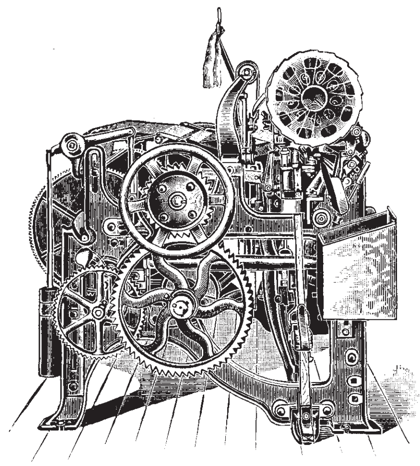
Labor Saving Looms

FIRST EDITION
1904

PRESENTED BY
THE DRAPER COMPANY
HOPEDALE, MASS.



THE FIRST NORTHROP LOOM.

Designed for the weaving of Print Cloth and Sheetings solely. Used with great success on plain two-harness weaves by our original customers.

It was this model that first proved a weaver's capacity to run sixteen looms.

It incorporated the inventions of :—

JAMES H. NORTHROP,
CHARLES F. ROPER,
WILLIAM F. DRAPER,
GEORGE OTIS DRAPER,
EDWARD S. STIMPSON AND
JOHN W. KEELEY.

The loom frame and other conventional parts were designed for the HOPEDALE MACHINE COMPANY under supervision of OREN B. SMITH. The H. M. Co. was incorporated with the present DRAPER COMPANY in 1896.

LABOR-SAVING LOOMS.

(FIRST EDITION.)

A BRIEF TREATISE ON

PLAIN WEAVING

AND THE

RECENT IMPROVEMENTS IN
THAT LINE WITH SPECIAL
REFERENCE TO THE . . .

NORTHROP LOOMS

MANUFACTURED BY

DRAPER COMPANY,

HOPEDALE, MASS.,

U. S. A.

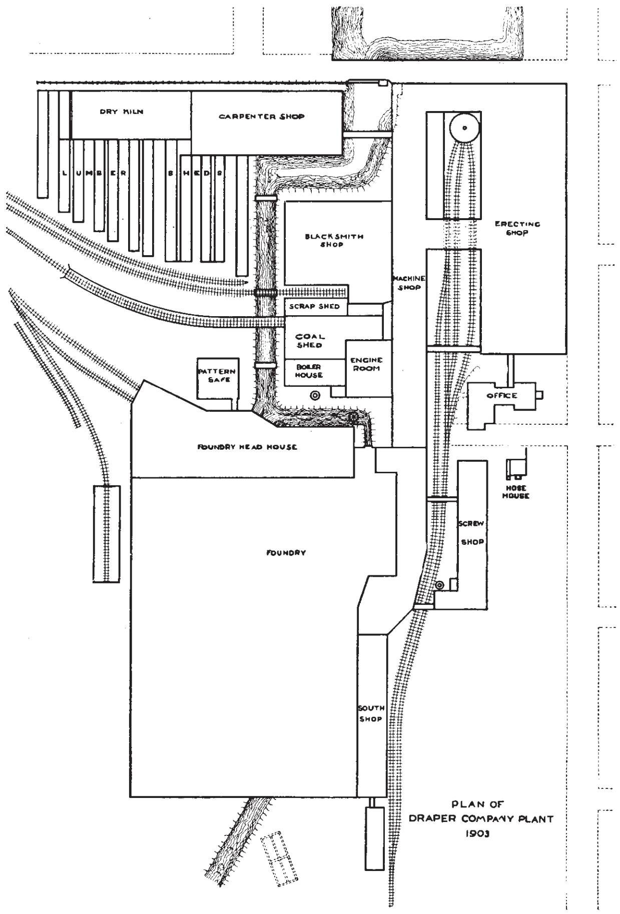
1904

WRITTEN AND COMPILED BY
GEORGE OTIS DRAPER,
SECRETARY OF THE DRAPER COMPANY.

PRINTED BY
COOK & SONS, MILFORD, MASS.

PREFACE.

This book cannot serve as a detailed catalogue by which the purchaser can always note the exact nature of the devices we shall continue to sell, as improvements are often unexpectedly invented. We can hardly expect to publish a work of this size at short intervals, but shall try to keep it reasonably up to date by amended additions. New matter will be inserted in the final pages of each edition after the first.



OUR HOPEDALE PLANT IN 1904.

Scale, 315 feet to the inch.

About 27 acres of floor space in all.

FORMER LITERATURE ON THE NORTHROP LOOM.

1895.

Circular—*The Advent of the Northrop Loom*, issued April, 1895.

Essay, *The Present Development of the Northrop Loom*, delivered by George Otis Draper at the meeting of the N. E. Cotton Manufacturers' Association at Atlanta, Ga., Oct. 24, 1895. Printed in Vol. 59 of the Transactions.

1896.

Papers on *The Northrop Loom*, by F. M. Messenger, John H. Hines, H. D. Wheat, and discussion by Wm. F. Draper, Arthur H. Lowe, George F. Whittam and W. J. Kent, April 29, 1896, printed in Vol. 60 of the Transactions of the N. E. Cotton Manufacturers' Association.

Chapter in *Facts and Figures*, on the Northrop Loom, published by George Draper & Sons in the spring of 1896.

Speech of Hon. Wm. C. Lovering, published in the Scientific American of May 2, 1896, and other papers, containing pertinent reference to the loom.

Pamphlet—*The Looms of the South*, by F. B. de Berard, issued March, 1896, containing detail of savings from use of the Northrop Loom in Southern mills.

Speech of Hon. Charles Warren Lippitt, published in the Manufacturers' Record of June 19, and papers generally throughout the country, giving the history of the Northrop loom development as illustrative of the educational influence of manufacturing.

1897.

Pamphlet—*Instructions for Running Northrop Looms*, issued by George Draper & Sons, January, 1897.

Pamphlet—*Instructions Pour la Conduite de Metiers Northrop*, issued by the Draper Company, 1897.

Circular—*Our Common Loom*, issued by the Draper Company, June, 1897.

Circular—*The Triumph of the Northrop Loom*, November, 1897.

1898.

Circular—*Our Connection with the Art of Weaving*, issued by the Draper Company, April, 1898.

Circular—*Take-up Mechanism*, issued by the Draper Company, 1898.

Article—*Industrial Investigations*, by Jacob Schoenhof, in The Forum for October, 1898. Referred to the great savings of the "Automatic loom," as affecting differences in cost of production.

1899.

Pamphlet—*Instructions for Running Northrop Looms*, (Revised Edition,) issued by the Draper Company, January, 1899.

Pamphlet—*Machinery and Labor Displacement*, by George Gunton, issued by the Gunton Institute, containing pertinent reference to the Northrop Loom as a labor-saving invention.

1900.

Circular—*The Advance of the Northrop Loom*, January, 1900.

Pamphlet—*Factory Conditions in the South*, January 20, 1900, by George Gunton, in Gunton's Lecture Bureau course.

Paper on *Method of Cost Finding* by Wm. G. Nichols, delivered at a meeting of the N. E. Cotton Manufacturers' Association at Boston, April 26, 1900. Printed in Vol. 68 of the Transactions.

Essay on *Improvements in American Cotton Machinery*, by George Otis Draper, delivered at a meeting of the Southern Cotton Spinners' Association at Charlotte, N. C., May 18, 1900. Printed in the Association records and various periodicals.

1901.

Chapter in *Textile Texts*, published by the Draper Company, spring of 1901.

Various articles in publication, *Cotton Chats*, started in July, 1901, and continued since.

Circular on *Important Discovery*, relating to method of spinning to prevent bunches in cloth, August, 1901.

1902.

Circular on *The Keene Drawing-in Machine*, January, 1902.

1903.

Circular on *The Northrop Loom*, issued by the British Northrop Loom Co., January, 1903.

Essay on *Continued Development of the Northrop Loom*, delivered by General Draper at a meeting of the N. E. Cotton Manufacturers' Association in Boston, April 23, 1903, printed in Vol. 74 of the Transactions.

Various references in a book, *The American Cotton Industry*, by T. M. Young, published by Charles Scribners' Sons, 1903.

Chapter on Northrop Loom in *Textile Texts*, second edition, issued December, 1903.

Essay on *The Development of the Northrop Loom*, delivered before the Providence Society of Mechanical Engineers by George Otis Draper, printed in Providence Journal, Dec. 28, 1903 and other trade journals.

1904.

Circular on *List of Northrop Looms Sold*, issued January, 1904.

Article on *Evolution of the Cotton Industry*, published in Gunton's Magazine for February, 1904.

Pamphlet, *Labor Saving Looms*, (the present volume).

The present circular contains practically all the information that is applicable to date, so that our former issues would have no present interest.

(This list for 1904 is only complete to April 1st.)

COLLECTED EVIDENCE.

Also NORTHROP LOOM HISTORY, Vol. I, 1889-1892—574 pages.

NORTHROP LOOM HISTORY, Vol. II., 1893-1896—1097 pages.

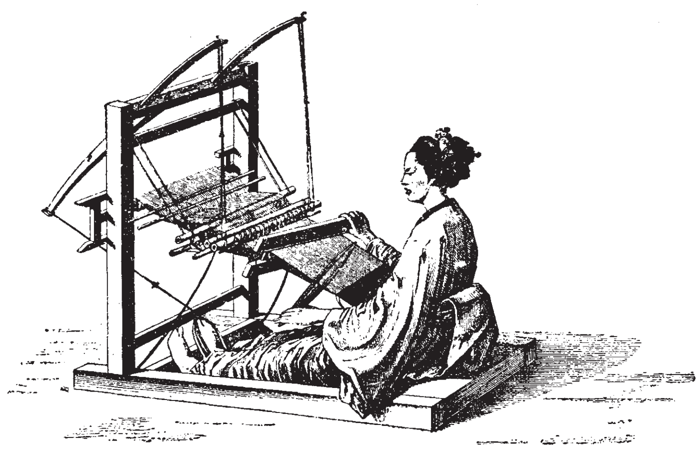
NORTHROP LOOM HISTORY, Vol. III, 1897-1900—818 pages.

These books are by the Secretary of the Draper Company and were compiled for general reference and use by counsel during litigation. They contain the history of the experiments and development of the loom, and associated matters of interest. Their contents are naturally private, and not intended for general circulation, although the public is therefore deprived of an acquaintance with a unique mechanical romance. It is believed that no other volumes of like size were ever prepared for such a purpose.

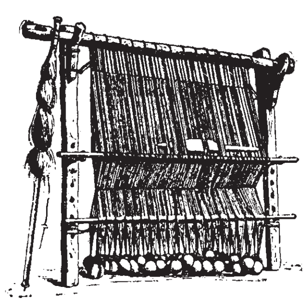
In our circular of November, 1897, we had a word to say to possible competitors which still seems pertinent. We therefore reprint a portion as a few unfortunate experimenters failed to note its truth on first appearance:

"There are doubtless many bright men who will in the next few years give time and toil in the endeavor to evade the claims of our patents while producing similar mechanism. In view of the many other fields for inventive skill we ask—Is it worth the while? We are undoubtedly the first in the field and legitimately entitled to a fair reward for the expenditure of money, loss of time and consumption of brain energy. Our success is no vagary of chance or lucky stroke of fortune. Every step in advance has been gained after constant thought and experiment, with ten failures for every success. The patent office has recognized the novelty of our devices by broad basic claims. We have searched the records here and abroad, and have proof that we are pioneers in our line. We shall defend our rights in the courts with the obstinacy of conviction, if such methods are necessary. We have no wish for chance to show our strength. A lawsuit involves a waste of energy for one side at least, and an expense for both. We appreciate these facts after thirty years of continuous litigation."

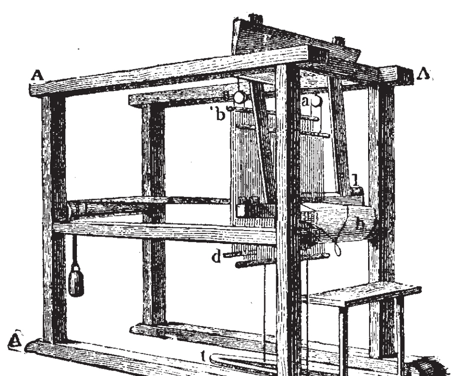
THE ART OF WEAVING.



The process of weaving cloth consists in interlacing a continuous thread amidst a series of parallel threads. Without giving an exhaustive history of the art it may be pertinent for further comparison to note down certain steps in its progress. It is fairly well established to-day that woven goods were used as clothing by the ancient Egyptians fully 6000 years ago. I have seen in Switzerland a preserved section of a net woven of



twisted threads supposed to have been the work of the Lake dwellers in pre-historic times. In the earlier processes it is probable that the warp threads were stretched on pegs, the weft being inserted by the fingers. In such weaving the warp threads usually lie vertically and in fact this is the method used to-day in producing rugs in the Orient with short wefts. With the use of longer weft also came the use of a stick with a hooked end for pulling it into position. If we are to form our further comparisons on a plain print cloth of the present width of 28 inches containing 64 threads of warp and 64 of filling per inch, it is possible that the rate of weaving by this method on such goods could be figured as low as one pick per minute per operative in the earliest use. Cloth is still woven by this method in India, although a harness motion is added. History gives us no record of the time at which the warp threads were divided by harnesses and the shuttle introduced. References are made to shuttles in the Bible and other ancient books. It is probable that the general styles of hand loom weaving were very similar for many centuries without definite change until the invention of the fly shuttle by John Kay in 1733. At this time, in weaving broad cloth, it was necessary to have two weavers at least, one at each end of the lay to throw the shuttle to the other. By Kay's invention one of these two men was dispensed with and even on narrow weaving a weaver could produce at least twice as much cloth per day.



No literature that I have run across gives any figures of production on the looms of this period and considering their crudeness in other lines, it is perhaps fair to assume that they could not produce at a greater speed than 20 picks per minute before Kay's time, probably averaging less. Kay's invention caused great commotion amongst the weaving trade and he was forced by persecution to leave the country. Cartwright's power loom patent was granted in 1785. Authorities differ as to the success of his first looms, some claiming that the early use was of no importance, while others refer to a mill of 500 looms in which Cartwright was interested, as being destroyed in 1790 by a mob in sympathy with the hand loom weavers. Whatever the cause, there were as late as 1813 but 2400 power looms in all Great Britain. The first power loom was introduced in Waltham in America in 1815. At this period one operative was required to each loom, as they had no weft stop motion and no self acting temples, the weaver having to intermittently move the flat wooden pieces with points at the end which held the cloth extended at the selvage. The invention of the rotary temple by Ira Draper in 1816, as developed several years later, allowed the operative to tend two looms instead of one. The speed of the common power loom at this time does not seem to be recorded, but it was probably between 80 and 100 picks per minute. In 1820 it is figured that there were about 15,000 power looms in England and Scotland and in 1830 perhaps 60,000. Even as late as 1840 there were said to be 250,000 hand looms still running. At this time weavers in England were not given more than one loom each, although in America they were running two looms, as the English manufacturers did not adopt the rotary temple so early as our American manufacturers. As to the comparative production of the common looms at this period, it is difficult to find any accurate basis of comparison. Hand looms were weaving print cloth as late as 1896 in Bohemia, where the production figured on 64 picks per inch in the cloth at ten hours per day would give an average of 35 picks per minute. I have been given figures of hand loom production recently that would suggest a possible speed of 60 picks per minute. About 1840 the weft fork began to be introduced and in America, by 1850, print looms were running at a speed of 150 picks per minute, with one operative tending four looms. Perhaps they even ran faster in England, but the operatives only tended two looms. From this period to 1895 the plain loom was not materially changed in principle, and yet the perfection of detail had brought the speed of the American plain loom up to 190 picks with one good weaver tending eight looms, while the English operative with looms at a speed of 220 picks per minute was tending four looms, though usually with a helper. In 1895 the Northrop looms then introduced immediately allowed one weaver to run 16 print looms at 190 picks and to-day it is assumed that a good weaver with the Northrop loom on prints can easily tend 24. In calling the speed of the American print loom 190 picks it is not intended to give a maximum. American print looms have run over 200 picks, but such is not the general practice. In the same way English looms have run higher than 220 picks, but the figures given are assumed as fair for the purposes of comparison and as illustrating the general practice.

Arranging a table of comparison, if we take 24 Northrop looms at 190 picks per minute, we have a total of 4560 picks. On the same basis, without allowance for stops, eight common looms would show 1520 picks, or four English common looms at 220 picks, 880 picks per weaver. The perfected hand loom would show perhaps 30 to 60. The power loom of 1850, at 150 picks, with four to the operative, would show 600 picks per minute, while the loom of about 1840, before the weft fork, would show with two looms per weaver at perhaps 130 picks per minute, 260 picks. Before the temple, the loom at 100 picks with one loom per weaver, would give 100 picks, while the hand loom before Kay at 20 picks, the loom of the middle ages with a possible 10 picks, and the loom of ancient history with a possible one pick per minute, brings our table down to a concrete illustration, which, even if faulty in detail, allows a comprehensive idea of the wonderful advantages since the earliest application of the art. The Northrop loom in eight years has added over 3000 picks per minute per operative; the development since 1850, 920 picks; the inventions from 1830 to 1850, 370 picks; the inventions from 1820 to 1830, 130 picks; the inventions from Kay to 1820 would add 80 picks, the progress previous to this time being represented by 20 picks. It will thus be seen that within two centuries the productive power of the operative has been increased 228 times, and it is also seen that **the advantages of the Northrop loom show twice as much in product as all of the other inventions put together.**

History is practically silent as to the inventors who supplied the earlier devices employed on the hand loom. It is not, therefore, known who suggested the idea of the harness motion with its shifting heddles, the swinging lay with its reed, the take-up roll, the early jaw temple, and the shuttle itself. Starting with Kay, the development before the Northrop loom is shown by the following table, material for which is collected from standard works on weaving. No attempt is made to include the various inventors of fancy loom devices, including the jacquard motion, the dobby motion, and other ingenious developments. It might be well, however, to note that the earliest mechanism for fancy weaving; namely, the drop box, was invented by Robert Kay, son of John, in 1760. In preparing the table it has also been thought well to limit the inventions to show only the anticipation of the general principles employed. It is impossible to properly note any but the pioneer inventors, and the dates given are usually those of their patents. Very possibly more credit is due other inventors not mentioned, for their perfection of ideas that otherwise would not have been useful.

1733. Fly shuttle, John Kay.

1786. Power loom, Edmund Cartwright.

(First suggestion of warp-stop-motion, weft-stop-motion, positive let-off and take-up.)

1796. Over-pick, binder, protector, and frog, Richard Gorton.

1796. Ratchet take-up, Robert Miller.

1803. Shedding motion, John Todd.

1816. Revolving temple, Ira Draper.

1821. Multiple harness motion, Robert Bowman.

1828. Complete power loom with modern over-pick, William Dickinson.

1830. Complete power loom, Richard Roberts.

(These two instances of complete power looms are mentioned as showing a general development of ideas not noted in detail, which together produced practical weaving machines.)

1831. Weft fork, claimed by Clinton G. Gilroy.

1834. First shuttle-changer, John Patterson Reid and Thomas Johnson.

1834. Weft fork, claimed by Ramsbottom and Holt.

1838. Picker check, Robert Pickles.

1840. Improved temple, George Draper.

1841. Weft fork improvements, William Kenworthy and James Bullough.

1842. Loose reed, James Bullough.

1845. Loom brake, John Sellers.

1846. Parallel shuttle-motion for under-pick loom, Warren W. Dutcher.

1851. Reciprocating temple, Elihu and Warren W. Dutcher.

1857. Automatic let-off, Snell and Bartlett.

1859. Rocker motion, W. Stearns.

1863. Loose frog, George Draper.

1867. Double beam let-off, Cottrell and Draper (George).

1868. Practical self-threading shuttle, J. A. Metcalf.

1868. Broad loom shuttle-motion, J. Lyall.

1869. Inside catch shuttle, J. H. Coburn.

There is quite a lapse between 1870 and 1890 in which no very important patents on plain looms were granted. In fact, looms made before 1850 continued running for years in competition with those built long after, the more modern looms not showing any notable advantage, except perhaps in heavier construction and higher possible speed. It must be remembered that I am still referring to the plain, common loom, not in any way intending to disparage the remarkable advance in the range of fancy loom devices in that period, including the hair-cloth loom, pile fabric loom, tape loom, etc., etc., etc.

Owing to an error in the index of the official British publication of Abridgements of the Specifications relating to Weaving, it was only recently that we discovered the first patent in which the idea of changing shuttles automatically is referred to. Such a reference occurs in that granted John Patterson Reid and Thomas Johnson, No. 6579, in the British Patent Office, dated March 20, 1834. The specification refers to a number of different inventions, contemplating the weaving of four webs of cloth at once in a vertical loom. It shows a mechanism designed to change the shuttles when any one weft thread breaks, or fails, the substitution occurring by an instantaneous movement, without any act of the attendant, and without stopping the loom, the mechanism being brought into action by a weft stopper annexed to the shuttle. The specification also refers to changing shuttle boxes to bring different colored weft into action. It also contains a jacquard mechanism. Both Reid and Johnson were prolific inventors, Johnson having taken out a patent as early as 1803, for a dressing machine, and Reid as early as 1827, for a lay motion. Johnson and Reid together took out several other patents for less interesting improvements.

The discovery of the Reid and Johnson patent of 1834 displaces a former claimant; namely, Charles Parker, who took out an English patent in 1840 for a very similar combination. The next invention in this line is of the year 1852. Meanwhile, however, Mr. Clinton G. Gilroy issued his noted work on weaving in 1844, in which in a satirical and humorous vein, he refers to the loom of Arphaxad, explained to Deioces, the first king of the Medes. In the description of this loom it states:

"*In order to avoid stopping the motion of the loom when one or more of the weft threads break, or become exhausted, a few spare shuttles are to be lodged in suitable receptacles, which are so arranged that the mere breaking of a weft thread will cause a change of shuttle instantaneously (by the substitution of a spare one in its stead).*"

The detail of the operation is described at some length; also the mechanism by which the loom will stop, supposing the total number of shuttles to be exhausted. He also describes a shuttle-changer for application to different colors of weft yarn to produce patterns in the cloth. The operation of the change of filling is similar to that in the Reid & Johnson and Parker patents, the details seeming to show that the author was well acquainted with the Reid & Johnson patent, and possibly the Parker patent also. Gilroy's reference is merely an indirect satire on our patent system, though many of his readers have since taken this part of his work seriously. Gilroy himself was an inventor of considerable prominence in the weaving line, and must have considered the idea of changing filling too chimerical to be practically developed.

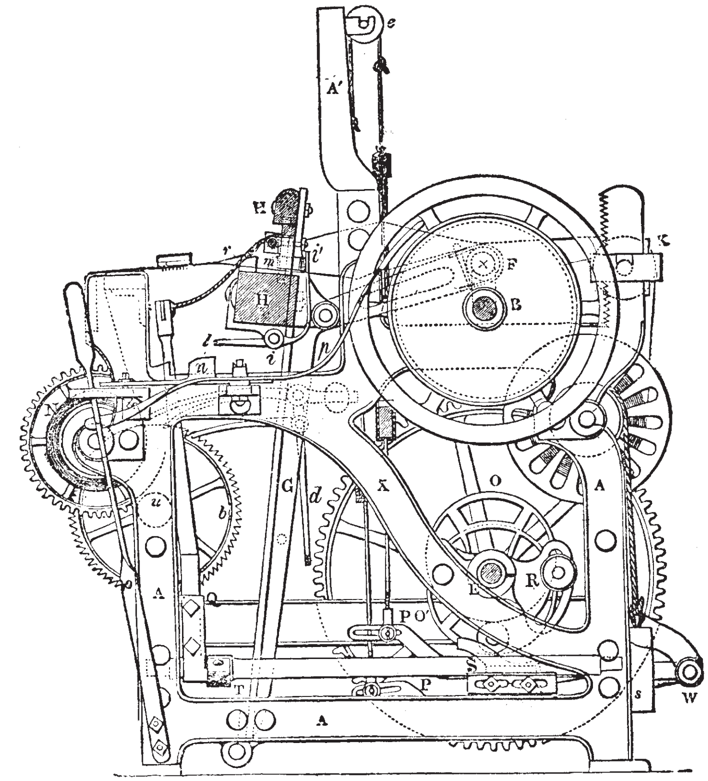


Fig. 20—Roberts Loom. Side Elevation.

In our earliest public reference to the Northrop loom, namely, that quoted in the paper of our Mr. George Otis Draper, read before the New England Cotton Manufacturers' Association, at their meeting in Atlanta, October, 1895, it was stated that looms rested while improvements changed the form of other cotton machinery, "*plain weaving remaining in its elementary stage*." Also, "*No radical change in any vital feature can be shown as the result of the last fifty years*." These remarks awakened some comment and criticism, calling forth a reference in our circular, *The Advance of the Northrop Loom*, to the loom manufactured by Richard Roberts in 1830. We now show a print of this loom, which was sixty-five years old at the time of the Atlanta meeting, and call attention to the fact that its general design and equipment is very similar to that of common looms at the time of the introduction of the Northrop improvements. Practically all of the important elements of plain weaving are shown in precisely the same relative positions which they now occupy; in fact, the weft fork is the only notable omission.

Other authorities have since added testimony of similar sort:—

"It may safely be asserted that at the present time no subject is receiving more careful consideration than that of weaving. In its essentials the power loom has changed little since the date of its invention. It has been made heavier, the details of the let-off and the take-up and the numerous other parts have been changed in their degree of efficiency, but little in their method of operation. Yet from the beginning of the century it has been clearly foreseen that a most radical change in weaving would take place upon the invention of a simple and efficient weft supplying mechanism."—[*Henry I. Harriman at the Boston meeting of the N. E. Cot. Man. Asso., April* 26, 1900.

The incompleteness of the earlier automatic looms is also verified:—

"In the case of weft supplying looms the difficulty of transferring such a large body as a shuttle, in the very short period of time given between picks, prevented their general use. The process was destructive both to the loom and the shuttle, and it is safe to say that none of these numerous inventions was ever put to practical use."—[*H. I. Harriman at Boston meeting of the N. E. Cot. Man. Asso., April* 26, 1900.

"But following 1870 there was a very general absence of work on automatic looms until there appeared that remarkable series of inventions perfected by the Draper Company."—[*H I. Harriman at Boston meeting of the N. E. Cot. Man. Asso., April* 26, 1900.

HISTORY OF THE NORTHROP LOOM.

In order to avoid the usually inevitable misstatements made years afterward concerning the early conception and introduction of important inventions, we will briefly record the pertinent facts concerning the early history of the Northrop loom.

The predecessors of our present Company started as far back as 1816, to perfect the power loom, Ira Draper inventing the revolving temple at this period. At the formation of the partnership of George Draper & Son in 1868, the business controlled by this firm and other Hopedale companies chiefly related to loom improvements, including let-off motions, parallel motions, thin-place preventers, loose frogs, etc. The ring and spindle inventions, however, coming in soon after, assumed such prominence that the loom department became a secondary feature. The members of the firm, however, often speculated on the possible advantages of automatic weaving, considering this as a possible field for future development.

On July 26, 1888, Mr. William F. Draper, Jr., heard of a loom invention in Providence, and saw the inventors and their device, which was an automatic shuttle-changer. He reported at home that the general idea was interesting, but the device not practical, in his opinion. Our firm then had an exhaustive investigation of the patent situation made through competent counsel. The report seemed to show that there was little novelty in this special application of the idea, but the firm had become sufficiently interested to risk a further trial of the general principle, and on December 10th voted a sum of $10,000 for experiments, and started an inventor, Mr. Alonzo E. Rhoades, on the task of devising a practical shuttle-changing loom. That Mr. Rhoades lost no time is proved by the fact that he had an operative loom ready to be started, with warp and filling, by February 28th of 1889. This loom, after being reconstructed with new patterns during the next few months, though not changed in principle, ran with good success. Some twelve years later, for purposes of patent litigation, the same loom was started up and run for days under the eye of a patent expert, accomplishing its purpose so well as to draw forth his unqualified approval.

Leaving the Rhoades loom at this stage, it is necessary to retrace our history to the year 1857, when Mr. James H. Northrop was born in Keighley, England, on May 8th of that year. After becoming an expert mechanic and factory foreman in his own country, Mr. Northrop came to this side in May, 1881, soon drifting to Hopedale, where he became employed as an expert on metal patterns. His invention of the Northrop Spooler Guide brought him to the notice of his employers, and he was selected by them to work out the idea of an automatic knot-tyer for spoolers. Although showing great ingenuity, the devices did not appear commercially practical, and the inventor became sufficiently discouraged to abandon the shop and devote his time to farming. Not finding this occupation congenial, he applied for employment some years later, in the fall of 1888, but the only opening then present was a job as mechanic at $2 per day. In February, Northrop, who had noted the progress of the Rhoades idea, spoke to Mr. George Otis Draper, who had just entered the firm of George Draper & Sons, stating that if given a chance he could put a shuttle-changer on a loom in one week's time, that could be made in quantities for a cost of $1 each. On March 5th, Mr. Draper drove to his farm and saw a rough wooden model of his idea, which was set up in his hen-house. At Mr. Draper's recommendation, the firm ordered another loom for experiments, and after its arrival Mr. Northrop was started on April 8th to work out his scheme. By May 20th he had concluded that his first idea was not practical, and having meanwhile thought out a new plan, he asked for an extension of time until the fourth of July in which to perfect it. On July 5th, the completed loom was running at speed, and as it seemed to involve more advantages than the Rhoades pattern, the weaver was taken off of the Rhoades loom and transferred to the Northrop. On October 24th a loom with new construction, from revised patterns, was running at the Seaconnet Mill in Fall River, and more looms of the same kind were started up there at intervals. Mr. Northrop had, however, meanwhile thought out his idea of changing filling in the shuttle, some of the parts of such a mechanism taking shape as early as October. The development at our works continued so favorably that by April of 1890 a lot of filling-changing looms were started in the same Seaconnet Mill, the shuttle-changing looms having been changed back to common looms, in view of the additional advantages of the filling-changing pattern.

To show the situation at this period we quote from a letter sent a prominent mill official May 15, 1890:

"Replying to your favor of the 14th inst. would say that we are getting along as rapidly as we could hope or expect with our new shuttle patent, considering the fact that we are doing what seemed to be a very difficult thing and reaching out into a field where we have nothing to guide us.

We are now running 12 looms in a mill constantly. They are producing from 5 per cent. to 10 per cent. more per loom than other looms in the same mill and are all making first-class cloth. We have not yet fully tested them to see how great a reduction we can make in the number of weavers. This we are proposing to do at the earliest moment.

We do not feel at liberty to change one or more looms for you at the present time and in explanation will map out to you our proposed course and we think you will agree with us that our policy is a wise one.

What we intend to do is to perfect by practically running as long as seems necessary these 12 looms before making or trying any more. When we have perfected these 12 looms we propose to put in 100 or 200 looms and when these 100 or 200 looms are running to our entire satisfaction we shall hope to apply the invention to the entire mill. When the entire mill is running to our satisfaction we shall then be very anxious to try our inventions at other places.

Our reasons for adopting this course are, first, we want to devote all our time and energy and inventive capacity to perfect the design in one place so as to be sure we shall make a success of it there. We believe that in this way we shall be able to put the invention on 3000 or 4000 looms or 10,000 looms much more quickly and satisfactorily than in any other way."

Attempts have been made by interested parties to show that these earlier trials were experimental in character, and productive of nothing practical at the time. Such, however, was not the case. These earlier trials, both of shuttle-changer and filling-changer, showed practically operative mechanisms, which were run on many looms weaving cloth for the regular mill product, with the regular mill help; in fact, when we transferred our trial of mechanisms from Fall River to another mill centre, the looms which we left were run for months by the mill help without superintendence on our part, and without even a casual inspection by any of our men.

We left the twelve looms running under the normal supervision of the mill management in March, 1891. To show how well these early mechanisms did their work we quote from the following letter received from the overseer of the room June 27, 1891:—

"I am proud to inform you that there has not been a mishap of any kind this week. The looms are weaving faster than the spinning frame can spin. Mr. ——— seems surprised to see the weavers standing at the end of the frame waiting for the doffers and their looms stopped. Notwithstanding having to wait so many times for filling, the production for the week ending 27th is seventy-eight (78) cuts."

We found it would be necessary to build complete new looms in order to derive the best results from the new mechanisms. This required an entire equipment of the necessary tools and a considerable enlargement in plant, as we had never been loom builders. We also found that it was advisable to develop a practical warp-stop-motion for use with the filling-changer, and this of itself delayed the introduction of the loom for several years. We ran into annoying mechanical difficulties, it requiring a long time to solve the apparently simple problem of tempering the shuttle springs so that they would not break. Even with the loom complete in every detail, we were not ready to take large orders until we had equipped a weave room of our own and run it continuously for many months.

To go into further detail and cover the entire ground would require more space than can now be afforded. The further contents of this book may aid in giving a proper conception of the further development; and yet the finished products shown convey no intimation of the countless experiments and trials of devices which have not entered into the accepted combination. Many of these are shown in our voluminous patents; others are still unhonored. They all form a part of the unwritten story, however, and often might furnish interesting chapters.

Our manner of developing improvements is outlined in the paper of Gen. Draper delivered before the New England Cotton Manufacturers' Association on April 22, 1903.

"Our routine has been, firstly, to run a number of looms experimentally in a room in our shop, and by means of special observers, in addition to the weavers, to note results in detail. These results are collated in daily reports, which are preserved for study and reference. Notes are made of everything outside of perfect weaving, the breakage, wear or slipping of parts, the failure of mechanism to act every time as intended, imperfections in the cloth, like thick or thin places, the number of warp and filling threads broken and why they break, if it can be known. After studying these reports in connection with personal observation of the running looms, changes are made, with a view to improvement if possible. Pieces that break are strengthened, or strains are removed; parts that slip are more securely fastened; and wear is obviated where it seems possible.

New devices are suggested to obviate cloth imperfections, or breakage of warp or filling, of bobbins or shuttles. The new parts are made and tested in comparison with the old ones, and nine times out of ten they don't work as well. Perhaps they don't overcome the difficulty; perhaps in overcoming it they introduce new ones. After one failure comes another attempt, and as a rule another failure, but something is learned from each trial and the general course is towards improvement.

The worst troubles to find and cure are those that are intermittent and infrequent. A device will work as intended a hundred or a thousand times. Then it fails once from some unknown cause; then it goes on all right as before. One seldom or never sees the failure except in result, and if it happens before one's very eyes the motions of the loom are too rapid to make eyesight of much advantage. One can only reason in these cases and, as in some other matters, unassisted reason without sufficient data comes pretty near being a *guess*. However, guess we must or let the defect continue, and in some cases we have guessed right. In others we are still guessing.

After we reach what seems a real improvement on one loom, we try it on a dozen, more or less, and keep records for a month or two. Here again disappointment often comes in and we return to fresh study and experiment. If, however, the advance proves real, we next arrange a mill test; that is, we fill an order, or a part of an order, for looms with the new device, and submit it to the tender mercies of those who have to run it practically and without any special interest beyond "day-pay and Saturday night."

This kills many an infant invention that would be of value if properly cared for. No new device in minor detail can succeed in the mill if it causes extra trouble, even if it does better work; and if any new adjustments are introduced, they are almost sure to introduce wrong setting. Lack of adjustment induces filing and chipping to attain positions that our experiments have shown to be wrong, but the fixers have not been through the experimenting and sometimes want to make improvements themselves. Cams that have been carefully worked out have been filed or ground so that they would not work as intended and the device has been condemned, and in more than one instance operating parts have been cut off with a cold chisel and the new device pronounced valueless.

After this experience we re-design, simplify and try to make the new arrangement easier to run than the old, and if we succeed and accomplish the original design, we have made a step forward.

It is fair to say that from these mill tests we often get ideas of great practical value from intelligent operators, who see necessities that had not occurred to us, more than enough, perhaps, to offset the stupid condemnation of others who do not appreciate fine points and never will until they have become a part of their regular drill, and only then because if *they* can't make a machine run, there are plenty of others who know how to do it."

Perhaps nothing in the line of history is more significant than our various statements published in the way of advertisements in trade papers. The whole of anticipation, progress and realization is thus set down as it was, or assumed to be, at the time. Those that follow are actual quotations from publications of the years mentioned.

1895.

"We believe that certain improvements we are soon to introduce will divide the cost of weaving by two on all plain goods.

We have a complete weave room of eighty looms running on print cloth, which is open to the inspection of interested manufacturers."

"It is a grave question whether we should invite more (loom) orders under the circumstances. A success may prove embarrassing when it comes so suddenly."

"Textile workers should be interested in all inventions that make their labor easier, cleaner or healthier.

What is more unclean or unhealthy than the now necessary process of sucking filling through a shuttle eye?

We are introducing a loom which automatically threads the shuttle without labor on the part of the weaver. This loom also prevents damage to the cloth, caused by broken warp threads."

"Many persons are disappointed in the Northrop Loom because it does not produce finished goods at one end from a bale of cotton fed into a hopper at the other side."

"We believe a purchase of common looms a grave error at the present day."

1896.

"A mill that orders common looms at the present time deliberately handicaps its future prospects."

"We now recommend this (Northrop) loom and stake our reputation on its success."

"The majority believe in progress. They favor inventions that relieve human labor by transferring operations from fingers to levers and cams. The Northrop Loom is of this class."

"We do not have to reply on assertion. Thousands of (Northrop) looms are in actual use testifying to their own merit."

"We have had additional orders already from six of the first ten mills supplied."

"Consign your common looms to the scrap heap where they belong, and equip with machines that will earn a profit."

1897.

"The Northrop Loom is now an Unquestioned Success on all plain cotton fabrics. . . . We have never had a more positive conviction. This Loom must be adopted."

"When mills like the Pacific and Tremont & Suffolk throw out common looms for New Northrop Looms, the question of success is solved.

Before the year is over the Amoskeag Mfg. Co. will have nearly 10,000 looms changed to take our motions."

"Weavers on all common looms choke their lungs with cotton fibre. When the filling is colored the effect is more or less poisonous, and in either case the health is undermined."

"It is commercial suicide to buy a common loom in the face of facts easily known and proved."

"Why not return to hand looms and get a cheap equipment, also giving more laborers employment?"

1898.

"What would you think of a loom that requires but half the labor, weaves more perfect cloth and will run over time without need for attention?

Would you buy it at a price that makes it the cheapest machine ever put in your mill, or would you wait, and doubt, and doubt and wait, until the competition of the enterprising forced you into line at the rear of the procession?"

"Adverse criticism has often killed a good idea in its infancy while its strength was not equal to the struggle. We escaped the fate which many prophesied."

"The only hope for our cotton mills in these critical times lies in the prompt adoption of improved machinery. . . . It may be urged that if all mills put in new machinery they will simply be back at the old competitive level—very true—but they *will not all do it.* Therein lies the chance for profit for those who have the necessary courage, capital, or happy combination of both."

"The doubters and the skeptics are not yet silenced—they never will be. Some of them still think it a great mistake for mills to use high speed spindles, filling frames and revolving flat cards. We have no time to waste on their conviction, as their species must yield to the natural law—the survival of the fittest."

1899.

"The mills that refuse their opportunities will find their future utility serving as picturesque ruins in the landscape."

"If old mills stand in timid dread on the brink of indecision the new mills will crowd them over the edge."

"You can feel assured that merit is recognized when the copyist appears—but you don't want a copy."

"Let us then renew the assurances of our distinguished consideration, while we devote our energies to filling the orders with which we have been favored."

1900.

"The greater part of the cloth woven in this country is made on plain looms. We have devoted about 10 years to the perfection of the plain loom and have now made it automatic and self-protecting against errors."

"We intend to keep up with the demand for our machinery if we have to roof in the whole town."

"A new common loom in a Southern cotton mill is now a curiosity."

"We are battling with nature, filling ponds, diverting river channels, raising valleys, etc., to make room on which to continue extensions."

"We still solicit orders in the confidence that bricks and lumber may be obtained in sufficient quantity to house our increase of plant."

"Why ship cotton to Europe when mills at home can manufacture it more profitably now that improved machinery gives them another advantage?"

"The great development of the Southern cotton mill system started with the Northrop loom and the continued association of the two forms an interesting object lesson."

"We melt 100 tons of iron per day to make the castings for our Northrop looms, etc. But that is not enough. Enlargements still in progress."

"We have now sold over 60,000 Northrop looms. We are shipping 1500 a month and enlarging our works to increase that output. We are employing 2500 men and shall greatly increase this force when new shops are ready. And what does this all mean? Simply that the success of the Northrop loom is astounding, even those who have held their faith."

"The steady progress of the Northrop loom is a certain evidence of its merit. Adverse criticism has often killed a good idea in its infancy while its strength was not equal to the struggle. We escaped the fate that many prophesied. Our loom has passed the trial stage."

"Let all who favor progress unite in placing American cotton mills where they can compete with foreign countries without reducing their labor scale to the standard set in England, Germany, Russia, India, China, Japan and other outside manufacturing sections."

"We build the famous Northrop Loom. It is also manufactured by our licensees in Canada, Germany, France and Switzerland. Four of these looms are running at the Paris Exposition, attracting wide attention."

"The successful development of our loom gives a mill a chance of making a great saving in its expenses without increasing the labor or responsibility of the management, and by reduction of the number of employes it actually lessens the investment necessary for tenements and the labor used in paying off and supervising. The possible profit from a Northrop loom mill will pay good dividends when a competing mill with common looms is not able to show more than an even balance. Mills have been prompt to take advantage of improved machinery in the past, as they universally use high-speed spindles and are thoroughly committed to the revolving top flat card. Neither of these changes, however, can show more than a fraction of the profit possible with our loom, for the saving in weaving is more than the entire cost of carding with the picker-room thrown in, and more than the entire cost of spinning."

"New mills are flooding us with orders, and old mills must realize that equality in competition demands equality of equipment."

"We used to claim that weavers could attend Northrop Looms in the proportion of two to one common. The users are finding this prediction far too moderate as they often run three to four times their former limit. In several mills weavers are paid less than one-half the former price for weaving cloth per cut, and yet make higher wages than when running common looms.

A mill that cannot appreciate that statement simply cannot appreciate the tale told by concrete figures. Those who attempt to sell cloth handicapped by an extra cost of from one cent per pound upward, can cling to their obsolete common looms while their more enterprising neighbors glean the profits."

"We begin to feel quite independent in our loom trade, as the results of experience have proved that our position is absolutely unassailable. A few facts speak for themselves: Good weavers running 24 to 32 print looms and 20 3-harness looms."

"In one large print mill the average number of looms per weaver is 18."

"We are employing more hands than ever worked before in an American Cotton Machine Shop and are enlarging our plant in every direction."

"Every new idea meets the same opposition, goes through the same routine. In the first few years this machine had to bear the brunt of criticism, antagonism, doubt, fear, and misrepresentation. Now it suddenly sweeps away opposition, flooding us with orders, and necessitating the doubling of our plant. We intend to keep abreast of the demand if pig iron and steel can be obtained in sufficient quantity."

"It is an interesting problem to note how much longer the old mills can continue competition, when handicapped by the obsolete common loom."

1901.

"With a record of 75,000 looms sold, it is no longer necessary for us to predict what these looms will do.

We point to what they have done."

"Although our order list lengthens and strengthens, we do not adopt the simple and inexpensive plan of building without change, but continually add improvements whenever possible."

"We shipped more than 16,000 complete Northrop looms during the last year. What better testimonial of value could be presented? With our new plant and enlarged facilities we shall easily beat that record in 1901.

This simply means that those running common looms must expect a continuously harsher competition."

"Having adopted a business founded on improvements in cotton machinery, the habit of striving after perfection leads us, at times, to give the public more than they have required. Although the Northrop loom has sold faster than we could supply the trade, we have recently made many expensive changes, in spite of the fact that our customers, if ignorant of their existence, would probably have never realized the need of them. All loom improvements tend toward increased cost of construction. We have taken the common loom and not only applied important attachments, but have also raised its mechanical grade."

"Every loom that we sell furnishes an additional argument for replacement of common looms, as each Northrop Loom increases the competition that its rivals must endure.

Those having common looms must admit that, sooner or later, the Northrop loom, or some similar type, will replace them. Then why delay? Every year of postponement could have helped to pay the cost. Those who are waiting for the similar type to be developed can hardly find a large degree of encouragement from the present situation. They used to wait, in the same way, for spindles of possible competing capacity in earlier years. They waited five, ten, twenty years,—and then finally fell into line, after losing a large share of their comparative value. Some of them lost time and money in experiments with inferior styles, and history will undoubtedly repeat itself. Some insist on patronizing cheap doctors, cheap lawyers, and cheap eggs. Perhaps they are satisfied with the results. Our loom is not cheap in price, but is certainly cheap at the price."

"The success of the Northrop Loom has forced a series of wide spreading events.

It has delivered the trade in looms, for plain fabrics, of the United States, over to a company which had never sold one loom prior to 1895. It has stimulated the building of new mills and the increase of the American textile industry to an extent never before known. It has forced us to more than double our plant, and more than treble our number of operatives.

The profits have been shared with the manufacturer, who has cheapened production; and by the laborer, who has received better wages.

While common loom mills are shut down, Northrop loom mills continue running."

"We shipped more than 25,000 complete Northrop looms during the eighteen months of January, 1900, to July, 1901. What better testimonial of value could be presented? Southern mills are taking their share, but there are still thousands of old looms that ought to be replaced."

"We shipped nearly 6,000 looms in the first three months of the year 1901.

Facts like these carry conviction to those of average comprehension. We shipped over 9,000 Northrop looms from our works in the six months ending July 1, 1901. Further comment is unnecessary."

"We enter on the seventh year of our loom business with an enormous order list, a doubled plant, and a reputation established by the experience of our customers.

Every claim has been justified, every assertion proved.

· The Northrop Loom *does* halve the labor cost of weaving, *does* make better goods, and *does* earn dividends for its purchasers.

Having absolutely removed the common loom from competition, so far as new sales are concerned, we may next have to spare some slight consideration for the mushroom element of automatic substitutes designed to share the fruits of our victory. Let none of us get unduly excited, however, until their trial has proved them worthy of attention."

"We started to apply attachments to looms in order to make them more automatic. We soon found it necessary to first improve the loom itself. We believe that we are turning out a weaving machine fit to class with other developed mill machinery, and not a cheap mass of ill fitting parts, half wood, half metal, nursed into efficiency with bits of leather and string.

Our castings are machine moulded to ensure uniformity. They are drilled in jigs and assembled to gauges. We use iron and steel wherever possible. We know we put more expense into this loom than any other builder of similar machines. We are not content with having already done a larger loom business per year than any competitor. We see no reason why we should not sell all the looms needed for plain weaving."

"Our total sales to date, including old looms changed over, amount to over 74,000.

We have built up a modern plant of large capacity in order to meet the demands of our customers, and now have 22 acres of floor space in connected buildings, the greater part of which represents recent construction.

We are now ready for increased business and await it with a confidence based on the evolution of the past. It may be noticed that we refer more often to the amount of our sales than to the details of our products. The latter course would simply illustrate *our* opinion, while sales illustrate the opinion of our *customers*—and that counts."

"We know no half-truths in mechanics.

A machine is either efficient or incapable—superior or inferior.

The Northrop Loom has now been running in large quantities for more than six years. Its success is proved by the frequency of orders from those having the knowledge that comes with use. Some of the earlier customers have lately wished to actually duplicate those first machines part for part.

But we build a better loom now.

We have an experience gained by continued construction and experiment. We have vastly increased our range and our variety of models. We cannot only show a purchaser important novelties, but can refer to successful operation in any of the ordinary lines of application."

1902.

"The largest single order we have yet taken has just been placed with us for Northrop Looms by the Grosvenor Dale Co., of North Grosvenor Dale (and Grosvenor Dale), Conn.

These looms were chosen after lengthy and continued trial of former lots. These were used in a wide variety of cloth, including various standard weaves for which the Grosvenor Dale Company has long been famous. Those who have been cautiously awaiting the outcome of others' experiments may now perceive the verification of our earlier contentions."

"The Spindle and the Loom.

Our first ten years of spindle sales, about 2,000,000.

Our thirty years of spindle sales, about 20,000,000.

Every prominent mill in the country uses them in their Spinning Frames or Twisters.

And yet in the first ten years the introduction was comparatively slow.

Our first seven years of loom sales figure over 75,000 (including looms changed over), and there are only about 375,000 looms in this country to which our improvements are at present adaptable.

Every mill that waited to change spindles made a mistake. They admit it by their present policy.

A less proportion are making the mistake of indecision in the loom line, but the conservative are still ruining their chance in the same old way.

Every year of delay means just so much lost profit. The above figures of fact prove more than pages of argument. Think them over."

"On June 1st our unfilled orders for complete Northrop Looms figured exactly 15,701—and the boom has hardly started."

"Our unfilled orders for complete Northrop Looms figured exactly 21,586 July 1st, 1902. The boom is beginning to boom."

"Delegations of foreign business men, operatives and labor leaders have been visiting this country to investigate the claimed advantages of our Northrop Loom.

We started selling them eight years ago and have averaged sales of over 10,000 per year.

Outsiders are becoming alarmed and yet there are American mills still blindly buying common looms.

Not that we have any reason to complain. It takes a doubled plant to keep pace with our orders—but it ought to take a trebled plant."

"In spite of loom shipments during August of 1799 looms, our unfilled orders still amounted to over 20,000 September 1st, 1902."

"Out of 64,540 looms now running or ordered by the single state of South Carolina, 27,980 are Northrop Looms."

"20,000 looms to build. 20,000 Northrop Looms. Equivalent in cost to 60,000 common looms. 10 months' work at 2,000 looms per month and new orders coming in all the time. Works must be increased again. 300,000 looms yet to be replaced in the United States alone, and new mills being organized. Such is the situation confronting the Draper Company of Hopedale, Mass."

1903.

"We shipped 15,746 complete Northrop Looms in 1902, and applied besides, 1,028 filling changers and 1,234 warp-stop devices to looms in mills.

We commenced the new year by shipping 2,500 complete looms the first month.

Let the good work go on."

"Our present output of Northrop looms, over 2,000 per month. The majority of new orders are placed by Southern Cotton Mills."

"We have today sold over 80,000 complete Northrop looms. We have applied attachments, in addition, to over 15,000 looms. We figure that there are still 350,000 looms that must be replaced. They will vanish as surely as the common spindle and the old style card. We are enlarging our plant to prepare for their elimination. In a certain well known mill six weavers and four boys to fill hoppers run 216 Northrop looms. In another mill no weaver runs less than 24 Northrop looms. Facts like these breed conclusions."

"We have a new Northrop Loom that should be of interest to weavers of print cloth and similar goods. It has the latest large pattern hopper, our steel-harness warp stop-motion with simplified knock-off, a double fork to prevent thick and thin places, the simplest take-up ever devised, our improved Draper-Roper let-off, and a new device called the Anti-bang, which prevents jar and breakage when a shuttle is trapped. We call it the J model. Large orders already being filled."

THE PRESENT STANDING OF OUR LOOM—APRIL, 1904.

A record of over 100,000 looms actually introduced within a period of nine years, sold at prices equivalent to three times the cost of the common looms with which they compete, is certainly sufficient evidence that the Northrop loom has come to stay. The amount thus paid us for Northrop looms would actually replace three-quarters of the common cotton looms now running in the whole United States. As our last year's sales were larger than those of any previous year, it is evident that the introduction is not based on any quick enthusiasm, or false data.

We started with the assumption that the Northrop loom would enable the weaver to produce a doubled product; in fact, before even making this modest assertion, we proved its truth to our own satisfaction by running a weave room of eighty looms in our own works, for many months, open to the inspection of hundreds of practical mill men. The first looms that we put out were therefore seasoned, as it were, by experience; in fact, the first models ran so well that we have been asked in recent years to duplicate them.

It is no slight task to introduce an improved machine which aims at replacing the entire equipment of the most important section of one of the greatest industries in the world. It cannot be done in one year, or one decade. Nothing within our memory has so completely ousted competition as the high speed spindle; and yet comparison of sales will prove that our loom has met with readier appreciation in the earlier years. There are still several hundred thousand common looms which should be replaced, and which will be replaced. The delay is not due to hesitation based on disbelief, but rather a hesitation based on financial conditions. With new mills, where capital is raised by subscription, equipment with Northrop looms is becoming a matter of course; but an old mill faces a serious proposition when considering the replacement of an entire division of its plant, where the surplus is not sufficient to meet the cost, and where stockholders are not inclined to pay assessments, or take new stock. The mills that have a comparatively new equipment of common looms are naturally indisposed to reduce their valuation by considering them practically worthless for active use. We are, however, selling tons of looms for junk, that are equal, if not better, than similar looms still bought by a few obstinate adherents to obsolete methods. There is also a class of overshrewd managers who wait in hope that competition may reduce our prices, or that patents will expire in time to force a reduction to meet their demands. Nine years of constant introduction finds the anxious ones still waiting the possible competitor; and the constant improvement, with continual issue of important patents, assures us that our hold on this line will continue beyond the time to which their hopes might limit us. Meanwhile these waiting purchasers are losing the possible profits of use. The fact that they may be making favorable showings by reason of "luck" in purchase of cotton, especial advantage in situation, labor, or power, cannot disguise the fact that with the Northrop loom their profits would be still higher.

When we refer to the Northrop loom improvements, we are speaking primarily, of the filling-changer, the warp stop-motion, and their co-operating parts. Before our application of these devices, there had never been a successful use of filling-changing devices of any nature, and warp stop-motions were only used in a very limited field, a few instances being known of their application to special classes of double warp weaving. There is hardly any vital change in any line of mechanics, which so suddenly brought successful automatic mechanism into extensive use, without the preliminary record of long use of partially successful devices of similar nature. This fact is particularly curious, in view of the fact that a warp stop-motion was one of the inventions disclosed in the original power loom specification of Cartwright, as shown in his patent of 1784. Many inventors had struggled for years with the problem of automatic change of shuttles. The inventor of the Northrop filling-changing devices, however, borrowed practically nothing from the former art in this line, and when it was found necessary to incorporate a warp stop-motion with the filling-changer, there was nothing formerly developed that could be adopted, and inventors practically started in this field also without the aid of prior thought.

Neither the filling-changer nor the warp stop-motion necessarily increases production in the loom itself. The filling-changer does save time formerly occupied in changing shuttles by hand, with the loom stopped, but the warp-stop-motion actually decreases production by stopping the loom oftener than it would be stopped in the common practice of plain weaving. The combination of the two devices, however, allows the operative to multiply efficiency; for the filling-changer replaces labor, and the warp stop-motion relieves the annoyance of constant oversight. To appreciate the great saving introduced by the filling-changer, it may be well to note the operations gone through by a weaver on a plain loom, when the filling is exhausted. They follow in the sequence now recorded, the weaver performing the following functions:

1. Releases the shipper brake.
2. Pushes the lay back.
3. Withdraws the shuttle.
4. Puts the reserve shuttle in the shuttle box on the lay.
5. Pulls the shipper handle to start the loom.

6. Rubs the cloth below the breast beam to prevent a thin place, if light goods are being woven.

7. Picks up the discarded shuttle again.

8. Pulls the shuttle spindle out on an angle.

9. Removes the empty bobbin or cop tube.

10. Puts in a new bobbin or cop.

11. Pulls off a sufficient length of filling.

12. Snaps the shuttle spindle back into place.

13. Holds the filling over the shuttle eye entrance.

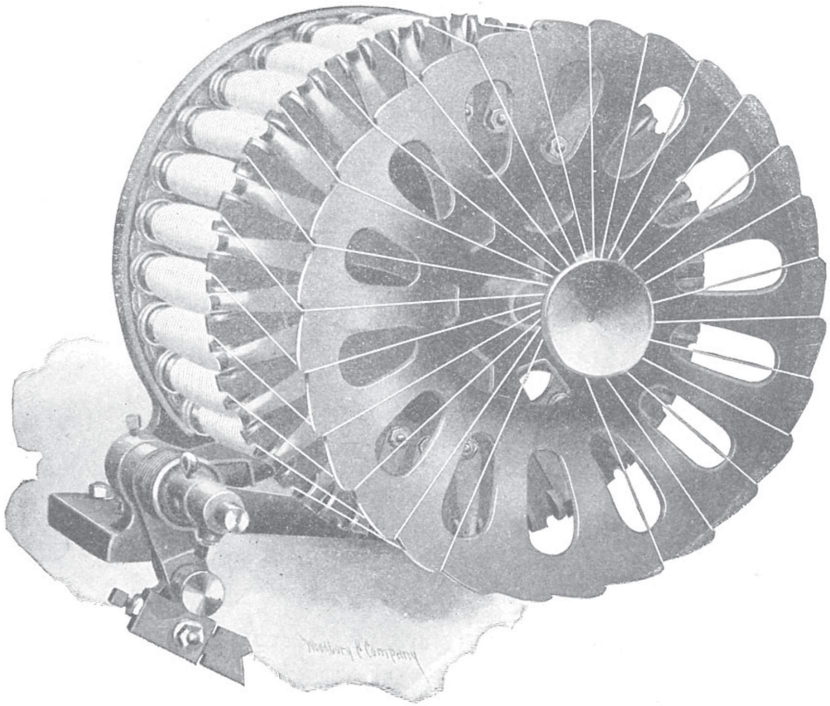
14. Sucks the filling through the eye.

15. Places the shuttle in its holder, where it remains until needed.

Now, this series of performances must be gone through with every time the filling is exhausted. On one loom, the filling may run from one minute to twenty minutes, according to the size of the yarn and the amount of yarn in the shuttle. The average time is perhaps six minutes, especially if we count the number of times that the weaver must come to the loom to start it up when the filling breaks. With a loom having an average of six minutes between such stops, the weaver must come to the loom once every ten minutes. If running eight looms, he would have such a duty nearly once a minute. With the Northrop loom, on the contrary, the weaver can fill a hopper containing 25 bobbins, which, with the same average of running time, would last two hours and a half, without requiring attendance. But a co-operating feature of great advantage with the Northrop loom is the fact that the weaver can fill the hoppers when convenient, rather than be forced to come to the looms with irritating regularity.

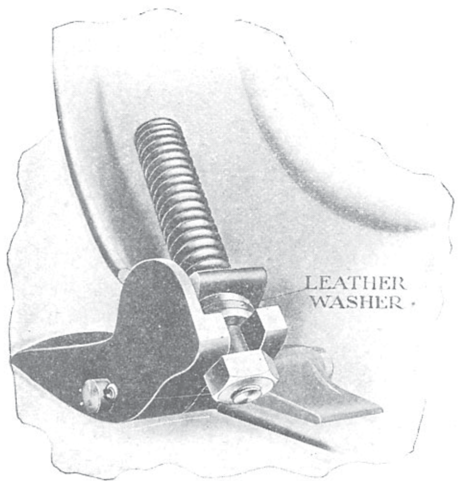
Referring to the associate attachment, the Warp Stop-Motion, it is, of course, well known that the warp threads will break in weaving. On a common loom, the broken thread will not be raised by its heddle, and thereby leaves an open space in the cloth, more or less visible to the eye, according to the character of the goods woven. Very often the broken end gets tangled around adjacent threads between the harness and the reed, holding several of them either above or below the tip of the shuttle, which therefore causes a defect known technically as a "float" or "overshot." If the weaver does not notice the fault promptly, the extra strain will break many of the warp threads, and in any event, a pickout is necessary. In some mills, a weaver is forced to stop all looms under his charge while attending to a pickout. It is not necessary to explain the trouble caused by these defects to any weaving expert. The temples must be pulled back, all the filling threads that have been laid since the tangle commenced removed by a tedious combing operation, the warp beam must be turned back, the tension of the cloth properly adjusted, and the loom again set in motion.

When we first applied filling-changing devices, we found that the weaver, although greatly relieved of manual labor, was even more uneasy, on account of possible overshots, having more looms to look after. We saw that it was absolutely necessary to furnish a protection in the way of an accurate warp stop-motion, so that there should be no mental anxiety whatever, and no necessity for alert observation. It took our inventors several years to produce a practical mechanism of this nature; in fact, the introduction of the Filling Changer itself was delayed for quite a period while waiting for the associate mechanism. With the protection of the Warp Stop-Motion, a weaver is only limited in the number of looms attended, by the amount of warp breaks which must be repaired, and the number of bobbins which can be put into the hoppers within the time to be given. Under present systems, Northrop loom weavers are usually relieved of oiling and cleaning their looms, so that apart from the warp and filling duties, they have practically nothing to attend to, save the removal of the cloth.



PERSPECTIVE VIEW OF LARGE HOPPER, ORIGINAL DESIGN.

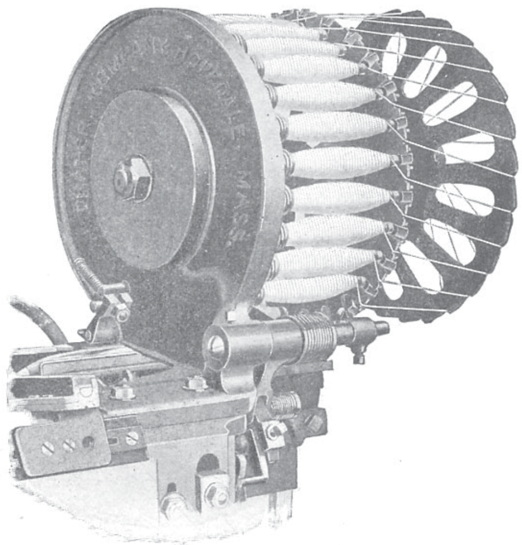
Taking the various attachments in order for detailed consideration, we shall consider the Hopper first, as the more important element of the whole combination. The cut shows the "Large Hopper," or "24-Bobbin Hopper." It is operated in rotation by the reverse motion of the transferrer. Our latest forms have a new and improved bobbin support,

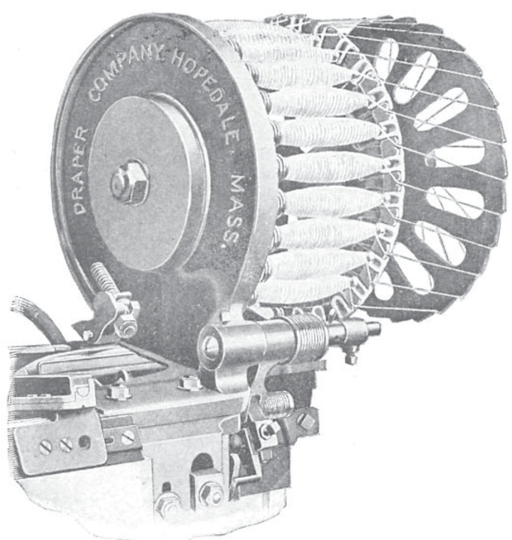


provided with a leather washer cushion to prevent breakage, and we are also using a new form of bobbin tip holder, which will take either bobbins or cops, as desired. We started with a hopper that held a supply of 14 extra bobbins, but the change to the 24-bobbin hopper has proved a distinct advantage, removing the Northrop loom still further from competition with the possible perfected Shuttle-Changing loom, which would probably be limited to a reserve supply of six or eight shuttles. We proved by an absolute test on our old hopper, that a reduction in the number of bobbins held in reserve, placed an absolute restriction on the weaver's capacity; and the converse of the proposition is a natural sequence.

A vital principle of the Northrop invention is contained in the Shuttle, which is adapted not only to hold a bobbin or cop skewer, but to hold it so that it may be automatically removed by the entrance of a new bobbin or cop skewer. The spring jaws of the Northrop shuttle co-operate with the rings or ribs, on the bobbin or cop skewer, so as to hold either one normally

Our first Large Hopper. Holds twenty-four extra bobbins. Is rotated by reverse action of transferrer.





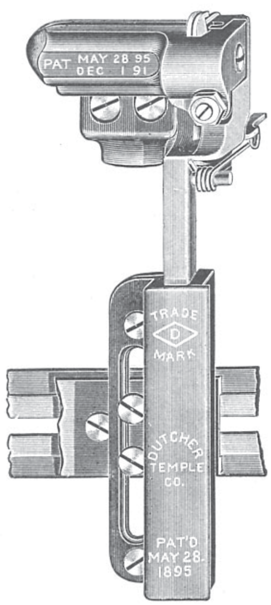
Present pattern Large Hopper. New end holders adapted for either bobbins or cop skewers. Also new bobbin support, and thread discs with wider surfaces for thread to bear against.

in proper horizontal position, and yet liberate them quickly when opened by the entrance of the new filling-holder, pressed into the shuttle from the hopper when the transferrer is in motion. The Transferrer is a simple pivoted lever with a hammer head, normally in position over the lowest bobbin in the hopper. A pivoted dog attached to a crank arm on the transferrer is normally out of reach of a moving part on the lay called a "Bunter." When the supply of filling in the running shuttle is either broken, or exhausted, the ordinary weft fork detects the fault and by simple co-operation with a moving shaft raises the dog aforesaid to meet the impact of the bunter, thereby transfering the forward movement of the lay through the transferrer pivot, to press the transferrer head down onto the reserve bobbin in the hopper, and push it into the shuttle. The bobbin formerly in the shuttle falls through the exit opening of the shuttle, down onto a guiding chute into a large box, or receptacle, attached to the loom side.

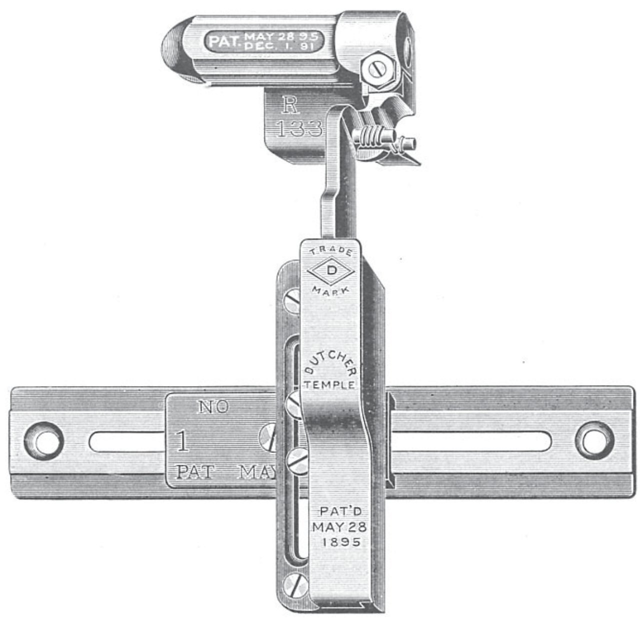
Reference to the cuts, which show various views of the shuttles, bobbins and cop skewers, will make the operation clear.

It is not only necessary that the new bobbin should be placed properly in the shuttle, but it is vitally necessary that the thread on the new bobbin should enter the shuttle eye, so that it may be properly drawn off in weaving. The threads of the bobbins in the hopper are wound round a stud in the center of the rotating hopper itself; and when a bobbin is transferred to the shuttle and the shuttle is thrown by the picker-stick, the thread still held by the hopper disc automatically enters the slotted eye of the shuttle; the final position, however, not being attained until the shuttle has been thrown back from the opposite side of the loom.

It is quite evident that when the shuttle receives the bobbin it must be under the hopper in approximately correct position. Variation is allowed by reason of the several notches in the shuttle spring, and also by reason of an incline, which guides the bobbin down into the spring, even if the shuttle be quite a distance out of place. To protect against any abnormal position, which would cause the incoming bobbin to strike a solid part of the shuttle and cause breakage, we provide a device known as the "Shuttle Position Detector," which reaches a finger across the front of the shuttle whenever the dog on the transferrer is raised. If the shuttle is in the path of this finger, the dog will not be raised sufficiently to encounter the bunter, and therefore no transfer will take place. If this be twice repeated, the loom stops automatically by a device called the misthread stop-motion, attached to the fork slide, so that the weaver knows that the shuttle is not being properly picked. The same mechanism will also stop the loom, providing the hopper is exhausted, or providing the shuttle fails twice to thread, or "misthreads," as we term the operation. It will be remembered that the thread on the incoming bobbin is attached to a stud on the hopper. It therefore extends from the stud to the cloth, and, if not attended to, would break in time from the strain, as the cloth moves towards the take-up roll, and the snapped end might fly into the cloth. We therefore provide a Thread-Cutting device, attached to the regular temple, which operates from the motion of the lay to sever any such threads close to the selvage. As it operates every time the lay beats forward, it has many chances to cut the thread.



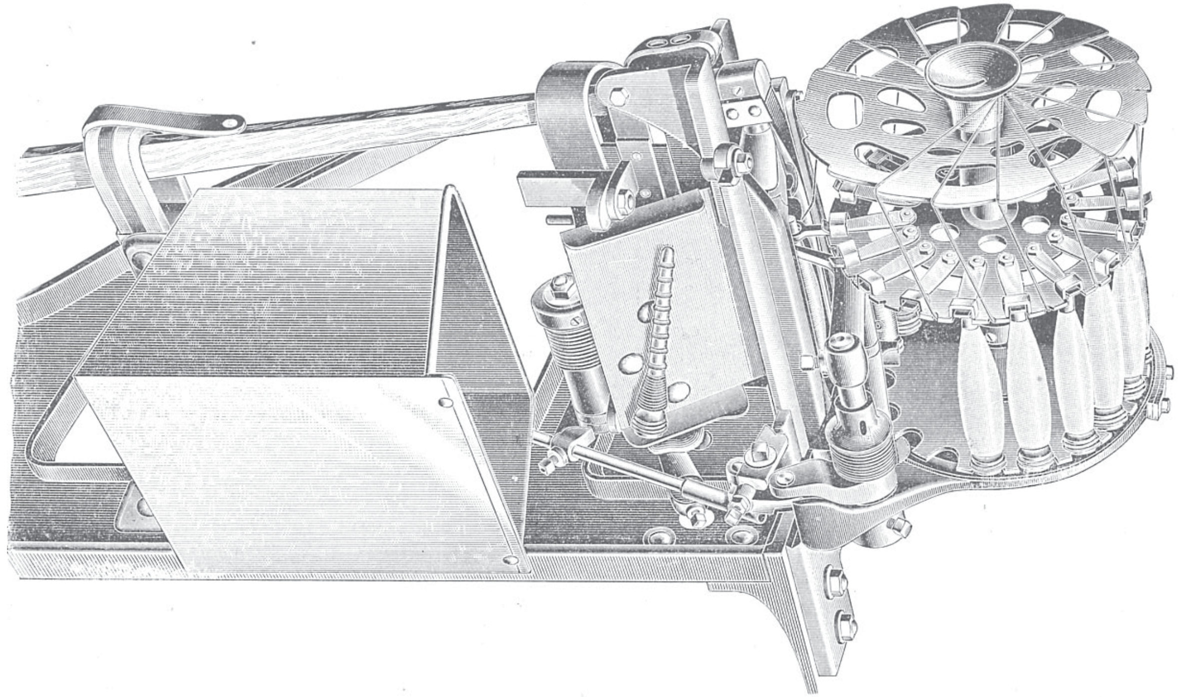
Early form of Thread-Cutting Temple.



Later form of Thread-Cutting Temple.

Made with solid heel so that a loose heel will not bring extra strain on the cutter and cause the temple to be reciprocated through the cutter.

It may be noticed that Filling-Changing mechanism includes five distinct and separate devices, namely; the Filling-Changer itself, the Shuttle, the Shuttle Position Detector, the Misthread Stop-Motion and the Thread-Cutting Temple. There are, therefore, several distinct lines, all covered by patents, many of which extend much longer than the original patents on the original mechanism.

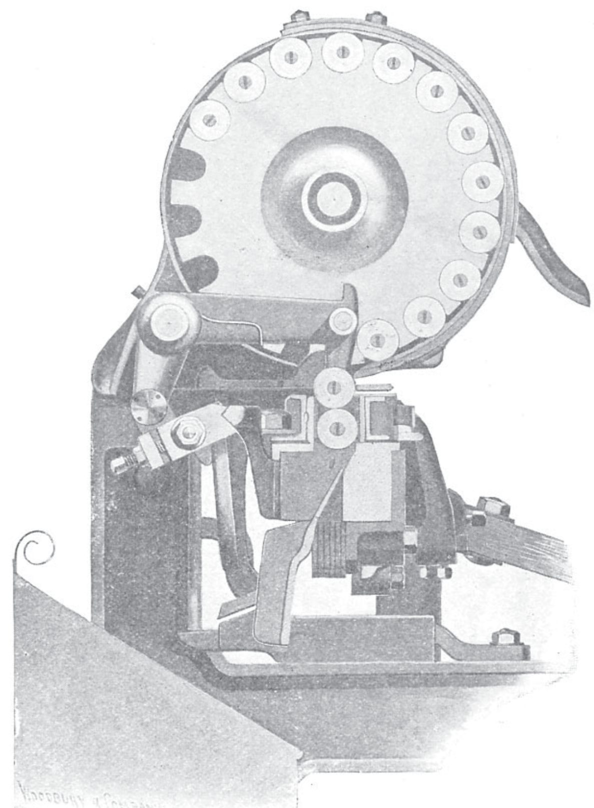


DETAIL OF HOPPER MECHANISM ON A MODEL LOOM.

(Other parts of loom erased.) Shows empty bobbin falling into box while fresh bobbin is being inserted.

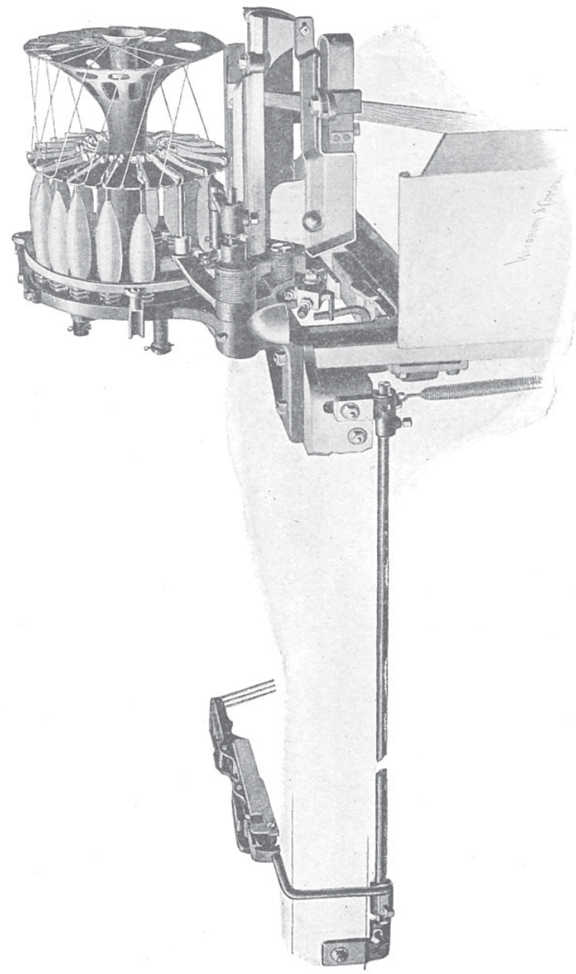
As shown, the transferrer is placing the bobbin in the shuttle, the dog being in engagement with the bunter on the lay. The empty bobbin is falling down the chute into the box. The chute as first designed was a movable part, independent of the lay itself.

This cut was made from our first model loom and happens to show the hopper on the left side, we making hoppers in rights and lefts at that time.



CROSS-SECTION OF A NO. 1 COP-HOPPER WITH TRANSFER TAKING PLACE.

The entering cop skewer has just started the pressure that expels the one in the shuttle. It has still to move some distance down the chute to reach the box. The expelled skewer is not empty in this instance, as it illustrates a case in which the filling thread broke while weaving.



DETAIL OF CONNECTION

Between the filling fork which detects the absence of filling and a No. 1 cop hopper or magazine.

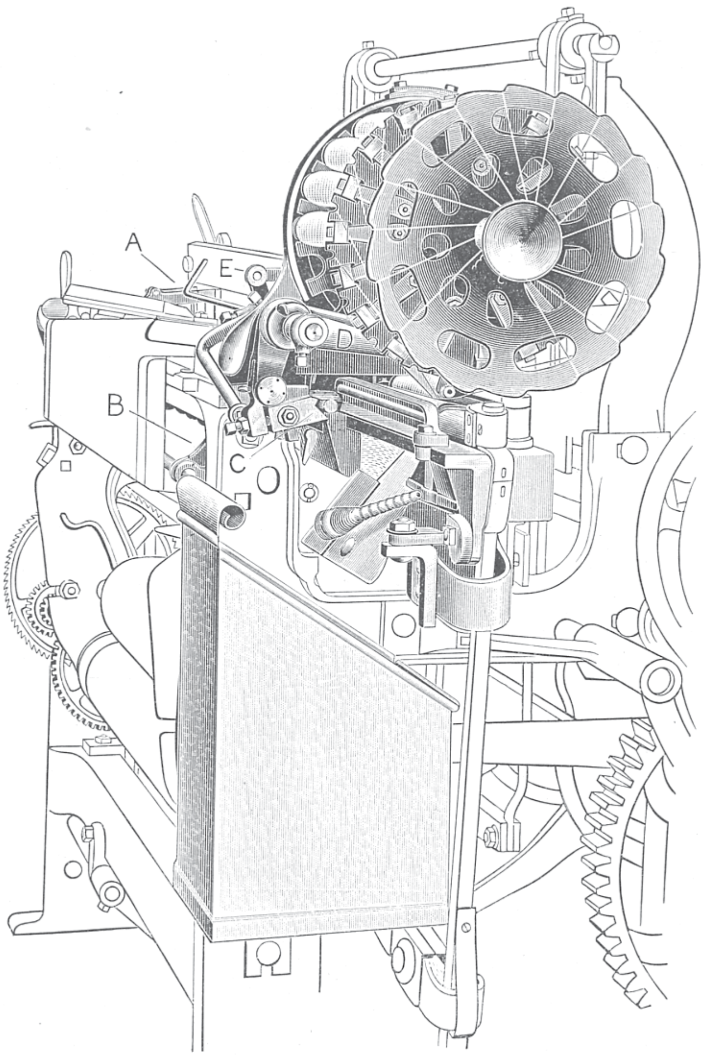
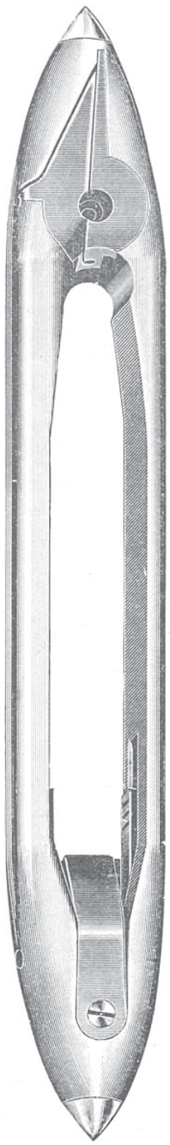


ILLUSTRATION OF HOPPER ACTION ON B MODEL LOOM.

A is the filling-fork which detects absence of filling, and through the usual catch and vibrator gives action to rod B controlling latch C.

When latch is raised it will be in contact with a bunter on the lay, thus forcibly depressing the transferrer D which pushes a bobbin from the hopper into the shuttle beneath it, at the same time expelling the one carried by the shuttle, which is then guided into the large tin box held on the loom side.

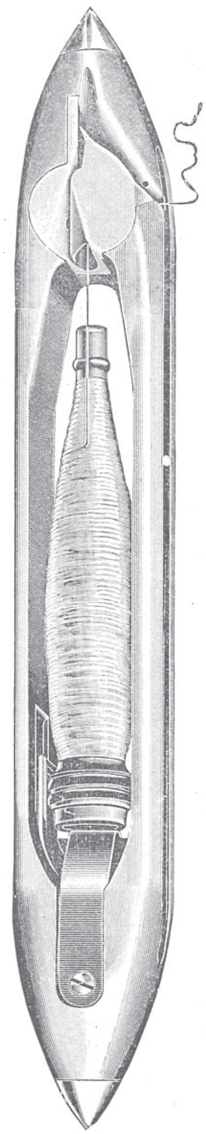
E is a portion of the device which determines the position of the shuttle in the box. If not properly in place the latch C will not engage the bunter, as the device of which E is a part will be prevented from further movement by contact with the shuttle tip, and as E and C work in unison, the movement of C is also checked. This special shuttle position detector did not go into extensive use on our own looms but was adopted as standard by our Canadian licensees.

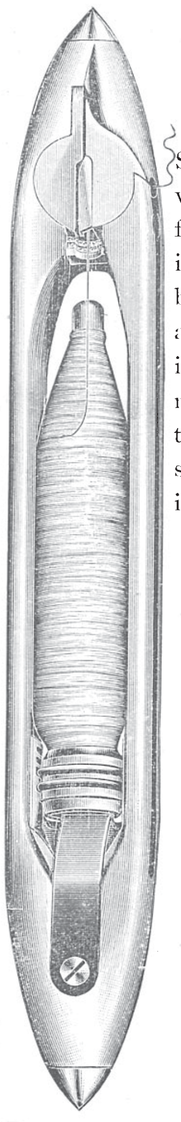


A FEW OF THE SHUTTLES USED WITH OUR NORTHROP LOOMS.

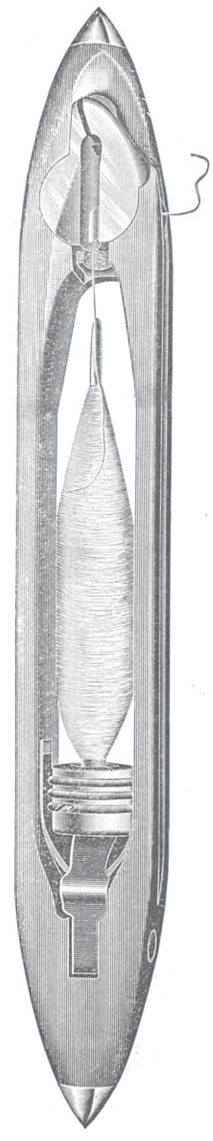
Shuttle at the left is known as the "Keeley," although incorporating the spring of J. H. Northrop and the incline cover of G. O. Draper.

Shuttle at right is known as No. 7 in our shop records. It has what we know as the "Stimpson" eye. This first model had no friction pocket and the eye casting was held by a nut on the bottom.

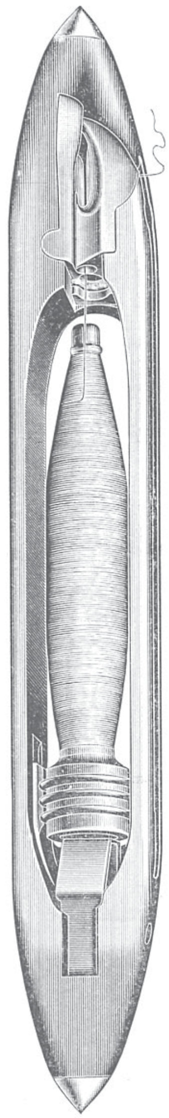




No. 16 Shuttle. Stimpson improved eye with pocket for flannel friction, the casting being held in the shuttle body by a transverse bolt and nut. Various modifications have other numbers, but this is the regular standard design which has gone into most extensive use.



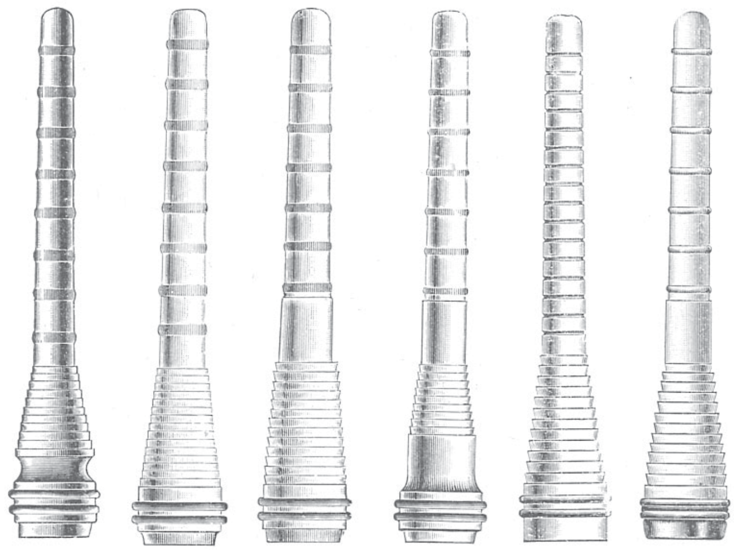
No. 167 Shuttle. Stimpson special eye and new spring and cover. A very satisfactory model. Note the new spring and cover which leave the wood of the shuttle body less cut out and therefore stronger. We have little trouble with loose springs in this design.



No. 263 Shuttle, or Jonas Northrop Eye style. Very successful on cops and coarse filling; in fact, the best threading eye which we have for all classes of work.

This shuttle saves filling breakage and makes misthreading immaterial.

We recommend it unreservedly until a better design is possible.



1 2 3 4 5 6

NORTHROP LOOM BOBBINS AND COP SKEWERS.

No. 1. Represents our early type of bobbin—now discarded.

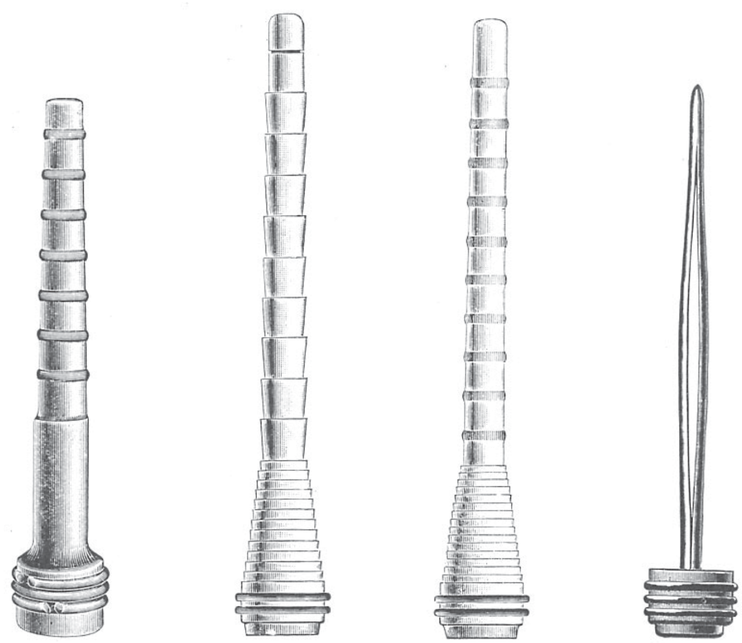
No. 2. First abandonment of groove at base.

No. 3. Standard pattern with Claus step for ordinary yarn.

No. 4. Special Queen City pattern.

No. 5. Standard for coarse filling. Note also the base on this and No. 6, made larger than formerly. We fit all our new looms to take this bobbin, as it has greater strength and is less affected by reaming. Of course, all the other patterns can have this same base. In ordering filling spindles for these bobbins be careful and specify the large cup.

No. 6. Special metal base cover extending under bobbin rings to prevent their loosening. A most important improvement.



7 8 9 10

No. 7. Feeler bobbin for use with feeler or mispick preventer loom. This style has three rings on base. Note chamfer on rings at ends. We have all our rings made in this way now, as they are less liable to catch yarn in the spinning-room.

No. 8. Long traverse bobbin, special notches on barrel.

No. 9. Long traverse bobbin with ordinary ribs.

No. 10. Cop skewer.

Our bobbins and cop skewers are made in three lengths.

1.	6 3-4 inches long	for traverse of	5 1-2 inches.
2.	7 3-8 "	" " "	" 6 1-8 "
3.	8 "	" " "	" 6 3-4 "

The exteriors shown in the cuts are used on all three lengths.

We have many additional contours to suit the whims of customers, but those shown are approved by use.

All bobbins and cop skewers must be ordered from us. They are patented articles.

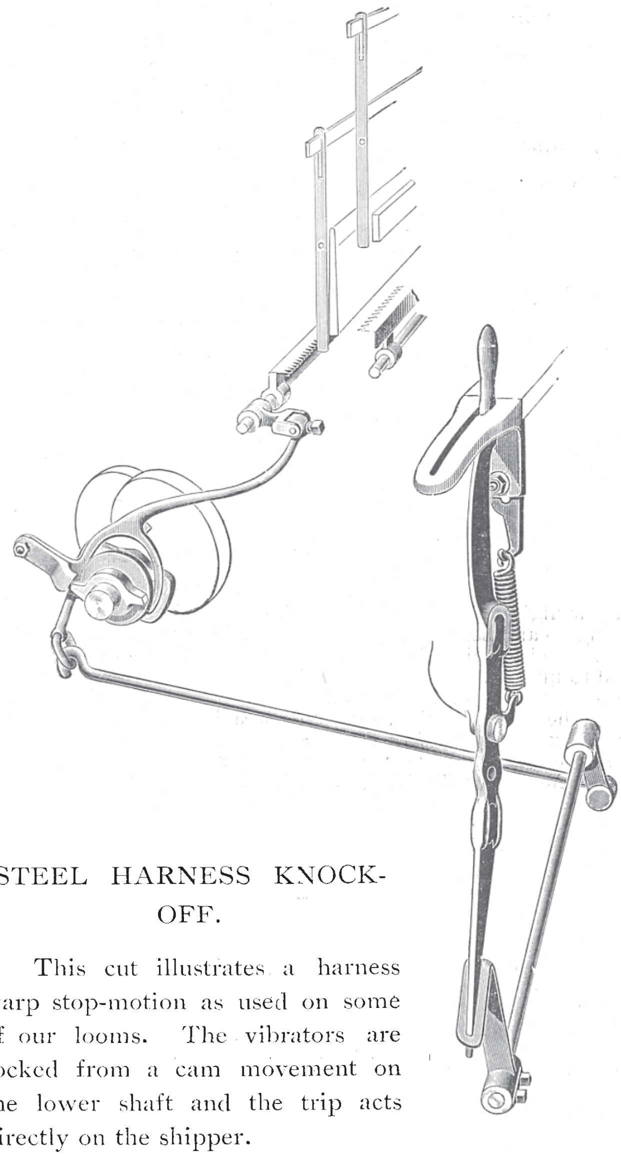
We insist on this simply to protect the successful operation of our looms. We do not take profit enough to pay us for the trouble in handling this part of the business.

"A few nights ago the night watchman of the mill told of seeing strange sights and hearing queer noises during the small hours of the morning. He is a sober man of middle age and in perfect health, so it was hard to find reason for not believing his story.

He says that shortly after midnight he heard a noise in a remote corner of the mill like the running of weaving looms. He went there and found six looms running at full speed without any apparent motive power and cloth was being woven without any guidance."—[*From dispatch to the New York World, Nov.* 17, 1900.

"The Northrop-Draper loom has had many tests and made many records. We will now chronicle one that, in romance, surpasses the loom of this make at Tucapau mills, Wellford, S. C., which ran nearly 24 hours without stopping a second:

—Young couple engaged—against wishes father—hurried consultation—wedding party gathered in the dynamo-room—returned—the bride finding all her Northrop looms running along as merrily as ever."—[*Textile Excelsior.*



STEEL HARNESS KNOCK-OFF.

This cut illustrates a harness warp stop-motion as used on some of our looms. The vibrators are rocked from a cam movement on the lower shaft and the trip acts directly on the shipper.

WARP STOP-MOTIONS.

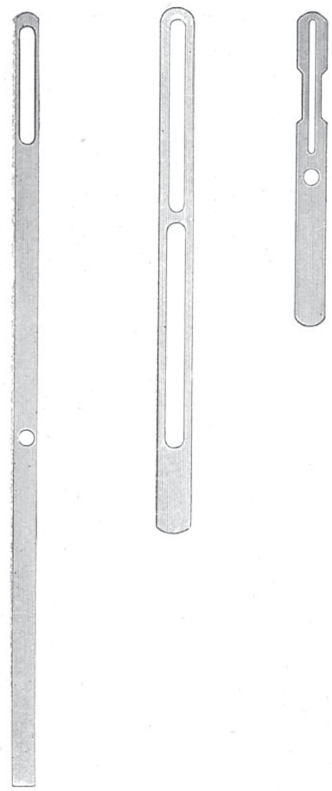
At the start of our loom introduction, we limited ourselves to the weaving of two-harness goods, utilizing simple warp stop-motion devices, which were perfectly efficient in this field. When we began to supply looms to weave with 3, 4 and 5 harnesses, together with the field covered by dobbies, it became necessary to develop new designs, so that we now have four distinct styles of warp stop-motion, and modifications in each class. Whenever possible, we recommend the use of our steel harness stop-motion. This has only been adapted to more than two harness work in recent years. With this arrangement, the heddles themselves serve as warp-stop detectors, being thin, flat steel ribbons, sufficiently stiff to act in arresting the motion of a vibrator. The heddles are strung on bars, through slots much wider than the bars themselves; thus when a thread breaks the heddle may drop a distance equivalent to the extra length of the slot, and thus come within the path of a moving vibrator which, when arrested, effects the stopping of the loom by intermediate mechanisms.

The advantages of the Steel Harness Warp Stop-Motion over all other kinds are numerous. In the first place, the heddles themselves are practically indestructible. They show no signs of wear after years of use; in fact, they are probably better for use, through the polishing given by the passing threads. The cotton harness, with which they compete, wears out, needs revarnishing and probably averages an expense for repair and replacement of perhaps a dollar a loom per year. We see no reason why the steel harness should not wear at least twenty years, saving some nineteen dollars in actual outlay, if our premises are correct. Another important advantage, especially noticeable with coarse yarn, is the saving of expense in drawing-in. Cotton harness warp stop-motions, with additional warp-stop detectors, cost more to draw in, because the drawing-in hand has to draw threads through the detectors as well as through the reed and harness. Our steel harness is even easier to draw in than the cotton harness, for the heddles may slide on the bars at will, accommodating themselves to the convenience of the operative. Another advantage of the steel heddle warp-stop is that it will stop more promptly, preventing warp runs after warp breakage; and it does not stop so often for slack threads. A further advantage, of great importance in mills where they change the product frequently, is that the steel harness heddles space themselves automatically, so that the same harness may be used for various weaves. The free lateral movement also allows the weaver readier access when repairing broken warp threads.

We have been asked more than once why it is that the shuttles in a Northrop loom fail to throw out of the loom like the common shuttle; in fact, our shuttles stay in the shade so uniformly as to question the need for shuttle guards. The reason is easily seen on investigation. Shuttles are thrown out of looms for several possible causes, but the most frequent one is the formation of floats, or the preliminary to a pickout. All of our looms will stop before a float can make serious trouble, and our steel harness warp-stop type will stop the loom before the warp threads can tangle sufficiently to swerve the shuttle from its proper course.

In the line of steel heddle warp-stops we are absolutely without competition. No other loom builder has ever attempted to introduce this class of devices, to our knowledge.

In the earlier use of the steel harness, it was claimed that the steel heddles broke more warp threads than the twine harness. This may have been true at that time; yet the advantages were more than enough to compensate. After learning proper methods of sizing, proper shape of cams and proper arrange-



No. 1 Steel heddle.

No. 2 Cotton harness drop wire for "Roper" warp stop.

No. 3 Detector for single-thread stop-motion.

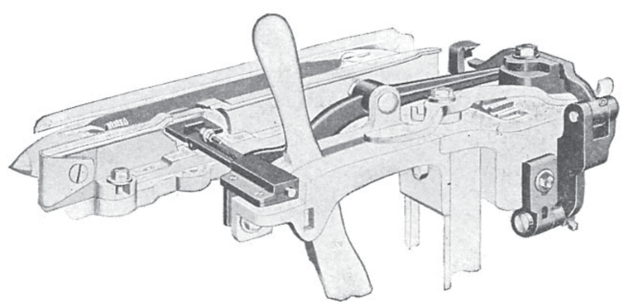
ment of heddles in their frames, we have now brought the steel heddle warp-stop where it is practically equal to the cotton harness in the number of warp faults. On regular print weaving, we find the stops for both breaks and slack threads combined, is between 10 and 15 per day, per loom, with either steel heddles or cotton harness.

At present, we do not supply steel harness mechanisms for a greater number than five harnesses.

The original cotton harness warp stop-motion which we introduced, used a drop wire device applied between the heddles and the lease rods, each detector serving for two or more threads. This could be used on looms having more than two harnesses, in a large number of applications. This motion was very successful and has been used on thousands of looms. We are recently applying a stop-motion situated between the lease rods and the harness, but which uses one detector for each thread, which looks very promising for cotton harness work with any number of harnesses.

A fourth type is known as our Single-Thread Warp Stop-Motion, and has been very largely used in recent years. In this class, one detector acts for each thread, and a peculiarity is noticed in that the detectors are arranged in two banks, and placed in the position of the usual lease rods, where they accomplish the functions of leasing devices, as well as warp stop-motions, doing away with the necessity for leasing rods, and simplifying the loom to that extent. Where drop wires are applied back of the usual lease rods, a broken warp thread does not always promptly allow the drop to operate, as the lease rods sometimes make sufficient friction on the thread to hold the drop in position.

While we are subject to more or less competition in applying warp stop-motions to old looms, our competitors are either limited to use of electrical devices, with their inherent evils, or to the use of warp stop-motions in which the detectors are subject to a more or less severe twisting strain. Our patents cover the use of serrated vibrators which can engage the detectors without twisting and bending. Sometimes the vibrators and co-operating devices on competing devices are made light and delicate, in order not to bend the drops, and therefore are less positive in action, and more liable to damage. So far as the application of warp stop-motions to other than Northrop looms is concerned, we were interested primarily in applying warp stop-motions to looms that could not use the filling-changer, such as drop box looms. We have taken little interest in attempting to introduce warp stop-motions on common looms for plain weaving, because we consider such application a mere makeshift, in view of the greater advantages of the combined filling-changing and warp-stop, which the mills should avail themselves of, rather than attempt to try and cheapen their weaving by adding expensive devices to old machinery. Warp stop-motions of themselves, do not lessen the weaver's labor, except in the prevention of floats and overshots. Every thread that breaks must be pieced up, as formerly, and it is even possible that the additional weight of the detectors causes more breakage.

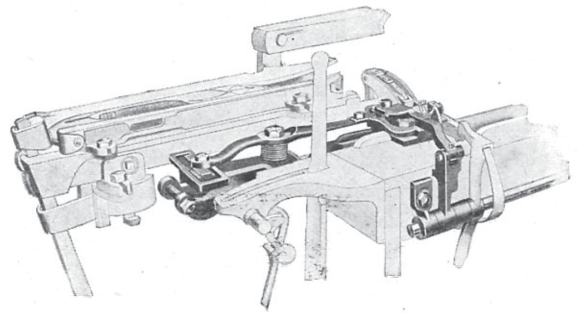


DEVICES FOR MAKING PERFECT CLOTH.

The third new attachment introduced with the advent of the Northrop Filling-Changer and the Warp Stop-Motion, is a mechanism only used on certain classes of goods, which co-operates with the filling-changer to prevent mispicks, and thus make perfect cloth. Mispicks are due to the running out, or breakage of filling, and the insertion of new filling without removing the particular thread of weft remaining in the shed, and also without inserting the new filling in the proper shed. In the general line of goods woven, mispicks have not been considered as important defects, but with other goods, such as napped fabrics and certain classes of multiple harness weaving, mispicks are not allowable. In common loom weaving, they may be obviated by extra pains and extra labor on the part of the operative, who can pick out the particular thread by hand, and turn the loom over to find the true shed before inserting the full shuttle. With automatic looms, the prevention of mispicks is attained by changing the filling before final exhaustion, so that a full thread is left in every shed. If the filling should break, the loom may be stopped automatically, so that the weaver can find the pick; or, if such breakage is not frequent, the loom may be arranged to run the chance of a mispick at such periods.

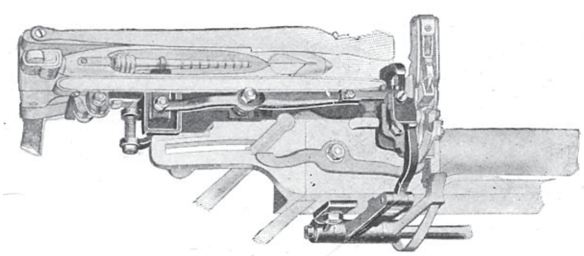
The mechanism employed for this purpose consists of a simple device called the "Feeler," because it feels of the weft in the shuttle through an opening in the shuttle side, and absolutely measures its volume. When reduced to a certain definite quantity, the feeler operates to liberate mechanism governing the action of the filling-changing devices.

The cut first printed shows our latest feeler, which is applied at the shipper end of the loom. As shown, it is in contact with the yarn in the shuttle, passing through a hole in the front box plate and a slot in the side of the shuttle itself. Like the Aumann feeler, on the opposite page, it is independent of back lash in lay and position of front plate. The operating parts are shown in full relief, and are few in number. The cuts of the Aumann feeler show the pattern in use just previous. The mechanism at this side end of the loom, however, does not accomplish all that is necessary, for the operation of the filling-changer by a feeler introduces a curious problem, the ejected bobbin having its thread extended through the shuttle



AUMANN FEELER JUST BEFORE OPERATION.

This cut shows the form of feeler mechanism devised by Mr. Louis A. Aumann, agent of the Dwight Mfg. Co. at Chicopee and modified by inventions of W. F. and C. H. Draper.

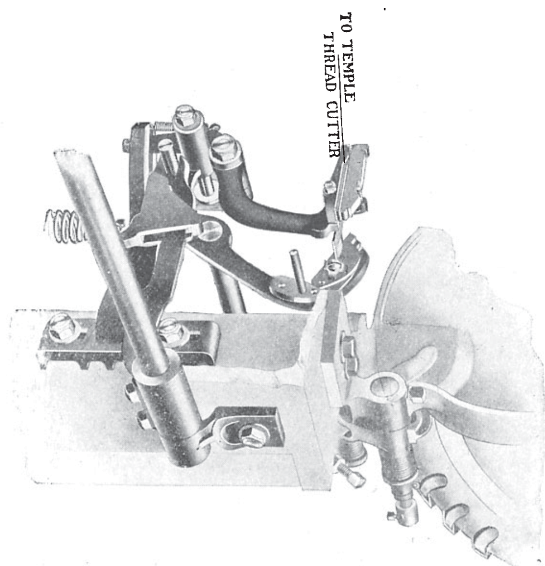


AUMANN FEELER OPERATING.

We have had these applied to thousands of looms. They are independent of the wear or alteration in the throw of the lay and therefore require practically no adjustment after the first setting.

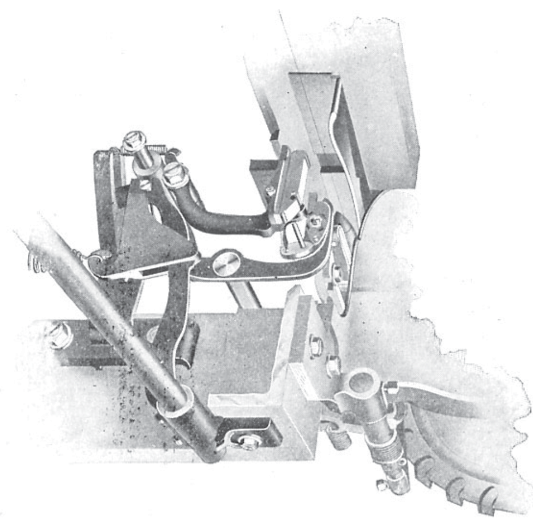
eye to the cloth, while the bobbin itself is in the receptacle, thus leaving an additional thread to be taken care of by cutting apparatus. Unfortunately, this thread does not lie in the path of the regular thread-cutter, requiring an extra cutting device to operate at the proper time. Such a device is attached to the shuttle position detector, which reaches forward to determine the position of the shuttle in the box, as the position detector passes into the path of the thread referred to. This additional cutter not only severs the thread at this point, but also holds the severed portion taut until the regular thread-cutter severs it again near the selvage of the cloth. While somewhat difficult to describe, the operation is perfectly simple and efficient.

The Feeler is practically necessary on certain classes of goods, yet objection has been raised on account of the waste yarn left on the bobbins. We have endeavored to reduce this to small limits by continual perfection of the feeler mechanism itself. We also limit the amount of waste by applying attachments to the spinning frames which spin the filling yarn, called "Bunch Builders," which govern the traverse motion so as to wind a slight preliminary bunch on the bobbins near the lower end of the traverse, so that the feeler will not operate until the bunch itself begins to be reduced in volume. We have patterns of these mechanisms to fit all the American makes of spinning frame. Another objection to the feeler has been raised on account of the extra labor necessary in removing the waste yarn from the bobbins, especially as the bobbins have sometimes been damaged by the use of knives for this purpose. We are now building little machines, in which a large, rough-surfaced roller, by rapid revolution, will easily wind off the waste yarn of several bobbins at a time, reducing the expense as compared with the former process, and causing no damage at all to the bobbins. Most of the waste yarn is easily pulled off by the fingers.



FEELER THREAD CUTTER JUST AFTER OPERATION.

With short thread held ready for temple thread cutter to operate.



FEELER THREAD CUTTER JUST BEFORE OPERATION.

THE DOUBLE FORK.

The cloth which we intend to weave on our looms may be roughly divided into three classes. First, including goods on which mispicks are not important and on which slight thick and thin places are of little moment. These are produced by the ordinary plain loom of commerce which our regular Northrop loom is replacing.

The second class includes the grades on which mispicks are considered important, and for which we apply the feeler device.

The third class includes all the goods on which mispicks are not important, but on which thick and thin places are not desired. This grade can be woven on our new double-fork looms and we expect to find all grades improved by use of this new idea.

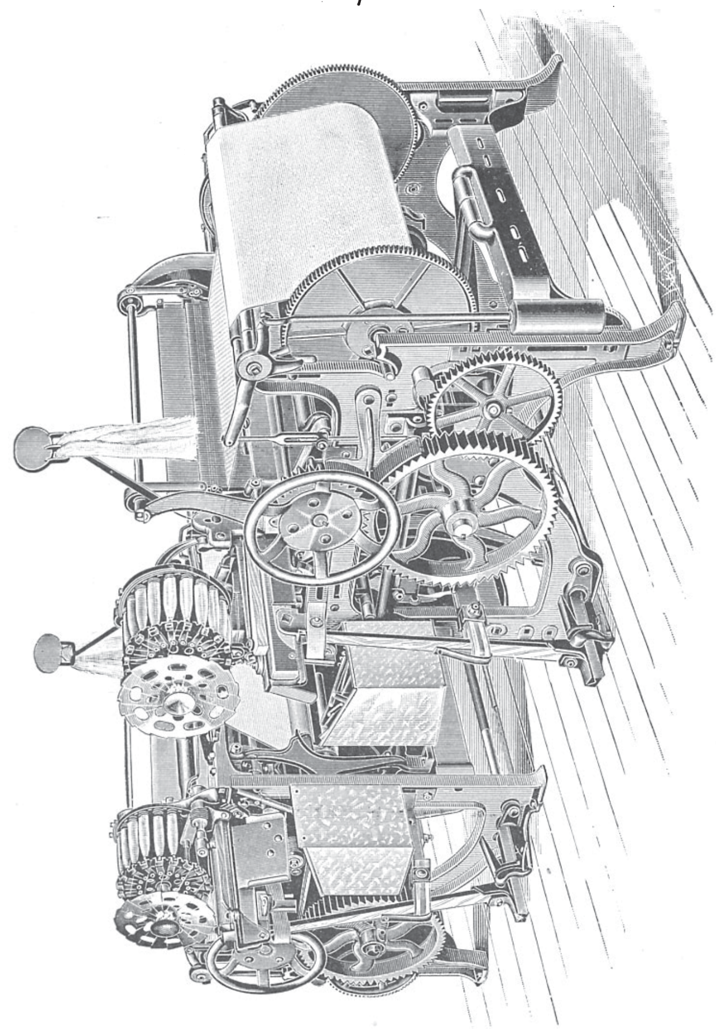
There is a prevailing notion to the effect that print cloth may have all sorts of faults, because the dyes disguise them. Anyone who looks at the cloth running over the blackboard in the cloth room of any print mill, will notice defects in every single cut of cloth woven, there being full as many with cloth woven on the common loom as with the cloth woven on the Northrop loom. The buyers have grown accustomed to these faults. When it is understood, however, that cuts of print cloth, or any other cloth, can be woven entire, without a thick or a thin place, the trade will undoubtedly demand improvement.

The Double Fork system, has already worked with great success on thousands of looms, and has recently been improved and simplified in detail. It detects the absence of filling on either side of the loom, and prevents the take-up from moving if filling is not present. With two forks, absence of filling is detected more promptly, and they also take care of any trouble caused by a dragging end of filling, which sometimes holds the fork up at the left side of the loom, if the yarn is coarse. The double fork is therefore applicable to coarse weaving, as well as very fine goods, having special advantages in each application. It is also added to Feeler looms as an additional precaution.

The Filling-Fork, whether single or double, is the most important element of the loom, to our mind. It is liable to false operation if the tines get bent, or if the lay gets out of position, or loose in its bearings. We are now making a fork in which the tines are cast in place in a solid block, and are also bringing out improvements in loom construction intended to prevent the possibility of variation in the position of the lay itself.

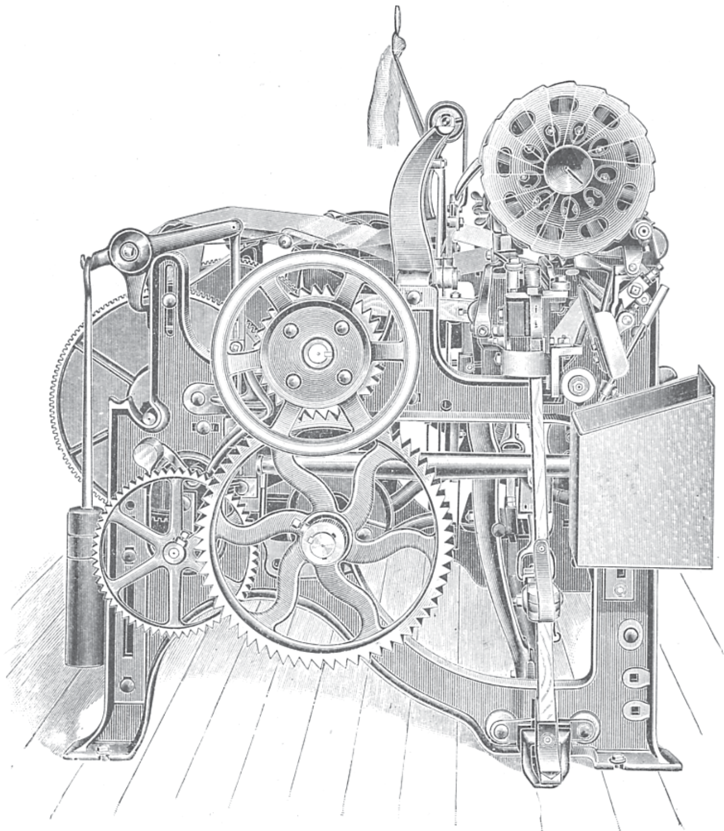
STANDARD MODELS OF LOOM CONSTRUCTION.

Having considered the different new attachments which are peculiarly adapted to automatic weaving, we next show cuts of looms complete with the devices in their relative co-operation with the standard loom organisms where their detail may be still further elaborated. Although many loom manufacturers have built from one standard set of patterns for years at a time, we have brought out ten different models, with full sets of patterns for each, within a period of ten years. These different models are not only necessary by reason of variety in width and weight of cloth woven, but also represent improvements in design of sufficient importance to warrant new construction throughout.



A MODEL (ALSO CALLED 1894 PATTERN).

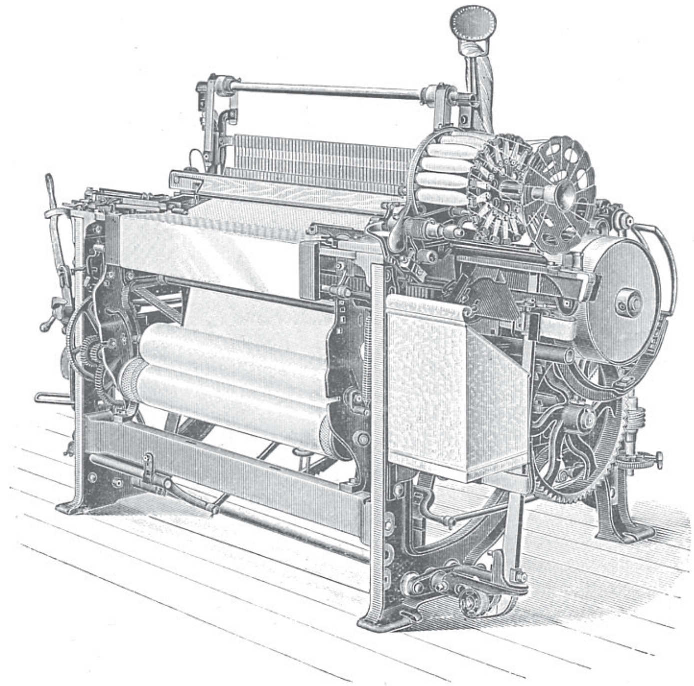
Not now built. This was the loom sent out on the Queen City, Tucapau, and other early orders. We built this model in rights and lefts, not having then adopted our one-hand loom construction.



END VIEW OF A MODEL LOOM.

Steel Harness, Saw-tooth Gearing, Shepard Let-off, Mason Take-up, Movable Bobbin-chute and other details as originally presented.

"The cloth is as near perfect as can be. Weavers run, or attend, from 16 to 28 Northrop looms, and do not work any harder than I have seen them do on eight common looms, and pretty near all the weavers here are what would be called new weavers; that is, having only from two to three years' experience; and, in fact, the majority of them learned here."—[*Contributor to Wade's Fibre and Fabric.*

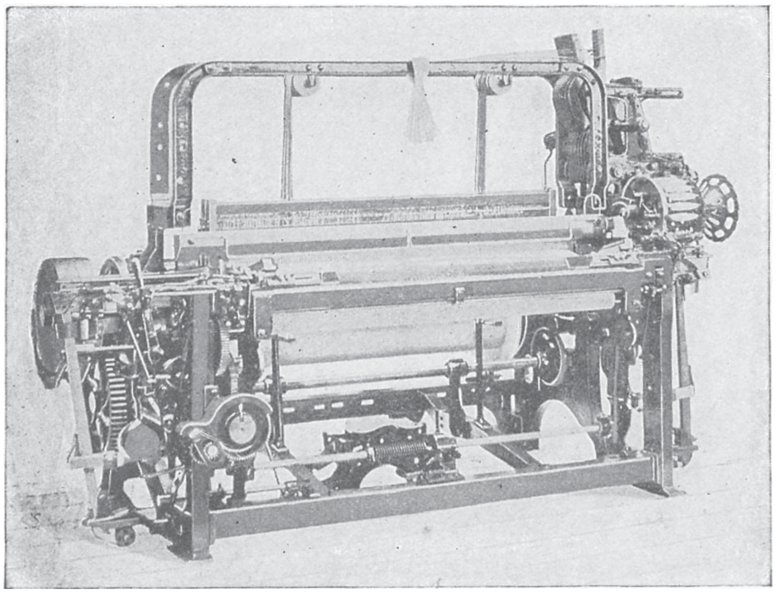


B MODEL (ALSO CALLED 1895 LOOM).

Not now built. This pattern was continually improved and was our standard for prints and other light goods until 1898. It had a wider frame than the A model, longer shuttle boxes, new take-up, Stearns rocker and One Hand construction.

C MODEL (ALSO CALLED 1896 LOOM).

Not now built. This was our first heavy pattern loom. It was of the One Hand construction with heavy design throughout. (No cut of this to show.)

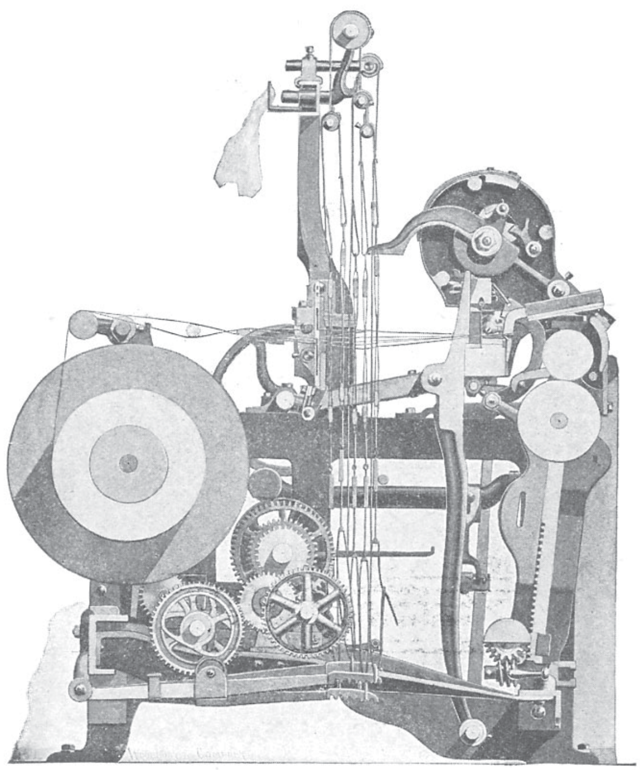


D MODEL, HEAVY STANDARD, NO. 1 HOPPER.

Cut shows dobby head applied. The take-up on this special style of D loom is of the worm gear variety.

"Constant progress has been the watchword of the last quarter of a century, and will lead in the next, so near at hand. Mr. Draper puts the Northrop loom, the latest production of his model shop, into your mill today and starts it with amazing success, but while this pattern, the product of many years of hard work of the inventor, with the added talents of many mechanics, has been in course of construction, a new and better way has been devised to accomplish desired results or to overcome some slight defect obvious in your lot of looms. And you are told that in the next lot of looms built these defects will be remedied, and too late you regret that you had not waited before giving your order.

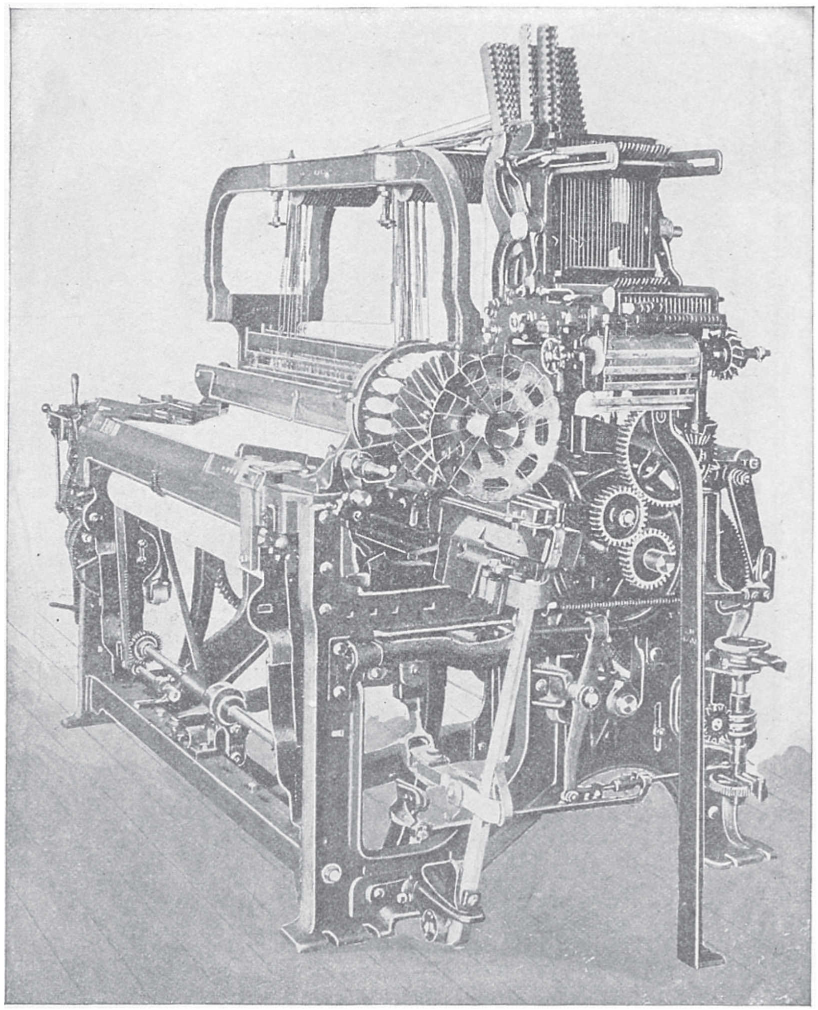
The difficulty, however, is inevitable. Evolution is constant in everything to which the mind devotes itself earnestly, honestly, and persistently—and each lot of looms turned out will naturally be superior in some respect to that which preceded it."—[*Prest. Frederick E. Clarke at Montreal meeting of the N. E. Cot. Man. Asso.*, *Oct.* 5, 1899.



CROSS SECTION OF D MODEL LOOM.

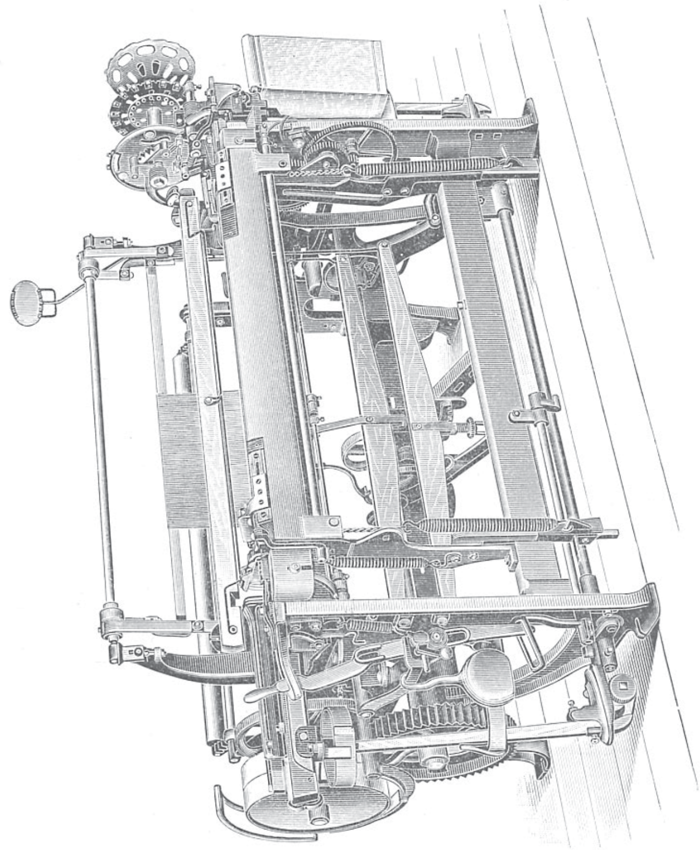
No. 1 hopper, five harness, cotton-harness, Roper warp-stop.

"The Northrop looms at this mill are running on 60s warp and 70s to 80s filling. I have never seen looms run any better, on coarse numbers even, than these are running; in fact I do not see how any looms could do better. The weavers run 16 looms each and did not seem to have anything to do. The overseer called my attention to his loom fixers on these looms sitting down by their bench sleeping, which he said was no unusual sight. He says he gets all of 95 per cent. product."—[*Extract from Expert's Report, June* 20, 1903.



D MODEL LOOM WITH DOBBY.

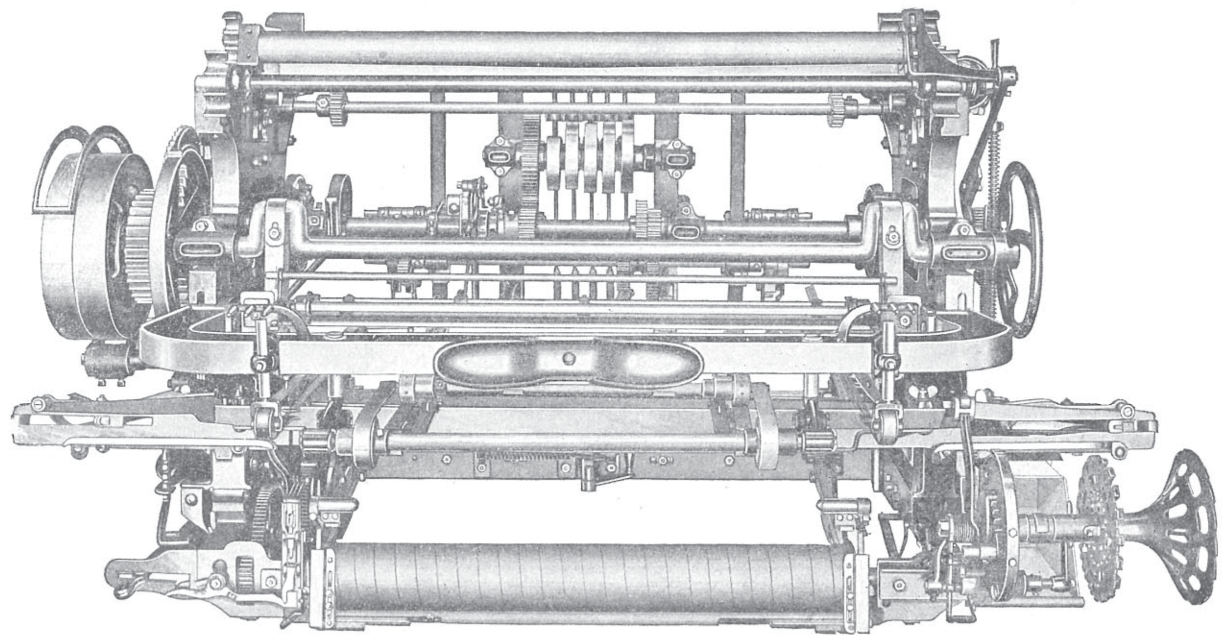
We have sold hundreds of looms for dobby weaves which are giving the best of satisfaction.



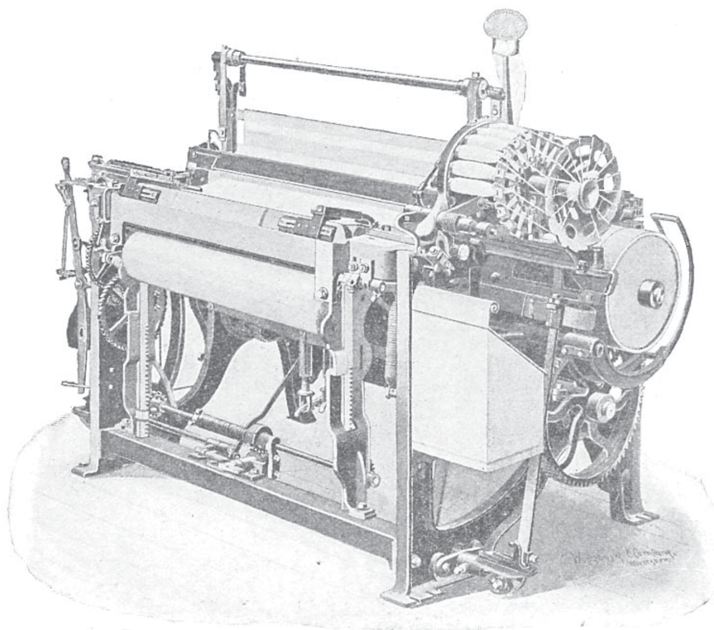
FORTY INCH E MODEL LOOM,

No. 1 Hopper, Steel Harness, original High-roll Cut Motion.

"In conversation with one of our most prominent manufacturers this week, who has just returned from a trip through the South, he informed us that he took especial pains to visit a mill making print cloths, where it had all Northrop looms, and that he never saw nicer woven goods, and made at a cost which we are not at liberty to state, but it was very low indeed."—[*Boston Journal of Commerce.*



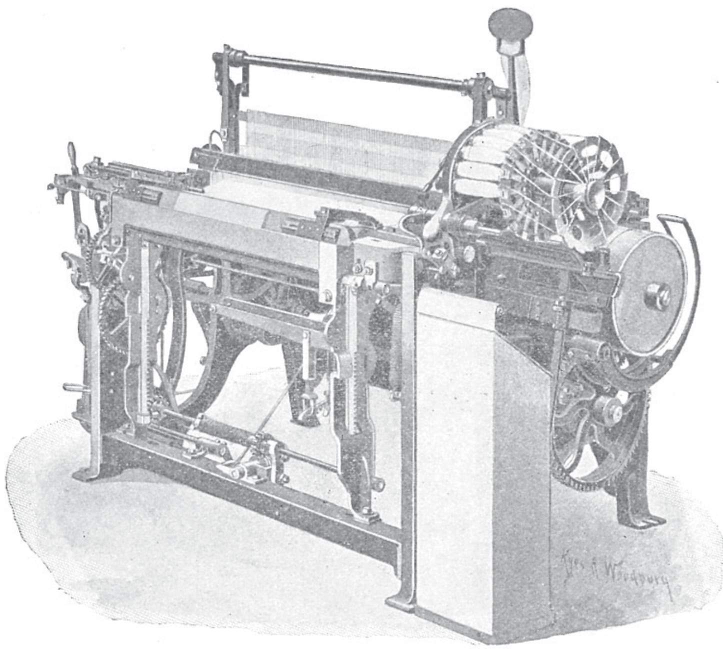
TOP VIEW OF E MODEL, FIVE CAM LOOM, NO. 1 HOPPER.



E MODEL.

Regular pattern for prints and sheetings up to 1904. Cut shows a steel harness bobbin filling loom as made in 1898 and 1899. Improvements have been added continuously, as will be shown in other cuts to follow.

"I called at the ——— Mills; found the looms running very well. They have reduced the seconds on their plain work to 1½ per cent, and on their sateens to one-half of one per cent. This is perfectly satisfactory to them."—[*Salesman's Report*, *Oct.* 24, 1903.



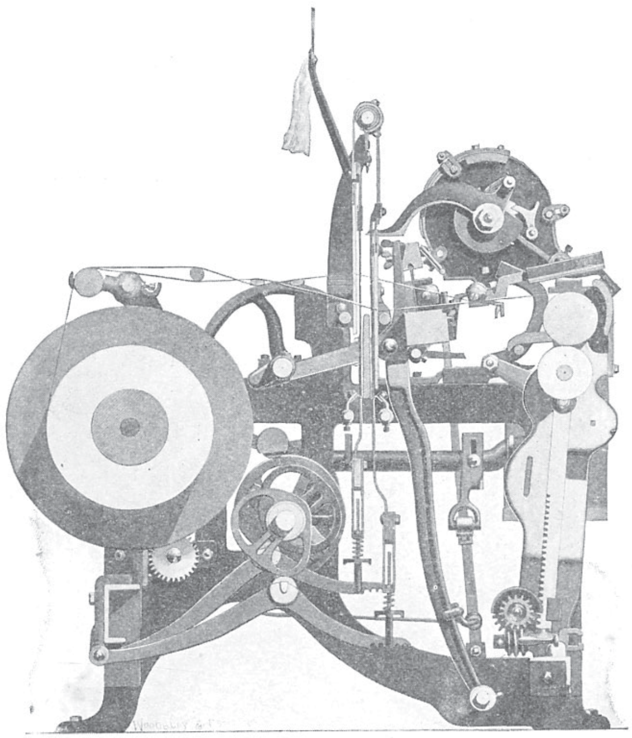
E MODEL LOOM WITH FEELER.

NO. 1 HOPPER.

The deep can is used to enable the dropping bobbin to drag out the length of filling cut by the extra thread cutter.

While the cut shows the feeler on a two-harness loom, it is more customary to use this device on multiple harness weaving. The feeler shown is one of the earlier constructions.

"We looked at the Draper looms, which are running extremely well, with weavers running 16 looms each on 4-shade cotton flannel, 17s warp and 9s filling. They are doing very well with the feelers and were making little waste."—[*Salesman's Report of Nov.* 28, 1903.

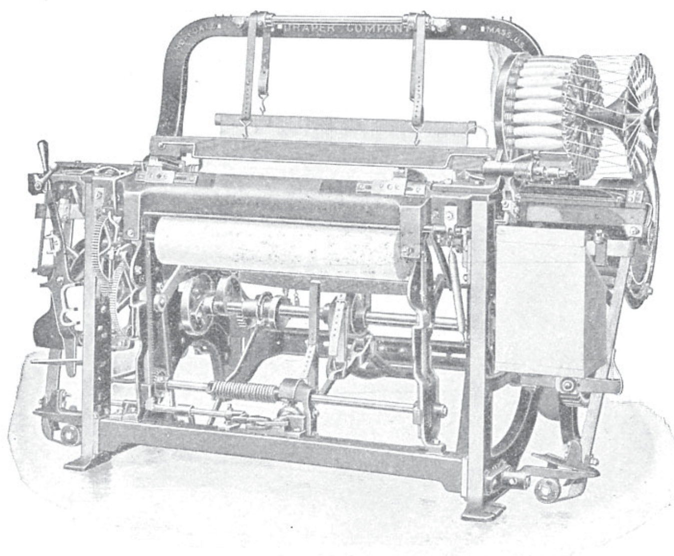


CROSS-SECTION OF E MODEL STEEL HARNESS LOOM, NO. 1 HOPPER.

(Shuttle positioning device is different from that in perspective view of E model, and hopper is for cops instead of bobbin. Pulleys are at the left hand on this loom.)

This cut gives a good detail of the cloth winding device on our high roll take-up. Also shows hand adjustment of harness jacks.

The detail of the warp-stopping connection cannot be shown in this cut, as the devices used are not on the half of the loom which appears in the cut.



E MODEL WITH LARGE HOPPER.

This is the regular standard type for general weaving used from 1898 to 1904 (still in use). It began to receive the large hopper as per cut in 1901. More looms have been sold of this model than any other that we have put out.

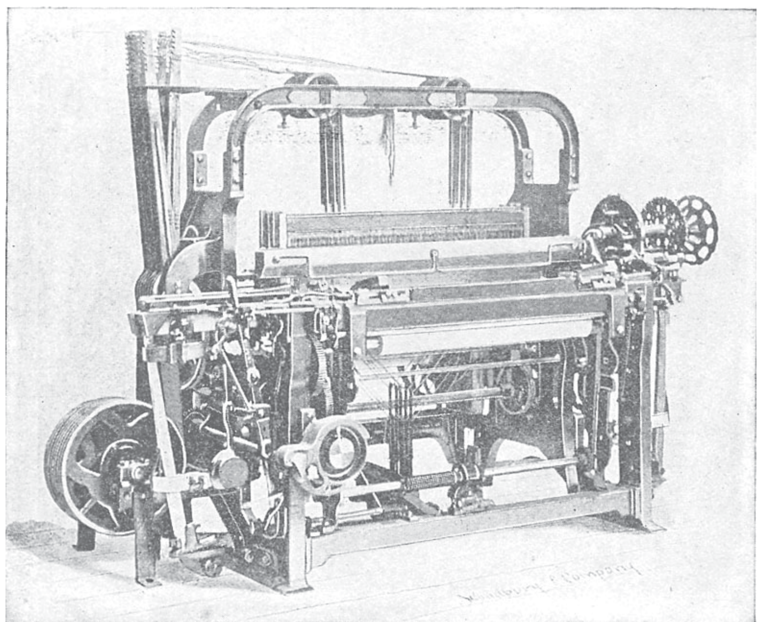
"In New England to-day the price of weaving on the ordinary looms, with the last ten per cent. that has just been given, is nineteen and eight-tenths cents—say twenty cents—per cut, that is, for fifty yards. A new loom has been invented by which the weaver can mind about twice as many, and therefore the price per cut is reduced about one-half. These are what are called the Draper looms. . . . . In the South they have hardly any other kind of looms; they have the best. I saw one woman minding twenty-four looms. . . . . The price they pay for fifty yards in South Carolina is six and one-quarter cents. The operatives of course, even at this rate, are earning more than they ever earned before." . . . . *George Gunton.*

F MODEL.

Extra heavy pattern for goods 72 inches and wider. Made with compensating let-off for two beams, triple cranks, compound spring cloth winder, friction pulley drive.

G MODEL.

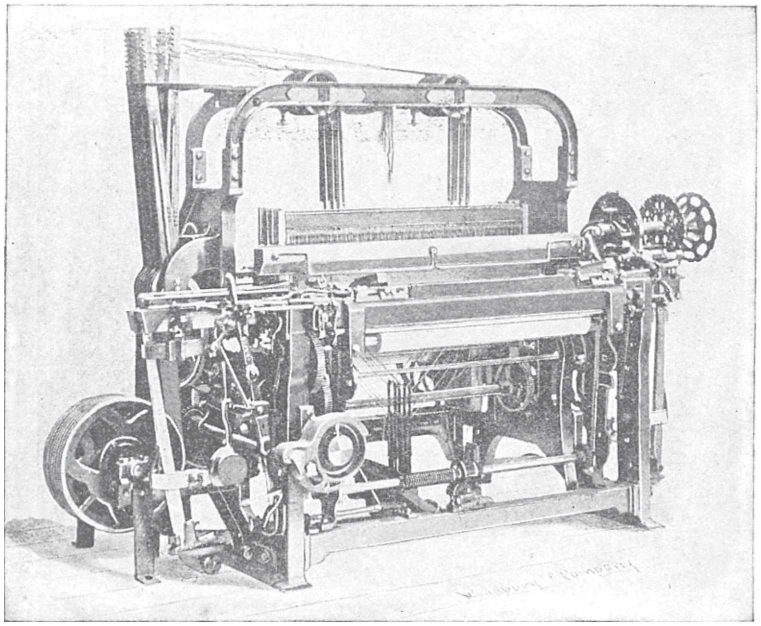
Special frame. D Model weight with E Model depth. We have no cuts to show these two latter styles.



H MODEL, HEAVY SIDE CAM LOOM, 8 HARNESS.

Frame same as D and E Models.

I MODEL, not ready for illustration. This will be of a construction somewhat similar to our present E Model and adapted for the same class of weaving.



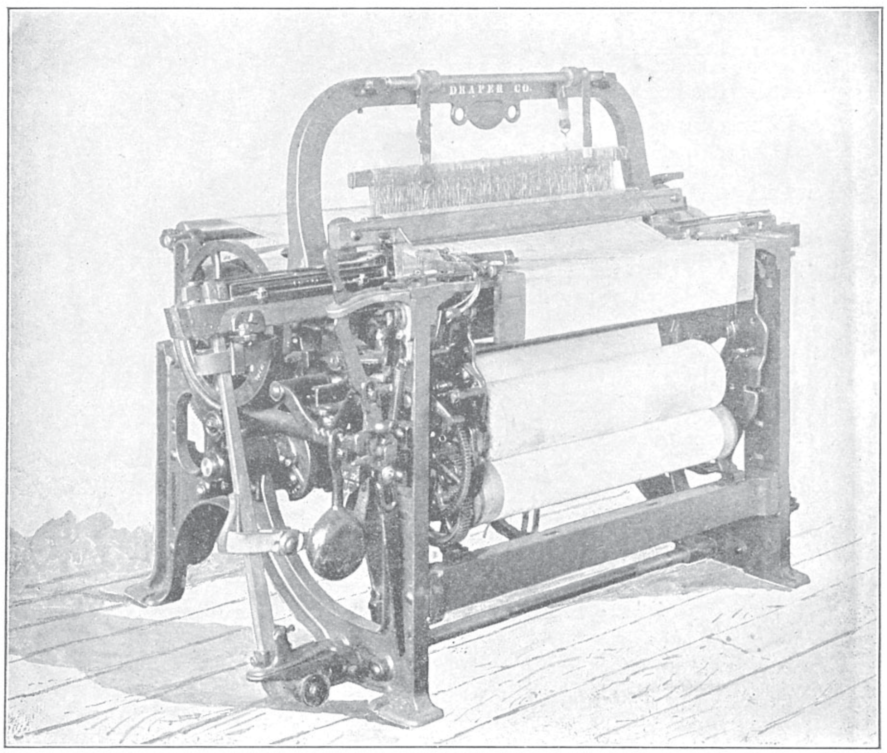
J MODEL LOOM FOR PRINT CLOTH AND LIGHT WEAVES.

There are more looms weaving plain two harness goods on print cloth style than on any other single grade of cloth. Mills can equip for this standard product and run continuously for years without necessity for changes. We started originally with a loom for weaving these goods, but in designing foresaw other uses and therefore prepared the frame and other parts for them as well. A year or so ago we made up our minds that there was a sufficient field in light narrow weaving to warrant the building of a special loom primarily adapted for this use. We have thus developed a model that takes up no more floor space than is necessary, that is no heavier than is necessary, and in which the moving parts are not clumsy and power absorbing. The fatigue of running and handling such a loom must be greatly reduced. We utilize new inventions to reduce shock, jar, smashes, etc., and in view of the light goods to be woven, protect against the slightest crack or thin place by novel mechanisms. Several of these will be particularly referred to in the special articles on take-up, double fork, anti-bang, etc. These various motions have shown so much advantage that we do not intend to limit their adoption to the J Model loom alone. There are several thousand of these looms already running and several thousand more on order. They have proved a great success, especially when fitted with the complete range of devices which we recommend for them. They will run at high speed if necessary, and with lighter power. They can be made with either front or back binders and with either steel or cotton harness, though we recommend the steel harness unreservedly for this class of work.

OUR COMMON LOOM.

We have at times filled several orders for common looms for parties who were not fully decided as to whether our mechanisms were applicable to their special kind of goods, with the idea that when we should have the necessary devices they could be attached to the looms. At the present time, however, our range of weaving is so broad that we rarely find a case where the common loom could be advised, and we foresee little future chance for their introduction.

Owing to our expensive experimenting and disregard for cost, we probably make the best common loom now in the market. Our common loom is simply our Northrop loom with the hopper and warp stop-motion left off and a slight change at the fork. With our make of loom it is, of course, guaranteed



OUR COMMON LOOM.

The cut shows the common loom of the B model type, of which we have sold several lots to purchasers who bought to equip with Northrop devices later. We have not encouraged the sale of plain looms as our force has been busy with Northrop Loom orders. It seems strange, however, that those who continue to buy common looms do not universally demand a type that will be guaranteed to receive future improvements readily.

that our devices can be easily applied, while this is not always true of looms made by other builders.

We have given fully as much attention in late years to perfecting the conventional loom parts as we have to the betterment of our own additional devices. The common loom which we should furnish would, therefore, have all of our latest improvements in the line of let-off, take-up, etc.

It is, of course, understood that the cuts which we show do not pretend to illustrate all of our loom products. Each model that we build is made in many widths, and modifications are often necessary. At present, our range in width is from looms for 28-inch goods, which will, of course, weave narrower, up to looms for cloth 108 inches wide. We call any loom a wide loom which requires additional parts, such as centre swords, double beam, etc. We have found it advisable on these wide looms to use front binders, and a simple rocker motion that will give the shuttle a smooth, straight pick.

Some classes of looms require clutch pulleys, which we can supply when ordered, but we do not recommend them for universal application.

While we prefer to sell complete looms, we can apply our devices to certain models of old looms of others' manufacture. Such changing over is especially advisable where the common loom is too valuable to be discarded, as in the case of broad looms, dobby looms, etc. We have changed over several thousand common looms with good results and have a special department for that work.

LOOM CONSTRUCTION.

Soon after the introduction of our first looms, which were made in rights and lefts, we found that the shuttle used with one type of loom threaded up better than the shuttle on the other, the eyes being entirely different in threading detail. This led to the idea of making looms all one hand, and as this change only necessitated invention in the line of shipping mechanism, we promptly adopted the idea, and have built all our looms in this way ever since. It is, of course, a great convenience to us, as builders, to have all of our looms made from the same patterns, and it must be an even greater advantage to the mills, for not only is their supply of repair parts lessened, but the weavers find it much easier to go through a set of one hand movements, rather than learn to do many operations with either hand.

It seems strange that the original error of complicating parts and detail by right and left construction was prolonged for a full century. It is, of course, still necessary to have the pulleys arranged to belt at either side of the loom, and we find it also more convenient to have our let-offs changeable in position; but the shipper handle is always at the left, and the hopper always at the right, on all looms which we have built with the exception of the A model. When we change over looms of other makes, we supply parts for both right and left hand looms, as no other builder has followed our lead, especially as the system we use is protected by several patents. It is well known that with the ordinary type of loom, as built, one hand will run better than the other, as patterns of one hand are not precise opposites to the other, and are necessarily better or worse in adaptation. This gives two differently operating constructions to bother the fixer.

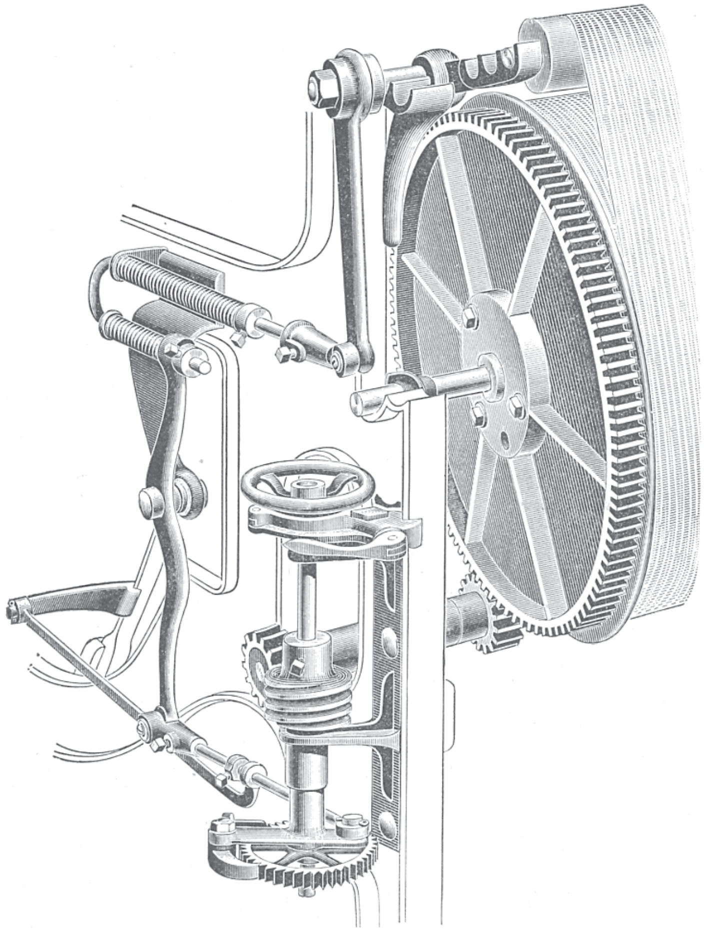
LET-OFF.

Although the Bartlett was our own original let-off, and although we did use it on thousands of our Northrop looms in an improved form, we have now replaced it by a greatly superior mechanism known as the "Draper-Roper," which is self-adjusting and thoroughly efficient for nearly all the possible requirements.

We made a curious mechanical error on these motions as first sent out, which tended to give them a bad name, but on discovery of the fault it was promptly remedied by sending correct parts to every mill where the let-offs were in use, and we now hear nothing but praise for their performances.

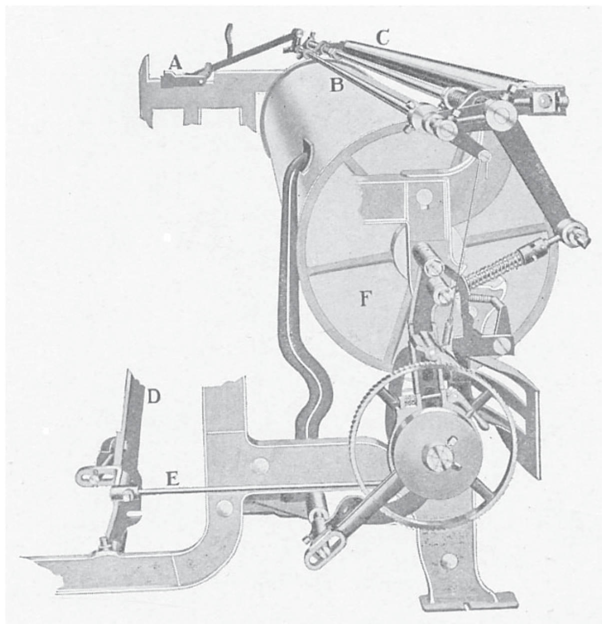
Like the Bartlett Let-off, the Draper-Roper is actuated from the motion of the lay and governed by the tension of the yarn at the whip-roll. It is, however, additionally controlled by the variation in the diameter of the warp beam, as the warp is woven off, by a follower, pressing against the beam, which by its change in angle determines the limits of motion by which the actuating parts operate. With ordinary let-offs, the cloth woven varies remarkably in width from full to empty beam, whereas with the Draper-Roper this variation is practically eliminated, so far as influence of the let-off itself is concerned. There are other causes which affect the width, and their results should not be confused with the let-off action. A recent test of actual tension at the whip roll during the entire time a beam was weaving off showed that the variation was confined between 33 1-2 and 32 pounds—certainly a remarkable uniformity for this class of mechanism.

"Their Northrop looms were all running very well; the weavers run 18 prints each, and on the wider looms 16 each; the fixers run 115 looms each."—[*Extract from Expert's Report, Jan.* 2, 1904.



BARTLETT LET-OFF.

The Bartlett was our standard until the Draper-Roper let-off appeared. We owned the original Snell and Bartlett patent and sold over 50,000 of them for use on old and new looms before 1870.



DRAPER-ROPER LET-OFF AND ANTI-BANG.

The cut shows this let-off applied to a J model loom. Note the follower which bears against the warp on the beam. The operative parts are largely hidden from view.

Note in the cut of the let-off another new idea which we call the anti-bang. The frog slide connects to the whip roll so as to release the warp in case the loom bangs off. This relieves the loom itself from shock and also prevents smashes. We believe this idea will greatly lessen loom repairs and the loosening of nuts and screws.

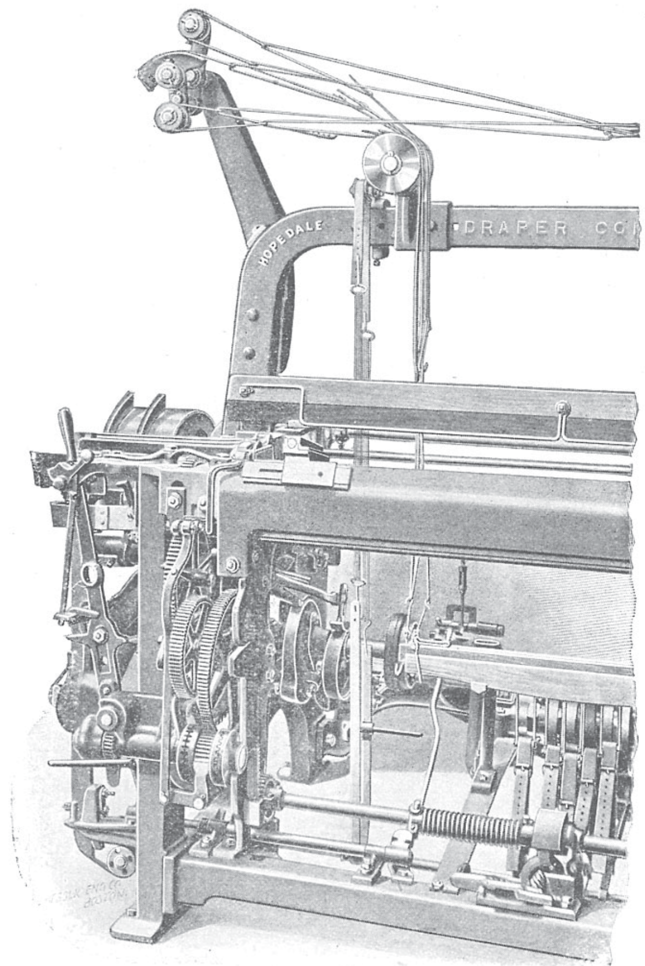
SHEDDING MECHANISM.

Our standard forms of shedding mechanism at present include the ordinary single roll with strapping at top and cam treadle drive at bottom, for two harness work, with either steel or cotton harness, the Lacey Top Rig for multiple cotton harness, and a spring compensating motion for the top rigging of our multiple steel harness mechanism. We are, however, experimenting with new motions for our steel harness looms, and shall soon introduce a complete novelty in the line of shedding mechanism, doing away with all treadles, cams, and jacks under the warp, giving more space for the warp beam and bringing all of the operating parts out where they are easily observed and adjusted. We shall have more to say publicly about this device when our patents are issued and a further trial made.

The Lacey device is simple and durable for cotton harness use, and it is always in place to hang a warp, does not wear out straps so fast as the ordinary motion, and is easily adjusted. It is quite similar to the Wyman motion used on Crompton & Knowles looms, but we think it contains important additional improvements; in fact, other loom builders have wished at times to have the privilege of using our motion on their own makes of loom.

We are ready to equip looms with side cams for special weaves, or dobbies, when desired. We have built hundreds of side cam looms for corduroy and thousands of dobby looms for various weaves.

"One man who came under my personal observation was working 27 looms. He was producing a print cloth, 28 inches wide, 60x64 ends per inch, 29's warp and 37's weft. The average for the whole mill was about 19 looms per weaver. Is it possible for our manufacturers to compete with this?"—[*English expert's report on visit to America, from English paper, October*, 1902.



DETAIL OF LACEY TOP-RIG ON D MODEL.

Our steel harness is becoming so universal that we have less field for this motion than formerly. Cut also shows our worm gear take-up with the let-back modification.

TAKE-UP AND CUT-MOTION.

Although it might have been simpler to stick to standard designs in this line, copying from well known mechanisms, we have, as a matter of fact, given as much time to the Take-Up of the loom as any other separate feature. We started with a conventional pattern, but on finding that many of our customers desired to weave large rolls of cloth, we tried to design an arrangement which would wind any size roll desired up to 18 inches in diameter. We saw that the High-Roll arrangement of cut-motion seemed to offer marked advantages in this line, although the High-Roll had never gone into noticeable use in this country and was open to many objections in the forms commonly known abroad. Mr. Northrop devised our present standard construction with the exception of quite recent changes, and the majority of our looms now in use are equipped with the High-Roll pattern.

In its best known form, the cloth passes directly to the rough-surfaced roll and is wound around a core, or bar, which is pressed up against the roll by two supports operating from a coiled spring which governs a double gear and rack device. The spring is wound up by the action of the racks as the roll winds, and the cloth is removed by releasing the spring with a hand crank. There are marked advantages in this arrangement, as the cloth will not shrink or wrinkle and the width of the goods will be more uniform and the picks more even. The breast beam comes outside the cloth, protecting it from blemish when the weaver leans over the loom. The direct acting roll also helps take strain off the temples and lessens warp breakage.

On all our cut-motions we use a metal cloth roll, to which the filleting is applied, unless the goods woven demand some special surface only applicable to a wooden roll. This will not shrink or swell like a wooden roll, thereby keeping the picks per inch uniform and the yards per pound at a proper standard. We believe the mill that runs wooden rollers will make its cloth either too light or too heavy. If too heavy, the mill is giving away value without remuneration, and if too light, there will be dissatisfaction at the buying end.

Quite recently we have made an improvement by which the core or bar in the cloth roll is positively started by having geared teeth engage with gears on the large winding roll when first starting to wind. As the cloth gets larger in diameter on the roll the gear teeth move apart and unlock.

While the mechanisms just described are parts of the cut-motion, they are operated directly by the take-up devices proper which transmit movement from the lay or cam-shaft or other moving parts of the loom. We have quite a variety of mechanisms for various classes of looms, many of which we have not shown separately, and some of which have been considerably modified since the cuts were made. It is practically impossible to keep our cuts up to date in view of the rapidity of improvement in the devices themselves.

"There has been expended in experiments, in investigation and for patents, some $300,000. The result is a reduction of one-half in the cost of weaving cotton cloth. The cost of weaving constitutes one-half the cost of labor required to produce cotton cloth. Consequently the saving secured by the loom is approximately one-quarter of the labor of producing the cloth. Experts have estimated that in 1895, $80,000,000 was paid for labor in the cotton manufacture in the United States. Assume that the improved loom had been thoroughly introduced, the saving secured thereby would have been approximately $20,000,000. The interest on the national debt of the United States in 1892, the last year of Republican control, was $22,893,000. The possible saving of the new loom, therefore, would be about seven-eighths of this interest."
—[*Hon. Charles Warren Lippitt, ex-Governor of Rhode Island.*