permitted to engage the bunter but is made to strike on the inclined part of the bunter below its edge. The forward movement of the lay will throw the latch down into its normal position and this movement, acting through the stud e_2, Fig. 9, and latch depressor e_4, will cause the shuttle feeler e_5 to remove the heel n_1 of the movable knife n from the influence of the bunter e_{14} before the knife can be closed.

36. When the feeler thread cutter is employed, the shuttle-feeler finger f_2 attached to starting rod is arranged in a manner somewhat different from that previously explained. In this case the finger, while still arranged to rest on the stud e_6 carried by the shuttle feeler, also supports a casting f_9 to which the spring f_3 is attached. An extended portion, or projection, of the casting f_9 is held by the spring in contact with the stud e_6. The result of this arrangement is that the operation of the shuttle feeler and latch is made more positive and the spring e_8, Fig. 2, can be dispensed with, because the upward movement of the shuttle-feeler finger throws these parts into their operative positions by virtue of its own motion. It will be noticed, however, that the stud e_6, Fig. 9, is not rigidly held in position and no breakage will result if the shuttle feeler in being raised comes in contact with a shuttle projecting from the box, etc.

37. Yielding Trip for Shuttle-Feeler Thread Cutter.—In Fig. 14 there is shown at m_3 an improved form

of trip for opening the shuttle-feeler thread cutter. This is known as the *yielding trip*, which operates in a manner somewhat similar to the trip previously described. As the shuttle feeler is thrown into its operative position, the pin n_2 comes in contact with the bottom, or cam, surface of the trip and is thus forced down to open the thread cutter, the pin passing beneath the lower corner of the trip. As the shuttle feeler returns to its normal position, the pin n_2 strikes the trip and easily forces it out of the way, the trip being held in its normal position by a small encased coil spring, not shown in the illustration.

The principal advantage of the yielding trip is that it allows much more freedom in setting the shuttle feeler than the older form of trip and results in a more accurate functioning of the various parts of this device. With this trip the combined adjustments for shuttle protection and thread cutting are more easily obtained and, as less compromising in setting is required, the failure of either operation is less liable to occur. When the yielding trip is used, the arm m that supports the trip does not interfere if a shuttle is trapped in the shed, and, is securely fastened in a fixed position by a capscrew m_4.
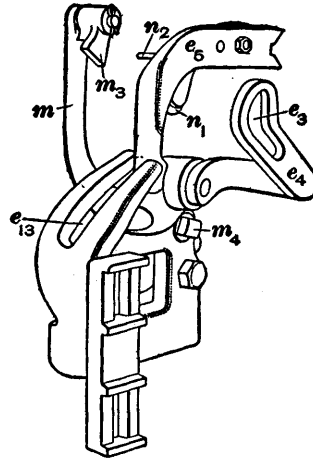
Fig. 14

38. Double Filling-Fork Arrangement.—A single filling fork placed at one side of the loom can detect the presence or absence of only every alternate pick of filling. This is true because the filling fork can operate only when the filling extends from the cloth to the box on the same side of the loom as the fork, which occurs only when the shuttle rests in the box on that side of the loom. Naturally, the filling may break when the shuttle is traveling toward either side of the loom. As the transfer of filling can take place only when the

shuttle is at rest on the hopper side of the loom and because of the peculiar action of the filling motion, shuttle feeler, etc., which may delay the transfer, from one to three picks of filling may be missed in the fabric before fresh filling is supplied. The number of picks, and possibly portions of picks, varies, of course, and it is clearly evident that a single filling fork operating at one side of the loom will be unable to detect all of these variations. When, therefore, cloth in which the slightest defect is objectionable, is woven, an additional filling fork operating on the right-hand side of the loom is supplied. This extra filling fork is applied to looms equipped with the filling-feeler device and, also, is very often attached to looms having only the single-fork filling-changing mechanism, because it not only affords extra protection against possible improper functioning of various parts but, in addition, furnishes a double control over the take-up motion. By virtue of this latter fact, the slightest thin place or crack in the fabric is prevented.

39. As shown in Fig. 9, the additional filling-fork arrangement on the right of the loom is of very simple construction. It consists essentially of a filling fork g_{24} which is mounted in a slide g_{25} and operates in connection with the usual grate, or grid, attached to the lay. A hook g_{29} is attached to a filling-cam follower g_{27}, the latter being operated by a cam attached to the cam-shaft. This cam, of course, is set opposite to, or 180° from, the position of the filling cam operating the filling motion on the left of the loom. The filling-fork slide g_{25} is kept in its normal position by a coiled spring similar to that employed on the left of the loom and an extended portion of the slide contains a notch engaged by a stud f_{11}. This stud is carried by an arm f_{10} connected to the sleeve f_1 supported by the starting rod f. Thus, when the absence of filling is detected by the filling fork on the right of the loom and in consequence the fork slide is moved forwards, the arm f_{10} will cause a partial revolution to be imparted to the sleeve f_1. This movement of the sleeve will depress the rod f_7 and disconnect the take-up motion clutch, as previously mentioned, thereby letting back the cloth and preventing a thin place.

It will be noted, also, that on looms equipped with the filling-feeler device, when the straddle bug g_8 is reversed so that the loom will not transfer when the filling is broken but instead will be stopped, this stopping of the loom is controlled by either filling fork. The control of the filling fork on the right of the loom is brought about by the stud g_9 of the straddle bug, because, when the latter is reversed, this stud will rest directly in front of the arm f_5 attached to the sleeve f_1. Thus, when the sleeve is operated by the filling fork on the right, arm f_5 will draw forwards the straddle bug and filling-fork slide on the left of the loom. This, of course, will cause the loom to be stopped in the same manner as it would be stopped if the absence of filling had been detected by the left-hand fork.

THE NORTHROP LOOM

(PART 2)

CONSTRUCTION AND OPERATION—Continued

WARP STOP-MOTION MECHANISMS

40. Object.—When an end of the warp breaks in a loom of ordinary construction, the machine continues to run until the defect is observed and the loom stopped by the weaver. If a considerable period of time elapses before this is accomplished, not only will a more or less prominent defect be formed in the fabric but the broken end often will become entangled with adjacent ends, which also may become broken, and a more serious imperfection will be made in the cloth. To obviate this fault and automatically stop the loom whenever a warp end breaks, warp stop-motions are applied to many looms. Such devices are especially necessary when automatic, or filling-replenishing, looms are employed, because, in such cases, the weaver attends to so many looms that the prompt observance of broken warp ends is difficult, and the immediate stopping of the loom is otherwise impossible.

There are several different types of warp stop-motions, but those ordinarily employed in connection with the Northrop loom are mechanically operated and of two principal kinds, namely, the cotton-harness warp stop-motion and the steel-harness warp stop-motion.

41. A general perspective view of a common arrangement of the cotton-harness warp stop-motion, as seen from the front of the loom, is given in Fig. 15, and in Fig. 16 is shown an illustration of the operating mechanism as viewed from the rear. The particular arrangement shown is known as a single-thread stop-motion, because, in this construction, each end of the warp is individually controlled by a detector, or drop wire, whereas, in some types of warp stop-mechanisms, one drop wire serves for two or more warp threads. In the device dealt with, the drop wires, being arranged in two *banks,* or rows, take the place of ordinary lease rods in doing the leasing.

The cotton-harness warp stop-motion takes its name from the fact that it is entirely independent of the shedding mechanism of the loom, and allows the use of ordinary cotton harnesses, or other common types of harnesses, the ends of the warp being drawn through the eyes of the harnesses, as indicated at p, Fig. 15, and also through eyes in the drop wires, or detectors, p_1, p_2. The drop wires are constructed of thin slips of steel and, in addition to the eye through which the warp end is drawn, contain a long slot by means of which they are threaded on bars p_3. The latter extend entirely across the loom and support the drop wires in a position directly behind the harnesses. When two banks of drop wires are employed, as shown in Fig. 15, they are supported between front and back box plates p_4, p_5 that also extend completely across the loom, although shown broken in the illustration. Secured to the bottom of each box plate is a narrow strip of steel, the inside edge of which is notched, or serrated. Directly below the box plates is a flat steel strip p_6, serrated on both edges and known as a feeler bar. The feeler bar is supported by an oscillating feeler shaft p_7 and owing to the movement of the latter reciprocates backwards and forwards beneath the box plates.

The tension of the warp ends holds the drop wires in a raised position during the normal operation of the loom, as indicated in Fig. 15, and the movement of the feeler bar is
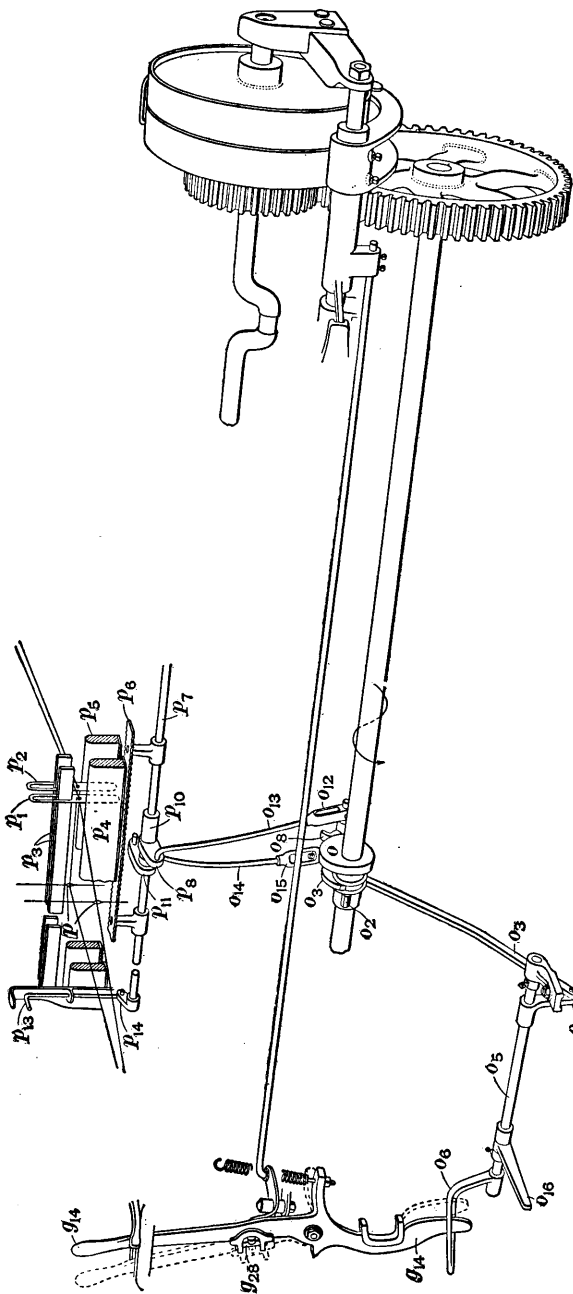
Fig. 15

39

uninterrupted. When, however, an end breaks, the drop wire through which it is drawn falls for a short distance, and its lower end is trapped between either the front or the back box plate and the feeler bar. This, of course, checks the motion of the latter and of the oscillating shaft p_7, which, as will be described, causes the loom to be stopped.

The object of the serrated edges of the feeler bar and the strips secured to the bottoms of the box plates is to hold the thin steel drop wire, or detector, at right angles when it falls and is trapped by the feeler bar and box plate. This prevents the drop wire from becoming bent or damaged, and enables it to check easily the motion of the feeler bar. The top edges of the box plates p_4 and p_5 are rounded, and serve as supports for the warp threads, thus enabling them in turn to support easily the weight of the drop wires and prevent them from interfering with the action of the feeler bar except when a warp end breaks and allows its drop wire to fall.

42. The motion of the feeler bar is derived from an oscillator cam o secured to the cam, or bottom, shaft of the loom. The hub of this cam carries two projections, or lugs, o_1 and o_2 and also contains a groove, or bearing, that supports a long casting o_3, which extends toward the front of the loom and is called the knock-off link. At its front end the knock-off link is connected by an arm o_4 to a shaft o_5, at the other end of which is an arm o_6 engaging with the end of the shipper handle g_{14}, as shown in Fig. 15. At the rear, as shown in Fig. 16, the knock-off link supports in bearings a short shaft o_7 to which is securely fastened an oscillator-cam follower o_8 and a small casting o_9 called the tight knock-off dog. The oscillator spring o_{10} causes the cam follower to follow the face of the cam as the latter revolves, and the shaft o_7 also supports the loose knock-off dog o_{11}. The knock-off dogs o_9 and o_{11} are designed to work in conjunction with, and be operated by, the lugs o_2 and o_1 on the hub of the oscillator cam.

A coupling o_{12} and the oscillator rod o_{13} connect a backward-extending arm of the oscillator-cam follower o_8 with an oscillator finger p_8 loosely supported by the feeler shaft p_7. Attached

to the loose oscillator finger p_8 is a spring p_9, which in turn is fastened at its other end to the retaining case p_{10}, the latter being fast to the shaft p_7. A backward-projecting arm of the loose knock-off dog o_{11} is connected by an oscillator rod o_{14},
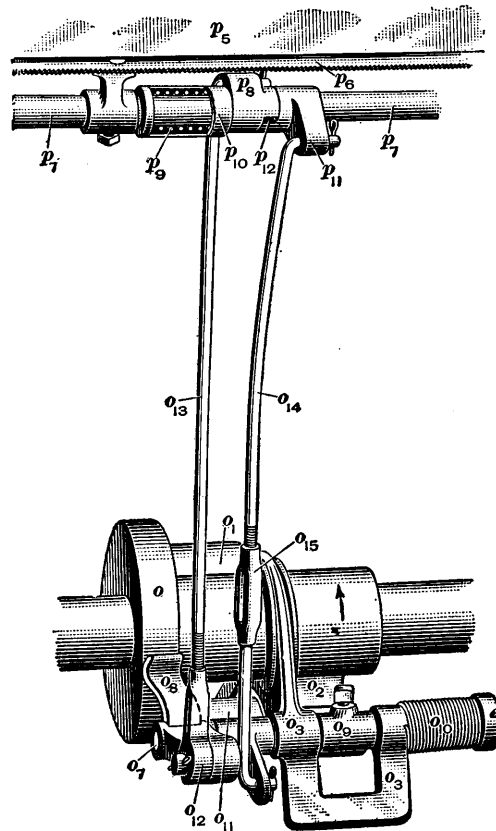

FIG. 16

containing a turnbuckle o_{15}, with a tight oscillator finger p_{11} securely attached to the feeler shaft p_7. The loose oscillator finger p_8 and the tight oscillator finger p_{11} each contain a projection and these projections are engaged as shown at p_{12} and normally held in contact by the spring p_9.

43. The operation of this mechanism may be described as follows: When no end of the warp is broken and the drop wires are all held in a raised position, the oscillator cam o imparts an oscillating motion to the feeler shaft p_7 and feeler bar p_6. As the contact of the cam follower o_8 is moved from the heel to the toe of the cam o, owing to the rotation of the latter, the oscillator rod o_{13} will be lowered, which will cause the loose oscillator finger p_8 to be pulled down. Although the finger p_8 is loose on the shaft p_7, it is held in contact with the tight oscillator finger p_{11} at the point p_{12} by virtue of the tension of the spring p_9; thus, the finger p_{11} will follow finger p_8 and being on the opposite side of the feeler shaft p_7, to which it is attached, it will be raised and also will rock the shaft and feeler bar p_6 toward the front box plate p_4. The tight finger p_{11} in rising will raise the oscillator rod o_{14} and thus depress the loose knock-off dog o_{11} so that the latter will not be engaged by the lug o_1 on the hub of the cam.

If, however, a warp thread becomes broken and allows a drop wire p_1 of the front bank of drop wires to fall, as the feeler bar moves forwards toward the front of the loom, the drop wire will be trapped between it and the front box plate p_4, thus checking the oscillation of the feeler bar and the shaft p_7. This, of course, will prevent the tight oscillator finger p_{11} from rising and the rod o_{14}, therefore, will hold the loose knock-off dog o_{11} in such a position that it will be struck by the lug o_1. This action will cause the knock-off dog, and the knock-off link o_3 by which it is supported, to be forced backwards, the knock-off link sliding in its grooved bearing in the hub of the oscillator cam. As the knock-off link is moved backwards, it will operate the arm o_4, shaft o_5, and arm o_6 in such a manner as to throw the shipper handle g_{14} from its retaining notch. As the shipper handle springs to the end of its slot, it will, of course, stop the loom, disconnecting the driving power in an ordinary manner, as shown in Fig. 15.

It will be noted that when the drop wire is trapped between the front box plate and the feeler bar the contact of the cam follower is moving from the heel to the toe of the cam and the rod o_{13}, therefore, is positively pulled down. The feeler bar is

not pulled forwards, however, because the finger p_8 is loose on the shaft p_7 and, in this case, simply moves down against the tension of the spring p_9, pulling away from the tight oscillator finger p_{11} at the point p_{12}.

44. As the point of contact of the cam follower o_8 and the cam o moves from the toe to the heel of the cam, the cam follower is caused to follow the contour of the cam by virtue of the tension of the spring o_{10}. This action will raise the oscillator rod o_{13} and the loose oscillator finger p_8, and the latter, engaging with the tight oscillator finger p_{11} at p_{12}, will rock the shaft p_7 and feeler bar p_6 toward the back of the loom, or toward the box plate p_5. At the same time the movement of the cam follower being transmitted to the short shaft o_7 will cause the tight knock-off dog o_9 to be lowered so that it will escape the lug o_2 on the hub of the cam. If a warp end breaks and one of the drop wires p_2 of the rear bank of drop wires falls, it will be trapped between the feeler bar and the rear box plate p_5. This will cause the backward movement of the feeler bar and shaft p_7 to be checked and as the loose finger p_8 and rod o_{13}, under this condition, cannot rise, the cam follower o_8 will be prevented, against the tension of the spring o_{10}, from following the cam o. As this action will prevent the shaft o_7 from making its partial revolution, the tight knock-off dog o_9 will remain in a raised position and be engaged by the lug o_2. This will cause the knock-off link o_3 to be forced backwards and stop the loom, as previously described.

45. After the loom has been stopped by the warp stop-motion, the broken warp end must be pieced and again drawn through the drop wire and harness heddle, thus repairing the break and raising the drop wire so that it will not interfere with the feeler bar. In order that the weaver may readily find the drop wire that has fallen, an *agitator* is applied. This consists of a wire p_{13} that operates an arm p_{14} attached to the shaft p_7. By operating this wire, the shaft p_7 and the feeler bar can be moved so that the fallen drop wire will be agitated and its location readily detected.

46. Variations in Construction.—The general principle of the cotton-harness warp stop-motion will be found as described and illustrated, but there are some variations in construction. Sometimes the drop wires are formed with long slots, instead of a round eye, for the reception of the warp thread and in plain-weave work two ends of the warp are drawn through each drop wire. If one of these ends breaks the drop wire will fall when the harness through which that end is drawn is lowered. With some other weaves, in which only one harness is raised on each pick, more than two ends can be controlled by one drop wire. Sometimes the drop wires are of special light construction, and sometimes they are arranged in a single bank, and sometimes in three or four banks, the construction being varied to suit these conditions. Sometimes a separate *free bar* is passed through slots in the lower ends of certain drop wires to serve as a weight for the purpose of keeping all of the drop wires in a perfectly upright, or vertical, position.

Additional attachments of minor importance are sometimes employed, such as a release motion to prevent damage to the drop wire from continued blows of the feeler bar and a slack-thread controlling device, which, when operated by a foot-pedal, will temporarily throw the stopping mechanism out of commission until a slack end weaves tight and raises its drop wire out of the path of the feeler bar, which it frequently will do.

STEEL-HARNESS WARP STOP-MOTION

47. The steel-harness warp stop-motion in some respects and in general principle is very similar to the cotton-harness warp stop-motion, but in other respects the mechanism and action vary to a considerable extent. In the steel-harness construction, extra drop wires, or detectors, to operate the warp stop-motion are not required, as the heddles of the harnesses act not only in their ordinary capacity but also in connection with the warp stop-motion mechanism as well. Putting the matter in another light, the drop wires of the warp stop-motion are operated by harness cams in such a manner as to form the

proper sheds for the filling and at the same time their ordinary functions in connection with the stop-motion are retained.

48. A general view of the steel-harness warp stop-motion, as seen from the front of the loom, is given in Fig. 17, and in Fig. 18 is shown a rear view of the principal operating parts. It will be noted that the heddles q, q_1, through the eyes of
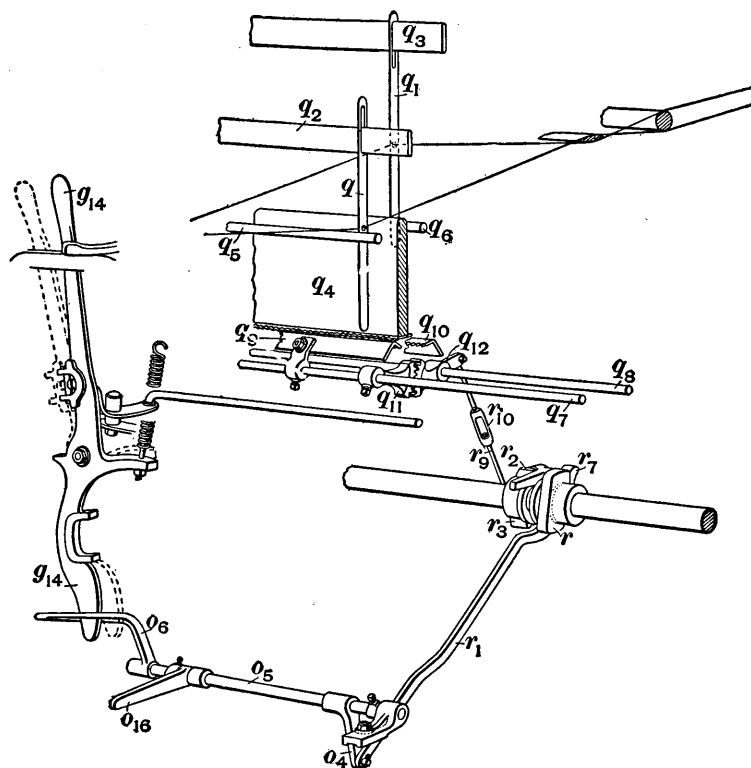
FIG. 17

which the warp ends are drawn, are supported by the heddle bars q_2 and q_3, which pass through long slots in the tops of the heddles. The heddle bars are so arranged as to be operated by ordinary harness cams placed on the cam-shaft of the loom. They thus raise and lower the heddles through which the warp ends are drawn and cause the sheds, for the reception of filling

yarn, to be properly formed in the warp. The lower ends of the heddles are entirely free and the heddles are constructed of thin slips of steel as in the case of the drop wires, or detectors, used in connection with the cotton-harness warp stop-motion.

To keep the two banks of heddles separated and to resist the action of the feeler bars whenever a warp end breaks and a heddle falls, a stop-motion girt q_4 is employed. Two rods q_5 and q_6 are so placed as to assist in holding the heddles in position and these rods, in conjunction with the top edge of the girt q_4, also assist the warp threads to support easily the weight of the heddles when they are lowered.

Placed directly below the heddles and stop-motion girt are two shafts q_7 and q_8, which support angular, serrated feeler bars q_9 and q_{10}. As the shafts q_7 and q_8 are connected by segment gears q_{11} and q_{12}, an oscillating motion, which is imparted to the shaft q_8, will cause the feeler bars q_9 and q_{10} to simultaneously move toward and recede from the stop-motion girt q_4, to the bottom of which a serrated steel strip is fastened. This movement continues as long as no warp end is broken, but whenever an end does break the heddle through which it was

FIG. 18

drawn will be unsupported. As the corresponding heddle bar is lowered, therefore, the fallen heddle will be trapped between one of the feeler bars $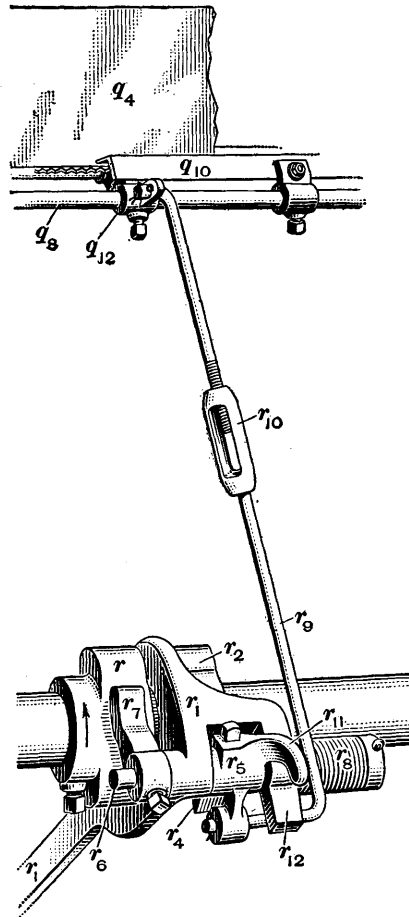q_9$, q_{10} and the serrated bar secured to the bottom of the girt q_4, and the oscillation of the feeler bars will be checked. The construction of the serrated bar referred to and of the feeler bars, of course, is such that the fallen heddle will be held edgewise and thus will not be twisted or bent.

49. As illustrated in both Figs. 17 and 18, the normal movement of the feeler bars is obtained by means of a double oscillator cam r, attached to the cam-shaft in the center of the loom. The oscillator-cam casting contains a grooved bearing in which is supported a knock-off link r_1; it also carries two projections, or lugs, r_2, r_3, designed to engage a projection r_4 of the knock-off casting r_5. The knock-off link supports a short shaft r_6 to which is attached an oscillator-cam follower r_7 that is kept in contact with the face of the oscillator cam by a spring r_8. The knock-off dog r_5 is attached also to this shaft and by means of an oscillator rod r_9, containing an adjusting turn-buckle r_{10}, is attached to a backward-extending arm fastened to the shaft q_8. As the cam r rotates, the oscillating movement is imparted to the feeler bars by these parts. As the feeler bars move toward the stop-motion girt and the point of contact of the cam follower and oscillator cam moves from the toe to the heel of the cam, by virtue of the tension of the spring r_8, the knock-off r_4 is depressed so as to be removed from the path of the lugs r_2, r_3.

50. Whenever an end breaks and the heddle that it supported falls and is trapped by one of the feeler bars, however, the oscillation of the feeler bars is stopped and, hence, the cam follower r_7 will be prevented from following the contour of the cam. The knock-off r_4, therefore, will not be depressed and, in consequence, will be struck by one of the lugs r_2, r_3 on the hub of the cam. The knock-off link r_1 thus will be forced back and operate the arm o_4, shaft o_5, and arm o_6 in such a manner as to throw off the shipper handle g_{14} and stop the loom. The stop r_{11} of the knock-off dog r_5 comes in contact

with the portion r_{12} of the knock-off link and thus limits its movement and supports it when the knock-off r_4 is engaged by the projection on the oscillator cam.

Although in Figs. 17 and 18 the steel-harness warp stop-motion is shown arranged for only two harnesses, this mechanism is often used for three- and five-harness work, the stop-motion girt being placed as nearly as possible in the center of the harnesses and the other arrangements being practically as described.

TAKE-UP LET-BACK MECHANISM

51. Most power looms are equipped with some form of let-back device for the purpose of letting back the take-up gears one or more picks whenever the loom is stopped. The warp and cloth thus are slackened slightly to compensate for the overrunning of the loom, so that when the loom is again put in motion no crack or thin place will be formed in the fabric being woven. In the Northrop loom, the take-up motion is not radically different from the similar mechanisms found on other looms, but the let-back arrangement is designed to operate in conjunction with the filling-replenishing mechanism, as has been mentioned, and also in connection with the warp stop-motion. This device is shown in Fig. 19.

The power required to operate the take-up gears and take-up roll t is transmitted through a toothed clutch, one half of which is cast integral with the gear s. The other half s_1 of this clutch is capable of being moved in a transverse direction, but the clutch is kept in an engaged position during the normal operation of the loom by means of a coiled spring, contained within the shell of the part s_1 but not shown in Fig. 19. A yoke o_{17} is arranged to operate in such a manner as to disengage the toothed clutch by sliding the part s_1 to the left for a short distance. This yoke is operated from two distinct sources, as intimated. First, whenever the loom transfers or whenever it is stopped by the filling stop-motion, the filling-fork slide g_5, operating through the pin f_6 and arm f_5, will cause the rod f_7 to be depressed. The rod f_7 also will be

lowered by the action of the filling-fork slide g_{25} on the right of the loom, through the pin f_{11}, arm f_{10}, and sleeve f_1. As the lower end of the arm f_7 is connected with the yoke o_{17}, as shown, the clutch will be disengaged whenever it is depressed and the take-up gears, being thus let back, will prevent the formation of a crack or thin place in the cloth due to the action

FIG. 19
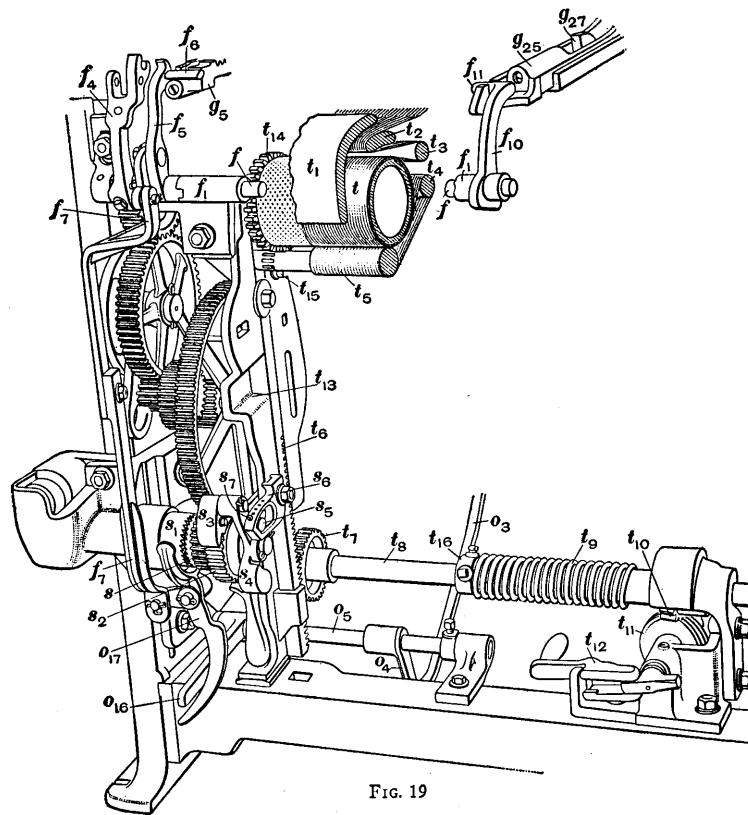
of the transferring mechanism or the filling stop-motion. Second, whenever the loom is stopped by the warp stop-motion, the knock-off link o_3 in being drawn toward the rear of the loom will impart a partial revolution to the shaft o_5 through the arm o_4. An arm o_{16}, fastened to the shaft o_5, is in contact with the downward-extending cam-shaped portion

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of the yoke o_{17} and, as the partial revolution of the shaft o_5 depresses the arm o_{16}, the lower part of the yoke is forced to the right, thus causing its upper part to move to the left and disengage the toothed clutch by moving the part s_1 also to the left.

52. The distance, or number of picks, that the take-up motion is let back is governed by a ratchet gear s_2, compounded with the gear s, and a let-back, or slack, pawl s_3 engaging with the ratchet. The pawl is supported by a weighted arm s_4 that carries a stud s_5 engaging with a slot in the bracket s_6. During the normal operation of the loom, the toothed clutch is engaged and the rotation of the ratchet gear s_2 allows the weighted lever s_4 to carry the pawl s_3 forwards until the stud s_5 rests in the forward end of the slot in the bracket s_6. When the toothed clutch is disengaged, however, the tension of the cloth and warp, operating through the take-up gears, will cause · the ratchet gear to move backwards, carrying with it the pawl s_3. This movement continues until the stud s_5 reaches the rear end of the slot in the bracket, whereupon the movement is checked and the take-up gears securely held in that position. In Fig. 19, the various parts are shown in the positions that they assume immediately previous to this movement. The extent of the let-back motion is adjustable so that it can be accommodated to different fabric constructions and. weaving conditions. This adjustment is made by means of a number of holes drilled in the bracket s_6. A cotter pin s_7 may be placed in any one of these holes so as to limit the forward movement of the stud s_5 and pawl s_3; this, of course, governs the amount of movement of the take-up gears before the stud reaches the rear end of its slot.

CUT MOTION

53. Although the ordinary arrangements of take-up and cloth rolls can be applied to the Northrop loom, a somewhat different and improved construction is customarily employed. This is usually referred to as the *high take-up roll* arrangement, which, as shown in Fig. 19, is so devised that the take-up

roll t is carried very high and is placed behind a false breast beam, or shield, t_1. The latter protects the cloth from being blemished by the weaver in leaning over the loom to tie in broken warp ends, etc. The cloth passes around a breast beam t_2, a rod t_3, the take-up roll t, and a rod t_4 before being wound on the cloth, or cut, roll t_5.

One advantage of this arrangement is that it allows a very large roll of cloth to be accumulated before removal from the loom is necessary, and also the high positions of the parts mentioned make access to the mechanism in the center of the loom easy for the loom fixer. Another advantage is that the cloth, when wound down in this manner, will be of a more uniform width. When the take-up roll is some distance from the fell of the cloth, there is an opportunity for contraction in the width and wrinkling that does not exist when the cloth is stretched over the rough surface of the roll almost immediately after it is woven.

The cloth is not always led to the cloth roll in the manner described, as the method of accomplishing this can be varied to suit different conditions. Sometimes it is not passed around the rod t_3, but passes directly over the breast beam t_2 to the take-up roll t. Both the breast beam and the rod t_3 are frequently omitted and the cloth passed directly to the take-up roll.

54. The cloth roll t_5 is supported by racks t_6, carried in slides at each side of the loom, gears t_7 on a shaft t_8 extending across the loom and engaging with the teeth on the racks. On the shaft t_8 is a strong coiled spring t_9, one end of which is attached to the shaft and the other end secured to a sleeve on which is a worm-gear t_{10}. A worm t_{11}, operated by a folding crank-handle t_{12}, engages with the worm-gear t_{10}. By means of the crank-handle, the tension of the coil spring t_9 can be increased so that the racks t_6 will be raised and the cloth roll t_5 pressed firmly against the take-up roll t. The spring t_9 allows the roll of cloth to increase in size and its tension increases according to the size of the roll. By reducing tne tension of the spring, the cloth roll can be lowered and
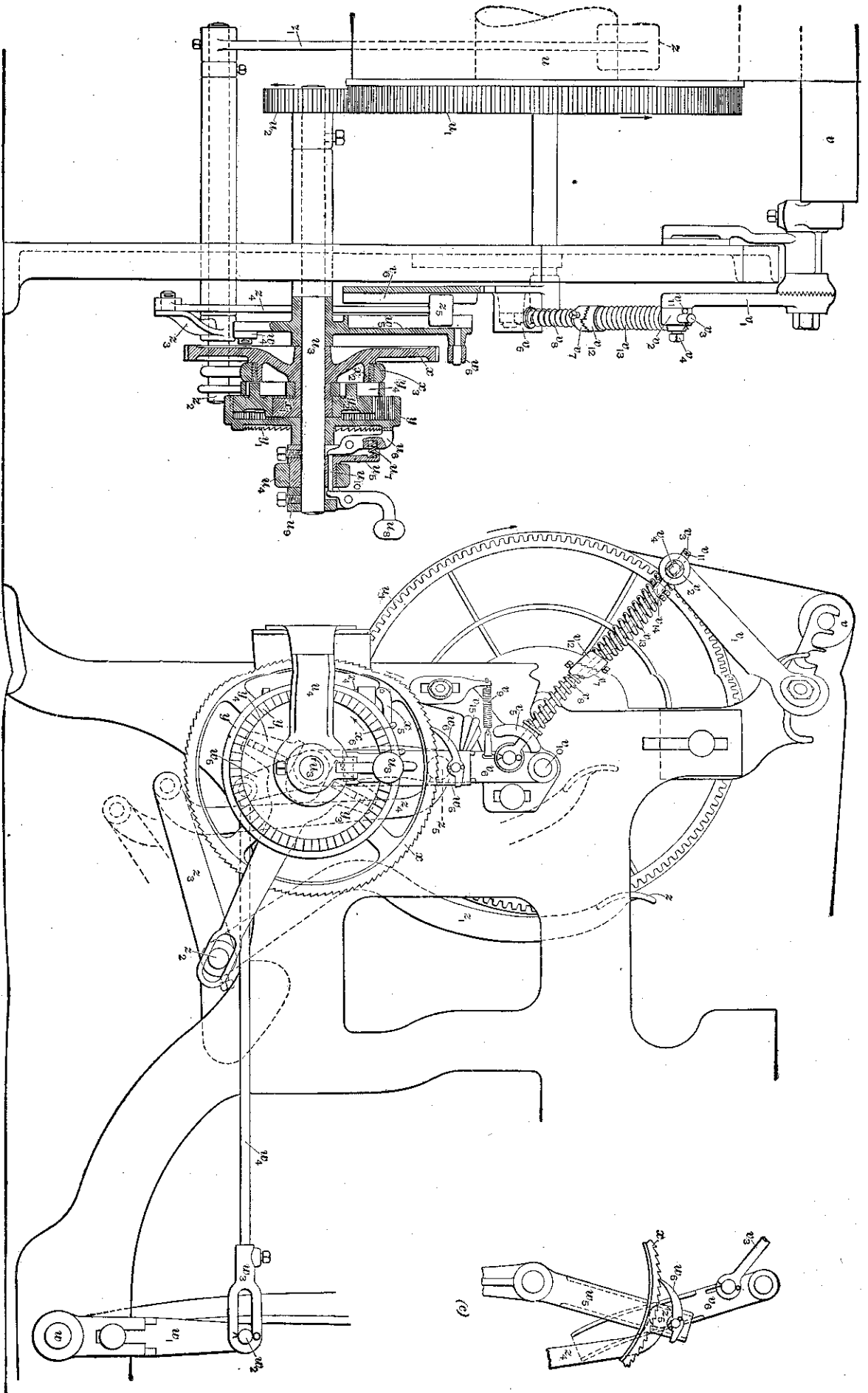
Fig. 21

(a)

(b)

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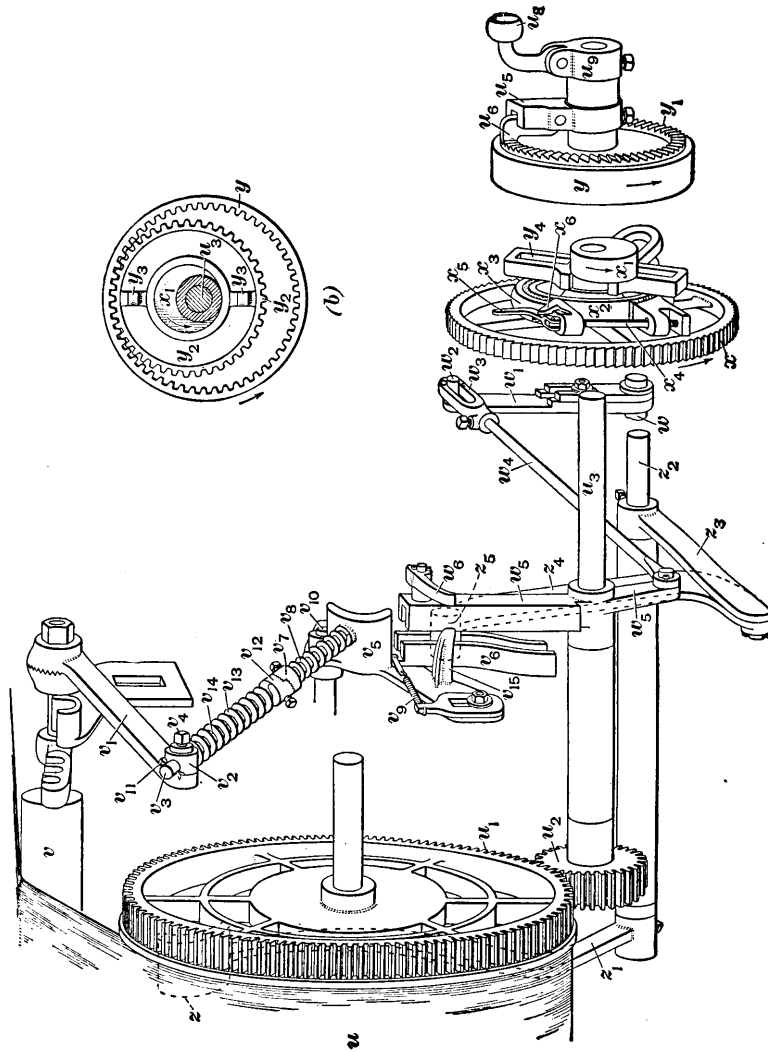
Fig. 20

removed through the opening t_{13}. By rotating the collar t_{16}, the pressure of the spring on the shaft t_8 can be adjusted. The handle t_{12} when folded, as shown in Fig. 19, is locked in position and the jar of the loom cannot interfere with the tension adjustment of the spring. When the cloth roll is empty and forced up against the take-up roll, the position of the worm t_{11} on the shaft t_8 should be such that the handle t_{12}, by means of which it is turned, will just enter its retaining notch.

The cloth roll, of course, is driven by frictional contact with the take-up roll, but to positively start and turn the cloth roll, when the cloth is first wound on it, a gear t_{14} is placed on the take-up roll. The teeth of this gear engage with teeth t_{15} in the cloth roll until the amount of cloth wound on the latter is sufficient to remove the roll from the influence of the gear.

DRAPER-ROPER LET-OFF MOTION

55. In order that even cloth may be produced, and to eliminate thick and thin places in the fabric, it is essential that the warp yarn be released from the beam at a uniform rate of speed in accordance with the demands of the goods being woven. There is no inherent reason why any efficient type of let-off motion, including the ordinary friction let-off, cannot be applied to an automatic loom.

Many Northrop looms have been equipped with the well-known Bartlett type of let-off mechanism, but the present standard looms are supplied with a very efficient device known as the Draper-Roper let-off motion. This mechanism is illustrated in section and side elevation in Fig. 20 (a), (b), and (c), and in perspective and detail in Fig. 21 (a) and (b).

56. The construction and operation of this let-off motion may be described and explained as follows: The warp, in being pulled forwards through the reed and harnesses by the take-up mechanism, is drawn over the whip roll v and is unwound from the beam u. A gear u_1, cast integrally with the beam head, meshes with a gear u_2 attached to a shaft u_3, the latter being supported by a bracket attached to the back

girt and framework of the loom and also by the bracket u_4. Setscrewed to the shaft u_3 is a casting u_5 that supports a pawl u_6, the latter being caused, by a spring u_7, to engage with a ratchet y_1, formed in one piece with an annular, or internal, gear y, which is loosely supported by the shaft u_3. The rotation of the beam caused by the warp being unwound from it as the weaving of the cloth progresses, rotates the internal gear y in the direction indicated by the arrow. The pawl u_6 is really a driving member and imparts motion to the ratchet and internal gear.

During the ordinary operation of the loom, the pawl is held in contact with the ratchet y_1, but it may be disengaged, when it is desired to loosen the tension of the warp, by means of a handle u_8, which is supported by a casting u_9 setscrewed to the end of the shaft u_3. This handle operates the pawl u_6 by means of a pin u_{10} contained in the casting u_5.

57. To cause the beam u to release the warp uniformly in order that even cloth may be produced, the rate of speed at which the internal gear y and, consequently, the beam u are allowed to rotate must be accurately governed in accordance with the varying conditions that are met with during the progress of the weaving. The mechanism governing this action derives its motion from the rocker-shaft w of the loom, to which is attached an adjustable arm w_1 that supports a pin w_2. This pin engages with a slot in a casting w_3 which by means of a rod w_4 is connected with a lever w_5, known as the pallet lever, that is fulcrumed loosely on the shaft u_3. At the upper end of the lever w_5 there is a pawl w_6, called the pallet, designed to engage with a ratchet gear x. The ratchet gear is cast in one piece with an eccentric x_1 and these parts are also loosely supported by the shaft u_3. The eccentric x_1 supports and operates a pinion gear y_2 that engages with and controls the movement of the internal gear y. The pinion gear, however, is not allowed to rotate, as a crosshead y_4, loosely supported on the sleeve of the ratchet x and eccentric x_1, its slotted end engaging the shaft z_2, is formed with two slots in which studs y_3, carried by the gear, are engaged.

58. The peculiar operation of this somewhat unique arrangement is as follows: Whenever the upper end of the lever w_5 is moved toward the front of the loom, as will be described later, the pawl w_6 will take up one or more teeth in the ratchet x and at the same time the lower end of the lever w_5 will be moved toward the rear of the loom, carrying with it the rod w_4 and casting w_3. This action will cause the casting w_3 to assume such a position that the pin w_2 (which, by being connected to the arm w_1 and rocker-shaft w, has a reciprocating movement), in moving forwards with the lay, will strike the end of the slot in w_3, drawing the rod w_4 forwards. This action, of course, will operate the lever w_5 in such a manner as to cause the pawl w_6 to rotate the ratchet x and eccentric x_1 in the direction shown by the arrows on these parts. As has been stated, the pinion gear y_2 is not allowed to rotate. However, as the eccentric x_1 which supports it is rotated as explained, the point of contact of the pinion gear with the internal gear y will be altered. When the eccentric has made one complete revolution, the point of contact of the pinion gear with the internal gear also will have made one complete revolution. As the pinion gear is not allowed to revolve, this action will cause the internal gear y to be moved in the direction of the arrow for a distance equal to the number of teeth in the internal gear minus the number of teeth in the pinion gear. For instance, if the pinion gear contains 40 teeth and the internal gear 46 teeth, the latter will be moved a distance of 6 teeth in the direction of the arrow for each revolution of the eccentric. As explained earlier, the internal gear y actually has a tendency to turn in the direction indicated by its arrow, but this movement is governed and regulated by the mechanism just described. To prevent backlash and spinning and to hold the ratchet gear x in position when the upper end of the lever w_5 is moving toward the front of the loom in order to cause the pawl w_6 to take up a tooth, a friction device is employed. A drum x_2 is cast in one piece with the ratchet gear and is encircled by a two-piece leather-lined friction band x_3. The amount of friction caused by this device is regulated by the bolt x_4, which holds the friction band together. This friction

band can be released entirely, so as to cause no friction on the drum x_2, by raising the cam lever x_5. When in its raised position, the lever x_5 may be turned to operate the bolt x_4 and adjust the friction device. When in its lowered position, the lever x_5 is held in position by projections x_6.

59. The movement of the upper end of the lever w_5 toward the front of the loom, which causes the pawl w_6 to take up on the ratchet and which draws back the casting w_3 so that the pin w_2 will operate the lever w_5 to turn the ratchet x, is controlled primarily by the tension of the warp yarn. The tension of the warp will depress the whip roll v, and this movement serves also to depress the arm v_1 attached to the shaft of the whip roll. The arm v_1 carries at its end a swivel plug v_2 through which is passed a vibrator rod v_3 that may be securely fastened by a setscrew v_4. The rod v_3 is passed through an extended part v_5 of a supporting bracket and attached to a lever v_6, known as the controlling lever, which swings on the stud v_{10}. The rod v_3 carries, between the bracket v_5 and an adjustable collar v_7, a spring v_8 that when compressed by the downward movement of the whip roll tends again to raise the whip roll against the tension of the warp and also tends to return the controlling lever v_6 to its initial position after it has been pushed toward the front of the loom by the movement of the whip roll described. The movement of the controlling lever v_6 is communicated to the pallet lever w_5 by means of a stud z_5, supported by the controlling lever link z_4. This stud is arranged in such a manner that it engages with slots, or grooved chambers, in both the controlling lever and the pallet lever. By means of these parts, as the tension of the warp tends to increase while the filling yarn is being inserted in the cloth, the depression of the whip roll will cause the controlling lever v_6 to force the pallet lever w_5 toward the front of the loom and cause the pawl w_6, or pallet, to take up a tooth in the ratchet x, as has been previously described. The action of the controlling lever and pallet lever in causing the pallet to take up a tooth on the ratchet gear x is illustrated in Fig. 20 (c). The controlling-lever spring v_9 insures the

return of the lever to its initial position and also tends to prevent the controlling lever from moving too far toward the front of the loom when pushed forwards by the depression of the whip roll and vibrator rod. The initial positions of the controlling and pallet levers are governed by the stop v_{15} against which they are drawn by the spring v_9.

60. In order that the warp tension may be kept uniform at all times, it is clearly evident that the loom beam must be allowed to rotate at a faster rate of speed when it is nearly empty than when it is filled with warp yarn. In this let-off motion, this feature is automatically taken care of by a mechanism designed to increase the speed of rotation of the ratchet gear x, which it does by causing the pallet lever w_5 to swing through a greater arc, thus causing the pawl w_6 to take up more teeth on the ratchet when it is moved toward the front of the loom by the action of the whip roll, vibrator rod, and controlling lever. A pad z at the end of the beam lever z_1 is designed to rest on the warp yarn wound on the beam. The lever z_1 is attached to a shaft z_2, as is also an arm z_3 to which the controlling-lever link z_4 is pivoted. By means of these parts the stud z_5 in the end of the controlling-lever link is held in a raised position when the warp beam is full, and under this condition the controlling lever v_6 will impart a minimum amount of movement to the pallet lever w_5 and pawl w_6. Thus, the pawl will take up fewer teeth on the ratchet x and the loom beam will be allowed to rotate at its slowest speed. As the warp yarn is unwound from the loom beam, however, the diameter of the beam will constantly decrease and the pad z will fall toward the center of the beam. This movement of the pad imparts a partial rotary movement to the shaft z_2 by means of the lever z_1, and the arm z_3 will be depressed. The arm z_3, therefore, will allow the controlling-lever link z_4 and stud z_5 to assume a lower position with reference to the controlling lever v_6 and pallet lever w_5, which will increase the length of the forward movement of the latter and cause the pawl w_6 to take up the teeth of the ratchet x faster, as explained. As the decrease in the diameter of the

warp beam is gradual as the weaving progresses so is the increase in the movement of the ratchet gear x. Thus, the speed of rotation of the warp beam is constantly kept proportional to the diameter of the warp beam and a uniform tension is maintained throughout the weaving of the warp.

61. Haynes Thin-Place Preventer.—The Draper-Roper left-off motion, shown in Figs. 20 and 21, is combined with a device known as the Haynes thin-place preventer. The object of this arrangement is to allow a slight movement of the whip roll to accommodate minor inequalities in the tension of the warp, thus tending to make impossible the formation of any thin places in the cloth. When this device is employed, the setcrew v_4 is always loosened so that the vibrator rod v_3 will be free to slide in the plug v_2, a cotter pin v_{11} retaining the rod in position. Between the plug and an adjustable collar v_{12}, the vibrator rod carries a preventer spring v_{13}, and inside of this spring the vibrator rod supports a sleeve, or tube, v_{14}, known as the thin-place-preventer core. This core is slightly shorter than the distance between the plug v_2 and the collar v_{12}, thus allowing the preventer spring a certain amount of action before the plug comes in contact with the core. The preventer spring is somewhat lighter than the spring v_8, and as the tension of the warp compresses it a certain amount this spring will take care of any slight variations in the tension of the warp yarn by causing the whip roll to rise or fall as the case may be. When the tension of the warp increases sufficiently to compress the spring v_{13} to a certain point, the plug v_2 will come in contact with the core v_{14} and the vibrator rod v_3 then will be depressed against the tension of the spring v_8, operating the controlling lever v_6 as has been explained. When it is desired to operate the Draper-Roper let-off motion without the action of the Haynes thin-place preventer, the whip-roll lever v_1 is pulled up until the plug v_2 is almost in contact with the cotter pin v_{11}, and the setscrew v_4 is securely tightened, thus holding the vibrator rod v_3 in the plug and preventing the spring v_{13} from acting.

FIXING NORTHROP LOOMS

CARE OF FILLING-CHANGING DEVICES

62. The adjustment, timing, and repair of many parts of the Northrop loom are not different from the care of the similar parts of an ordinary loom, and no mention is necessary. The additional and typical devices and mechanisms of this loom, however, require special care on the part of the loom fixer, although the adjustments to be made are not difficult of comprehension. These motions, nevertheless, should be set and timed with exactness in order that the loom may function properly at all times. Incorrect timing and setting will result not only in failure to replenish the filling when required or to stop the loom in the event of a warp end breaking, but in some cases will cause parts to be broken.

63. Adjustment of Filling-Changing Mechanism. As has been explained, the filling-changing mechanism may be caused to operate either by the filling fork on the left-hand side of the loom or by the operation of the filling-feeler device. In adjusting this mechanism on the former type of loom, first, the lay should be pulled forwards to the front center and the filling fork carefully adjusted so that the prongs of the fork will freely pass through the grate, or grid, without the slightest contact with either the grid or the lay. The filling-motion cam g, Fig. 2, on the cam, or bottom, shaft of the loom is timed in the ordinary manner, so as to be just starting to move the filling-motion hook forwards when the crank-shaft of the loom is on the front center, the shuttle being on the same side of the loom as the fork. The filling-motion arm, or finger, f_4 now should be placed against the stud g_9 of the straddle-bug g_8 carried by the filling-fork slide g_5 and the finger secured to the starting rod f in that position. Next, the loom should be turned forwards with the filling-motion fork g_4 engaged with the hook g_8 as when the filling is absent, and this movement should be continued until the full extent of the forward motion

is reached, which will push back the finger f_4 and turn the starting rod into its operative position.

As the shuttle now should be on the right-hand side of the loom and in position to receive a fresh bobbin of filling, the next operation is to loosen and raise the shuttle-feeler finger f_2 until the shuttle feeler e_5 passes in front of the mouth of the shuttle box and is checked by its stop, whereupon the finger should be securely fastened to the starting rod. Care should be taken that the shuttle-feeler finger is raised high enough to remove the shuttle feeler from the influence of the spring f_3 on the finger and allow the shuttle feeler to bear firmly against its stop, and with its end close to, but not touching, the back of the shuttle box.

By means of the slotted latch depressor e_4, attached to the shuttle feeler, the latch finger e_1 should now be adjusted to be in position to be struck by the bunter e on the lay which should be brought forwards to its front center, thus operating the transferrer d and forcing a bobbin from the hopper into the shuttle.

The latch finger should be adjusted by means of the adjusting screw e_9 and locknut e_{10} so that the transferrer and transferrer fork will have a downward movement just sufficient to force the empty bobbin from the shuttle and place the fresh bobbin in correct position in the shuttle spring. The proper adjustment is to have the head of the transferrer just clear the head of the bobbin when the latter is in its lowest position; this clearance should not exceed $\frac{1}{16}$ inch.

The coil spring e_8 should be so adjusted as to prevent the shuttle feeler rebounding. This, of course, would prevent the transfer from taking place.

64. Position and Care of Shuttle.—It is important to have the shuttle stopped in the box in exactly the correct position to receive the bobbin or the cop when the latter is pushed into it by the transferrer. Several causes, however, tend to interfere with the exact positioning of the shuttle. If the pick is too weak, the shuttle may not fully enter the box, and if too strong, the shuttle may rebound. When adjusting the shuttle feeler and latch finger, therefore, the shuttle should

be pulled from the box until the shuttle feeler will strike its tip when thrown upwards. When the shuttle feeler is in this position—that is, in contact with the protruding shuttle—great care should be taken to see that the latch finger will not engage the bunter on the lay in such a manner as to cause the transfer to take place. Should the loom be stopped with an empty bobbin in the shuttle, it is an indication that the transfer has been prevented by the shuttle feeler, and steps should be taken at once to insure that the shuttle will be properly boxed.

In some cases the picker may be so badly worn that the shuttle will enter the box too far. It usually is necessary to place a piece of leather around the end of the lay to prevent this, and when the picker is badly worn extra pieces of leather may be placed inside this loop to hold the shuttle in proper position. The spring cover of the shuttle, moreover, is bent or inclined so that if the shuttle is too far in the box when the transfer takes place the heel of the bobbin will strike the incline and move the shuttle into the correct position as the bobbin is forced into it. However, total reliance should not be placed on this device; the loom should occasionally be inspected to ascertain whether the shuttle is boxing properly.

When the shuttle is being correctly boxed, it will stop in the center of the shuttle box, and when its tip is in contact with the picker, the shuttle spring will be exactly in line with the heads of the bobbins in the hopper.

It is important to box the shuttle smoothly and with not too heavy a pressure of the binder, which will require a light, easy pick on the loom.

65. The forward position of the shuttle is governed by the extent of the forward movement of the lay, which should bring the shuttle forwards into such a position that when the transfer takes place the transferrer will not touch the shuttle at any point, but will place the bobbin as nearly as possible in the center of the shuttle. This adjustment of the extreme forward point of the movement of the lay is secured by turning to the required position eccentric pins that connect the lay swords with the pitman arms carried by the crank-shaft of the loom.

Care should be taken that this adjustment is made exactly the same on each side of the loom, so that the lay will be carried in a position at right angles to the warp yarn.

If the transferrer fork is slightly out of adjustment when the head of the transferrer is in the center of the shuttle, it may be bent slightly to attain the correct position. If the fork is not in the correct position and "stabs" the bobbin, the filling will be cut. If the pitman arms become worn so that they are too short to bring the lay forwards to the proper position with the full extent of the eccentric adjustment, they should be replaced.

66. The metal parts of the shuttle should be kept securely fastened, especially the shuttle spring, which must be kept tight in order properly to receive and hold the bobbin. The eye of the shuttle and the thread passages to the eye must always be kept open and free. Sometimes these become clogged with lint and occasionally the thread passages to the eye are closed by jamming or bruising of the metal. Lint should be removed thoroughly, and closed thread passages may be opened cautiously with any thin tool, but care must be taken not to bruise the metal and not to open the passages too wide.

Any defect that prevents the filling from entering the shuttle eye will cause misthreading to take place, which will not only break the filling, but will cause a mispick to be made in the cloth. If the loom misthreads several times in succession, a defect in the cloth is sometimes made that is beyond repair, necessitating the cutting of the cloth. When the shuttle misthreads, the filling fork will be operated correctly on the first pick after the transfer, but as the shuttle is returned on the next pick, the filling will be broken and the transferring mechanism will again be placed in operation, which may continue until all of the bobbins have been transferred from the hopper, also making a defect in the cloth. In the case of plain cloth, as this defect will cause filling to be placed in the cloth only when the shuttle is passing from the hopper to the shipper handle side of the loom, all of the filling will be placed in the same shed.

made with slight additions and modifications to accommodate these mechanisms and to allow of the starting rod being functioned by the filling-cam follower, filling-cam-follower trip g_{22}, Figs. 9 and 10, and feeler slide f_8. The filling-cam-follower trip should be so adjusted on the upper end of the filling-cam follower that the notch g_{23} will engage the feeler slide when the latter has been raised into its active position by the filling-feeler mechanism, and this contact should take place just as the crank-shaft of the loom reaches its front center.

70. To adjust the filling feeler itself, an empty bobbin, or cop skewer with an empty paper tube on it, should be placed in the shuttle and the latter inserted in the box. With the loom on the front center and the lay in its extreme forward position, the adjusting screw j_4 should be turned until there is a distance of about the thickness of one layer of yarn between the feeler j_1 and the bobbin or the cop tube in the shuttle. Several bobbins or skewers containing a small amount of yarn now may be taken, and the loom started after one of them has been inserted in the shuttle. If the bobbin or the skewer is ejected before the filling yarn has been woven down close enough, or if the filling weaves entirely off before the transfer takes place, the screw j_4 can be adjusted one way or the other as may be required. A number of trials may be necessary before the feeler is correctly adjusted, but when a correct adjustment is obtained, the locknut j_5 should be securely tightened. When it is desired to avoid mispicks, it is well not to attempt to weave off the filling too close, as mispicks can occur only in the case of filling breakage or feeler failures.

71. The spring j_2 regulates the pressure of the feeler j_1 on the filling in the shuttle, and the tension of this spring should be as light as is consistent with accurate operation. If the tension of this spring is too great, it is likely to push the bobbin out of alinement with the shuttle.

The filling feeler should be set to pass through the slots in the box plate and in the shuttle, without touching either part. For the same reason, care should be taken that the shuttle boxes properly on the left-hand side of the loom. It is good

practice to set the feeler as closely as possible to the upper edge of the slot in the shuttle, because the latter may rise slightly in entering the box. This may cause the feeler to strike the lower edge of the slot in the shuttle and force back the feeler so that the transfer of filling will be prevented when the filling in the shuttle is exhausted. The end of the filling feeler should be kept smooth, because if rough or damaged it is liable to cut the filling and cause an excessive number of transfers because of filling breakage.

72. Adjusting Shuttle-Feeler Thread Cutter.—In looms equipped with the filling feeler and shuttle-feeler thread cutter, the starting rod and shuttle feeler e_5, Fig. 9, will be operated in the same manner as when the former is functioned by the filling-fork slide. However, the feeler thread cutter, which is carried by the shuttle feeler on looms having the filling-feeler device, must be so adjusted that the bunter on the lay will operate the thread cutter and cause the filling to be cut properly. Also, the shuttle feeler must prevent the operation of the transferring mechanism in case the shuttle is projecting from the box so as not to be in proper position to receive the fresh bobbin of filling. The correct results ordinarily can be obtained without difficulty by changing the angle of the thread cutter so as to place it either farther, or not so far, forwards, or by raising or lowering it. The latter adjustment should be made by changing the position of the stand bolted to the side frame of the loom. Care should be taken to make the adjustment in such a manner that the thread cutter does not cut the filling unless a bobbin is transferred, as this will make a mispick in the cloth.

73. The shuttle-feeler thread cutter also must be adjusted so that whenever a bobbin is transferred the thread from the exhausted bobbin will enter the opening in the end of the thread cutter. The thread must not only be cut, but also must be held and drawn back until again cut by the temple thread cutter. This requires that the knives of the shuttle-feeler thread cutter, both movable and fixed, shall be sharp and that the screw n_5, Figs. 9 and 13, shall be so adjusted that the

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movable knife n will work just tight enough so that the thread after being cut will be pinched and held. However, the knife must not be so tight that the thread will be cut by the back of the knife. If the thread is not pinched and held but is cut by the back of the knife, it will either be left dependent from the edge of the cloth or else will be caught and woven in, making a defect. The same effect will be had if the movable knife is so loose as to fail to hold the thread after cutting it, or if it jars open after drawing the thread back and before the latter is cut by the temple thread cutter. Heavy or light filling may require this adjustment to be altered and also may require a slight alteration in the position of the shuttle-feeler thread cutter.

The shuttle feeler should be kept well oiled so that it will function properly when the transfer of a bobbin takes place, otherwise the transfer is liable to be delayed until the bobbin in the shuttle is exhausted, thus causing a mispick.

SETTING AND TIMING WARP STOP-MOTIONS

74. Care of Cotton-Harness Warp Stop-Motion. In adjusting the cotton-harness warp stop-motion, the first operation is to throw off the driving belt of the loom or else disconnect the belt-shipping mechanism so that the shipper handle g_{14}, Fig. 15, can be placed in its retaining notch, that is, in the position that it occupies when the loom is actually running.

The belt-shipping mechanism can be disconnected easily by removing the key g_{28} that holds the end of the shipper lever in the recess in the shipper handle. The knock-off link o_3 is then drawn forwards against its bearing in the hub of the cam o so that it will have no play. Next, the feeler bar p_6 is placed in its central position with reference to the two box plates p_4 and p_5, and the loose and tight oscillator fingers p_8, p_{11} adjusted so that they will project evenly from each side of the feeler shaft p_7, or at right angles with the feeler-bar holders.

The oscillator cam o now should be loosened in order that the cam may be revolved by hand, and the tight knock-off dog o_9, Fig. 16, adjusted by its setscrew so as to clear the lug o_2

part, of the cam. The knock-off dog r_4 now should be set so as to just clear the lugs r_2 and r_3, Fig. 17, on the hub of the cam as the latter revolves.

The setting of the oscillator cam is controlled by the setting of the harness cams that raise and lower the heddle bars q_2, q_3 to form the sheds in the warp, and this setting should be altered to work with the setting of the harness cams if the latter is changed for any reason.

When the harness that is rising is just passing the harness that is falling, or is level with it, the long axis of the cam should be horizontal, or level, and the cam should be fastened to the cam-shaft in this position. The tension of the oscillator cam-follower spring should be adjusted so that the feeler bars will not strike too hard a blow on the heddle when the latter is allowed to fall by a broken warp end and is trapped between the feeler bar and stop-motion girt.

76. General Care of Warp Stop-Motions.—As a rule, warp stop-motions occasion but little trouble. There are, however, several minor difficulties that may be remedied easily when the causes are recognized. The lower ends of the steel heddles or of the drop-wire detectors are sometimes badly bent and twisted by the action of the feeler bar. In most cases, this will be found to be due to an improper adjustment of some working part, the fallen heddle or drop wire being struck repeatedly by the feeler bar and the loom failing to be stopped.

The bars supporting the drop wires or heddles should be kept straight, clean, and smooth. In the steel-harness stop-motion, if the heddle bars are not straight, reedy and uneven cloth will be produced. Oil should not be placed on these bars, however, as it is apt to stain the warp. Extra heddles and drop wires are sometimes applied by breaking open the slot and slipping them into position. These always should be removed when drawing in a new warp, as they may catch on other drop wires and interfere with proper action.

Occasionally, a set of drop wires or steel heddles will become magnetized, which makes trouble by causing the individual heddles to stick together. This prevents the formation of clear

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sheds and interferes with the fall of the heddle or detector if a warp end breaks. The difficulty is remedied by having the heddles demagnetized by passing them through an electrical coil.

77. Slack warp threads often cause considerable annoyance, the loom being stopped repeatedly and the weaver being unable to find a broken warp thread. This is due to the slackness of the thread allowing the detector to fall just low enough to engage with the feeler bar. Sometimes this trouble is due to the whole warp being woven too slack but more often it is only one thread or a group of threads that gives difficulty. Occasionally, the stop-motion girt or box plates are not in the correct position relative to the whip roll. In some fancy weaves, certain ends do not interlace with the filling as frequently as other ends and, hence, tend to become slack. As such threads are not liable to become broken on account of their slackness, it is well not to draw them through detectors of the stop-motion. Large spooler knots with long tails often cause excessive warp breakage and if automatic knot tiers are not employed, it is desirable to have spooler tenders tie a weaver's knot instead of the customary overhand knot.

When a cotton-harness type of warp stop-motion is used and extra drop wires employed, the warps should be sized a trifle more heavily in order to give the yarn the extra strength required to withstand the additional chafing and wear. This is not necessary in the case of the steel-harness stop-motion.

SETTING THE TAKE-UP LET-BACK MECHANISM

78. When setting and adjusting the take-up let-back mechanism to operate in conjunction with the filling-changing mechanisms, the loom first should be turned so that the filling-cam follower is in its extreme forward position—that is, its position nearest to the breast beam. As the lay comes forwards, the filling fork should be slipped over the filling-cam follower hook, which will bring forwards the filling-fork slide and operate the rod f_7, Fig. 19. This now should be adjusted sc

that the yoke o_{17} will positively operate the let-back clutch s_1 and allow the cloth to be let back as far as allowed by the slack pawl s_3. If this adjustment is not correctly made, a crack or thin place will be made in the cloth each time that the transfer of filling takes place. On looms equipped with the double filling fork this adjustment should be made for both forks so that each fork will correctly let back the take-up gears. The knock-off link o_3 of the warp stop-motion should be drawn back and the arm o_{16} adjusted to operate the yoke o_{17} and let back the cloth whenever the loom is stopped by the action of the warp stop-motion.

ADJUSTING AND SETTING THE DRAPER-ROPER LET-OFF MOTION

79. If all parts of the Draper-Roper let-off motion are so adjusted as to be free to move as intended, very little trouble with the device will be experienced. In setting the various parts of this mechanism, it first should be noted that the bearing of the shaft u_3, Figs. 20 and 21, is raised high enough so that the pinion gear u_2 will mesh properly with the beam-head gear u_1. The stand supporting the controlling lever v_6 should be secured well toward the back of the loom and high enough so that the controlling lever will swing clear of the bearing of the shaft u_3. This adjustment should be such that the upper ends of the walls of the grooved chamber of the controlling lever will be about level with the upper ends of the walls of the similar grooved chamber on the pallet lever w_5. If convenient, the controlling lever can be adjusted by the upper ends of these walls.

The pallet lever should work freely on the shaft u_3 and the pallet spring (not shown in Figs. 20 and 21) that holds the pallet, or pawl, in contact with the ratchet x should not be either too stiff or too weak. If this spring is too strong, the pallet and ratchet teeth will show undue wear and if too weak, the engagement of the pallet with the ratchet may not be positive enough and the pallet may miss a tooth now and then.

The leather-lined friction band x_3 should be adjusted just tight enough to prevent spinning or overrunning of the ratchet

gear x when operated by the pawl w_6. No attempt should be made to adjust this friction device to alter the tension of the warp, as its sole purpose is to control the let-off ratchet gear, as explained. When the pawl w_6 is released from the ratchet by pressing down on its tail, or outer end, the adjustment of the friction should be such as to just prevent the ratchet gear from being turned by the tension of the warp. Insufficient friction will result in uneven cloth, and too much friction strains, and is liable to break, the mechanism.

The bracket supporting the beam-lever shaft z_2 must be set so that the crosshead y_4 will not bind against the shaft when the crosshead is carried to the extremities of its movement by the action of the eccentric x_1. The lugs y_3 of the pinion y_2 should operate freely in the slots of the crosshead and the pinion gear should mesh properly with the internal gear y.

The let-off pinion shaft arm u_5 must be set close enough to the internal gear y to allow the pawl u_6 to mesh properly with the teeth of the ratchet y_1, but great care must be taken not to make this adjustment so tight as to cause any binding of the parts supported by the pinion shaft u_3. The same care must be exercised in adjusting the outside bearing u_4 and the handle hub u_9.

80. The beam lever z_1 and the link lever z_3 preferably are set by using an empty warp beam. Reference has been made to the setting of the bracket supporting the shaft z_2 so as to allow clearance for the shaft in the slot of the crosshead y_4; the bracket also should be adjusted so that the beam lever pad z will not be situated too high or too low with reference to the barrel of the warp beam. With the lever z_1 loose on the shaft z_2, it should be raised to the position that it will occupy when a filled warp beam is in the loom. If nothing apparently interferes with this movement of the lever it now may be dropped to its initial position with the pad z resting on the barrel of the beam and the setscrew in the lever securely tightened.

With the beam lever resting in the position described, the link lever z_3 should be setscrewed to the shaft z_2 in such a

position that the controlling lever link stud z_5 will have a good clearance above the bottom ends of the grooves, or chambers, in the controlling lever v_6 and pallet lever w_5 when these levers are pushed back against the stop v_{15}.

The beam lever now may be raised to the full-beam position and then allowed to drop back to the empty-beam position, in order to make sure that the lever and pad will correctly follow the warp beam as it is emptied in weaving, and to ascertain whether the controlling-lever link and stud will work properly in the grooves of the controlling and pallet levers. The parts should drop promptly and freely if correctly adjusted.

81. In adjusting the connections of this let-off motion with the lay, the latter should be pulled forwards until the crank-shaft of the loom is on its front center. The connecting-rod end w_3 now should be loosened and pushed back as far as the pin w_2 will allow and the connecting-rod w_4 should be pulled forwards as far as the stop v_{15}, which checks the movement of the pallet and controlling levers, will allow. The set-screw in the connecting-rod end w_3 should now be tightened.

To complete the setting of this let-off motion, it now is only necessary to carefully adjust the vibrator-rod-spring collars v_7 and v_{12}, to obtain the desired tension on the warp and cloth. The method of adjusting the various parts, as described, is the same for all kinds of fabrics, and when changes are made in the goods to be woven it is only necessary to adjust the vibrator-rod-spring collars to obtain the proper tension for any fabrics within a reasonable range. Of course, if a change is to be made from very low-picked goods to very high-picked fabrics, or vice versa, a change of gearing will be required in order to allow for the slower or faster movement of the warp beam, as the case may be.

82. When this let-off motion is once set for a certain style of goods it, of course, is not necessary to reset the vibrator-rod-spring collars for each new warp that is placed in the loom. It also must be understood that this let-off motion automatically controls the tension of the warp during the entire weaving of the warp from the beam. When working under ideal con-

ditions, the pawl, or pallet, w_6 will move the ratchet gear x at least one tooth for each pick of the loom, and under this condition the control of the cloth tension is adjusted automatically as the beam empties. If the ratchet gear x is not moved one tooth for each pick of the loom, the tension will be correctly controlled, provided the ratchet gear is moved uniformly. The usual care should be taken in oiling, and especial precautions should be taken to keep oil from the leather-lined friction. Grease is used in preference to oil for lubricating the internal and pinion gears and the chambers of the controlling and pallet levers.

SPEED AND POWER

83. The speed at which Northrop looms can be run and the power required to drive them depend largely on the width,

TABLE I
SPEED OF NORTHROP LOOM FOR DIFFERENT WIDTHS OF CLOTH

Width of Cloth Inches	Recommended Speed Rev. per Min.	Width of Cloth Inches	Recommended Speed Rev. per Min.
23	190–195	60	128–132
30	185–190	64	124–128
32	180–185	68	120–124
34	175–180	72	116–120
36	170–175	76	112–116
38	165–170	80	108–112
40	160–165	84	104–108
42	154–160	88	100–104
44	148–154	92	96–100
46	144–148	96	94– 96
48	140–144	100	90– 94
52	136–140	104	88– 90
56	132–136	108	86– 88

weight, and character of the loom and the weight and construction of the fabric being woven. The filling-replenishing devices are capable of operating at any speed at which it is practicable to run the loom. Excessive speed causes a large increase in the number of breakages of warp yarn, however, and the loom is stopped so often to tie in broken ends that any gain made by the increased speed is apt to be more than offset. This is true of any loom, whether an automatic loom or not.

Table I gives speeds recommended for Northrop looms when weaving medium-weight goods of various widths and average constructions. When heavy-weight cloth is being produced, it often may be advisable to reduce these speeds to some extent.

Both looms and fabrics vary so in weight, width, and construction that the amount of power required should be determined for each particular case. Northrop looms, however, do not require appreciably more power than other looms of similar specifications. It has been estimated that from three and one-half to three and three-quarters narrow print cloth looms will absorb 1 horse power; that is, 100 horsepower will be required to drive from 350 to 375 looms.

ARRANGEMENT OF AUTOMATIC LOOMS

84. Since many more automatic looms than common looms can be attended to by one person, it frequently occurs that much of the weaver's time and physical energy is expended in moving from one loom to another as the requirements of various looms dictate. Weavers try to attend to each loom as soon as it is stopped for any reason, in order that it may be again started and the maximum production attained. Hoppers are filled and the cuts of cloth removed, as far as possible, when all of the looms are running.

It has been found that when weavers operate from twelve to twenty-four automatic looms, the distance that the weaver must travel in the course of a day, in order to attend to the requirements of these looms, is considerably lessened if the looms are arranged in two alleys. The two-alley system has a further advantage over a one-alley system, in that the weaver can by

this means move in what may be termed a circular path so that the looms most apt to require attention are being constantly approached. With the single-alley system, when the weaver has reached the end of the alley, the looms requiring immediate attention are located at the other end of a rather long alley.

85. The single-alley system is advisable when a movable weaver's seat is employed. As shown in Fig. 22, this device consists of an adjustable seat carried on a small four-wheeled truck, t h e latter being mounted on rails attached to the floor in the center of the alley. This arrangement enables the weaver to easily propel himself along the alley by
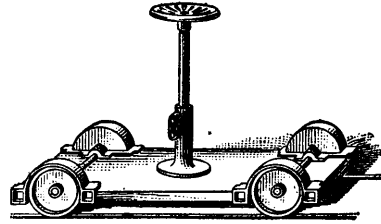

Fig. 22

pushing against the frames of the looms or kicking against the floor, and saves a great deal of walking. The weaver should not push against the hoppers of the looms when using this device, as the looms may be injured by doing this.

A folding seat is sometimes attached to Northrop looms in order that the weaver may have a convenient place to sit and rest when the looms are all running. This consists merely of a small seat attached to the frame of the loom and held in a raised, or folded, position by a coil spring. The seat is lowered for use and automatically folds up when released. Usually, one of these seats is attached to every eighth or twelfth loom.

RANGE OF APPLICATION OF THE NORTHROP LOOM

86. When the Northrop loom was first introduced, it was capable of weaving only the very simplest of cotton fabrics, and was essentially a print-cloth loom. As the loom was perfected and developed, it was seen that its range of application was considerably broader and that the automatic filling-replenishing principle could be applied to many fabrics.

The Northrop looms are manufactured in different types capable of producing a large variety of fabrics. In fact, it is possible to obtain these looms with practically any type of head motion and suitable for practically all types of fabrics. Looms dependent on cams for their shedding motion or those employing dobbies or even jacquards may be obtained utilizing the Northrop principles. Then, the types of yarns possible for these looms to utilize are not limited as looms embodying these principles have been designed for weaving cotton yarns, woolen and worsted yarns, silk yarns, and rayon yarns.

However, the single limitation of looms employing the Northrop automatic attachments is that they are limited to inserting filling yarns in a fabric of only one color, counts, and quality. The utilization of color in the warp yarns is not limited and may, therefore, tend to overshadow this loom defect.