USEFUL INFORMATION

FOR

COTTON MANUFACTURERS.

Compiled and Issued

by

STUART W. CRAMER,

Mill Architect and Engineer.

Contractor for

Cotton Mill Machinery

and Equipment.

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Preface to Volume III., Second Edition.

Owing to various unexpected and unavoidable delays, this volume will appear about two years later than was originally contemplated. It is therefore necessary to supplement the general preface to the Second Edition, contained on pages vi. and vii. of Vol. I., at least to the extent of making acknowledgment to such of my professional friends as have given me valuable assistance in the way of information since Vol. I. was brought out,—among whom I would particularly mention E. C. Barnhardt, J. H. M. Beaty, H. C. Butler, J. F. Cannon, R. L. Cumnock, John W. Fries, Andrew E. Moore, W. R. Odell, H. A. Orr, Elias Richards, J. L. Scott, J. E. Sirrine, E. W. Thomas, Wm. Whittam, E. B. Wilbur and Eben C. Willey.

STUART W. CRAMER.

March 31, 1906.

ANNOUNCEMENT.

The above cut illustrates **our new building** now in process of erection on **Court House Square, at Charlotte, N. C.**

Our general and engineering offices are located in that part of the building in the foreground, the offices occupying all the second floor and a part of first floor, and the draughting rooms with our experimental laboratory occupying the top floor.

That part of the building shown in the rear will be used for a **shop, in which my new Automatic Combined Humidity and Temperature Regulators will be manufactured, as will also be my new Air Conditioners.**

Our new **draughting rooms** on the **top floor** of this building afford us ample room, light, and other facilities for the proper carrying on of this department of our business, the extent and importance of which will be realized when we call attention to the fact that we have made plans and specifications for over one hundred and twenty-five Southern cotton mills and have installed in them complete outfits of machinery and equipment, not to mention the additional detailed draughting that has been required in connection with the machinery and equipment that we have furnished to practically as many more mills designed by other engineers or by the mill officers themselves.

We also call attention to our **Branch Office** in the **Equitable Building, Atlanta, Georgia.**

Our customers and friends are cordially tendered the use of our offices as headquarters when in either Charlotte or Atlanta.

STUART W. CRAMER,
Agent for

THE WHITIN MACHINE WORKS,
WOONSOCKET MACHINE AND PRESS COMPANY,
KITSON MACHINE COMPANY,
ETC., ETC.

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An Alphabetical Index for all three volumes.

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SECTION III.

Dyeing and Special Finishing Machinery.

Raw Stock and Skein Dyeing Machines.

There are two general types of machines at present in common use for raw stock dyeing.

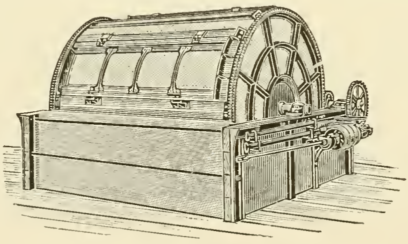
One consists of a basket in which the cotton is placed and slowly revolved in a vat of dye liquor; the other consists simply of a tank or vat into which the cotton is thrown and through which a continuous circulation of dye liquor is effected by a centrifugal pump.

The former type has occupied the field until quite recently, but it is now being gradually superseded by the latter, which possesses very decided advantages not only in the better condition of color obtained, but in economy of dye liquor, and in general convenience of handling, particularly in the matter of unloading.

At the same time, both types are herewith illustrated and described for the benefit of those operating the older and former types of machines, known as the Klauder-Weldon or Delahunty.

The essential difference between the Klauder-Weldon and the Delahunty is simply the difference in the means employed to carry the cotton around through the dye liquor as the basket revolves: in the Klauder-Weldon this is effected by diaphragms dividing the basket into four regular compartments; in the Delahunty, hooks are used to drag the cotton around, which practice can not be too strongly condemned. Of this type of machine, therefore, only the Klauder-Weldon will be described.

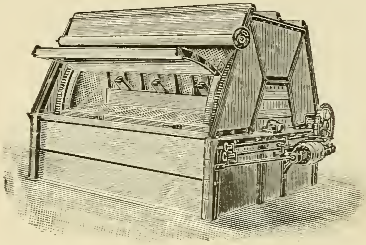
KLAUDER-WELDON DYEING MACHINES.



(View with cover removed to show cylinder.)

These machines are built for both raw cotton and raw wool, in four sizes with the following capacities: 200, 500, 700, and 1,000 pounds per batch.

The cylinder or working part of these machines is constructed of heavy cast iron, coper or bronze, well put together with heavy copper rivets, and bolts. It is divided into four compartments or pockets, with door on each pocket.



(View of machine with cover on and front raised to show one compartment just after unloading.)

The stock is loaded by hand; some put the stock into the machine without first putting it through an opener. When this is done the results are not so good, however, for with this type of machine the stock should be well opened so the dye liquor can evenly permeate the whole mass as the machine revolves.

The stock is not taken from the machine during the different processes, and is also washed before taking out of the machine.

The unloading is done as the bottom of the pocket, or compartment, comes to the level of the top of the tub presenting a level surface from which the stock is pulled off with a rake.

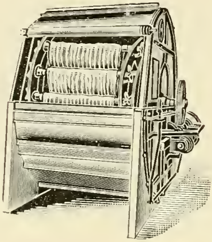
One dip colors, 3 to 4 batches per day of 10 hours.
Developed colors, 1 to 2 batches per day of 10 hours.

Table of Sizes, Floor Space, etc.

Size M'chine, Capacity in Lbs. per Batch.	Overall Dimensions.		Pulley.			H. P. Required to Drive.
	Width.	Length.	Diam.	Face.	R. P. M.	
200	9′– 0″	8′– 2″	10″	3½″	135	1½
500	10′– 3″	8′–10″	12″	4½″	100	2
700	10′–10″	8′–10″	12″	4½″	100	2½
1000	11′– 3″	10′– 6″	12″	4½″	124	3

KLAUDER-WELDON SKEIN DYEING MACHINES.

The machines are for either dyeing or bleaching cotton or wool skeins and slubbing singly or in combination.



(Single machine, capacity 150 to 200 pounds per batch.)

The reel or working part revolves in the dye liquor. Adjusted to this reel are sticks on which the skeins or slubbing are suspended, and held taut. At every revolution of the reel the sticks are automatically turned, and as the skeins move with the sticks there is no friction on the fibres. This ensures the skeins coming out smooth, straight, evenly dyed, and free from tangling or felting.

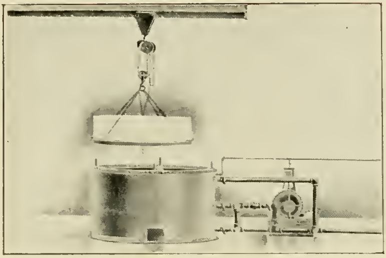
The driving gear is heavy, durable and fitted with friction clutches. The gearing is fastened to a heavy iron frame on side of tub, which prevents it from sagging or getting out of line.

One dip colors, 3 to 4 batches per day of 10 hours.
Developed colors, 2 to 3 batches per day of 10 hours.

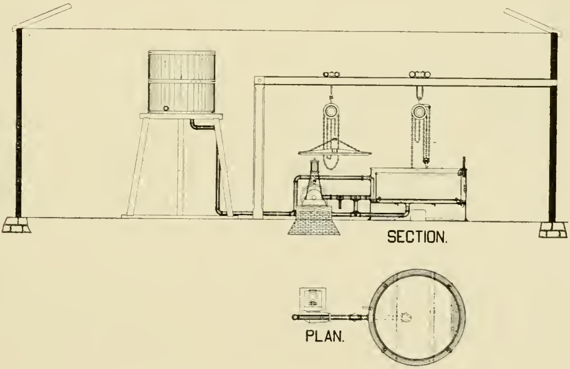
Table of Sizes, Floor Space, etc.

Size Machine, Capacity in Lbs. per Batch.	No. of Sticks.	Overall Dimensions.		Pulley.			H. P. Required to Drive.
		Width.	Length	Diam.	Face.	R.P.M.	
150 (Single)	21	7′-6″	9′-10″	16″	5½″	120	2
200 (Single)	28	8′-0″	9′-10″	16″	5½″	120	2
250 (Double)	42	11′-6″	9′- 1″	16″	5½″	120	3
400 (Double)	56	12′-9″	9′-10″	18″	5½″	120	3½

THE VACUUM RAW STOCK DYEING MACHINE.



(The machine with the bottom containing the dyed stock lifted out with the chain hoist ready for dumping.)



(This cut shows a section of the machine and makes clear its general internal construction.)

The above cuts illustrate by both perspective and diagram the standard type of the so-called "Vacuum" machine. It will be noticed that it consists of two cylinders, one within the other, substantially built of steel plate. The outer cylinder acts as a receptable for the dye liquor, and the inner cylinder holds the material to be dyed. It is provided with two removable perforated plates; one at the bottom for holding the cotton, and the other at the top for a cover.

A centrifugal pump direct coupled to a self-contained engine circulates the dye liquor.

A later type of this machine does away with the two cylinders, and may be termed a single tank machine.

Vacuum Dyeing Machines, Concluded.

Operation.—The inside cylinder is riveted to the bottom of the outer cylinder and there is no other connection between these cylinders except at the top, the outer cylinder being four inches higher than the inner cylinder. The stock to be dyed, say 500 lbs., is placed in the inner cylinder, which has a false bottom or perforated plate on which the cotton rests; —care being taken to pack the cotton well and evenly around the edges, and to leave the chains in approximately the position they assume when lifting out. When this cylinder is filled the chains are folded over and the perforated plate is placed on top and held securely in position by compression clamps screwed down.

The dye liquor is then turned into the machine until the amount required is in, and the steam turned into the heating coil until the dye liquor is up to the proper temperature. The pump is then started which takes the dye liquor from the outer cylinder passing it through the pump and discharging it into the bottom of the inner cylinder, from which it passes up through the cotton and over the top of the inner cylinder back again to the pump,—thus continuing the circulation until the batch is dyed. The washing is carried on in a similar manner. The machine is so constructed, that by reversing the valves the dye liquor can be drawn from both inner and outer cylinders and pumped into the storage tank or wasted into the sewer as may be desired.

The machine is fitted with an overhead track and two chain blocks for unloading. When ready to unload, the small block is run into position, and connects with cover by means of chains suitably arranged. The clamps are unscrewed and the cover lifted off and pulled to one end of the overhead track, and left hanging as shown in the cut. The large chain hoist is then shoved into position, and is hooked to the chains attached to the false bottom. The entire load of cotton rests on this plate and is lifted bodily out of the machine. This load is run to the other end of the track and is dumped off. This plate is then replaced in the machine and it is ready for the next batch, which is treated in the same manner.

Owing to the exceeding difficulty of unloading the machine by hand hoisting, the later types are fitted with the mechanical hoists but still attached by chains in the regular or usual manner. Also the unloading has been further facilitated by a tripping arrangement for unhooking one of the chains on one side and tilting the bottom up so that the batch tumbles off on the floor.

CRAMER AUTOMATIC DYEING MACHINES.

(For Dyeing Raw Stock, Warp Skeins, Hosiery, Piece Goods, Etc.)

In General.

To overcome certain well known objectrons to the revolving cage or basket type of dyeing machines, numerous attempts have been made to find satisfactory substitutes.

The first one was the **Church Continuous Automatic Machine.** This appeared so plausible that it was adopted by the Kitson Machine Company, who spent a very considerable sum of money trying to make it a commercial success. The machine met with more or less favor but owing to the difficulty of duplicating shades, its requiring skilled help to operate it, its high first cost, and for other similar reasons, it was not found to meet the conditions existing at the average mill, and the Kitson Machine Company abandoned the making of it.

The **Obermaier Machine** was next in the field. This was of German invention, and it may be termed the parent of the later tank types of raw stock machines. The general principles involved in the construction of the Obermaier machines were evidently sound. At the same time, it failed to give satisfactory results. It is unnecessary in this article to enter into a discussion of the reasons for or details concerning its failure.

The Vacuum type of machine was a decided improvement over the Obermaier, but built along substantially the same lines, and is the type of machine that has been described in the preceding pages. The term "Vacuum," however, is a misnomer as those machines are now built: originally the circulation depended upon a vacuum produced by suction, which was an utter failure; but exactly reversing the process and forcing the circulation of the dye liquor, the machine at once became a commercial success. Users of them experienced great annoyance in unloading the stock, and numerous attempts were made to devise some more convenient arrangement. The help in the dye house objected most strenuously to having to hoist out of the tank the load of cotton, which was both heavy and hot. And even in its improved form of unloading with mechanical hoist, the batch is dumped out on the floor in a disarranged mass, whereas in many colors it is desired to keep the batch together and to allow it to "smother" for a while before "extracting" it.

Again, it is highly important that the pressure all through the batch should be perfectly uniform during the process of

Cramer Automatic Dyeing Machines, Continued.

dyeing; in the Vacuum machine, the pressure is put on the cotton by the screwing down of the cover by hand, so that not only are different batches dyed under different pressures, but the same batch is often in a state of a greater compression on one side than the other.

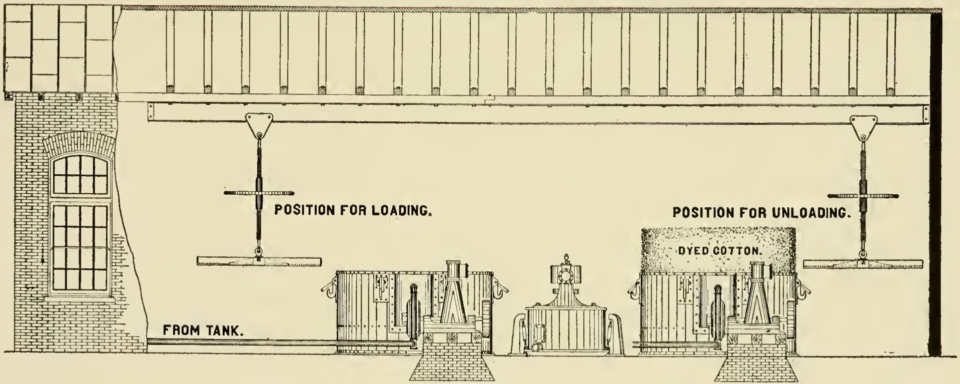
Another German invention has been introduced in the shape of a combined dyeing machine and hydro-extractor. The advantages claimed for it are the hydro-extraction in vacuum and oxidation previous to washing. The inherent trouble of the machine that would preclude its use in this country, however, is the enormous amount of labor required to operate it. The cotton is packed in a half dozen small air-tight cases that are clamped around a central spindle, through which the dye liquor is forced by centrifugal action. As each successive batch is dyed, these relatively small boxes are removed by manual labor and unloaded, their places being taken by others which have been previously packed and filled. Attempts have been made to build this same type of machine in larger sizes, but as would naturally be expected, the wear and tear is great in keeping it in order.

The **Cramer Automatic Dyeing Machine** built by the Textile-Finishing Machinery Company, of Providence, R. I., the largest manufacturers of dyeing and finishing machinery in the country, is illustrated and described in the following pages in the belief that it is another step towards the solution of the problem of raw stock dyeing.

This impression is shared by those who have these machines already in operation.

That the general scheme of raw stock dyeing, washing, drying, etc., as now operated leaves something to be desired, there is no question. In the near future, however, I am in hopes of introducing a new system that is now being tried out which will, it is believed, be thoroughly satisfactory, and overcome some if not indeed most of the objections to the present system.

Cramer Automatic Dyeing Machines, Continued.



LONGITUDINAL SECTION SHOWING TWO DYE MACHINES
AND
HYDRO-EXTRACTOR.

(No. 1 machine without mechanical means for removing the dyed stock after it has been expelled from the machine. In this case the stock is raked off or removed by hand. This type is specially suited for boiling out skein yarns in connection with bleaching, where the skeins can be picked off by hand as the bottom is shoved up and as the skeins appear over the side of the tank. At the same time, I would call attention to the fact that these machines can be fitted for dumping by tilting the bottom in its raised position to slide the batch off on the floor alongside the hydro-extractor, which is situated between the two machines. The hydraulic pump and its connections, and the other piping, are not shown.)

Cramer Automatic Dyeing Machines, Continued.

For raw stock work this machine has the unique advantage of dyeing cotton direct from the bale without any previous "opening." The process does not injure the fiber, as is the case with the rotary type of machine in which the cotton is continually rolled around in or dragged through the dye liquor, thereby more or less shredding it into strings in a very short time. Cotton dyed in this tank type of machine will card and spin equal to white cotton, and with comparatively no more waste,—as in the dyeing process the stock is simply placed in the tank and the dye liquor circulated through it under pressure.

With this improved type of machine, it is possible by shoving up the inner bottom on which the load is supported to obtain a uniform pressure on the loose cotton as well as the lumps, so that during the dyeing process the circulation of the dye liquor is so complete and so perfect that each individual fiber is dyed through and through, thereby producing a brightness of color in the goods that has been previously unknown except in the case of warp and skein dyeing. An examination of cotton as it comes from the bale discloses that it is composed largely of layers more or less closely matted together which are very dense compared with the loose and more flaky part. Now, in the ordinary type of tank dyeing machine, there is no practical means of putting a pressure on the whole mass so that the density of the entire batch is equal through and through.

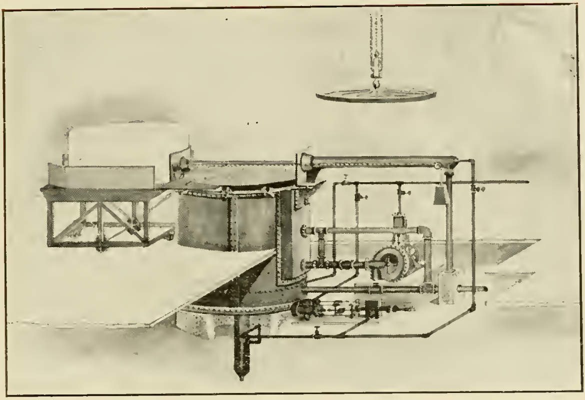
It is evident to anyone acquainted with the process of dyeing raw stock that in order to duplicate shades, it is necessary to duplicate conditions. Any type of machine depending upon hand screwing or clamping down a cover for compression is evidently too crude an attempt in this direction to be successful.

It will therefore be seen that this machine with its possibility of always obtaining a uniform pressure on the batch to be dyed, will result in an evenness of color as yet unapproached by any other machine, the lumps being dyed through and through as evenly as the rest of it.

Construction.

The cuts and diagrams on the following pages show the construction of the machine and give a clear conception of the improvements embodied therein.

It will be noticed that in general this may be termed a single tank machine provided with a perforated top and bot-



(Perspective illustrating **No. 3 Dyeing Machine** of the **Ram Unloading type**. The batch of cotton is shown pushed off on a truck in front of the machine where it can be moved to the hydro-extractors or allowed to stand and "smother," as may be desired. See also Sectional Diagrams with accompanying keys to lettered details.)

tom, between which the material to be dyed is placed, and through which the circulation of dye liquors is effected in the usual manner.

The distinguishing features in general appearance lie in the substitution of a piston head for the usual false bottom, the raising and lowering of this piston head by a hydraulic ram, all as shown in the diagram on the following page.

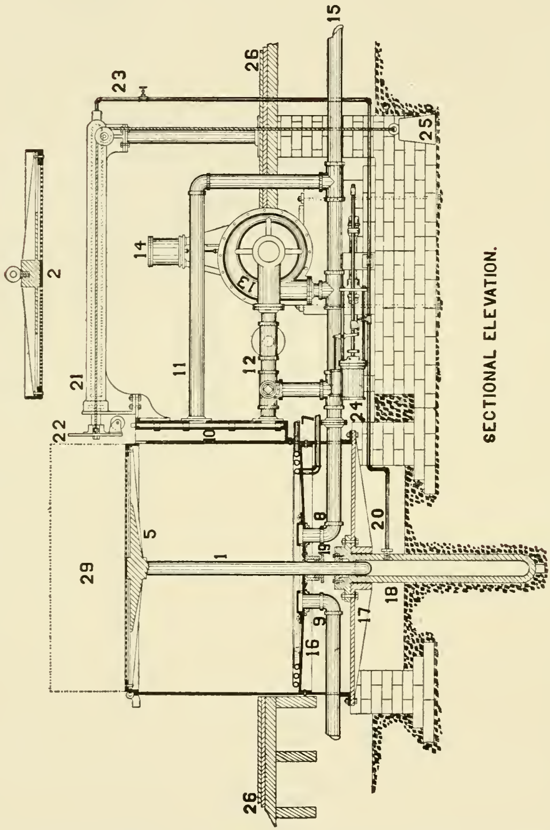
The method of raising the cover is relatively unimportant; at the same time, we furnish three types of cover removing devices:

(1). One hinged and counterweighted for the smaller size machine so that it may be lifted and swung clear to one side.

(2). Or, it may lift in the manner usually adopted for lifting the covers from iron kiers, by means of a special design of turn buckle with hand wheel in the center; a few turns of the wheel being sufficient to lift the cover high enough to permit its being swung clear of the tank.

(3). An ordinary chain block can also be hooked into the top of the cover. In my machine, however, it is unnecessary to hoist the cover by means of a chain block, because the cover goes up on top of the load as it is expelled from the tank by the raised piston; the chain block is only to support the cover when it is pulled to one side, and also to furnish a means for lowering it back on top of the new batch when the machine is again charged for dyeing.

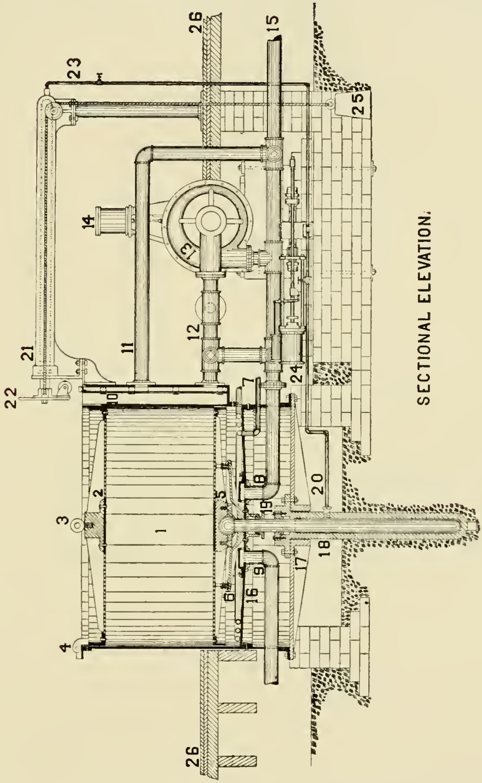
Cramer Automatic Dyeing Machines, Continued.



No. 3 Dyeing Machine with pushing off ram. The bottom is shown raised, the dotted lines representing the cotton in position ready to be pushed off. See also page 975.

(1) Raising and lowering ram. (2) Cover. (3) Eye bolt in cover. (4) Holding down lug for cover. (5) Bottom. (6) Supporting arm for springs to provide tilting feature to bottom. (7) Steam pipes. (8) Discharge pipe from circulating pump into bottom of tank. (9) Drain pipe from bottom of tank. (10) Overflow chamber. (11) Filling pipe (12) Suction pipe to circulating pump. (13) Circulating pipe. (14) Direct connected engine driven circulating pump. (15) Pipe to dye liquor storage tanks and to sewer.

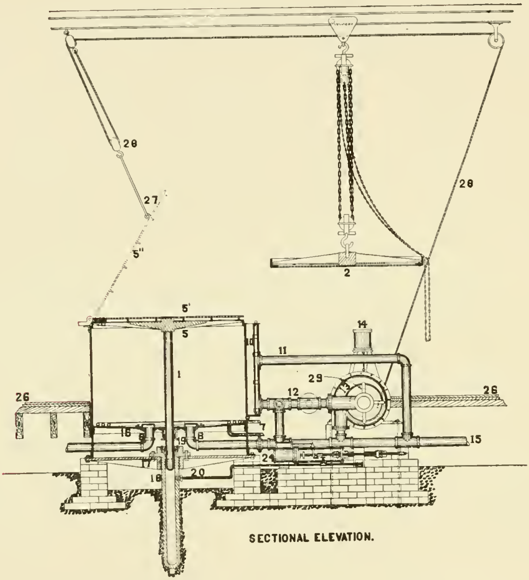
Cramer Automatic Dyeing Machines, Continued.



(16) Bottom to dyeing machine tank. (17) Supporting spider for cylinder in which raising and lowering ram works. (18) Cylinder. (19) Stuffing boxes to cylinder and bottom. (20) Piping connection to cylinder from hydraulic pump. (21) Pushing off ram and cylinder. (22) Curved push plate. (23) Connection to cylinder of pushing off ram from hydraulic pump. (24) Hydraulic pump. (25) Counterweight to pull pushing off ram back into position. (26) Floor. (29) Cotton expelled from the machine by the raising ram ready to be pushed off.

No. 3-A Dyeing Machine with pushing off ram, illustrated above, shows the bottom down and the cover in position. It will be noticed that the bottom in this case is provided with arms and springs whereby it can automatically adjust itself to the inequalities in loading. This is a refinement necessary only in matching very delicate shades.

Cramer Automatic Dyeing Machines, Continued.



SECTIONAL ELEVATION.

The No. 2 Dyeing Machine is the same as the No. 1 except with automatic means for tilting up the bottom and dropping the load to one side. The above sectional diagram shows how the tilting arrangement is effected. The dotted line shows the bottom in its tilted position; it will be noticed that the side of it is hoisted by a block and tackle,—the fly wheel to the engine driving the circulating pump being specially fitted to be used as a winch for raising, all as shown above. For explanation of the figures on the diagram, see pages 976-7 except for the following numbers:

(5) Supporting spider to reciprocating bottom. (5′) Perforated bottom in flat position. (5″) Perforated bottom in raised position for sliding off the batch of dyed cotton. (27) Hooks for raising the bottom. (28) Block and tackle. (29) Winch on engine wheel.

As an alternative proposition we can furnish without additional charge a separate crab winch for operating the hoist to tilt the bottom and thereby unload the machine. This is probably the better plan, as it leaves the engine and circulating pump free to perform their other functions at all times.

As for the method of removing the cotton after it has been expelled from the machine by the raising of the piston, there are two devices: one of them consists of another ram at right angles to the first, which shoves the batch off on to a truck; the other by raising one side of the bottom on a pivot, consisting of a hinge firmly attached to the spider supporting the cotton,—whereby the load is slipped off to the floor at the side of the machine.

The construction of the hydraulic ram is of the simple and well-known type ordinarily employed in hydraulic press work.

The dye liquor is introduced at the bottom of the machine, and is distributed radially in the bottom of the machine underneath the piston head, in a horizontal plane, so that it does not impinge directly at any point upon the perforated piston head or bottom.

When desired the bottom can be supported on a universal joint normally steadied in a horizontal position by stout springs securing the semi-supporting arms, but which allow the bottom to tilt into any required position to take care of inequalities in loading. It has been found quite impractical to load machines of this type so that when compression is put on the cotton it is found to have been uniformly loaded all around; more cotton is likely to have been placed at one side than another, so that in order to maintain a uniform pressure over the batch, it is desirable that this tendency toward unequal loading be automatically provided for.

And finally, the hydraulic pump is fitted with a gauge by which a uniform pressure can always be put on the batch while the dye liquor is being circulated, so that every batch is dyed under equal and uniform conditions.

Operation.

Starting, therefore, with the loose cotton from the bale, and the cover removed, a batch is placed in the tank, the amount of which is entirely immaterial. The charge may be only one hundred pounds, or the machine may be crammed full to its utmost capacity. The cover is then lowered into position and fastened on. The piston head or bottom is hydraulically shoved up until the pressure valve indicates that the contents to be dyed are under a pre-determined and uniform pressure. The necessary valve is now opened, and the dye liquor allowed to run into the machine from an elevated tank, or wherever it may have been mixed up and stored, or to save time, it can be pumped in. When the requisite amount has entered the steam is turned on, the valve is shut and the pump started; the liquor is forced in

Cramer Automatic Dyeing Machines, Continued.

at the bottom of the machine, is diffused radially in the manner already indicated, then rises under pressure through the perforations in the bottom up through the material to be dyed, out through the perforations in the top cover, and overflows into the chamber at the side of the tank from which it is removed by the pump suction, and again started in its cycle of operations comprising the circulation system. When the operation of dyeing has progressed far enough, the pump is reversed and the liquor drawn off, being returned to the tank or otherwise disposed of, according as may be desired. The heating of the dye liquor is accomplished in the usual manner by steam pipes; any washing that may be necessary is naturally accomplished in the same manner as the operation of dyeing itself, being facilitated by lowering the piston so that the water will more readily and quickly pass through the cotton. (For some colors it will be found to advantage to shove the batch off on to a truck and let it "smother" for awhile, after which it can be washed to advantage in the hydro-extractor during the operation of "whizzing.") The bottom is then shoved up to a pressure previously determined, at which the maximum of dye liquor may be expelled without having a tendency to cake the batch; the cover is now removed and swung clear of the machine, and the contents expelled by shoving the piston up so that the bottom is on line with the top of the tank. In this position it may be either slid off on to the floor and thrown directly into the hydro-extractor; or pushed on to a truck, as previously stated,—and both as illustrated in the accompanying cuts and diagrams.

Summary.

So much for the ordinary operation of dyeing. From what has already been said, it should be unnecessary again to point out the advantages of this machine. Regardless of the relative condition of the bales to be dyed, and regardless of the amount of cotton thrown into the machine for each batch, it is evident that by the simple device of shoving up the bottom until the gauge shows a uniform pressure each time, that the main and principal condition necessary for the duplication of shades has been secured; it only remains, then, to supply to the machine dye liquor of uniform strength circulated for a uniform period of time and the results will be beyond question.

The saving of the labor in the unloading feature of this machine has appealed to the trade already to such an extent that it demands that feature, and competitors have been compelled to furnish it. At the same time, it is not to be lost sight of that whereas others can remove the batch from their machines by power attachments, they are still unable to preserve the batch intact during its removal, which is the main feature about this type of unloading that really appeals to one. To explain further, it is necessary only to call attention to the fact that the details of dyeing raw stock by sulphur colors are yet to be definitely settled. There exists a decided difference of opinion as to the matter of oxidation. In the beginning it was contended that no air should be allowed to get at the cotton during the dyeing operation until after it was rinsed; it was next considered necessary to "aerate," as it was termed, the batch before it was washed; but now, it is concluded by some of the best operators that it is highly desirable to oxidize the batch by a process of "smothering." For accomplishing this result it will be seen at a glance that this machine is peculiarly well adapted. The batch can be expelled from the machine by raising the piston bottom and then can be pushed off in the form of a cake without derangement on to a truck and allowed to stand and "smother" as long as may seem desirable. It will therefore be seen that this type of machine is the only one that will properly meet this condition in case it is ultimately found to be the proper one under which raw stock should be worked; and at the same time it is quite as well adapted to meet either one of the other conditions should they ultimately prevail.

Capacity.—500 to 1000 lbs. per batch depending upon whether it is compressed cotton or not.

Floor Space.—The floor space for the standard machine complete, including pumps and piping complete, is approximately 8′–0″ x 16′–0″.

Note.—Machines of this type can be used to dye skein yarns or piece goods, the difference being that a variable depth is used in each case to suit the particular class of work to be done. The raw stock machine requires the greatest depth, and skeins, hosiery, and other goods lesser depths in proportion to the resistance they offer when compressed to the circulation of the dye liquor.

Also the machine is adapted to use as a boiling out, or washing machine for bleacheries, etc.

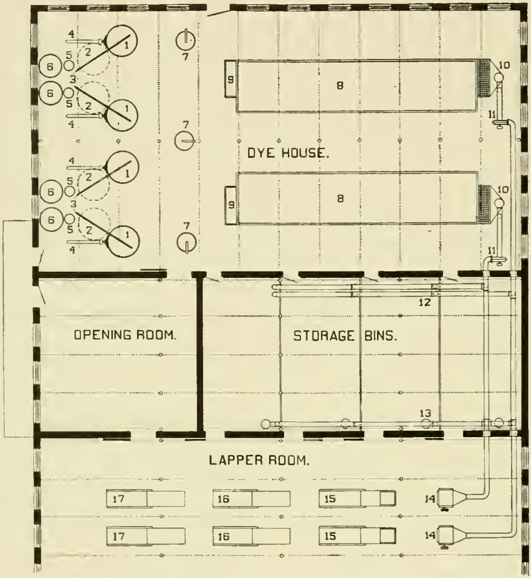
Smaller sized machines to order.

NOTICE!

We are installing in our laboratory at Charlotte working models of this dyeing machine. Arrangements are made for dyeing batches of 10 to 50 pounds each in the presence of visitors, which will not only make clear to them the operation of the machine but also furnish samples of what the machine will do on different colors.

It is also not amiss to point out that the possession of this outfit enables us to thoroughly investigate the best methods for producing results,—which will inure equally to the benefit of ourselves and of our customers.

Cramer Automatic Dyeing Machines, Concluded.



The above diagram illustrates a proposed installation of four dyeing machines, three hydro-extractors, and two dryers in a cotton mill.

As the power plant is generally located adjoining or near the lapper room, it will be seen that the above arrangement is not only convenient for handling the cotton but also for getting both steam and power.

The following key to the figures shown on the cut explains in a general way the details of the installation.

(1) Automatic Dyeing Machines, standard size. (2) Unloading position for the lid or cover. (3) Overhead track for handling the cover. (4) Pushing off ram for unloading the dyeing machine. (5) Color mixing tank (generally a barrel with the upper third sawed off). (6) Elevated tanks for holding dye liquors or water. (7) Hydro-extractors (8) Automatic raw stock dryers. (9) Automatic feeders. (10) Conductor pipes for conveying the cotton from the feeders to the storage bins. (11) Exhaust fans used in connection therewith. (12) Branches to each bin properly equipped with dampers so that the colors can be shunted at pleasure from either dryer into any bin. (13) Hoppers (one in each bin) into which the cotton is thrown to be delivered into the lapper room where it is deposited on the floors in a pile back of the lappers through the (14) condensers. (15) Single beater breaker lappers with automatic feeders attached. (16) Intermediate lappers. (17) Finisher lappers.

SCHAUM & UHLINGER HYDRO-EXTRACTORS.

In General.

(See page 987 for sectional diagram.)

Self-Balancing Feature.—The self-balance is gained by suspending the machine, by swivel bolts, from three standards. These standards are cupped out at the top to receive a ball and socket, the lower flange of machine likewise takes a ball bearing, and the necessary adjustment is made by means of swivels, fixed securely in proper position by a lock-nut at each end. Thus all vibration, resulting from unequal loading, or any other cause, is entirely taken up. The hydro-extractor vibrates as a whole, and within itself, preserving all its parts in their original relations to each other.

This method of balancing is vastly superior to the old way of allowing the basket to gyrate inside the tub, not only because it does away with vibration, but because there is no lost space between tub and basket. For the same capacity of work, this machine is less bulky and occupies less floor space than the old type.

It is not necessary to stop a machine to readjust the load; the self-balancing arrangement equalizes an uneven load.

All styles, except hand-power machines, are now built with the self-balancing arrangement.

Self-Oiling Step-Box.—The step-box is an improvement of recent date, and makes a notable advancement in the construction of a vital part of centrifugal machines. It insures constant and thorough lubrication, consequently ease of running and long durability. The box is entirely filled with oil The lower bearing is always immersed The rotation of shaft draws the oil from below and carries it upwards along the spiral grooves cut on inside of bronze sleeve, keeping it in constant circulation. It is correct in design and satisfactory in operation. The wear on the step-plates is reduced to the minimum.

Band Brake.—Another improvement is the new band brake. The stem, or head, of basket casting is enlarged into a flanged pulley-shaped head of proper size to receive the steel brake. The brake is lined with a hickory band, which has been found to outwear leather, fibre, or any other substance. With this brake the largest hydro-extractors can be easily and quickly stopped.

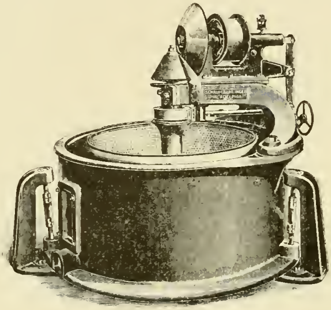
Cleaning Door.—All these hydro-extractors are now provided with patented cleaning doors. By means of this door the

Schaum & Uhlinger Hydro-Extractors, Continued.

revolving drum is readily cleaned while in operative position.

Machine "A."

Machine "A" is self-contained; only a steam connection is needed. The engine, attached to side of hydro-extractor, is connected to the shaft of basket by friction-cones.



Machine "C."

With friction cones and pulley for belt driving, this is the hydro-extractor we recommend for use where water-power is abundant, or where, for any reason, belt-driving is preferable to a steam engine or an electric motor. For such places machine "C" is highly satisfactory, being simple, compact, durable, and always ready for work.

The "Bd" or Bottom-Discharge Machine

is the newest style of hydro-extractor.

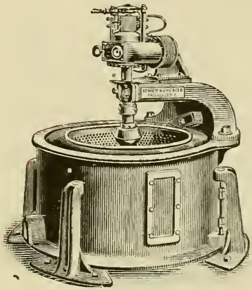
It is so constructed that, by means of a lever, the bottom of basket is easily opened and the contents are discharged into a suitable conveyor or receptacle beneath the machine.

In all other particulars this hydro-extractor is like machine "B."

The facility of loading, afforded by clear space three-fourths of the way around the basket, and the convenience of the bottom-discharge, coupled with ease of control, speed, and smooth operation, make machine "Bd" a time-saver, and a labor-saver, whose importance can hardly be over-estimated.

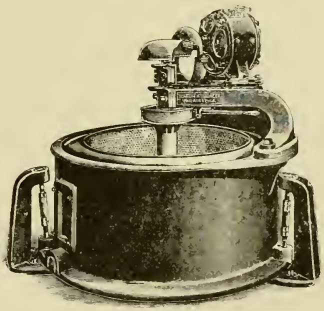
The "Bd" machine is built in only one size—48-inch basket, and can be supplied for any form of motive power: "C," "E," or "G."

Schaum & Uhlinger Hydro-Extractors, Continued.



Machine "E."

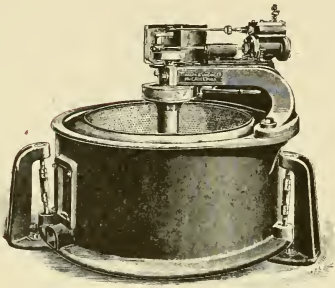
With its electric motor, this is the most compact hydro-extractor built, and more closely resembles machine "B" than any of the others.



The motor is mounted on the housing and either connected directly to the shaft of basket as shown in the upper cut or as shown in the lower cut by bevel gears. There can be no lost motion.

No other hydro-extractor is so easily started, nor attains full speed in so short a time. A turn of the wrist and the machine is in motion. In less than two minutes it is running at full speed. A minute or two more and extracting is completed. In actual work, with basket fully loaded, the total time of operation of one of these machines has averaged five and a half minutes. The most economical in operation.

Schaum & Uhlinger Hydro-Extractors, Continued.



Machine "B."

This is the style of hydro-extractor most largely in use. It can be employed advantageously in more ways and places than any other.

It will be observed that this machine is complete in itself. No shafting and belts, nor gears, are required. The engine is connected directly to shaft of basket, and is actually a part of the hydro-extractor, the basket serving as the fly-wheel.

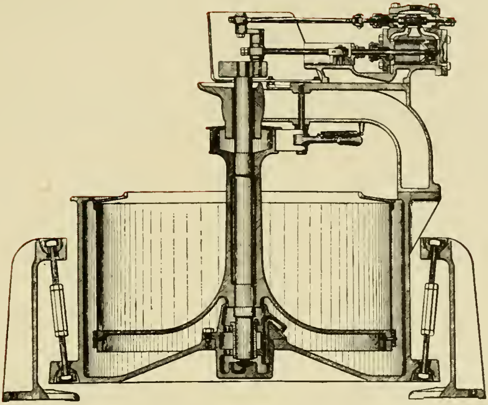
It starts instantly, and full speed is attained quickly. Only live steam required, conveyed through a small pipe direct from the boiler. No slipping belts—no time lost nor power wasted. Extracting begins with the first turn of the engine and is speedily finished. The very powerful band brake soon brings it to a stop.

An important consideration, especially where looms and spinning machinery are in operation, is that this hydro-extractor, running independently, can in no wise interfere with other machinery.

Notwithstanding the high velocity—six hundred to twelve hundred revolutions a minute—the speed of the piston is much less than that of the average high-speed engine, because of the shortness of stroke. Besides, ample wearing surfaces assure freedom from wear.

Ease of access is a notable point. The housing, supporting the engine, extends only a fourth of the distance around tub, allowing three-fourths of the space for loading and unloading.

The contents of basket are fully protected from oil and grease by large oil shields surrounding the moving parts of engine.



(Section showing general construction and details of the "B" machine.)

Foundation and Settings.

The diagrams on the following page show the size and character of the foundations required, but particular attention is called to the following points :

The foundation proper is to be constructed of concrete, consisting of cement and broken stone.

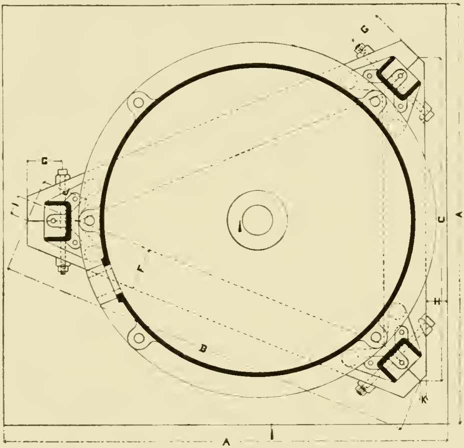
The frame work furnished with the machine is of yellow pine and care should be taken that the holes marked on the cut are bored correctly : the nuts for the bolts must be let in flush with the top of the timber in order not to interfere with the feet of the self-balancing stands.

The most convenient way to set up the machine is to place it centrally over the foundation, locating the stands as shown on the drawings, and bolt them into position. Then raise the machine up, and place the swivel bolt in position, when the block can be taken out and the machine suspended and leveled up by turning the swivels,—these being right and left hand threads.

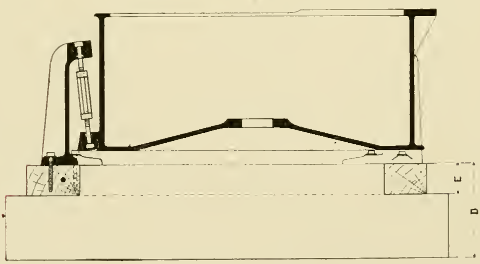
Both the live and exhaust steam pipe to the engine driven extractors must be connected with the rubber steam hose that is furnished with the machine ; they should be firmly clamped to all ends of pipe to prevent the possible light swaying of the machine from moving the steam pipe and causing leaky joints.

Schaum & Uhlinger Hydro-Extractors, Continued.

Acid=Proof Hydro-Extractors.—These can be supplied in any of our types with acid-proof baskets, either vulcanized rubber, or our acid-proof metal, made especially to do the work for which they are required.



Plan.



Section.

Setting Diagram and Floor Plan.

Schaum & Uhlinger Hydro-Extractors, Concluded.

Table of Sizes and Details.

Basket.			Machine "B." Engine. Cylinder.		Machine "B." Engine. Pipes.		Machine "C." Driving Pulley.			Machine "E." Motor.	
Diameter, in Inches.	Revolutions, per Minute.	Capacity, in Pounds.	Diameter, in Inches.	Stroke, in Inches.	Steam Pipe, in Inches.	Exhaust Pipe, in Inches.	Diameter, in Inches.	Face, in Inches.	Revolutions, per Minute.	Size Required in H. P.	Type, Volts, Current, Etc.
30	1200	75	3	3	¾	1	9	4½	625	3½	Any voltage, D. C. or A. C.
36	1000	110	3	3	¾	1	12	5	475	3½	
42	800	150	4	4¾	1	1½	15	6½	325	5	
48	600	200	4	4¾	1	1½	15	6½	175	7½	
54	500	275	4½	6	1½	2	22	8¾	250	10	

Table of Lettered Dimensions, in Inches.
(To accompany diagrams on opposite page.)

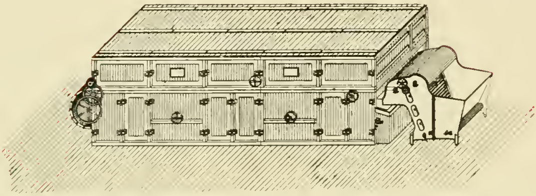
Size of Basket.	A	B	C	D	E	F	G	H	I	J	K	Lag Screws.
30	57	52⅝	40¼	16	3¾	6	5	5	3	7⅛	½	9- ¾ x 5
36	66	58¾	45	16	3¾	6	5	6	3	7⅜	½	9- ¾ x 5
42	78	69½	53	18	5¾	8	6¾	6½	3¾	9¼	⅞	9- ¾ x 7
48	84	75½	58	18	5¾	8	6¾	7	3¾	9¼	⅞	9- ¾ x 7
54	90	82½	63	18	5¾	8	6¾	7	3¾	9¼	⅞	9- ¾ x 7

Note.—These tables are to be used for estimating purposes only. Detailed drawings should be obtained in each case from the builder for the purposes of installation.

RAW STOCK DRYERS,

MANUFACTURED BY

Kitson Machine Company.



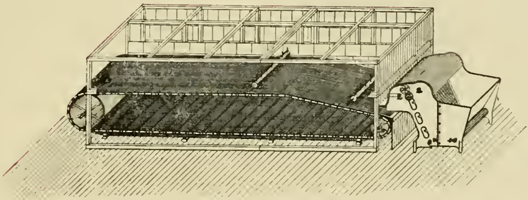
A description of these machines is best accomplished by the above cut and the following explanation of a **Two=Section Single Apron Dryer with Automatic Feeder:**

The frame is made from hard wood stock, mortised and joint bolted together, then covered with kiln-dried sheathing and lined throughout with best roofing tin. Everything inside the machine is metal, as well as the Automatic Feeder outside, which is of heavy iron construction and suitably built for handling wet stock. Unlike other dryers which depend upon the friction of wooden drums to carry wire aprons, the Kitson dryer has iron drums and long-link steel chains to do the work, while a specially woven apron or endless belt of tinned wire 72″ wide supports the stock being conveyed through the machine.

This combination of chain and apron is peculiar to the Kitson dryer only, and is a highly important feature of a successful conveyor of stock. In compartment back of apron are two steam coils, fitted for either live or exhaust steam, and containing about 2,700 feet of 1¼″ steel pipe and fittings.

Two 48″ patented steel fans, running in self-oiling boxes keep a constant circulation of air from steam coils passing down through stock being conveyed through machine. Two whippers running in close proximity to the top of apron keep stock loosened up, insuring perfect driving. Machines are built in three sizes and provided with countershafts complete.

Kitson Raw Stock Dryers, Concluded.



Sectional Diagram Showing Endless Belt, Whippers, Etc.

Table of Dimensions, and Production in pounds per day of 10 hours.

Drying Capacity, Pounds.	No. of Fans or Sections.	Length Over All. (In feet and inches.)	Width Over All. (In feet and inches.)	Height. (In feet and inches.)	Number of Whippers	H. P. Required to Drive.
3,500	2	35-0	11-0	8-1½	2	3.50
5,000	3	45-3	11-0	8-1½	3	5.00
6,500	4	55-6	11-0	8-1½	4	6.50

Dryer Pipe Coils.—At the end of each coil is a manifold with 3″ inlet bushed down to 1½″; the 3″ connection can be used for exhaust steam, or when bushed down to 1½″ a live steam connection can be made.

The two-section dryer has two coils with pipe of the standard length of 11 feet; the three-section dryer has one standard 11 foot coil, and one long 20 foot coil, which serves two sections: the four-section dryer has two standard 11 foot coils and one long 20 foot coil.

The Hand of Dryers—This is always designated by the location of the steam coil. For instance, if the steam coil is on the right side when facing the hopper or feeder, the dryer would be termed a right hand machine.

Countershafts are furnished with the above machines, fitted with 18″ x 5″ tight and loose pulleys, which should run 220 revolutions per minute.

The above are standard sizes, and one of them will generally be found applicable to ordinary cases. The capacity of a dryer is generally bought largely in excess of the production of the dyeing machine, to economize labor in the dye house.

However, when desired, we can build special intermediate sizes.

DISK WHEELS.

Probably the best device for removing exhaust steam, hot air, and offensive odors from dye houses is the style of fan technically known as a Disk Wheel.

These wheels are exceedingly simple, and very cheap. Their construction is clearly seen from the accompanying illustration.

Several arrangements of these wheels are possible to suit the different conditions under which they are to be operated, only two of which are here illustrated.

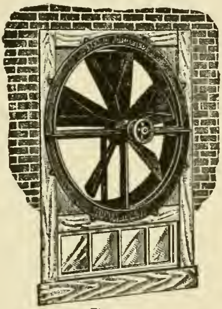


Fig. 1.

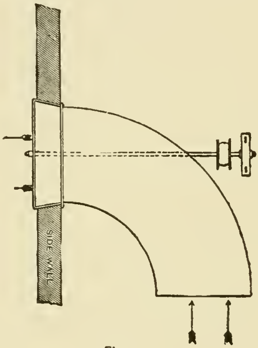


Fig. 2.

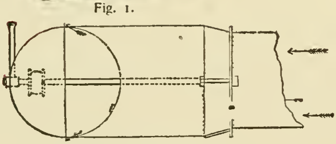


Fig. 3.—Side Elevation.

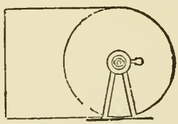


Fig. 4.—End Elevation.

Of course, the simplest case is that of an outside wall where the wheel is inserted in the upper sash of a window, or set in a specially made hole in the wall; no pipe connections whatever are required. This method of setting is shown in Fig. 1.

Figs. 2, 3, and 4 show different views of an arrangement applied to an inside wall. The disk wheel discharges outward into a galvanized iron pipe, carried through an adjoining room to a suitable point where it can be discharged outside.

Table of Capacities of Disk Wheels.

Number of Revolutions of Wheel per Minute.	Amount of Air Handled in Cu. Ft. per Min., Free Delivery.						
	24-in.	30-in.	36-in.	42-in.	48-in	54-in.	60-in.
100	....	....	....	....	4245	6059	8387
110	....	....	....	....	4676	6665	9258
120	....	....	....	....	5100	7278	10137
130	....	....	....	....	5530	7897	11024
140	....	....	....	....	5965	8522	11919
150	....	....	....	....	6405	9154	12822
160	....	....	....	....	6851	9792	13733
170	....	....	....	....	7302	10437	14652
180	....	....	....	5038	7758	11008	15579
190	....	....	....	5321	8219	11746	16514
200	....	....	3594	5607	8686	12410	17457
210	....	....	3779	5896	9158	13088	18407
220	....	2341	3966	6188	9635	13764	19367
230	....	2457	4155	6482	10117	14447	20334
240	....	2575	4347	6779	10605	15136	21309
250	1307	2696	4541	7079	11098	15822	22292
260	1444	2819	4738	7382	11596	16534	23283
270	1502	2945	4937	7688	12099	17243	24282
280	1561	3074	5139	7906	12609	17958	25289
290	1622	3205	5343	8307	13122	18680	26304
300	1684	3338	5550	8621	13641	19408	27327
310	1747	3474	5759	8938	14165	20143	28358
320	1812	3612	5971	9258	14695	20884	29397
330	1878	3753	6185	9580	15230	21632	30444
340	1945	3896	6402	9905	15770	22386	31499
350	2014	4042	6621	10233	16315	23147	32565
360	2083	4190	6843	10564	16865	23914	33633
370	2154	4344	7067	10898	17421	24688	34712
380	2227	4494	7294	11234	17982	25468	35799
390	2300	4650	7523	11573	18508	26255	36894
400	2375	4808	7755	11915	19119	27048	37997
410	2452	4969	7989	12260	19696	27748	39108
420	2529	5132	8221	12608	20278	28654	40227
430	2608	5208	8464	12958	20865	29467	41354
440	2688	5466	8706	13311	21457	30286	42489
450	2770	5636	8950	13967	22055	31112	43632
460	2853	5808	9197	14026	22658	31944	44783
470	2937	5982	9446	14388	23268	32783	45942
480	3022	6158	9699	14752	23884	33628	47109
490	3109	6336	9953	15119	24503	34480	48284
500	3197	6516	10210	15489	25127	35338	49467
510	3286	6698	10470	15862	25755	36203	50640
520	3376	6882	10632	16238	26390	37074	51795
530	3468	7068	10897	16616	27030	37952	52632
540	3561	7256	11162	16997	27675	38836	54051
550	3656	7446	11430	17381	28325	39727	55152
560	3752	7638	11702	17768	28980	40624	56235
570	3849	7832	11977	18158	29640	41528	57300
580	3947	8028	12254	18550	30283	42438	58347
590	4047	8226	12534	18945	30909	43355	59376
600	4148	8426	12816	19345	31518	44277	60401
610	4250	8628	13101	19744	32110	45208	....
620	4354	8832	13388	20148	32685	46144	....
630	4459	9038	13678	20554	33243	47087	....
640	4565	9246	13970	20963	33784	48036	....
650	4671	9456	14265	21375	34310	48992	....
660	4779	9668	14562	21790	34836	49954	....
670	4888	9882	14862	22202	35362	50923	....
680	4998	10098	15164	22611	35888	51898	....
690	5109	10316	15469	23017	36414	52880	....
700	5221	10536	15776	23420	36940	53858	....

Blower Systems for Handling Raw Stock.

Under the head of **Mill Engineering** blowing systems will be both illustrated and described in detail; these systems are suitable not only for conveying cotton from the opening room to the lapper room in the ordinary mill, but to the dye house where it can be dropped directly into the dyeing machines if desired.

A few mills have tried this, but the practical working of it has been found less satisfactory than to have it discharged into a bin from which the different batches are taken to the dyeing machines as required.

A similar system can be installed to convey the damp stock from the hydro-extractor to the automatic dryers. Such an outfit usually consists of a fan, and a hopper alongside each hydro-extractor, with the necessary piping branching to the dryers,—no condenser being required, as the damp stock drops directly down into their feeders.

Another fan (See page 982) with hopper can be advantageously placed alongside the delivery end of the dryers, into which the dried stock is thrown and conveyed through a system of pipes with dampers that shunt it either into different storage compartments. or straight to the picker room, as desired. In the picker room it is necessary to have a condenser to receive the dried stock and deposit it on the floor or in a bin; no condensers are required, however, on the branch pipes that deliver into the tight storage compartments that are usually provided in dye houses for the different colors of dried stock.

When raw stock has been dyed, many manufacturers claim that it works better by "ageing,"—which is a term to designate a sort of "conditioning" of it by exposure to the air for a certain length of time before working it up. Some mills contend that the ageing takes place just as satisfactorily when the dyed stock is baled as when it is left lying loose; in such a case, a cotton press is used to bale it, the advantage being that a considerable amount of it can be stored in a very limited space.

For that matter, no mill should have any trouble working raw stock immediately on its receipt from the dryers, provided a proper humidity is maintained in the different departments, particularly in the card room. Of course the automatic dryers should be so set that the stock will be delivered only sufficiently dry to work well, and not "tinder-dry,"—the proper degree of dryness being discovered by actual experiment in each case.

YARN DYEING.

Yarn may be dyed either in warps or skeins. As warp dyeing in the long or short chain is the usual method of dyeing yarns, these processes are fully described in the following pages, with cuts illustrating the different machines required for each operation.

As skein dyeing is very limited, little need be said of it more than to refer to the skein dyeing machines previously described. After dyeing, the skeins are spooled or quilled, as the case may be,—generally the latter.

The machinery for this purpose described and illustrated in the following pages is built by

The Textile-Finishing Machinery Company.

DYEING YARN IN THE WARP.

There are two well recognized and distinct systems of dyeing yarn in the warp known as the Long Chain or Scotch System and the Short Chain or English System of dyeing. The relative merits of the two systems depend entirely upon the quantity of yarn to be put through, the variety of shades to be dyed and the class of goods for which the yarn is to be used. Each mill must decide for itself after careful consideration of its own needs.

In brief, however, it may be stated that by the long chain system warps can be dyed long enough to get 12,000 to 15,000 yards of a uniform color ; the white in the pattern can be kept clear by having the slashers equipped with double size boxes, one for the colored yarn and the other for the white yarn. The short chain system is very convenient for a small mill having short patterns of 2,000 to 3,000 yards each. It does not require much floor space nor a slasher. The cost of drugs and labor is about the same with each system.

Warp Dyeing, Concluded.

The Long Chain System.

For the Long Chain system the warps to be dyed are usually from 5,000 to 15,000 yards long, each consisting of 300 to 500 ends. They are usually and best brought into the dye house in balls made on a ball warper.

The warps are first run through a warp boiling out machine. (See page 998 9). Each warp will have a certain number of leeses each, say from 600 to 1,000 yards long, and on leaving the boiling out machine are dropped into cans. They are next drawn through a doubling machine (see page 1000-1) and are reduced in length to 600 to 1,000 yards. They are then dyed in round or Scotch dye tubs (see page 1002-3) by running through from four to seven times or even more according to the shades to be dyed. After dyeing, they are split out into long chains again by running through a warp splitting machine (see page 1004-5.) They are then dried on a warp drying machine consisting of a number of cylinders sufficient for the amount of yarn to be dried. (See page 1006-8.)

Warp yarn is run direct on a beamer (see pages 218-9) and starched or sized on a cylinder slasher (see page 220-227) or a "tape dressing" machine as it is termed (see pages 228-9.)

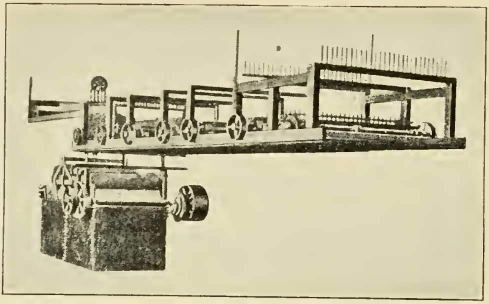
Filling yarn while still in the warp or skein is sized on a sizing machine (see page 1014-5,) and is again dried on a warp drying machine (see page 1006-8,) and then run direct on a Whitin Long Chain Quilling Machine (see pages 206-9.)

The Short Chain System.

For the Short Chain System the warps are often warped the full number of ends, or they are dyed in lots of two, four or six. They are best brought to the dye house in balls after running on a ball warper.

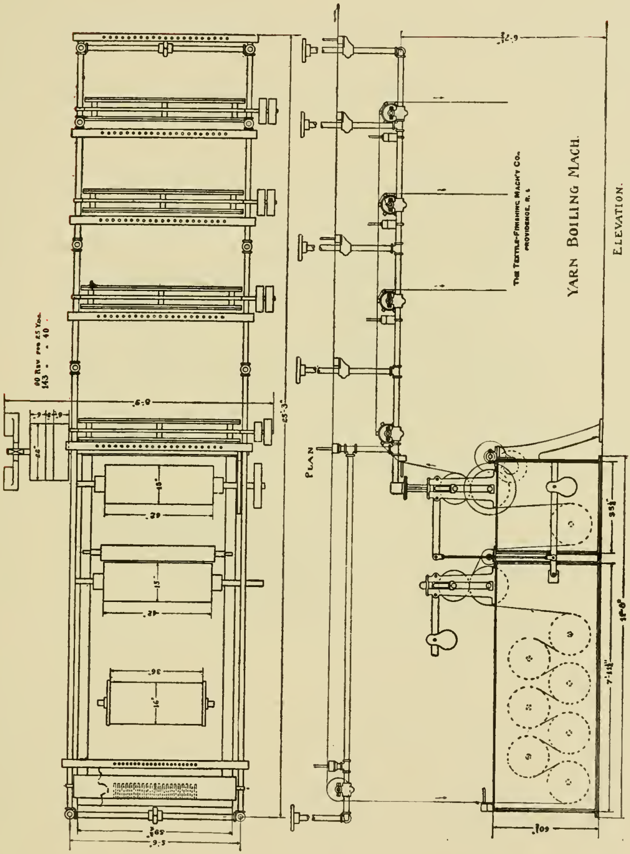
They are then boiled out or prepared the same as for the long chain system either on a regular warp boiling out machine (see page 998-9); or, where the quantity of yarn to be dyed is small, on a simpler or smaller machine. The warps are then dyed in one, two, three or four compartment dyeing machine, from four to eight warps being run at a time according to the width of the machine (see page 1012-3) After dyeing, they are delivered into trucks and are then dried on a warp drying machine as in the long chain system. They are sized in a yarn sizing machine (see page 1014-5) and are then again dried on a cylinder drying machine, and are ready for beaming.

WARP BOILING OR PREPARING MACHINES.



Before dyeing warps either by the long or short cinha system, or before dyeing with indigo, it is absolutely necessary to thoroughly wet out and cleanse the yarn by running it in boiling hot water. If this preparatory work is not thoroughly done, it will be impossible to get good results in dyeing. The warp boiling machine shown in cut and in outline is the latest and most approved machine yet designed for this work. Briefly, it consists of cast iron tanks with draw off plugs, nip stands or housings supporting bottom iron rolls and top rubber covered rolls, with levers and weights for putting pressure on the top rolls, copper immersion cylinders for leading the yarn through the water, overhead rigging, and driving by tight and loose pulley. The complete machine as shown in the outline drawing has a hot water or boiling compartment fitted with seven large copper cylinders, supported on an iron frame so that the whole nest can be lifted out by tackle in case of tangling of the yarn or to clean the cylinders, and a cold water or rinsing compartment separated from the boiling compartment by an air space and fitted with a single copper cylinder supported on a separate iron frame. The cold water compartment is of great value for certain classes of work, as it leaves the yarn thoroughly rinsed and cool and prevents it from drying up before it can be dyed. It may, however, be omitted. These machines are very complete, with a neat, light, but strong pipe overhead rigging carrying the necessary pin rails, bars and reels for running through the warps. The warps may enter and deliver at the same or at opposite ends. The machine shown is fitted to receive and deliver twenty warps or skeins at a time, each consisting of from 300 to 500 ends.

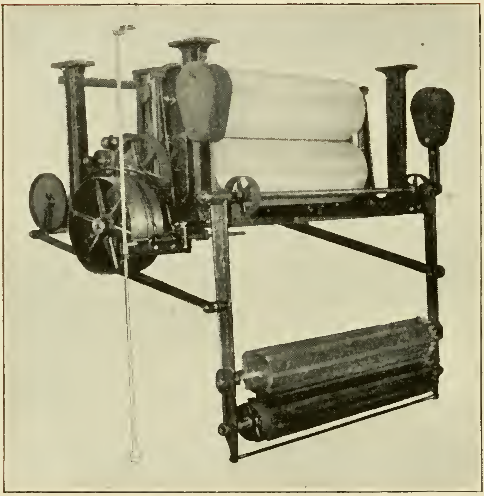
Warp Boiling Machines, Concluded.



The standard sizes of these machines are built to run either twelve, sixteen, or twenty warps. Smaller and simpler machines are also made to run four or more warps at a time.

The machines are usually fitted to drive at a slow and fast speed so that they can be started without putting undue tension on the yarn. The fast or running speed varies from 25 to 40 yards per minute according to the number of the yarn and the results to be attained.

WARP DOUBLING MACHINE.



The warp doubling machine shown in cut and outline drawing is designed to hang from the ceiling, thereby reducing to a minimum the floor space required to double the warps. As shown and built, it is a very complete machine with brass guide rolls for drawing the warp through and is fitted with traverse motion and folder for plaiting down the warps into trucks.

Warp Doubling Machine, Concluded.

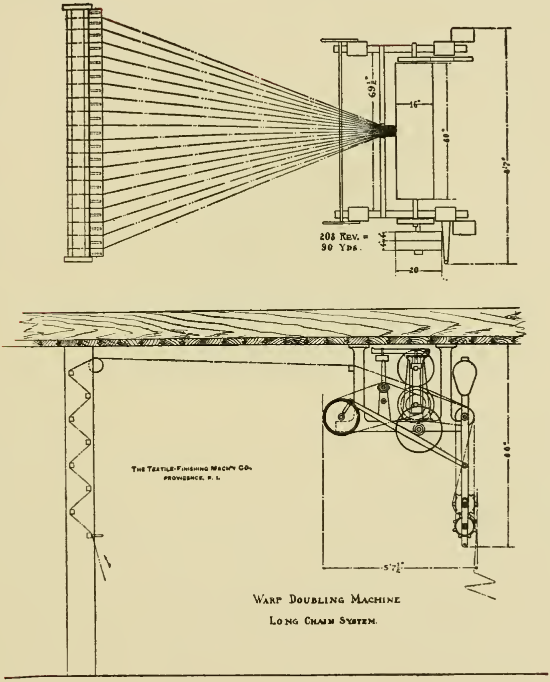
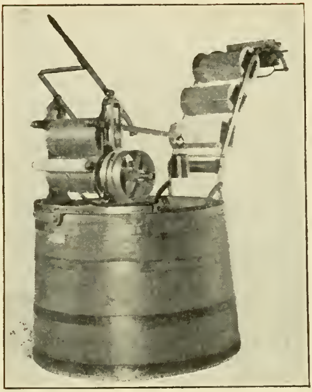


Diagram Showing Method of Installation.

SCOTCH DYE TUB.



The round or Scotch dye tub shown in cut and outline drawing is and has been for a long while the standard machine for dyeing yarn by the long chain system. Briefly, it consists of a round wooden tub 55 inches diameter at bottom by 41 inches deep, fitted with iron nip stands containing two squeeze rolls which in the best machines are rubber covered; pressure is put on these rolls by levers and weights and there is a lever and handle by means of which this pressure can be quickly removed while the ends of the chains are passing through the nip to avoid cutting the yarn. There are five brass immersion rolls with brass guides for leading the warp through the liquor, all supported on a brass immersion frame. There are square beater or tension rolls on iron brackets for entering the warps and a small reel for delivering them into trucks.

Scotch Dye Tub, Concluded.

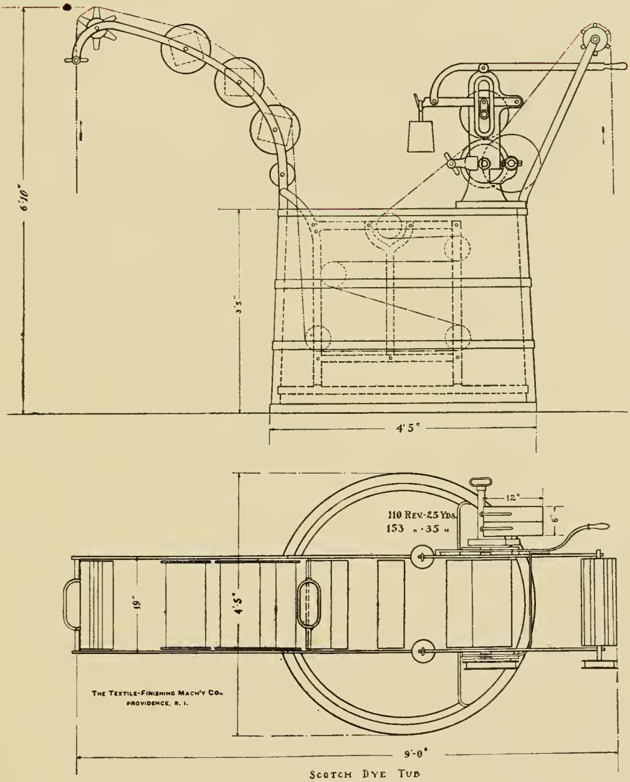
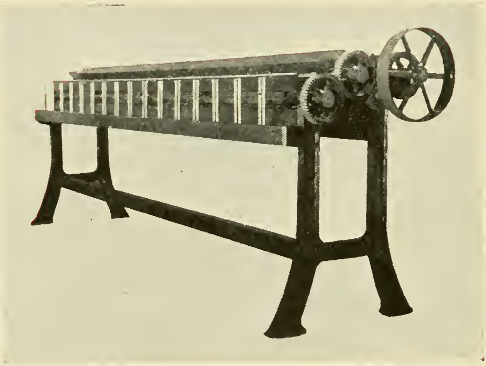


Diagram Showing Travel of the Warps and Floor Space Occupied.

WARP SPLITTING MACHINES.



These machines are designed to split out the warps into the same condition and lengths as they were before being doubled in the warp doubling machine and dyed in Scotch dye tubs. They consist of iron frame to stand on the floor and support the beaters, pin rail, driving pulley, and driving gears and small iron frames to hang from the ceiling and support the small beaters, pot eye, etc., which draw the warps from the box or trucks. About midway between the ceiling frames and the floor frames there is a countershaft which receives power from the shafting in the dye house and drives both the small beaters and the large beaters so that the whole machine is started and stopped at the same time.

Warp Splitting Machines, Concluded.

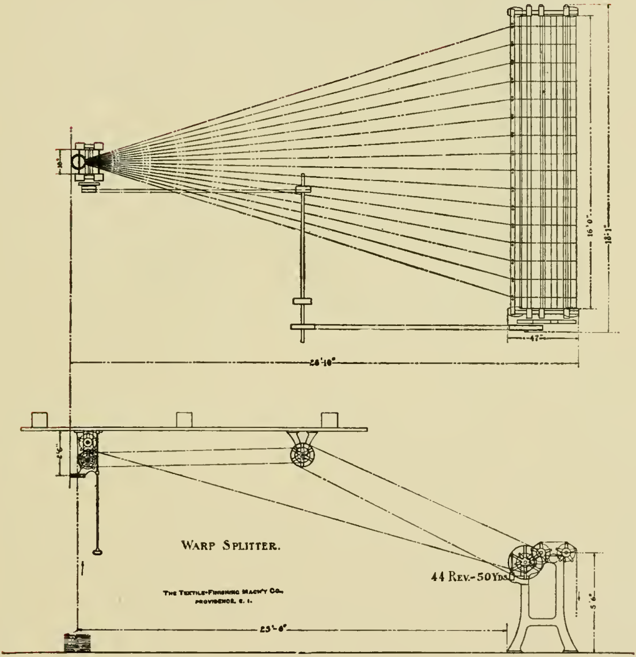
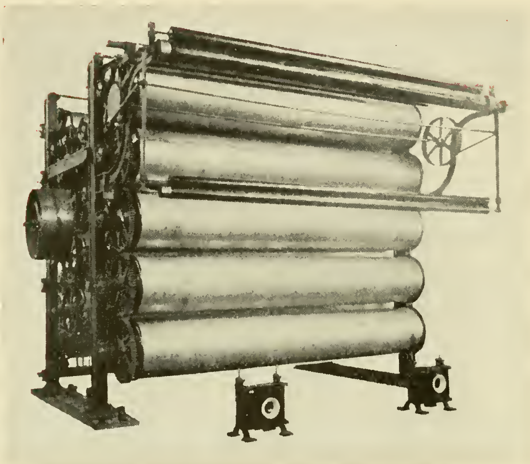


Diagram Showing Travel of the Yarn.

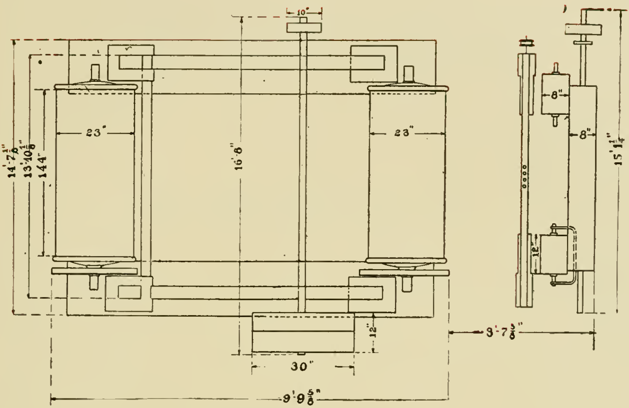
WARP DRYING MACHINES.



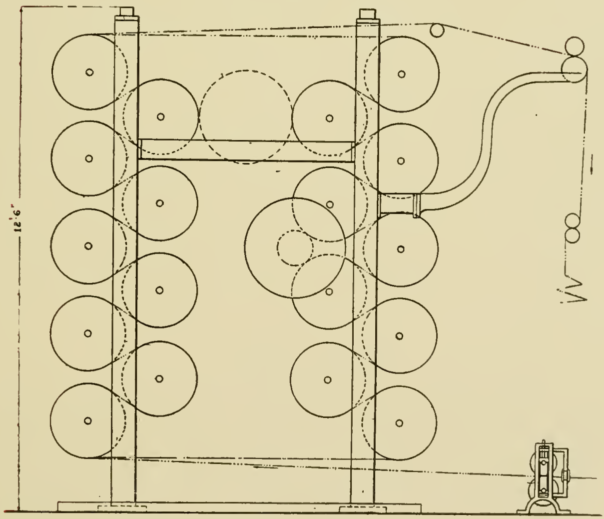
The cut and outline drawing on the opposite page shows what has come to be regarded as the standard warp drying machine. It consists of eighteen tinned iron cylinders arranged into columns of nine cylinders each, each cylinder 144 inches face by 23 inches diameter. For drying large quantities of yarn these machines are sometimes made with twenty-two cylinders with eleven in each column, and for smaller quantities fourteen cylinders arranged in two columns of seven cylinders each, or nine cylinders or less arranged in one column; in fact, almost any number of cylinders, provided there is an odd number of cylinders in each column.

Warp drying machines of the horizontal type are used by some, and can be furnished with any odd number of cylinders. The cylinders for these machines are very carefully and strongly constructed from the best imported English tinned iron, have iron heads with vacuum valves, and are fitted with the patent spiral scoops for keeping the cylinders free of exhaust water.

PLAN



WARP DRYER



ELEVATION

Warp Dyeing Machinery, Continued.

Warp Drying Machines, Continued.

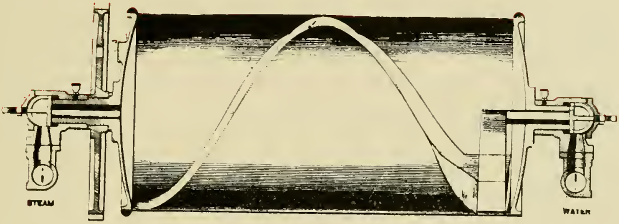
These drying machines are made with hollow iron or cored frames through which the steam is admitted to the cylinder at one end by means of hollow boxes and journals, and the exhaust water taken out from the other end of the cylinders in the reverse order. The form of packing used in the boxes permits of ready and quick adjustment and is absolutely efficient in every respect. All parts such as frames, boxes, packing rings, and gears are absolutely interchangeable.

During the past few years The Textile-Finishing Machinery Company has devoted much time and expense to investigating the best form of drying machine, from both a scientific and practical standpoint, and as a result of this careful study of the subject have remodeled their frames, boxes, method of packing, gears, etc., in order to get the greatest possible production for their machines for a given number of cylinders and steam consumption. These dryers are very substantially built with heavy large cored frames, boxes and journals and with wide faced strong gears, and embody the best practice in dyeing machine construction as well as many novel features. They are fitted with pin rails, wooden drag rolls, etc., for handling usually two or four warps at a time, although sometimes the cylinders are made 72 inches face to run one or two warps at a time. When so ordered they are fitted with a traverse motion and folder especially designed for plaiting the warps down in layers as they leave the machine. These drying machines are either driven by tight and loose pulley, cross shaft, pinion and gears on each cylinder, or by a separate double angle engine shown on page 1035 for giving a nice variation of speed. Sometimes three-step cone pulleys are substituted in place of the engine.

Spiral Scoops.

In the past it has been almost the universal custom where cylinder drying machines are used to fit the cylinders with what is known as a bucket scoop for lifting and discharging the exhaust water which accumulates in the cylinder. Live

Spiral Scoops, Continued.



steam enters the cylinder at one end through the hollow journal, and this bucket discharges the water at the opposite end. For a great many reasons this bucket scoop has never done satisfactorily the work for which it was intended. In the first place, as universally constructed, it does not reach into the cylinders more than 24 inches from the head; hence it is evident there must always be a considerable quantity of water which it cannot reach at once and which flows gradually toward the bucket. As the speed of the cylinder increases, the water is acted upon more and more by centrifugal force, which tends toward keeping the water against the surface of the shell of the can and prevents its discharge by gravity. The efficiency of the bucket scoop is therefore proportionately reduced and at a certain speed the bucket scoop practically ceases to operate. It requires but a very small quantity of water in a cylinder to materially reduce the surface heat, and hence the drying capacity of the cylinder. For years many other devices for removing the exhaust water have been tried, but all have proved unsatisfactory, for various reasons; so that until the spiral scoop was introduced, the old-fashioned bucket scoop still remained in almost universal use.

It was to overcome the defects of the bucket scoop that the spiral scoop was designed and patented. It consists of a spiral gutter extending the entire length of the cylinder. It starts shallow at the steam end and gradually increases in depth in order to take care of the increasing volume of water, makes a certain number of revolutions depending on the length and diameter of the cylinder, and finally terminates in a lifting pocket or bucket which discharges out through the hollow journal of the cylinder. It will be readily seen that by the use of this spiral scoop, as the cylinder revolves, the water is forced along mechanicallly and lifted out in a steady and uniform stream. There is no rushing of the water

Spiral Scoops, Concluded.

back and forth caused by varying steam pressures with consequent danger of damage or collapse of the cylinder, no high steam pressure absolutely necessary to force the water to where the bucket scoop can reach it, and above all no loss of efficiency caused by more and more centrifugal force as the number of revolutions of the cylinder is increased. The truth of the statements just made has been borne out by many practical experiments made both at the works of The Textile-Finishing Machinery Company and at those of many of their customers.

It is shown beyond a question that cylinders fitted with the old style bucket scoops operate with from one to one and a half inches of water in them all the time when running under the most favorable conditions. They never work on a closer margin than this, and usually have a much greater amount of water in them most of the time. The spiral scoop, on the other hand, will absolutely remove all water from the cylinder and keep it almost absolutely free from water at all times. The bucket scoop will commence to refuse to clear the cylinder of water, on account of centrifugal force, when the cylinder revolves to deliver 70 to 80 yards of goods per minute, and at a little higher speed absolutely ceases to operate; while cylinders fitted with spiral scoops revolved at a speed equivalent to 130 yards surface speed per minute are kept practically free of water.

By the use of spiral scoops the capacity of a drying machine is not only increased at least 20% to 25%, but the steam pressure and amount of steam necessary to do the drying decreased very materially. In addition to these advantages, it permits goods to be dried at a lower temperature, which leaves them softer and more mellow, as they are not baked by excessive heat. There is very much less or no liability of fugitive colors marking off and of starch sticking to the first few cylinders which is alone of the greatest value in drying many classes of goods. From a mechanical standpoint, it is possible to fasten the spiral scoop in a cylinder far more strongly than the bucket scoop, so that the old trouble of scoops becoming loose in the cylinders has been obviated. It can readily be put into cylinders of any face or diameter, and is especially advantageous in cylinders of wide face or large diameter.

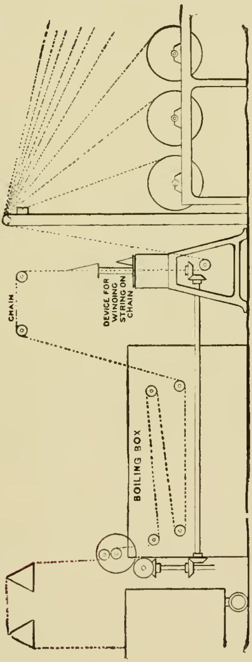
Since these spiral scoops were first put on the market some four years ago, hundreds of cylinders have been fitted with them. Some of the largest users of drying machines speak in the highest terms of the spiral scoop on account of its simplicity, strength and great efficiency.

DRAPER'S DEVICE FOR WINDING STRING ON CHAINS.

With the introduction of the Whitin chain quiller, the larger part of cotton yarns, both warp and filling, have been colored in the chain.

The most difficult and unsatisfactory part of the process of chain dyeing has hitherto been the rewinding or beaming of the colored or bleached yarns after they are returned from the dye house, owing to the large number of broken and snarled chains, slack threads, and twisted selvages.

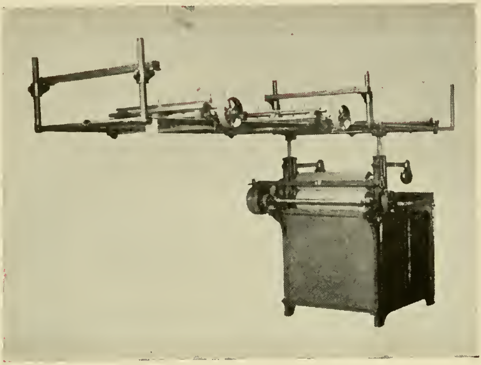
These troubles can largely be prevented by winding or coiling around each chain from end to end a thread of suitable strength to hold it together.



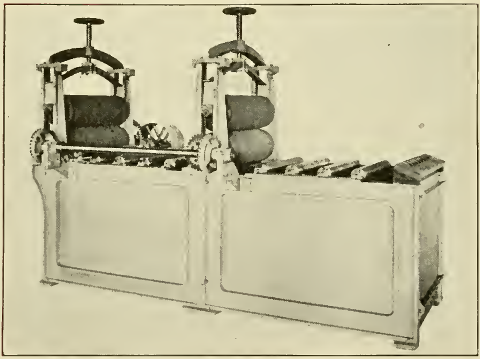
The above diagram gives an idea of the application of the winding device, which will be seen to be a very compact small machine introduced just back of the boiling box.

Before quilling or beaming, the thread has to be unwound from the chain and a corresponding device accomplishes this result.

COMPARTMENT WARP DYEING MACHINES.

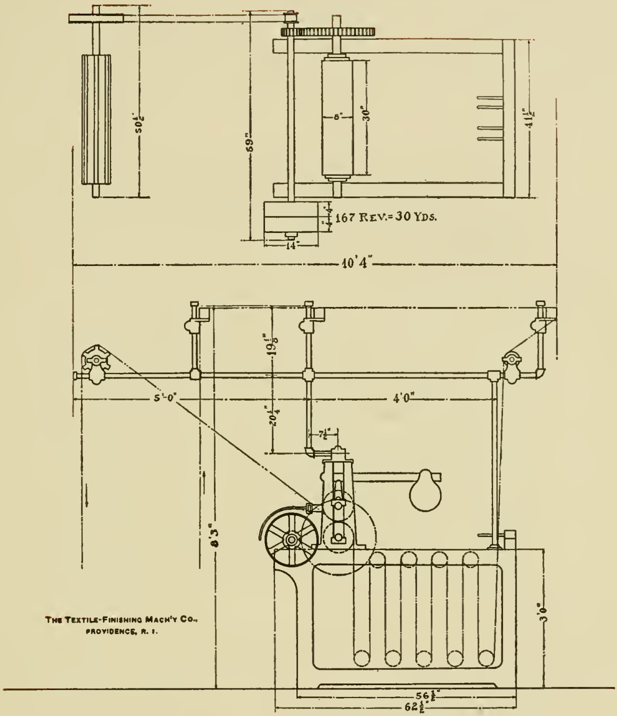


(Single Compartment Machine.)



(Two-Compartment Machines.)

These machines are intended for dyeing where the short chain system of dyeing is used. They are usually made with a single compartment as shown in the above cut, but sometimes where certain shades are to be dyed in large quantities in two, three, four or even more compartments. In the single compartment machine the yarn is run through the same machine a number of times, or it may be taken from one machine to another, while with machines having two or more



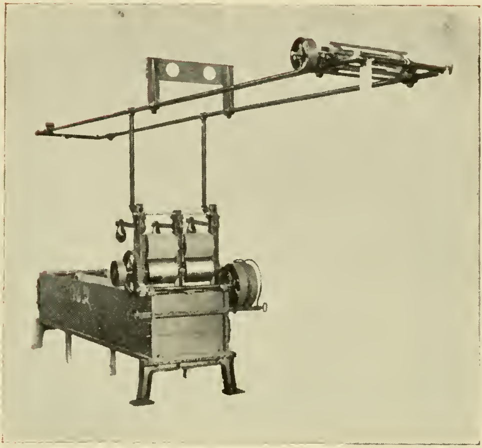
SINGLE COMPARTMENT WARP DYEING MACHINE

SHORT CHAIN SYSTEM

compartments the yarn runs from the first compartment to the next, and so on in order, and may be dyed in one run or in two or three runs. These machines consist of wooden tubs supported in iron frames to which are bolted the nip stand. Each compartment is fitted with a separate set of nip stands containing two rolls which in the best machines are iron rolls covered with rubber. There are means of putting pressure on these rolls consisting of either springs with top screws and hand wheels, or of levers with weights. Each compartment has seven immersion rolls made of either brass or wood for leading the yarn through the dye liquor.

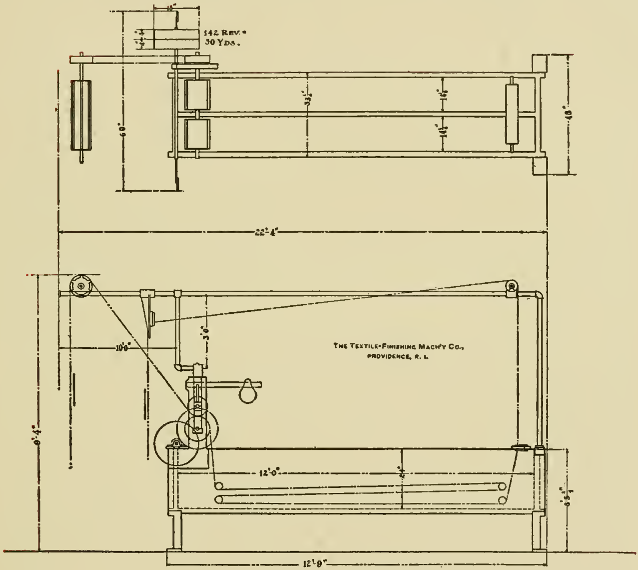
These machines are usually fitted with light but strong pipe overhead rigging supporting the necessary pin rails, bars and reels for receiving and delivering the warps. They are made in widths to run four, six, or eight warps at a time.

WARP SIZING MACHINES.



These machines are especially designed for sizing yarn in the warp. They consist of a wooden tub supported on iron legs to bring it to a convenient height, fitted with iron nip stands containing nip or squeeze rolls with pressure attachments. There is a brass immersion frame which stands inside the tub and supports the brass immersion rolls and necessary brass guides for leading the yarn through the size. These machines are sometimes made with a single compartment, but usually double with two compartments standing side by side. The nip rolls are made double and are supported in these stands and each compartment is fitted with a separate immersion frame, rolls and guides. When made double, one compartment is used for sizing dark shades and the other for sizing light shades. These machines are now fitted with a light but strong pipe overhead rigging carrying the necessary pot eyes, reels, etc., to receive, run through and deliver two warps in each compartment. They are driven by a tight and loose pulley.

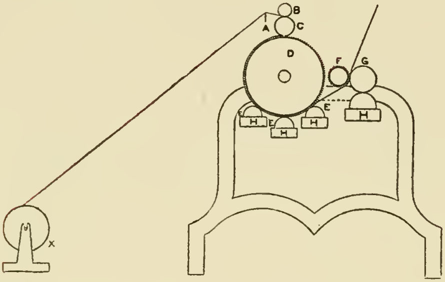
Warp Sizing Machines, Concluded.



Double-Box Warp Sizing Machine
Short Chain System

Diagram Showing Travel of the Yarn and Floor Space Occupied.

LUTHER YARN PRINTING MACHINE.



In printing, the beam is placed on the floor about eight feet from the machine, and the yarn is drawn into a smaller compass before passing through the printer, by being brought over the curved wire, or guide, as shown at A in the accompanying diagram. It then passes between the tension rolls (B, C,) and around the main printing cylinder (D), at the lower side of which it receives the print by passing between it and the color furnishing rolls (EEE), which are thrown out of and into contact with the cylinder, by means of cams at the side. If four colors are desired, the yarn is brought upward between the fourth color roll (F), and its furnishing roll (G), where it receives a print between each of the other colors, and is then carried to cans, for drying. Around these cans the yarn passes about 4 times, being guided spirally by fluted rolls placed at an angle, and as it leaves the cans it is folded or plaited and then placed in steam-box to bring out and set the colors.

They are made in sets of three copper cans with steel heads, are 30 in. wide x 23 in. diameter and are tested at 15 pounds, but as the yarn passes around each can several times, from 3 to 5 pounds is ample for drying the yarn. They are usually placed either on floor above or upon platform suspended from the ceiling just in front of printer. This allows the yarn to pass directly from the printer to the cans, which is preferable to placing cans on same level as the printer.

The print of the fourth color roll, (which is also used in printing a single color,) may be varied by the use of extra rolls of a special pattern, which will be furnished at reasonable rates. In printing a single color the machine is threaded in the same manner as for four but the three rolls, (EEE) are dropped out of the way.

The 4 color printer requires a floor space of 4x4 feet. The driving pulleys are 15 inches in diameter by 2½ inch face and are driven at a speed of 96 revolutions per minute which gives a speed of 18 revolutions to large printing cylinder, delivering yarn in ribbon form at a rate of 24 yards per minute.

THE FRIES DYEING MACHINES.

The Fries system may be said to be a modification of the long chain; the yarn is delivered to the dye house on balls from a leese warper; it is then dyed without boiling, and run direct to the drying cylinders, after which it is delivered again in front of the machine, dried, and finished, as shown in the accompanying diagrams.

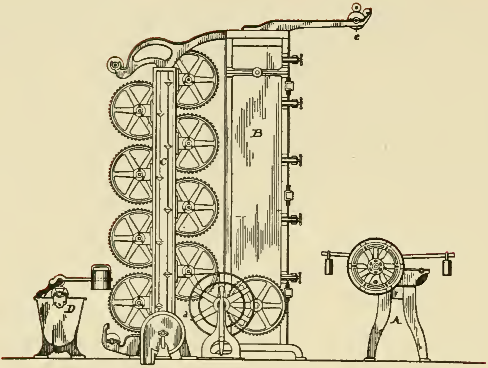
The fundamental principles upon which the Fries machines are built may be stated briefly as follows:

(1). The dyestuff should always be reckoned as a percentage of the *liquid,* and then the solution needed for any particular shade can always be duplicated with accuracy. Of course, the quantity of solution prepared would be with reference to the quantity of material to be handled.

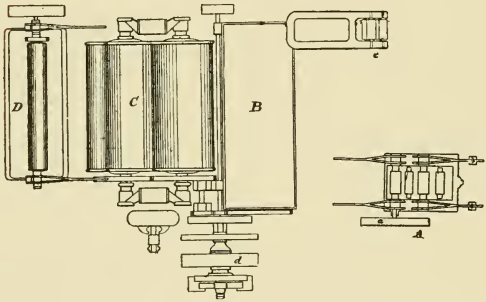
(2). The dye solution should always be applied to *dry* yarn, so as to get on to and into the yarn *at once* just as much water as will wet it and no more, and this water of hydration should have just as much color in solution as will give the desired shade and no more. Then by passing the yarn into a solution of known concentration, at uniform speed, between rollers under uniform pressure, we get uniformity of shade not otherwise attainable. If the yarn can also be dried in the same operation, all manipulation is reduced to a minimum.

Machine for Direct Colors.

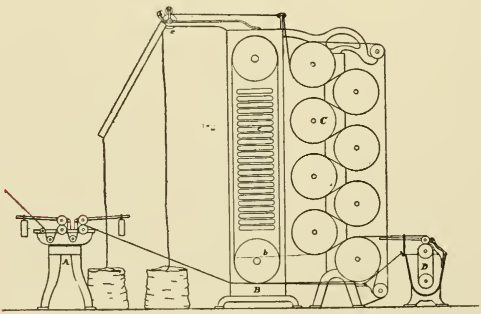
It is not material in what form the dry warp is brought to the machine, but it is approved practice to use balls, such as are usually made for the long chain or Scotch system, and to run two at once. These balls are placed in any convenient rack, and the warps pass to the coloring or padding machine *A* on the cuts shown herewith. This machine is driven by the expansion pulley *a* by which the tension on the yarn can be accurately adjusted. There is a small color pan in which two guide rolls are immersed and two pairs of squeeze rolls with weighted levers. Under the color pan is a steam cell by which the dye liquor can be kept hot. The color pan is provided with a stop cock by which the dye liquor can be run off and saved. Then by simply raising the immersion rolls, the color pan may be pulled out like a drawer, and in fact every part is arranged so that it can be easily washed when it is desired to change the color. What color is washed off in cleaning the machine is all that is wasted, for there are no half spent liquors to be run off.



(Elevation.)



(Plan.)



(Section viewed from opposite side to that of elevation.)

Fries Dyeing Machines, Continued.

From the padding machine the yarn passes to the steam chest *B* which is built of angle bars and steel plates, with cast iron feet and corners. All sides except the back have a ¼ in. asbestos board lining, and within that a sheet copper lining. The double doors of the chest are hung on hinges, but are provided all round with screw clamps, so that they can be closed air tight on asbestos packing by simply turning the screw clamps by hand, and then again opened on occasion with great ease. The yarn enters the chest at the bottom on one side, is guided spirally around and along the cylinders *b*, and leaves the chest at the bottom on the other side. Within the space formed by the cylinders *b* and the strands of warp, is the steam coil *c*, which serves to keep up the temperature of the chest. If the wash box *D* is not used, the yarn passes directly from the steam chest *B*, to the dry cans, *C*, over which it is guided by suitable pins, and delivered again in front of the machine, dry and finished, by the delivery rolls *e*. If the wash box *D* is used the yarn is guided through suitable porcelain eyes from the steam chest *B*, to and through the wash box *D*, then to the drying cans *C*, and then delivered through the rollers *c*.

The machines are provided with painted, galvanized iron safety floor pans, the drying cans are made of the best No. 18 gauge creamery tin plate, and are provided with vacuum valves. The inlet column has a safety pressure valve. The steam chest has thermometer, steam gauge, air injector, Marck trap, and all necessary valves and fittings, but the purchaser will bring the steam to the machine.

Data on Direct Color Machine.

The Whole is Driven by the Clutch Pulley *d* which may be belted from any direction, is 24 in. diameter, 4 in. face, and commonly runs at 110 revolutions per minute; but in one mill in North Carolina they are running one machine at 68 revolutions per minute on large, heavy warps, and by its side another at 125 revolutions per minute on light, fine warps. The driving shaft carries a pulley to run *A*, another to run the fan shown at the foot of column *C*, a spur pinion to run the gear wheels shown, and at the other end an expansion pulley to run the wash box *D*.

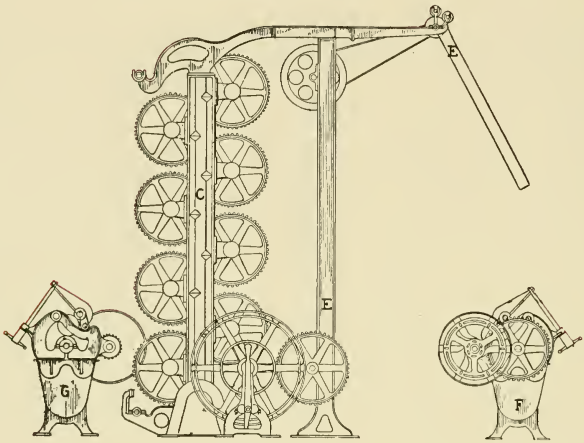
The Floor Space over all, including a rack for the balls, but with no allowance for alleys, is 19 ft. x 7 ft. 7½ in. The height of machine over all at delivery rolls is 10 ft. 9 in.

The **capacity** of the machine in pounds, of course, varies with the count of the yarn and number of ends in the chain, but it will easily do 150 pounds per hour.

With one competent man to prepare the dyes and a boy to watch the work, 2 employees can run a whole room full of machines.

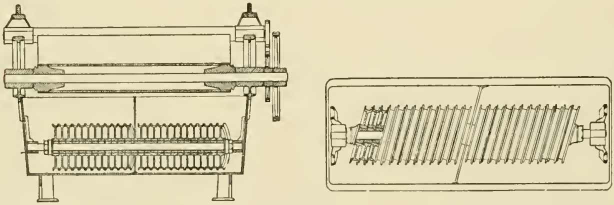
Fries Dyeing Machines, Continued.

Machine for Indigo.



(Elevation.)

The dry warp chain comes to the multiple dip box or trough F, which is divided into two compartments. The partition in this trough may be placed wherever desired, but for indigo it is put near one end of the trough, so that if two warp chains be run, they will each receive only two immersions in the padding solution; they are then guided over the partition into the larger compartment, where each receives at least ten



(Trough Details)

dips in the second solution. The lower shaft in the trough carries patented sheave pulleys set in an angle, which is an expensive construction, but is well worth the expense because

Fries Dyeing Machines, Continued.

it avoids the damage which would inevitably be done to the yarn by guide pins. After each immersion the yarn is thoroughly squeezed between the steel roll and a rubber roll, which is imperfectly shown in the cut.

From the trough *F* the yarn passes to the reels *E* where the indigo is thoroughly oxidized by exposure to the atmosphere. From the reels *E* the yarn may go directly to the drying cans *C* and then to the delivery rolls *E*. But if it is desired to wash the yarn, it is guided from the reels *E* to the wash box or trough G, and then to the drying cans and delivery rolls.

The reels and drying cans are positively geared together, while the two troughs are run by belts with patent expansion pulleys, so that their speed can be regulated to a nicety.

The whole machine is driven by a patent **clutch pulley 30″ diameter, 6″ face** which should run **at 120 revolutions** per minute.

The standard machine has eight dry cans, and its drying **capacity** is the measure of the production of the machine in pounds of yarn, easily 150 pounds of warp per hour.

Combination Machines for Indigo, Sulphur Colors, Etc.

Sulphur colors resemble indigo in so far as they are oxidation products. As a rule they must be reduced or dissolved by sodium sulphide, and when they oxidize on the fibre they are more or less fast to all ordinary tests except chlorine. It is to be remarked that the popular estimate of the excellence of all sulphur colors is exaggerated, for they are by no means all equally good and fast. Many of them are excellent, and the number of good products and desirable shades is being constantly increased by the efforts of chemical manufacturers the world over.

It has been found that steaming is of no benefit with indigo, and a decided detriment to some of the sulphur colors. But steaming is necessary to the development of other sulphur colors, and is especially beneficial with direct colors. There may be some manufacturers who would want a combination machine, even at a somewhat higher initial cost, and such a machine can be furnished when desired.

The heavy troughs require the same powerful drive as the indigo machine, and therefore the same driving **clutch pulley** is used, **30 in. diameter, 6 in. face,** and **at 120 revolutions.**

It will be readily understood that with this combination machine direct colors can be padded in, steamed in, and passed directly over the dry cans. Or the sulphur colors which require steaming can be padded and aftertreated in the one trough, steamed in the chest, thoroughly scoured in wash box, then passed over the dry cans and delivered in front of the machine dry. Or if colors are used which do not require steaming, the doors of the steam chest can be left open or even lifted off their hinges.

Fries Dyeing Machines, Continued.

Remarks on the Operation of—

"The Fries dyeing machine is based upon the well known fact that oil or grease will promptly penetrate the cotton fibre without its having been previously boiled out.

In the other methods of dyeing, the amount of dye-stuff is calculated upon the weight of cotton to be dyed, the volume of the dye-bath being little considered. Naturally, in using so large a volume of water, it is impossible to exhaust the bath. Common salt is used with direct colors to precipitate the dye-stuff on and in the fibre, but still a great deal of color 'runs down the creek.' To obtain more accurate and economical results, it is easy to see that it is very much better to put into the yarn an exact quantity of a color-solution of exact strength. No boiling out is necessary, as the dye-solution can be made to penetrate the fibre by using a small quantity of a soluble oil. By passing the yarn between rubber rollers under uniform pressure and at uniform speed, the yarn can be uniformly dyed.

Twelve gallons of water weigh 100 pounds and will 'wet out' with the aid of an oil or soap as a penetrator exactly 150 pounds of cotton yarn. Taking this as a basis, the necessary number of pounds or ounces of the dye-stuff are dissolved in 12 gallons of water with the required amount of penetrator and thereby shades can always be maintained.

All **direct colors,** with the exception of direct blacks, may be dyed with starch and 'oil mixture.' The 'oil mixture' is a mixture of equal parts of kerosene, turpentine, and soluble oil. The first two, being volatile, are driven off, leaving the soluble oil in the yarn to act as a softener. All direct colors, including direct blacks, may be dyed with soap as a penetrator.

Taking 12 gallons of water (100 pounds) and using the percentages of the other compounds on this weight, a formula might be as follows: 2 per cent. dyestuff, 2 per cent. starch, 2 per cent. oil mixture, 1/8 per cent. carbonate of soda, 100 per cent. water. Of course, the number of gallons to be made up will depend on the amount of yarn to be dyed (12 gallons to 150 pounds of yarn). After padding on the solution, the yarn is steamed for six minutes at 210 degrees Fahrenheit, and dried, the whole operation requiring one run and no handling, as against four or more runs and considerable handling on an ordinary warp-dyeing machine.

Sulphur Dyes are dyed very much in the same way as indigo. The principle involved is the same in both instances, viz., solution of the dyestuff by reduction, application of this

Fries Dyeing Machines, Concluded.

solution to the fibre, and oxidation. The reducing agent employed with sulphur colors is sodium sulphide. Some sulphur colors, i. e., dark blues and some blacks, require steaming with, or without, air or "smothering," while others are oxidized sufficiently by exposure to the air. Thorough washing of the yarn to remove the sodium sulphide is of the greatest importance; otherwise, sulphuric acid may be formed on the fibre, tendering it.

Application—The dyestuff is dissolved in hot water, the necessary amounts of sodium sulphide, caustic soda or soda ash, glucose if necessary, and alizarin oil being added. The solution is padded on in one compartment, run into a weaker solution of the dyestuff with an excess of sodium sulphide, aired, steamed at 210 degrees Fahrenheit, or at 150 degrees with air, as desired, washed and dried.

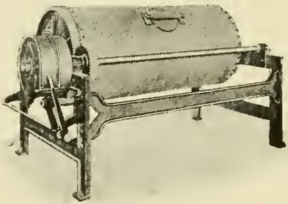
Indigo.— Considering the fact that almost all the dyestuffs used prior to the discovery of the coal-tar coloring matters have been replaced by these cheaper and better products, it is a notable fact that nothing has ever been found that would replace indigo. Many centuries ago, the method of its use in India was brought to Europe by a Phoenician explorer. At that time and until comparatively recent times, it was applied by means of the 'fermentation vat' — an exceedingly crude method. At the present time, the best vats for cotton are the 'zinc-lime' and the 'hydrosulphite' vats, nascent hydrogen, of course, being the reducing agent in both cases. In the 'zinc-lime' vat, zinc dust decomposes water in the presence of the alkali, calcium hydroxide; in the 'hydrosulphite' vat, sodium hydrosulphite is decomposed by caustic soda, liberating hydrogen. Where bright and fast shades are desired, the yarn must be given a number of dips in more or less weak vats with time for oxidation, and usually a rinse between each dip in the indigo solution. In the application of indigo, by Mr. Fries' method, the entire operation, including dyeing, oxidizing, washing and drying, requires only one passage through the machine. The indigo is applied from a strong zinc-lined vat solution in one compartment, and then passed into a weak solution containing hydrosulphite of soda. Here the coloring matter is practically re-dissolved and impregnated into the fibre itself, a condition rarely seen in indigo-dye yarn. The yarn then runs on to the reels, where it is oxidized, through the wash-box, and on to the drying cylinders.

There is no waste by this method, either in 'sludge' or in 'spenting liquors.' Every ounce of indigo can be accounted for, as it all goes on the yarn. Synthetic or natural indigo may be used as desired, as there is small difference in price between the two."

INDIGO DYEING.

By the usual method warps to be dyed with indigo are first run through a warp boiling out machine such as described on page 998. In order to get the best or even good results in indigo dyeing it is absolutely necessary that this part of the operation should not be slighted, and the cold water rinse compartment which is furnished with the complete boiling out machine is a very important feature as by its use the warps are left cool and moist and prevented from drying up before they can be run in the indigo. There are many variations in the form of dyeing vat used and style of rigging for handling the warps, but the indigo vats and overhead rigging shown in the following cuts, are used by many, if not most of the largest companies in the country doing this class of work.

Indigo Grinding Machines.



These machines are built in two styles, known as the horizontal such as shown in cut, and the vertical grinder. The horizontal grinder consists of a wrought iron cylinder 50 in. or 60 in. face by 30 in. diameter, supported on iron frame and driven by tight and loose pulley, pinion and gear. The cylinder is provided with heavy iron cylindrical rolls, which revolve in the cylinder and grind the indigo.

The vertical style of grinder consists of either a wrought iron or cast iron tank with upright shaft driven through bevel gears from a horizontal shaft supported on hangers from the ceiling. On the vertical shaft are cross arms with the neces-

Indigo Grinders, Continued.

sary steel prongs to drive four conical iron rolls on the bottom of the tank which grind the indigo.

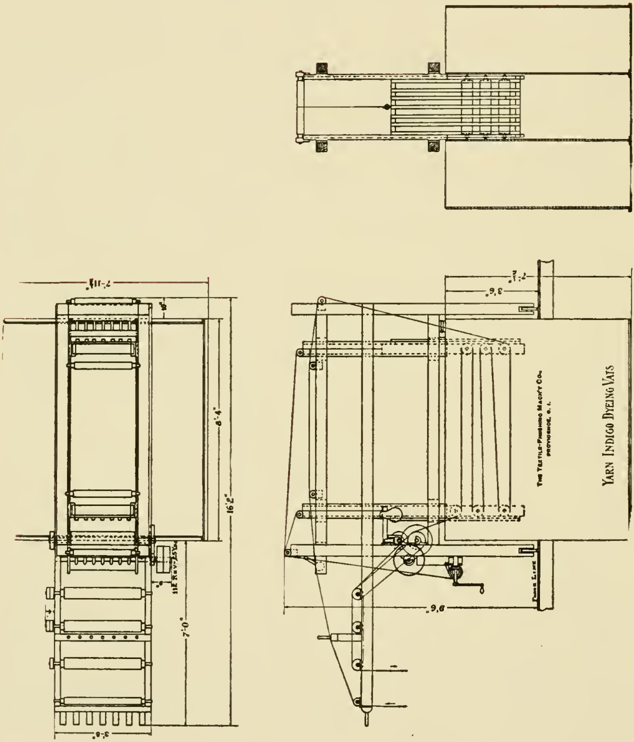
The vertical grinder is built in three sizes, namely, with tanks 56 in. diameter by 18 in. deep, 36 in. diameter by 20 in. deep, and 24 in. diameter by 20 in. deep. In large plants these vertical grinders are often placed in a row and driven from a single overhead horizontal shaft, each machine being provided with a clutch for starting and stopping.

Either style of grinder is very heavy, well constructed machine, and they have proved themselves most efficient for the work for which they are intended.

Indigo Dyeing Vats.

The vats are usually made up in sets of three or four with one overhead rigging for handling the warps for each set. The vats are made of cast iron plates bolted up in putty and each about 8 ft. long by 7 ft. deep by 30 in. wide. They are usually sunk part way through the floor for greater convenience in operating. The overhead rigging consists of a strong wooden frame which straddles the vats and can be moved from vat to vat by means of a track on the floor. This frame supports the necessary carrier rolls, pin rails, brass immersion rolls, rubber covered nip rolls for squeezing the warps after dyeing and delivery rolls. Part of the frame with the brass immersion rolls can be lowered or raised by means of a rack and pinion. Six to eight warps are usually run at a time at a speed of 25 to 30 yards per minute. The warps should be of such a length that they can be run through without stopping, as otherwise uneven dyeing will result. For a good deep shade the warps are run from three to four times, usually being dropped into trucks and allowed to oxidize between each run. After dyeing they are dried on a warp drying machine described on pages 1006-8.

Indigo Dyeing Vats, Concluded.



Diagram, Showing Plan and Two Vertical Sections With Path of the Yarn.

YARN BLEACHING.

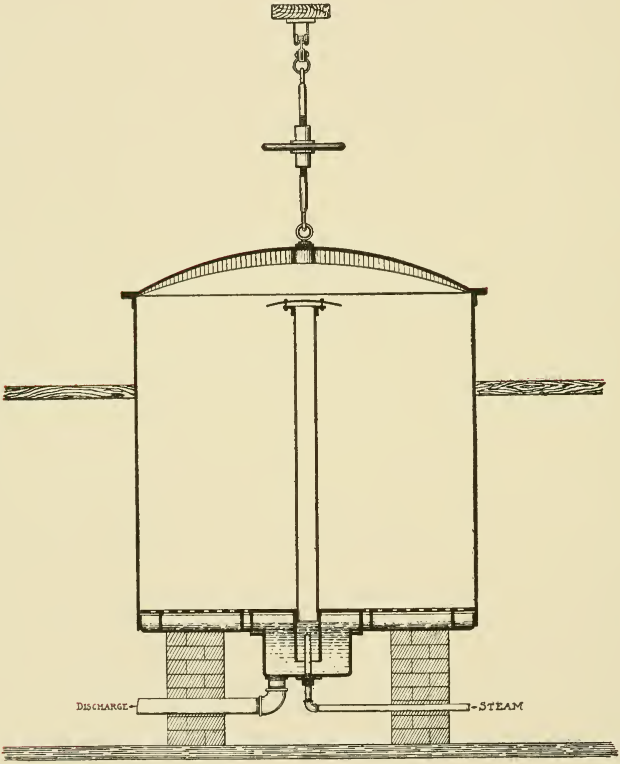
There are many different methods of bleaching cotton yarn depending on the quality of the white to be obtained, upon subsequent methods of handling the yarn and upon the preferences of the bleacher. The half bleach which up to the present time has proved satisfactory for most of the goods in the South is usually obtained by running the yarn in warps once or twice through chemic in a single compartment dyeing machine such as described on pages 1012-13. It is then washed in another similar machine and treated to sour in this second machine or in a third machine and again washed. It is, however, impossible by this process to get a full white bleach such as is necessary for thread and white yarn to be used in the manufacture of the finer grades of yarn dyed goods. In order to obtain this full white bleach, the yarn is either handled in warps or in skeins linked up by hand into chains. In either case it is first run into an iron kier such as is shown on the following page and thoroughly boiled from four to ten hours in either a solution of caustic soda or of soda ash. These kiers are made to hold from 2,000 to 3,000 pounds of yarn at once, and consist of boiler iron shells with cast iron covers which can readily be taken off by suitable means. They are provided with false bottoms, necessary pipe connections, valves, gauges, etc., and some means of circulating the water through the kier that is either by a center puffer pipe or outside injector pipes. These are designed to operate under a pressure up to 10 pounds and sometimes a higher pressure.

The yarn after boiling is drawn out and thoroughly washed in a machine especially designed to do this work and then plaited down in a wooden vat which is fitted with false bottom and perforated cover, where it is treated with a chemic solution which is pumped over and through the yarn. After washing, it is treated with a sour solution in a similar vat, and finally drawn out and thoroughly washed, soaped and blued in another machine designed especially for this work. The form of washing machine and the bluing and soaping machine varies according to whether the yarn is handled in the warp or skein chains. In the first case the yarn is dried on a cylinder warp drying machine shown on pages 1006-8, and in the second case is either dried by hanging in a hot room or on a skein drying machine.

As already pointed out on page 981, the Cramer Automatic Dyeing Machine is especially adapted for boiling out purposes.

Yarn Kiers, Concluded.

6 FT x 6 FT YARN KIER



THE TEXTILE-FINISHING MACH'Y CO.
PROVIDENCE, R. I.

Vertical Section.

(Showing connections and method of lifting cover.)

SPECIAL FINISHING MACHINERY

Manufactured by

The Textile-Finishing Machinery Company.

The following brief description of the methods of special finishing required for different classes of goods will not only give a good general idea of it to those unfamiliar with the subject, but will also serve as an introduction to the subsequent descriptions of the machines employed.

*FINISHING YARN DYED COTTON PIECE GOODS.

The goods included under the above heading may be divided in a general way into two classes as to method of finishing:

(1). Those that require to be dried on a tenter.

(2). Those that may be dried on a cylinder drying machine.

The first class almost always require a calender finish, and the second class are sometimes finished on a calender.

The better grade of the first class, including the finer ginghams, madras, shirtings, fancy dress goods, etc., when they come from the loom, are usually sheared, singed, soaped and washed before being starched, dried and finished on the machines described in detail in the following pages. By this treatment all threads and fuzz are removed and the goods thoroughly cleaned, which is especially necessary after singeing. The goods are soaped and washed either in the rope form in a machine similar to a bleach house washing machine, or in the open in an open washer, usually consisting of from two to five compartments. The latter method is preferable as the filling is kept straight and any colors which are not absolutely fast are prevented from marking off.

In the scope of this article it is out of the question to fully describe and illustrate all the machinery used for this class of work, but special information and estimates will be furnished upon application.

The goods of the second class, referred to in the first paragraph, which includes practically all tickings, awning

*In this article, for the sake of brevity, the term "yarn dyed cotton piece goods" includes those manufactured both from dyed raw stock and dyed yarns,—all in contra-distinction to goods that are dyed after being woven, which are termed "piece dyed."

Finishing Yarn Dyed Cotton Piece Goods, Continued.

goods, denims, etc., on coming from the loom are usually inspected and often brushed. They are then starched on a mangle and dried on a cylinder drying machine. The outfit shown on page 1037 has come into almost general use for this work both North and South.

Both the finer and coarser grades of this class, and occasionally even tickings and denims, are starched on a mangle and dried on a tenter. The outfit shown on page 1030-1 and there described in detail has been especially designed to do this work in the most economical manner and is coming into almost universal use in the South.

Almost all yarn dyed goods after they have been starched and dried by one or the other of the methods just referred to, and some goods which are not starched in the piece, are then finished on either a three-roll or a five-roll calender, as described in detail on pages 1038-40. They are either folded or wound for the market on a folder, often called a hooking machine, or on a winding machine. They are then pressed in a hydraulic press, such as described on page 1041, and put into the proper form for boxing for shipment.

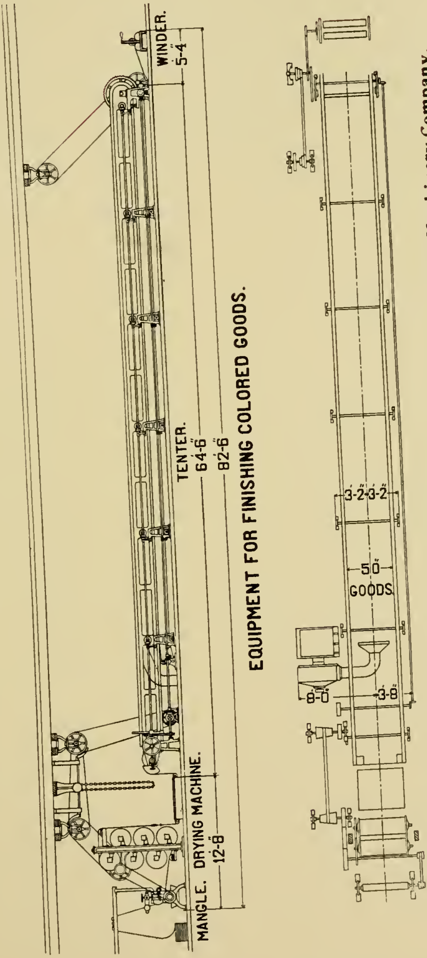
OUTFIT OF MACHINERY FOR STARCHING AND DRYING GINGHAMS AND OTHER YARN DYED GOODS.

The accompanying cut shows the standard arrangement of machines for starching and drying ginghams and many other yarn dyed goods, although the outfit is frequently varied to meet special conditions of location, of results desired, or to satisfy the preferences of customers.

The goods are brought to the machines either in trucks or rolls. They first pass through a starch mangle described in detail on page 1033, then pass over a small upright dryer, usually consisting of six or eight tinned iron or copper cylinders of type described on page 1034 and are partially dried. Then over a tenter where the goods are stretched and held to an even width while the drying is completed.

On leaving the tenter, the goods are wound by a two-drum

Finishing Yarn Dyed Cotton Piece Goods, Continued.



Diagram, Showing a Standard Outfit as made by The Textile-Finishing Machinery Company.

Finishing Yarn Dyed Cotton Piece Goods, Continued.

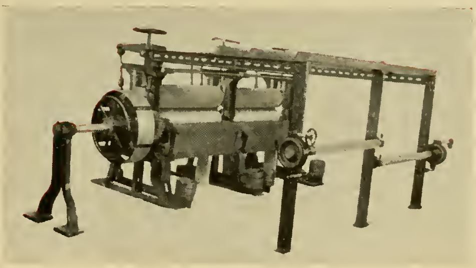
winder into large rolls and are ready to be taken to the calender. The tenter almost universally in use in the South is of the return type,—that is, the goods enter at one end, pass the entire length, turn and return underneath to the take-off rolls placed 12 or 15 feet from the entering end. The goods are then led by floor carrier rolls to the winder placed at the end of the tenter.

These tenters may be varied in length, as they are made up in sections, each section ten feet long. They are fitted with either spring clamp clips or pin clips for holding the goods at the selvages. The goods are dried by means of hot air blown in between the two breadths of goods from a blower drawing air through steam heated coils.

The tenter is driven either direct by a double 5 in. x 6 in. engine, or through a pair of three-step cone pulleys for varying the speed with a friction clutch for convenience in starting and stopping. The winder is driven direct from the tenter and the drying machine and starch mangle through proper means for varying the speed of these machines compared with the tenter and with each other. By this arrangement the machines are started and stopped in unison.

This arrangement of machines gives the greatest production and best results in proportion to the floor space occupied. The goods are starched, stretched and dried and wound in large rolls in one run without rehandling, thereby reducing the cost of labor to a minimum. Sometimes a back starching machine is furnished in place of the usual two-roll mangle. The drying machine is sometimes omitted, in which case the floor space required is reduced, and the capacity cut down from one-third to one-half. The drying machine must be kept comparatively small, as if the goods are too dry they can not properly be fed to the tenter, are very hard to stretch, and become harsh and more like goods that are dried on cylinder drying machines. A patent automatic feeding attachment especially designed to assist in feeding the goods on to the tenter can be furnished when desired. These automatic feeds will be found of the greatest assistance for not only preventing misclipping (in which event the goods must be either run again or sold as seconds) but will materially reduce the labor required to operate the machines.

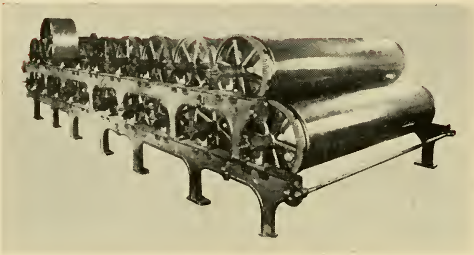
STARCH MANGLES.



There are many forms of mangles for starching or sizing in the piece, yarn dyed goods, varying principally in the type and dimensions of the rolls used to squeeze the size into the goods. The mangle most generally in use for this work consists of iron frames or housings containing one bottom copper electro deposited roll and one top rubber covered roll, each 8 to 12 inches in diameter and with face about 4 inches wider than the widest goods to be run if but one width of goods is to be run at a time. The diameter varies with the face of the rolls but should not be less than 8 inches for the narrowest face and should be increased where rolls of wide face are used. If the rolls are made too small in diameter, the starch will be plastered on the outside of the goods instead of being squeezed into the center where it belongs for the best finish. The mangles have necessary bearings for the rolls, means of putting pressure on the rolls by levers and weights, attachments for receiving and delivering the goods, starch box with immersion roll and necessary driving. These mangles are made wide enough to run one, two or three widths of goods at once if run in connection with a drying machine or wide enough to run one width of goods if run in connection with a tenter. Usually there is but one set of rolls no matter what the face may be. Outline drawing page 1037 shows a 2-roll mangle with rolls 80 in. face by 10 in. diameter capable of running two widths of ordinary goods side by side, running in connection with a horizontal drying machine.

The above cut shows a very convenient mangle capable of running two widths of goods at once and so arranged that the sizing of each width and the pressure on each is independent of the other, making it practicable to run two classes of goods at once, requiring a different kind or amount of starching.

PIECE GOODS DRYING MACHINES.



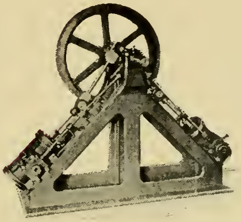
Horizontal Machine.

These machines are built with either the upright or horizontal form of frame. The character of the space available often determines which style must be used, as the upright machine, while it requires a high studded room, takes up much less floor space than the horizontal machine. Aside from this consideration it is very largely a matter of individual preference which form is used, although the horizontal form is slightly more efficient. The horizontal form also has the advantage that it can be more easily increased in capacity than the upright form as any number of cylinders from one up can be added at any time and still have the goods thread up properly. The upright machine is usually built with one, two or more columns, each column consisting of ten cylinders, although it is frequently built with eight cylinders in each column. The horizontal machine is built with any number of cylinders from one up to forty or even sixty. The cylinders are made of either the best Lake Superior sheet copper or of the best imported English tinned iron, and are designed to run under a maximum pressure of 15 pounds, if made of copper, and of 8 pounds if made of tinned iron. They have steel or iron heads, provided with brass vacuum valves and are fitted with the patent spiral scoops described on pages 1008-10. These cylinders are usually 23 in. diameter and are made of almost any face, although the usual limits are between 40 in. and 140 in. face. If intended to dry but one width of goods at a time, they should be four inches wider than the widest goods to be dried. If intended to dry two or three widths of goods at a time they are usually made with face equal to the total width of the various pieces of goods to be run plus an allowance of 2 in. between each head and the goods and 4 in. between each width of goods.

See page 1037 for diagrams of Horizontal Machine in connection with Starch Mangle.

Finishing Yarn Dyed Cotton Piece Goods, Continued.

ANGLE ENGINES.



Double Angle Engine.

These double angle engines were especially designed to drive various machines used for finishing cotton goods where it is necessary or desirable to be able to get a nice adjustment of speed. They are most frequently used to drive tenters and drying machines. These engines are very carefully and strongly built in order to stand the hard treatment and lack of care which they are apt to receive when operated by men and boys who have little mechanical knowledge. They are made up and carried in stock in the following sizes so that old or broken parts can be replaced at any time:

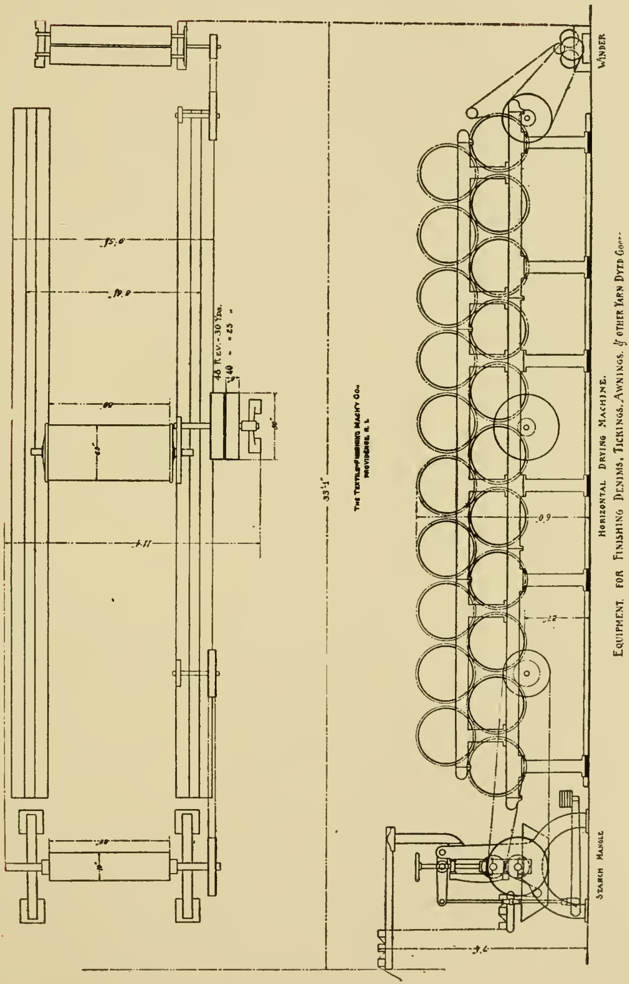
SINGLE.	DOUBLE.
5x6	5x6
6x6	5x7
6x8	6x6
10x12	6x8
	7x9
	8x12
	8x13

Finishing Yarn Dyed Cotton Piece Goods, Continued.

OUTFIT OF MACHINERY FOR STARCHING AND DRYING TICKINGS, AWNINGS, DENIMS, AND OTHER YARN DYED GOODS.

The accompanying cut shows the usual arrangement of machines for starching and drying many classes of yarn dyed goods. This outfit as shown consists of a 2-roll starch mangle, a horizontal drying machine and a 2-drum winder for batching up the goods. The goods are brought to the machine either in trucks or rolls. They first pass through the starch mangle which is described in detail on page 1033, and they then pass over the drying machine described in detail on page 1034, and are thoroughly dried and are then wound up in large rolls on the winder and are ready to be taken to the calender or to be folded for the market. The mangle is driven from the drying machine by some means such as an expansion pulley for varying the speed as compared with that of the dryer. The winder is driven direct from the drying machine. The drying machine is driven either direct by a double 5x6 engine, by a pair of tight and loose pulleys from counter or main line of shafting or through a pair of 3-step cone pulleys for varying the speed with a friction clutch for convenience in starting and stopping. The number of cylinders in the drying machine is varied according to the weight of the goods to be dried and the number of yards to be run in a given time. Sometimes upright dryers are substituted for the horizontal form of dryer. These outfits are designed to run through one, two or three widths of goods at a time and are very economical in first cost, floor space and labor required to operate as compared with the production obtained.

Finishing Yarn Dyed Cotton Piece Goods, Continued.



Finishing Yarn Dyed Cotton Piece Goods, Continued.

CALENDERS.

The accompanying cuts and outline drawings show three and five roll calenders which are the machines best suited and especially designed to finish yarn dyed goods. Upwards of fifty such machines are in use in the Southern States alone, and as each machine can finish from 20,000 to 40,000 yards of goods per day it will be seen that at least 1,000,000 yards per day is the capacity of these machines in the South at the present time. The calenders embody all the features which go to make a perfect finishing machine, and in design, strength and construction are unsurpassed by any in the world. These calenders have tension stands, brakes and bars for feeding in the goods and batching attachments for winding them up after calendering. They are driven by friction pulleys so arranged that they can be easily operated by the calender man. The merits and value of a calender depend very largely upon the character of the rolls. The metal rolls in these calenders are cast chilled iron, and after turning are ground perfectly true and smooth on a special grinding machine and are fitted with steam connections for heating. The soft or fibre rolls are very carefully made of husk, cotton, paper or patent combination stock under excessive hydraulic pressure.

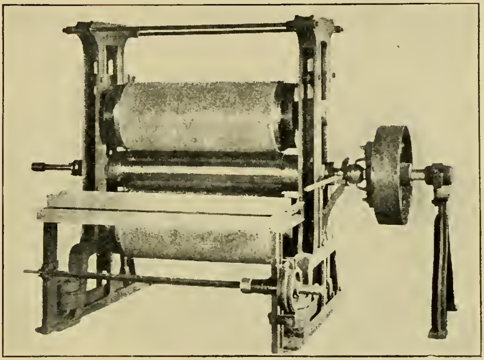
Patent Combination Rolls.

For the past nine or ten years The Textile-Finishing Machinery Company has had on the market a patented calender roll made from a specially prepared mixture of cotton and corn husk made in such manner that it is possible to obtain a roll with the smooth surface of the cotton roll and at the same time even greater elasticity and wearing qualities than that of the husk roll. This elasticity protects it in a great measure from damage from foreign bodies running through the calender, thus insuring a longer life for it than that of cotton or pure husk rolls.

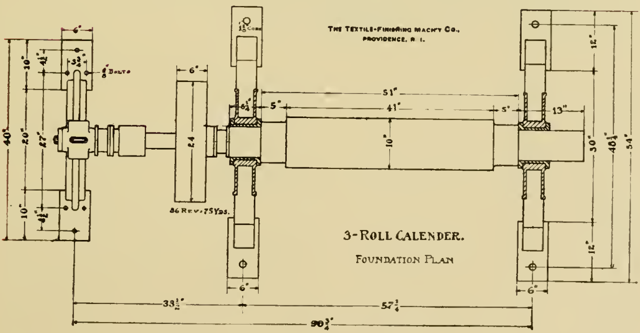
This roll has proved of the utmost value for general use in calenders and water mangles but it is especially adapted to soft calender finishes including the finish of almost all classes of yarn dyed goods. For the finish of this class of goods it has come into almost universal use and it would be hard to find a mill finishing this class of goods either North or South where this roll is not in use. Upwards of 1,000 of these rolls are in use at the present time in the United States and England.

Finishing Yarn Dyed Cotton Piece Goods, Continued.

Calenders, Continued.

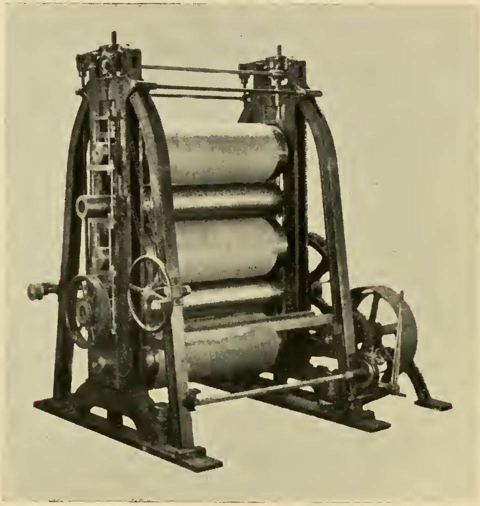


3=Roll Calender

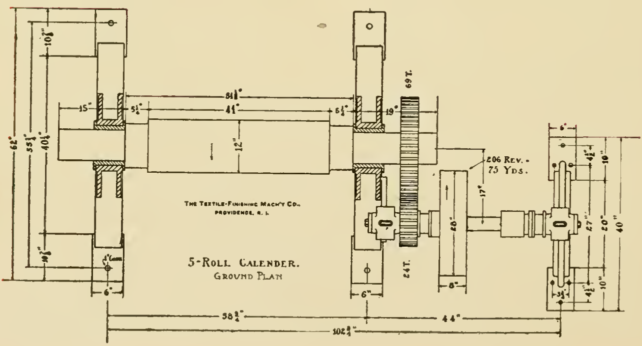


Finishing Yarn Dyed Cotton Piece Goods, Continued.

Calenders, Concluded.



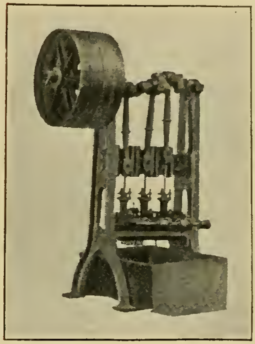
5-Roll Calender.



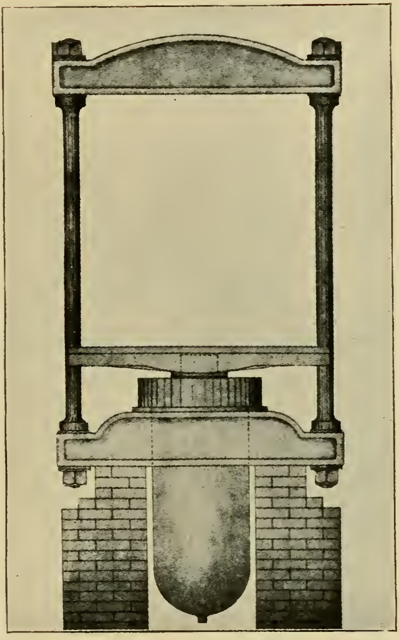
HYDRAULIC PRESSES AND PUMPS.

Hydraulic presses intended for pressing the goods in small compass are usually furnished with rams 10 in. in diameter for 100 tons pressure and 12 in. for 150 tons and upwards.

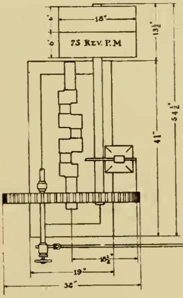
3-Plunger Hydraulic pumps arranged to be driven by belt are especially designed to operate the presses at the pressure necessary.



3=Plunger Pump.

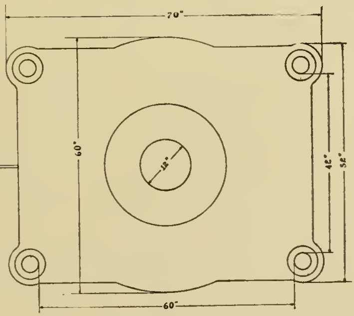


Hydraulic Press.



THREE-PLUNGER HYDRAULIC PUMP

The Textile-Finishing Mach'y Co.
Providence, R. I.



HYDRAULIC PRESS.

The Textile-Finishing Machinery Co.'s Dyeing, Bleaching and Finishing Machinery, Concluded.

In addition to the warp dyeing, bleaching and drying machinery and the finishing machinery for yarn dyed piece goods described in the previous pages, this company manufactures complete lines of machinery for bleaching, dyeing, drying and finishing all classes of textile fabrics, including cotton, woolen, worsted, silk and lace piece goods. They also make a specialty of machinery for bleaching thread and soft twist yarns, and of outfits for mercerizing cotton piece goods and yarn in the chain or warp.

The following are a few of the machines which they manufacture: Back Gray Brushers, Singeing Machines, Liming Machines, Mixing Tanks, Saturating Machines, Boiling Kiers, Centrifugal Pumps, Agitators, Bleach House Washing Machines, Water, Chemic and Sour Squeezers, Reels, Scutchers, Water Mangles, Starch Mangles, Friction Stuffing Mangles, Back Starching Mangles or "Toomy Dodds," Victoria Mangles, Clay Mixers, Padding Machines, Piece Dyeing Machines, Jiggs, Aniline Agers, Crabbing Machines, Carbonizing Machines, Canroy Winders, Rusden Patent Continuous Chainless Steamers, Open Soaping machines, Ammonia Boxes, Color Kettles, Color Strainers, Forcing Machines, Blanket Washers, Indigo Dyeing Machines, Horizontal and Vertical Drying Machines with copper or tinned iron cylinders, Straightaway Return and Upright Tenters with pin, clamp, or patent automatic Chains, Winders, Belt Stretchers, Sprinkling Machines, Revolving Stretchers, Conical Stretchers, Pasting Plates, Rolling, Friction, Glazing, Chasing, Embossing and Moire Calenders, with two to seven rolls, single and double Engines, Button Breakers, Hot Plate Finishing Presses, Hydraulic Presses, Hydraulic Pumps, Padding and Drying Machines for opaque shade cloths, Mercerizing Machines, Embossing Machines for oil cloths and imitation leather, Hydraulic Presses for finishing Celluloid, Yarn Washing Machines, Dumping Machines, Carpet Yarn Sizing and Beaming Machines, Expansion Pulleys, Lead Lined Tanks and many other special machines.

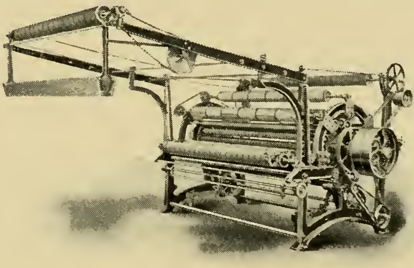
This company makes a specialty of cotton, husk, patent combination cotton-husk, paper, rag, chilled iron, steel, brass, electro-deposited copper, and rubber covered rolls for all purposes.

They make a specialty of general mill repair work and have large and well equipped machine and forge shops, iron and brass foundries, and copper and tin works for all classes of mill work.

IMPROVED FRENCH NAPPER,

Manufactured by

Woonsocket Napping Machinery Co.



(For Cotton Goods.)

Planetary Motion. This napper is provided with a 24-inch cylinder on the circumference of which are mounted 16 napping rolls, which revolve by a motion independent of the revolution of the cylinder and simultaneously with it, but in an opposite direction, giving to the whole what has been fancifully called "a planetary motion."

Napping Energy. The napping energy of this machine may be increased or diminished at will in two ways: First, by changing the relative speed of the cylinder and napping rolls, and, second, by a device for changing the speed of the cloth.

Capacity of Napper. The capactiy of this napper is twenty-five per cent. greater than any other French napper built, secured by adding one contact and two extra napping rolls and by making active the contact which in other French nappers is idle, thus giving to this machine from these improvements alone a clear gain of twenty-five per cent.

Contacts with Cloth. The cloth, in one passage through this napper, has six contacts with the napping rolls. The contacts in this machine are all real, active and effective, differing from other French nappers in this respect, which have only four bona fide contacts, the fifth being idle, useless and fraudulent.

Rotary Napper. This napper is a rotary machine, provided with

Woonsocket Napper, Concluded.

an overhead rigging for returning the cloth to the front of the machine when more than one run is necessary. The front arm is adjustable, either up or down, back or forward as may be desired; thus any height of the front arm can be obtained.

Napping Rolls. The napping rolls on this machine are made of extra strong steel tubing, especially made, and guaranteed not to spring at the center. All the napping rolls are turned, and ground, consequently giving a perfectly true surface to the napper clothing. Special attention has been given to this particular branch of the napper. The napper clothing on this machine is from selected stock, carefully ground, and thoroughly inspected, and special attention is given to the grinding of the same.

Boxes. The boxes, which hold the napper rolls are 2 5-16 inches wide, and the bearings of the rolls run in heavy brass caps. The boxes and bearings are self-oiling, and there has been designed for this machine, a hub oiling device with spokes or arms running out to each bearing. It is guaranteed to give perfect satisfaction and to oil all the rolls thoroughly and economically.

Power. All the carrying and guide rolls on this machine are provided with self-adjustable boxes. These reduce to a minimum the friction, consequently saving a large amount of power. We guarantee this machine to save from one to one and a half (1 to 1½) horse power over any other build of nappers.

Sizes. These nappers are built from 72 inches to 100 inches wide. Other sizes built on order.

Features of This Machine That Commend it to Manufacturers:

Greater.	Less.
Productiveness.	Loss of stock in process of napping.
Strength and endurance.	Damage to cloth in process of napping.
Adaptability to different kinds of fabrics.	Stoppage of machine for repairs.
Beauty in appearance of product.	Labor in quantity and quality.
Regularity in appearance of product.	Space to occupy.
Style in appearance of product	Power to operate.

Technical Data for Standard 72-inch Machine:

Working Width	72 inches.
Driving Pulleys	21½ in. by 5 in.
Revolutions per minute	150.
Shipping Weight	7800 lbs.
Dimensions:	
Length, right and left	11 feet 2 inches.
Height, adjustable	7 feet to 9 feet.
Depth, front to back, adjustable	12 feet to 15 feet

SECTION IV.

Cotton and its Manufacture, Mill Architecture and Engineering,

—with—

General Technical and Miscellaneous Information.

COTTON.

*DESCRIPTIVE AND STATISTICAL DATA.

Classification of Cotton in New York.

(In effect from Oct. 24, 1887).

Fair
Barely Fair.
Strict Middling Fair.
Fully Middling Fair.
Middling Fair.
Barely Middling Fair.
Strict Good Middling.
Fully Good Middling.
Good Middling.
Barely Good Middling.
Strict Middling.
Fully Middling.
Middling.
Barely Middling.
Strict Low Middling.
Fully Low Middling.
Low Middling.
Barely Low Middling.
Strict Good Ordinary.
Fully Good Ordinary.
Good Ordinary.
Barely Good Ordinary.
Strict Ordinary.
Ordinary.
Low Ordinary.
Inferior.

The **Full Grades** are Fair, Middling Fair, Good Middling, Middling, Low Middling, Good Ordinary and Ordinary.

The **Half Grades** are designated by the prefix "**Strict.**"

The **Quarter Grades** are designated by the prefixes of "**Barely,**" meaning the mean point between the half grade and the next full grade above, and "**Fully**" meaning the mean point between the half grade and the next full grade below.

The Standard American Bale—54″ x 24″ has been adopted as the standard length and width of a bale of compressed cotton, on account of the adaptability of this particular size for stowing in the hold of a vessel; in addition to this are the Lowrey lapped bale, and the American round bale; each claiming special merit as to density, etc. The standard rectangular compressed bale is brought to a density of about 28 pounds to the cubic foot. It is calipered at the shipping port and if the density is less than the standard, the bale is recompressed at the expense of the shipping compress. As a rule cotton is bought along the line of the railroad and brought into the compress for concentration; there it is classed, marked, and shipped out by what is known as expense bills. When the cotton is received, local rates of freight are paid on it, and sometimes an additional premium is paid to prevent the cotton from going out by other roads than the one which hauled it to the compress; then when the cotton is re-shipped, the receipt for the money or the expense bill is handed in, and if a bonus was paid originally it is handed back to the shipper and the local rate absorbed in the through rate to the mill.

***Note.**—I am indebted to Latham, Alexander & Co., 16 Wall St., New York, for much of the following statistical information (See their "**Cotton Movement and Fluctuations,**" **1900-1905**.)

*Cotton, Continued.

Long Stapled Cottons.

Sea Island—Grown in Edisto, John, James, Port Royal, and St. Helena, S. C., and Cumberland and St. Simon, Ga.; 1⅜" to 2¼" staple; .0004 to .0006 diameter; Silky, fine strong and clean fiber; usually used for 150s to 400s plied yarns; said to have been spun to 2150s in London in 1851.

Florida Sea Island—Grown on mainland of Florida, near coast, from Sea Island Seed; 1¼" to 1¾" staple; .0005 to .0006 diameter; fiber silky and clean; usually used for 150s to 200s plied yarns; good for lower grade Sea Island yarn.

Peruvian Sea Island—Grown on Peruvian mainland, from Sea Island seed; 1½" staple; .0004 to .0007. diameter; fiber silky and strong, but not clean; usually used for 100s to 150s plied yarns.

Medium to Long Stapled Cottons.

Brown Egyptian or Mako—Grown in lower, middle and upper Egypt; 1⅛" 1⅜" staple; .0005 to .0007 diameter; golden brown to brown fibre; usually used for 50s to 100s single twist or warp yarns, 70s to 100s single weft or filling yarns, 70s to 150s plied yarns.

Mitafifi—Grown in lower and middle Egypt; 1 3-16" to 1⅜" staple; .0005 to .0007 diameter; fibre rich dark brown, long strong and fine; principal variety.

Rio Grande, Pernambuco, Bahai—Grown in Brazil; 1" to 1⅜" staple; .0006 to .0008 diameter; fibre of all Brazilian is harsh, wiry, clean, creamy colored, tree cotton; usually used for 32s to 50s single twist or warp yarns; all Brazilian cotton is good for warp yarns, especially for sizing. Gives strength when mixed with American.

Rough Peruvian—Grown in Peru; 1¼" to 1½" staple; .0006 to .0008 diameter; fibre rougher than Brazilian; usually used for 40s to 70s single twist or warp yarns; some very weak and high color.

Short Stapled Cottons.

Indian Cottons:

Surat—Grown in Port, Bombay Pres. Dist. of Broach; a name given to all Bombay Presidency cotton.

Tinnivelly—Grown in Presidency of Madras; ¾" to 1" staple; .0007 to .0009 diameter; creamy fibre; usually used for 18s single twist and warp yarns and below; and 24s single weft or filling yarns and below.

Bengal—Grown in Bengal Pres.; ½" to ⅝" staple; .0007 to .0009 diameter; tinged, dirty weak fibre; usually used for 4s to 8s single twist or warp yarns, 4s to 10s single weft or filling yarns; dirtiest cotton grown.

*Extracts taken with the author's kind permission from "**Cotton**" by Christopher P. Brooks.

Cotton, Continued.

Other Asian Cottons:

China and Corea—½" to ¾" staple; fibre rough but very clean; usually used for 6s to 10s single twist or warp yarns, and 6s to 14s single weft or filling yarns.

Turkestan—Indigenous. Grown in Central Asia (Russian Provinces); fibre rough, 1" staple; good color and clean.

Japan—Grown in Japan; ⅝" to ¾" staple; fibre very clean.

Phillipine—Grown in the Phillipine Islands; ⅝" to 1" staple; fibre clean and smooth.

Persian—Grown in Persia; ¾" to 1 1-16" staple; fibre bright creamy color; leafy and strong; resembles Indian but is superior to the best Indian.

American Cottons, Medium Length of Staple.

Gulf Cotton of New Orleans—Grown in Mississippi, Louisiana, and neighboring States; 1" to 1¼" staple; .0004 to .0007 diameter; usually used for 28s to 44s single twist or warp yarns, and 50s to 70s single weft or filling yarns.

Benders or Bottom Land—Grown in Mississippi River bottom, Louisiana and Mississippi; usually used for 28s to 44s single twist or warp yarns, and 50s to 70s single weft or filling yarns; a variety of Gulf or New Orleans cotton.

Mobile—A variety of Orleans or Gulf, usually inferior in quality.

Peelers—Varieties originated in Mississippi and grown usually in Mississippi and Louisiana, Arkansas, and Alabama; fibre bluish white usually; usually used for 28s to 44s single twist or warp yarns, and 50s to 70s single weft or filling yarns; somewhat resemble short Florida Sea Island.

Allan Seed—Varieties originated in Mississippi and grown usually in Mississippi, Louisiana, Arkansas, and Alabama; fibre long staple; usually used for 28s to 44s single twist or warp yarns, and 50s to 70s single weft or filling yarns; ranking among best of New Orleans cotton, usually bad to card.

Uplands—Grown in Georgia, North Carolina, South Carolina, and Virginia; ¾" to 1" staple; .0006 to .0007 diameter; usually used for 30s to 40s single weft or filling yarns; a clean, easily manipulated, useful cotton, suitable for weft or filling.

Texas—Grown in Texas; ⅞" to 1" staple; .0005 to .0007 diameter; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; suited for warp.

Georgia—Grown in Georgia; a variety of Uplands.

Cotton, Continued.

Mississippi or Louisiana—Grown in Mississippi or Louisiana; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; varieties of Orleans or Gulf cotton.

Selma—Grown in Alabama; fibre generally very clean; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; varieties of Orleans or Gulf cotton.

Arkansas—Grown in Arkansas; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling; varieties of Orleans or Gulf cotton.

Boweds—Usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; another name for Uplands.

Memphis—Grown in Alabama; fibre generally good staple but leafy; generally used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; a variety of Gulf cotton or Orleans.

Norfolk—Grown in North Carolina and Virginia; fibre generally very clean; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; variety of Boweds or Uplands.

Savannah—Grown in Georgia; fibre generally clean; usually used for 26s to 32s single twist or warp yarns, and 32s to 40s single weft or filling yarns; variety of Boweds or Uplands.

Cotton, Continued.

United States Cotton Crops.

Season	Acres Planted	Bales in Crop	Net Weight Per Bale	Bales Per Acre	U. S. Consumption in Bales	Exports in Bales	Average price per pound Middling Upla'ds in N.Y.	Average price per pound in Liverpool.
1888-89	19,362,073	6,938,290	470	0 36	2,314,091	4,854,573	10.71	5.73
1889-90	20,171,896	7,311,322	471	0 36	2,390,959	4,996,543	11.53	5.97
1890-91	20,809,053	8,652,597	473	0 41	2,632,023	5,783,101	9.03	4.94
1891-92	20,714,937	9,035,379	473	0 43	2,876,846	5,868,545	7.64	4.18
1892-93	18,067,924	6,700,365	475	0 37	2,431,134	4,410,524	8.24	4.57
1893-94	19,684,000	7,549,817	474	0 38	2,319,688	5,360,318	7.67	4.23
1894-95	21,454,000	9,901,251	484	0 46	2,946,677	6,926,025	6.50	3.41
1895-96	18,882,000	7,157,346	477	0 38	2,504,972	4,751,384	8.16	4.24
1896-97	22,341,000	8,757,964	477	0 39	2,847,351	6,088,521	7.72	4.12
1897-98	24,071,000	11,199,994	482	0 47	3,443,581	7,674,065	6.22	3.53
1898-99	23,572,000	11,274,840	489	0 48	3,589,494	7,452,116	6.00	3.28
1899-00	22,583,055	9,436,416	479	0 44	3,665,412	6,055,874	8.69	4.87
1900-01	25,558 000	10,383,422	485	0 41	3,588.501	6,639,931	8.96	5.12
1901-02	27,532,000	10,680,680	483	0 39	3,988,501	6,715,793	8.75	4.78
1902-03	27,450,000	10,727,559	483	0 39	4,160,961	6,765,953	10.27	5.46
1903-04	28,907,000	10,011,374	483	0 35	3,963,981	6.109,755	12.42	6.94
1904-05	31,730,371	13,565,885	491	0 43	4,445,650	8,767,180	9.11	4.93

Cotton Industry of the World.

At every period of depression in business, a great many people begin to talk of the overcrowding of the mill industry in the Southern States. Even the most superficial examination of the following tables and those that appear on the next two or three pages will make very clear the fact that the business in the South has only really begun. As long as the South produces by far the majority of the world's production, and manufactures only 18.1 per cent. of its production, there is surely room for the industry to grow in this section.

As a matter of supply and demand, it is undoubtedly true that the world's supply of goods is very nearly if not quite equal to the demand; at the same time, the increased demand should logically be met by the increased supply from American mills.

Number of Spindles in the World.

	1905.	1904	1903.
Great Britain	48,400,000	47,500,000	47,200,000
Continent	35,000,000	34,600,000	34,300,000
Total Europe	83,400,000	82,100,000	81,500,000
United States—North	15,325,000	15,250,000	15,200,000
United States—South	8,747,810	7,963,866	7,039,633
Total United States	24,072,810	23,213,866	22,239,633
East Indies	5,250,000	5,191,533	5,100,000
Japan	1,400,000	1,400,000	1,350,000
China	619,648	610,000	600,000
Total India, etc	7,269,648	7,201,533	7,050,000
Canada	750,000	716,000	700,000
Mexico	675,000	650,000	610,000
Total other	1,425,000	1,366,000	1,310,000
Total world	116,167,458	113,881,399	112,099,633

World's Production and Consumption of Cotton.

COUNTRIES.	1904–05. Bales.	1903–04. Bales	1902–03. Bales.	1901–02. Bales.
United States	13,420,440	9,841,671	10,511,020	10,380,380
East Indies*	2,960,000	2,634,400	2,737,577	2,475,230
Egypt	1,187,000	1,275,754	1,148,700	1,292,443
Brazil, etc.†	215,000	307,516	329,390	265,896
Total	17,782,440	14,059,341	14,746,687	14,413.949
Consumption 52 weeks	15,506,225	14,010,428	14,436,589	14,414,908
Surplus from year's crop	2,776,185	48,913	290,098	*a*959
Visible and invisible stock				
September 1 beginning year	3,011,079	2,962,166	2,672,068	2,673,027
September 1 ending year	5,287,264	3,011,079	2.962,166	2,672,068

*Includes India's exports to Europe, America and Japan, and mill consumption in India increased or decreased by excess or loss of stock at Bombay.

†Receipts into Europe from Brazil, Smyrna, Peru, West Indies, etc., and Japan and China cotton used in Japanese mills.

a Deficiency in the year's new supply.

Cotton, Continued.

Consumption and Production of Cotton in the Southern States.

The following table by Latham, Alexander & Company shows their estimate of the number of spindles and looms in operation in the South:

Southern States.	Number of				Average Number Yarn.	Consumption.			Per Cent. of Crop Used
	Mills	Spindles. Alive.	Spindles. Running.	Looms Run.		Bales.	Av'ge Net Wt.	Pounds.	
Virginia	19	251,656	192,694	4,984	15	54,455	486.83	26,510,170	
North Carolina	238	2,222,888	2,107,909	42,338	19½	607,275	474.53	288,164,535	
South Carolina	134	3,296,194	2,970,447	69,963	23	658,019	480.01	315,853,265	
Georgia	119	1,490,138	1,403,904	28,028	15	493,456	480.40	237,055,578	
Florida	......	....	....	....	....	....	......	....	
Alabama	60	802,062	784,998	15,898	16	229,121	485.63	111,268,817	
Mississippi	22	153,888	145,692	3,854	19½	35,534	486.37	17,282,565	
Louisiana	5	67,496	63,810	1,587	16	13,917	492.08	6,848,290	
Texas	15	75,424	73,184	1,896	17	29,026	501.88	14,567,734	
Arkansas	4	25,520	17,520	60	14	3,210	491.56	1,577,904	
Tennessee	32	255,412	190,008	3,753	15½	51,335	490.88	25,199,268	
Missouri	3	14,696	14,696	461	15	4,205	497.39	2,091,500	
Kentucky	8	92,436	86,017	1,502	14½	23,853	492.16	11,739,505	
Total, 1904-05	659	8,747,810	8,050,879	174,324	19	2,203,406	480.24	1,058,159,131	16.2
Total, 1899-00	441	4,540,515	4,270,759	105,990	18¾	1,599,947	468.99	750,365,237	17.2
Total, 1889-90	240	1,554,000	....	....	....	526,856	......	....	7.1
Total, 1879-80	163	568,458	....	....	...	188,398	......	....	3.3
Total, 1849-50	168	245,810	... .	....	...	80,300	......	....	3.3

Cotton, Concluded.

Kinds of Cotton Goods Manufactured in the U. S.

In organizing a new mill, the management is generally confronted with the very difficult problem of what kind of goods it will be most profitable to make. The solution to this problem is generally difficult, even for experienced mill men.

The only advice worth giving on this subject is to consult the different leading cloth or yarn commission houses, as the case may be, and get their advice as to the needs of market at the time. Then from the combined information thus obtained, and bearing in mind local conditions, to decide, as it were, by "main strength and awkwardness." In making this decision, it will be interesting to glance over the following table showing both the variety and the extent of the output of the mills in the United States during the last census year.

Products in Detail of Cotton Mills in the U. S.

Kinds.	1900	
	Sq Yards	Value
Aggregate value	....	$332,806,156
Woven goods:		
Total	4,509,750 616	243,218,155
Plain cloths for printing or converting—		
Total	1,581,613,827	57,780,940
Not finer than No. 28 warp	1,056,278,952	35,616,575
Finer than No. 28 warp	525,334,875	22,164,365
Brown or bleached sheetings and shirtings	1,212,403,048	55,513,032
Ginghams	278,392,708	16,179,200
Ticks, denims and stripes	171,800,853	16,446,633
Drills	237,206,540	11,862,794
Twills and sateens	235,860,518	14,301,302
Cottonades	26,323,947	2,791,431
Napped fabrics	268,852,716	18,231,044
Fancy woven fabrics	237,841,603	21,066,310
Corduroy, cotton velvet, and plush	7,961,523	2,682,017
Duck—		
Total	129,234,076	14,263,008
Sail	11,750,151	2 216,371
Other	117,483,925	12,046,637
Bags and bagging	30,039,616	2,554,192
Mosquito and other netting	41,885,023	875,868
Upholstery goods—		
Total	50,334,609	8,670,384
Tapestries (piece goods and curtains)	10,131,538	4,123,600
Lace and lace curtains	36,880,198	3,585,138
Chenille curtains	805,414	257,840
Other, including covers	2,517,159	703,806
	Pounds.	Value.
Yarns for sale	332,186,012	$55,188,663
Sewing cotton	15,741,062	11,825,218
Twine	11,132,250	1,475,146
Tape and webbing		328 801
Batting and wadding	10,567,700	864,016
Waste for sale	270,100,756	5,552,234
Other products of cotton		5,154,170
All other products	....	9,199,753

COTTON CONTRACTS.

Cotton for Future Delivery.

As many are unfamiliar with the character of cotton contracts, and with the business that is transacted in them, I make the following explanatory remarks concerning this leading feature in the cotton trade.

A cotton contract is an agreement in writing actually to receive, say, 100 bales of cotton, and pay for it at or before some future period specified, usually at the end of the calendar month. It is the same as any other executory contract. There is no option to receive or deliver the cotton. It must be delivered to the buyer within the month, and the buyer must receive it and pay for it.

Settlements of cotton contracts can be made only by purchases and sales of like contracts. "Puts," "calls" and "options," which are privileges, are not and never were recognized by the New York Cotton Exchange, and are not traded in on the floor of that Exchange.

By means of cotton contracts the greater part of the cotton crops are moved and distributed throughout the markets of the world.

Contracts are sold in lots of 50,000 lbs., or about 100 bales each, on the basis of Middling Uplands; if cotton better than Middling is delivered by the seller, he receives a proportionately higher price than the contract figure, according to quotations for the various grades of cotton; if he delivers cotton lower than Middling, he receives a proportionately lower price.

The cotton is classed by the Classification Committee of the New York Cotton Exchange in the fairest and most careful manner.

Cotton delivered on contracts need not be of one grade; any grade from Good Ordinary to Fair, inclusive, can be delivered. A ready means of disposing of cotton is thus afforded; when the market is dull it is difficult to sell cotton from table, except at a sacrifice, but a contract can at any time be sold against it.

They are made at "seller's option"—that is, the seller has the option of delivering the cotton on any day during the contract month; he can, if he choose, wait till the end of the month; but the buyer must receive it any day it is tendered during the contract month, unless he sells out, or closes the contract, which can always be promptly done.

Many merchants, after selling contracts against cotton, find it to their interest to sell the cotton at home and to buy in, or cover, the contracts in New York or New Orleans.

Cotton Contracts, Continued.

As already stated, contracts can always be promptly settled—that is, bought in or sold out; yet on every one, actual cotton can be obtained, if desired; and cotton *must* be delivered on all contracts remaining open or unsettled at the end of the month for which they were sold.

To merchants and operators, cotton contracts for future delivery afford great advantages; this is evidenced not only by the large business in New York, but also by the extensive business done in them in Liverpool. They fluctuate more widely and frequently than cotton, though governed in general by the course of actual cotton on which they are based.

Contracts can not only be purchased, but can also be sold short. By dealing in them, loss in weight, interest, insurance and various other charges can be avoided. No large sums of money, such as are necessary when dealing in actual cotton, are required. At light expense the holder of a contract can avail himself of the fluctuations of the market during many months.

It is often the case that merchants hold a great deal of cotton. Under such circumstances it is more advisable to sell the cotton at once and replace it with contracts than to hold the cotton through several weeks or months at heavy expense; opportunity for profiting by a subsequent rise is thus retained, for the contracts will certainly advance afterward if actual cotton does.

On the next page we annex the form of contract, the only one recognized by the New York Cotton Exchange. This is the basis on which spot cotton would be delivered when bought on future contracts.

The New Orleans Contract is practically the same as the New York contract, and only differs from it in so much that it is not required for the cotton to be classed and weighed under the auspices of the Cotton Exchange, and the margins originally deposited are paid directly to the party in whose favor the market turns.

The Liverpool Contract differs from the New York contract in a number of respects. In the first place, the Liverpool classification for strict low middling, to middling fair inclusive is one-quarter of a grade lower than the New York classification; and for grades below strict low middling it is one-quarter to one-half a grade higher than New York. The contracts are sold in lots of 48,000 pounds net weight, or about 100 bales U. S. growth, to be delivered from warehouse. The delivery is at the seller's option but buyer must be notified when he is ready to deliver; the buyer then has the option of when

Cotton Contracts, Continued.

NEW YORK COTTON EXCHANGE.

CONTRACT.

New York, ...190.....

In consideration of one dollar in hand paid, receipt of which is hereby acknowledged, ...have this day Sold to (or Bought from) ....50,000 lbs. in about 100 square bales of Cotton, growth of the United States, deliverable from licensed warehouse, in the port of New York, between the *First* and *Last* days of..................................next, inclusive. The delivery within such time to be at seller's option in one warehouse, upon notice to buyer, as provided by the By-laws and Rules of the New York Cotton Exchange. The cotton to be of any grade from Good Ordinary to Fair, inclusive, and if Stained, not below Low Middling (New York Cotton Exchange Inspection and Classification), at the price of............. cents per pound for Middling, with additions or deductions for other grades, according to the rates of the New York Cotton Exchange, existing on the pay previous to the date of the Transferable Notice of delivery.

Either party to have the right to call for a margin, as the variations of the market for like deliveries may warrant, and which margin shall be kept good. This contract is made in view of, and in all respects subject to, the rules and conditions established by the New York Cotton Exchange, and in full accordance with Article II., Title IV., Chapter Second of the By-Laws.

Cotton Contracts, Continued.

he shall receive it, except that it must be within ten days from date of declaration or notice given him by the seller. The seller is often given two months in which to deliver. The price is based upon the Liverpool classification of middling, but nothing below good ordinary to be delivered. Payment is made before delivery on a transfer order for the cotton. The deductions as to weights are for the actual weight of the iron bands and a tare of four pounds on each 100.

Spot Cotton for Future Delivery.

Under this heading is designated the practice that is now in vogue among many mills of placing their orders for spot cotton for future delivery, covering an entire season.

By way of explanation, it is understood that a mill requiring 6,000 bales of cotton per annum can place its entire order on a basis of 500 bales of spot cotton to be delivered each consecutive month for the entire twelve months.

These orders are placed either at buyer's or at seller's option of shipment, as the case may be: by buyer's option the mill has a right to call for the shipment of cotton any time during the month, whereas by seller's option the seller has the right to ship the cotton any day during the month. Where no option of shipment is specified, then the 15th of the month is the date of shipment.

When spot cotton is delivered on contracts, it is shipped on the following terms:

> Be it understood that the following terms and conditions shall enter each and every contract between the seller and the purchaser. That seller shall prepay all messages and express charges when samples are asked for by shipper; that samples of all shipments shall be forwarded promptly to the purchaser; that Shepperdson's '78 and 81 code will be used unless otherwise understood; that for immediate shipment B L must be signed within three days from date of order; prompt shipment shall be ten days; that if samples redrawn from the mill do not come up to grade and staple mentioned in the contract, a claim will be made as

Cotton Contracts, Continued.

promptly as possible; if shippers object or demure said samples shall be sent promptly to New York or New Orleans Cotton Exchange and passed on by the Arbitration Committee and their award become binding on shipper; that if the shipment does not come up to the contract specifications, shipper shall bear all the pocket expenses of said arbitration; if otherwise buyer shall pay the same and make good to shipper any over plus; that all cotton shall be weighed promptly on arrival, which shall be a condition precedent of all contracts, that buyers pay for only net invoice weights, and without allowance of any sort. If, however, shippers accompany invoice with sworn certificate of weight, saying the cotton was weighed day of shipment, said certificate being signed by compress warehouse or other public weigher: In that event shipper only guarantes his weight within 3 lbs. per bale; that if bought f. o. b. at a given point, all purchases, including the exchange to put the cotton on cars, must be paid by shippers, buyers paying freight only.

Hedging Purchases of Spot Cotton.

By a system of hedging, mills who purchase spot cotton and carry it themselves in their own warehouses can protect themselves against a falling market. This is done by selling an equivalent amount of future contracts on the Exchanges for the different months during which the cotton is supposed to last them. As the cotton is put into the mill to be worked up, a corresponding amount of future contracts, or hedges, are closed out, so that by the time the entire supply has been worked up, the entire hedge has been closed out.

The greatest objection to this sort of thing is the large amount of money that might become tied up in the transaction; for the mill not only has the entire value of the cotton tied up in the purchase price, but in addition to that a greater or less amount on margins as the market goes for or against it on his future contracts or "hedges."

On the contrary, the policy of a great many mills is to buy their cotton against the actual sale of the manufactured

Cotton Contracts, Concluded.

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product. This is undoubtedly the safer system when it can be done. The difficulty in this case with large mills lies in their possible inability to get the spot cotton when they want it toward the end of the season, as it may all have been shipped out of the surrounding country. Of course, it could be brought back, but at considerable expense in various ways. In addition often times a very large mill cannot dispose of its product in advance in order to enable them to buy their spot cotton against their sales, in which event if they want to be protected against losses on the raw material, they can hedge their purchases of raw cotton, as above indicated.

*Advantages of New Orleans as a "Hedging Market."

In advancing the claims of New Orleans as being preeminently the Market for hedging purposes, the first great argument is the fact that its geographical situation is such that it is practically the most available outlet for the surplus of the entire cotton crop. Such being the case, manipulation during the active months of the season is practically impossible, and all parties placing their hedges in this Market, either Spinners or Exporters can rest assured that when they wish to liquidate they will realize a fair market value. Spot quotations are made daily and revised weekly, to conform to the *actual selling value of each grade* in the open market, so that the buyer of contracts accepting delivery gets cotton at its marketable value regardless of grade. In New York the reverse is the case. There differences on and off middling are fixed for a year in advance, and before any one can know what proportion of low or high grades there may be; and as generally happens, the buyer of contracts accepting delivery has to accept low grades at these fixed differences which make them cost much in excess of their marketable value and thus depresses the value of the contract.

It is valuable to a man hedging to have his contracts in the market controlling the price of the Spots he wants to buy at some future time.

*By courtesy of P. St. George Cocke, of New Orleans.

THE BONDED WAREHOUSE SYSTEM.

This term covers two entirely different systems for obtaining advances on cotton in storage.

(1). The one with which the average individual is familiar is that in vogue in many Southern towns, and developed largely for the convenience of the farmer and the cotton dealer. A standard warehouse is built, and bonded to some Trust Company which protects its receipts up to a certain specified amount. The dealer, merchant or farmer takes his cotton to the warehouse in either large or small amounts, and can store it at fixed rates based upon the price of cotton, varying from say fifteen to twenty-five cents per bale per month, and obtain a receipt therefor which is negotiable at any bank. The cotton so stored will be delivered up upon presentation of receipt and payment of all storage charges.

(2). This is a system that has been devised, as already stated, for the convenience of the mill owners, that they may obtain advances on cotton stored in their own warehouses. The system is as follows:

A large central warehouse company, as it may be termed, for a nominal sum leases the warehouse from the mill or from the mills. Then a custodian, representing the warehouse company, is appointed, who is often the superintendent of the mills. The mill then executes its notes in favor of the warehouse company for whatever amount of cotton they may be carrying, so timing the dates for maturity of those notes as to meet their wants for the release of the cotton. These notes are discounted to the warehouse company at a comparatively low rate of interest, say 5%; the warehouse company in turn, either holds them or sells them in the open market, as they may see fit. The custodian is in sole charge for the warehouse company of that cotton and of that warehouse, and no one has any right of admission into that warehouse except the custodian. Upon the payment of these notes and the surrender of these receipts to the custodian, the cotton is delivered to the mill.

An objection to this system is that should the mill want to use or get possession of the cotton before the maturity of any one of the notes, it may be impossible to do so, as the note may have been sold in the open market and even its whereabouts not be known until presented for payment at date of its maturity.

METHODS OF SELLING COTTON YARNS AND CLOTH.

It may be briefly said that the average Southern cotton mill sells its product either direct through commission houses, brokers, or through a regularly organized selling department of its own. Some mills have an idea that it is to their advantage to divide their account. It is to be seriously questioned, however, if this is the best policy, for in such cases the different sellers compete for the business, and often with samples from the same mill, vie with each other in offering inducements in price. A mill indulging in this practice can obviously hardly be expected to get the best prices for their goods.

Brokers sell on a 1% commission, and guarantee nothing.

Legitimate selling houses, or commission merchants, as they may be more properly termed, conduct their business on either one of the following bases, as their clients may prefer:

(1). **Guaranteed Accounts.**—Comprising those in which the commission merchant assumes the risk of credit, and guarantees the payment of the account.

(2). **Unguaranteed Accounts.**—Comprising those in which the mill accepts the orders at its own risk, the commission merchant being entirely released from any loss or liability in the transaction.

In both cases, the mill usually pays freights, dating and discounts, and cartage. The commission house pays storage and insurance while in their warehouse on the Northern market, also the labor of handling the goods; in an active market, however, a large proportion of the goods are shipped direct to their destination.

The actual commissions charged vary considerably, but guaranteed accounts for marketing cloth ordinarily run from 4% to 5%, and unguaranteed accounts 2½% to 5%. The discounts are 2% off for ten days and sixty days extra dating, which is simply another way of stating 2% for seventy days.

As to marketing yarns, the regular commission is 5% and 3%, or 5% and 2%, as the case may be, which covers guaranteeing the account, the commission, and all charges for storage, insurance, labor, cartage, etc. This 3% or 2% is usually allowed by the commission merchant to the buyer for net cash ten days. An extra allowance of 2% is made for paper cones.

When goods have been shipped to the warehouse of the selling agent at seaboard or other points, the matter of the second freight to the purchaser is one of special agreement. As a general rule, however, this second freight can be avoided by having the mill ship direct.

Methods of Selling Cotton Yarns and Cloth, Continued.

At first blush it would seem that the commission houses have the best end of this arrangement, and this impression is just about right unless the commission house is a first-class one in every respect, strong financially, active in pushing the sale of the goods entrusted to its care, and with an established reputation for honesty and fair dealing. Above all, no small or moderate sized mill can afford to deal exclusively with any other kind of a commission merchant; it is better to leave to the larger mills the encouragement of new men or unknown houses in this business.

Upon reflection, however, the amount charged is really very moderate considering the service that is supposed to be rendered so far in as handling the account of a small or moderate size mill is concerned. It is not infrequent that one-half the commission is consumed in the storage, labor, extra cartage, insurance, etc., where the market is such that goods must be held for any length of time, not to mention salaries, expense accounts, telephone, telegraph, etc. And just here it is also not amiss to suggest to the average Southern mill treasurer that it is distinctly to his disadvantage to encourage the growth of too many cloth commission houses. It means greater competition, with the attendant cutting of prices. It would be vastly better for the Southern mills if there were less than half a dozen recognized commission houses for each the cloth and the yarn trade,—just enough competition to cause the selling houses to display the proper amount of interest in their clients, on the one hand, but not enough to cause a scramble to unload goods regardless of price, which generally occurs at times when the mills can least afford it. This would result in placing the business on a higher plane, and would bring about conditions that would make it possible not only to get better prices, but to make prices firmer, not to mention finally reducing the selling cost, which would accrue to the benefit both of the mills and of their selling agents. In fact, I incline to the opinion now that groups of mills can combine to advantage and either sell their own products direct, or make a special trade with some good commission house to handle the joint accounts, at a rate materially below that now prevailing.

Methods of Selling Cotton Yarns and Cloth, Concluded.

A commission house financially strong and with ample capital to do its business is in a position to make advancements on the goods, thereby requiring of the mill a less working capital than would otherwise be the case. The amount and extent of these advancements is generally a matter of special agreement.

But where goods are to be piled up, it is much better for the mill to store them in its own warehouse and get its advances from local banks, rather than to pile them up unsold in the hands of the commission merchant, which tends to depress the market, as buyers finding out the amount of accumulated stock bid accordingly.

And finally, the average newly organized Southern mill, especially where the management is new to the business, will find it to its advantage to select its commission house soon after the arrangements have been completed with the mill architects and engineers, and certainly before the final specifications for the machinery are determined upon. While it is true that some of the selling agents are officious meddlers and are an unmitigated nuisance at such a time, such belong to the class that had better be let alone, anyhow; but unquestionably the value of the advice of the well informed and conservative selling agent can not be over estimated as to the range of the goods to be manufactured and the organization therefor.

COTTON IN PROCESS OF MANUFACTURE.

It is manifestly out of the question to tabulate an outline of operations that will fit all cases. This table is intended only as an introduction to the subject, for the particular benefit of those who are not familiar with cotton manufacturing but who contemplate going into the mill business. Comprehensively speaking, the different operations are as follows:

Single Yarns.		Plied Yarns.		Single Yarns, Soft.	
Warps	Skeins.	Warps.	Ball Thread	Carded.	Combed.
Mixing,	Mixing,	Mixing,	Mixing,	Mixing,	Mixing,
Opening,	Opening,	Opening,	Opening.	Opening,	Opening,
Lapping,	Lapping,	Lapping,	Lapping,	Lapping,	Lapping,
Carding,	Carding,	Carding,	Carding,	Carding,	Carding,
Drawing,	Drawing,	Drawing,	Drawing,	Drawing,	Combing,
Slubbing,	Slubbing,	Slubbing,	Slubbing,	Slubbing,	Drawing,
Roving,	Roving,	Roving,	Roving,	Roving,	Slubbing,
Spinning,	Spinning,	Spinning,	Spinning,	Spinning,	Roving,
Spooling,	Reeling,	(Reeling),	(Spooling)	Cone wdg,	Spinning.
Warping,	Baling.	Spooling,	Twisting,	Packing.**	Cone Wind'g.
Baling.*		Twisting,	Ball Wdg.		Packing **
		Spooling,	Pack'g.***		
		Warping,			
		(Cone or Tube Winding),			
		Baling.*			

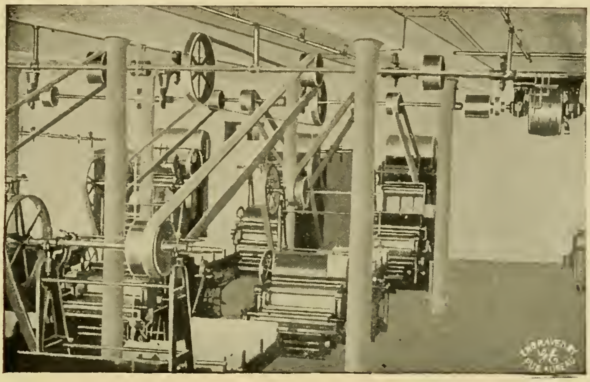
*Except in the case of ball warps.
**In cases.
***In boxes.

Plain "Brown" Sheeting.	Colored Goods.		
	Raw Stock Dyed.	Long or Short Chain Dyed.	Piece Dyed.
Mixing,	Mixing,	Mixing,	Mixing,
Opening,	Opening,	Opening,	Opening,
Lapping,	Dyeing,	Lapping,	Lapping,
Carding,	Lapping,	Carding,	Carding,
Drawing,	Carding,	Drawing,	Drawing,
Slubbing,	Drawing,	Slubbing,	Slubbing,
Roving,	Slubbing,	Roving,	Roving,
Spinning,	Roving,	Spinning,	Spinning,
Spooling,	Spinning,	Spooling,	Spooling,
Warping,	Spooling,	Ball Warping	Warping,
Slashing.	Warping.	Dyeing,	Slashing,
Drawing-in,	Slashing,	Beaming (Quill'g)	Drawing in,
Weaving,	Drawing-in,	Sizing (Slashing),	Weaving,
Finishing,*	Weaving,	Drawing-in,	Dyeing,
Folding,	Finishing,	Weaving,	Finishing,
Baling.	Folding,	Finishing,	Folding,
	Baling.	Folding,	Packing **
		Packing.**	

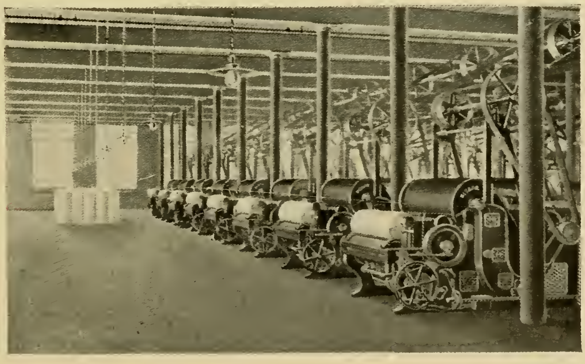
*Brushing, Shearing, Calendering, etc., only when goods are to be shipped to the trade direct, and not to converters or print works.
**In cases.

Cotton Manufacturing, Continued.

The following typical illustrations show the principal operations or processes in the manufacture of cotton.

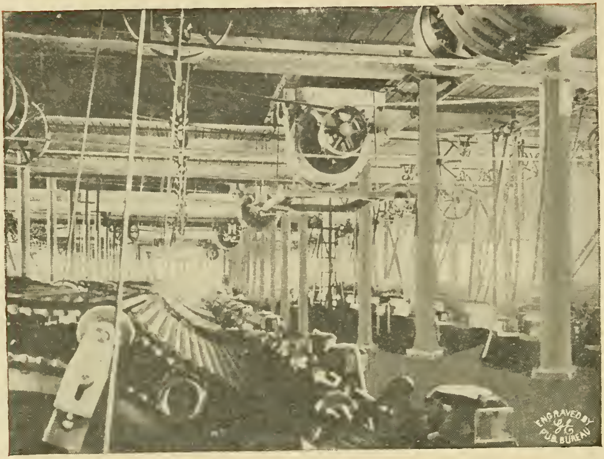


A typical lapper room, showing three sets of lappers installed according to the three-process system, viz., one each single beater breaker, intermediate and finisher lapper.

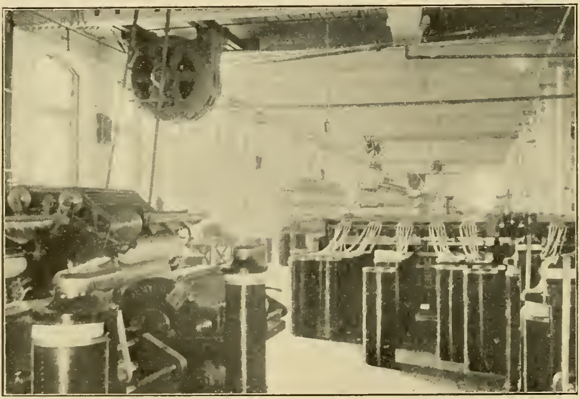


In this lapper room are shown the fronts of the finishers comprising eight sets of machines.

Cotton Manufacturing, Continued.



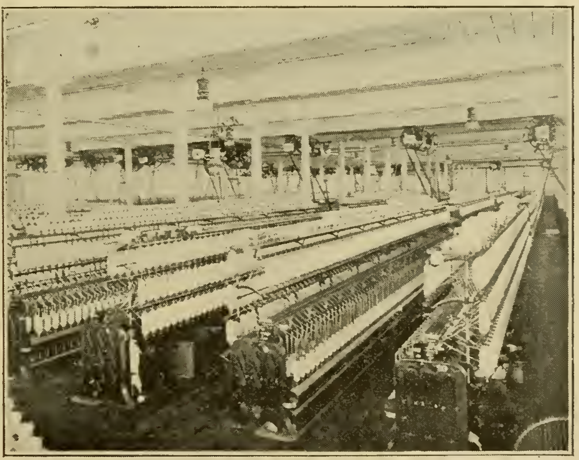
An electric driven card room, but not a good view, as it shows only the coiler and the top flats of one card in the foreground.



Another electric driven card room, showing the front of one card on the left hand side, the rear of a drawing frame on the right hand side, and roving machinery in the background.

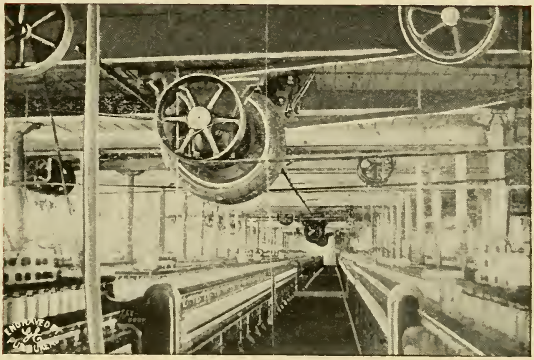
Cotton Manufacturing, Continued.

One corner of an electric driven card room, showing in the foreground the front of a drawing frame, over the top of which is seen the top flats of a row of revolving top flat cards.

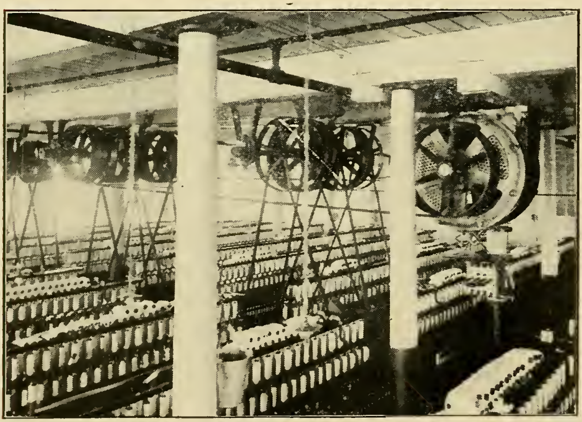


Another view of a typical card room, showing roving frames.

Cotton Manufacturing, Continued.

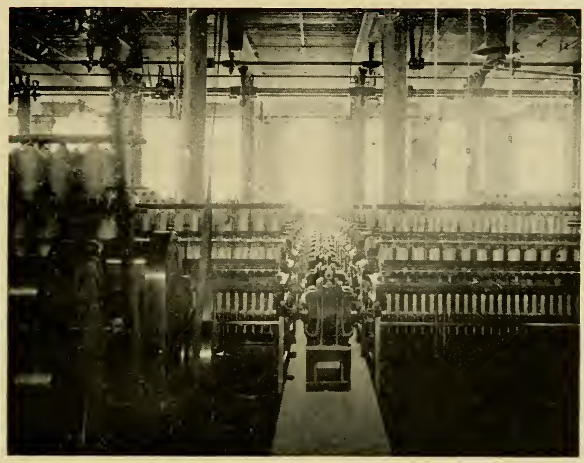


An electric driven spinning room, looking down the middle aisle.

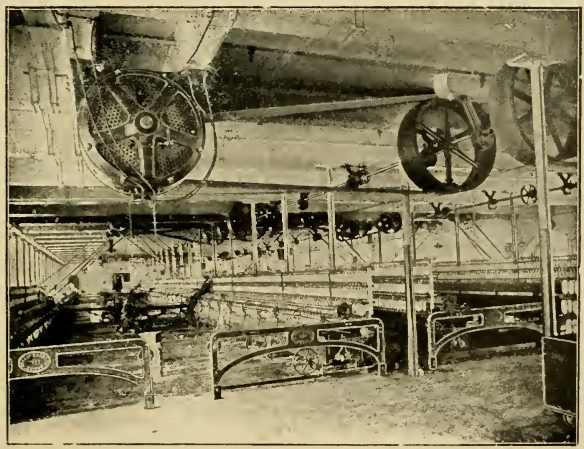


An electric driven spinning room taken from an angle.

Cotton Manufacturing, Continued.

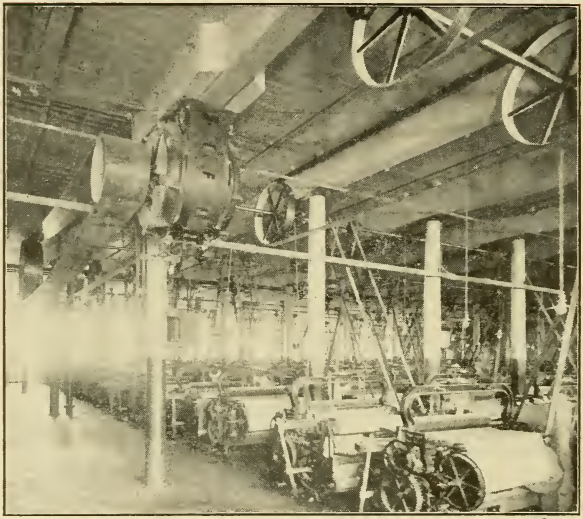


A view across a spinning room, showing spinning frames driven in pairs by direct connected motors.

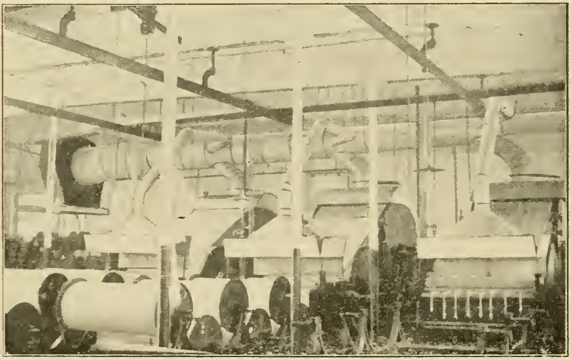


An electric driven mule spinning room.

Cotton Manufacturing, Continued.



An electric driven weave room, taken from one corner.



A slasher room, showing the rear of three slashers, with slasher ventilating fan and piping overhead.

Notes on Operations and Rules for Calculations.

I wish again to emphasize an explanation previously made to the effect that my customers for whom this book has been written are primarily of two classes: First, those who are already engaged in the manufacture of cotton, and for whom, therefore, the strictly technical information has been furnished; second, those who are not familiar with cotton manufacturing, but who are building new mills. And so, endeavoring to serve both classes, I must beg the indulgence of each,—elementary description and technical data often being thrown together apparently more or less indiscriminately.

MIXING AND OPENING.

These two operations can best be considered under one heading, as the present tendency is both to open and mix the cotton in a small opening room cut off from the cotton warehouse, and blow, or more correctly speaking, suck it through pipes to the lapper room.

The cotton is generally received at Southern mills in uncompressed bales, and therefore no bale breakers are required, nor is any great amount of mixing, strictly speaking, necessary, because the cotton purchased by the average Southern mill is fairly uniform in both color and staple.

As fast as they are to be worked, the bales are trucked into the opening room from the warehouse, and the ties cut and the bagging removed. They are generally left to stand for some little time so that they may "rise" and loosen themselves up, which they do to a very considerable extent. The mixing is then accomplished by taking alternately from the different bales and throwing it into the opener, or hopper, as the case may be. The cotton is then drawn through the pipes to the lapper room and deposited on the floor behind the openers in a thoroughly mixed and opened up condition.** At this point the waste from the stock in process of manufacture suitable for use is returned to the lapper room and mixed in the pile.

Production of Blower Systems 1201.

Production of Cotton Elevator Fans 1205.

Arrangements of Condensers, Fans, Etc., 1203.

Bagging and Ties.—Cotton is generally bought on gross weight, and the bagging and ties amount to approximately 22 pounds per bale. While the cotton account is subject to a corresponding tare, there is a considerable credit to be made in the way of "bagging and ties," both of which, if properly taken care of, are salable at a very fair price, particularly the latter.

In this chapter reference will often be made to preceding pages. For the purpose of economizing space, however, after the notice has first appeared on each page, the words "See pages" will be omitted, and only the figures in parenthesis denoting the pages will be given.

**The Kitson Machine Shop has recently brought out a special arrangement whereby the cotton is fed automatically, to the different openers in rotation as they are emptied. This system has the strongest endorsement of the Insurance Companies.

Cotton Manufacturing, Continued.

LAPPING.

The process of lapping (see page 10) may be said to be the preparation of the cotton for the subsequent operations in the process of manufacture; for that reason "lappers," or pickers, as they are frequently termed, are often spoken of as "Preparatory Machinery." This preparation is the rough or preliminary cleaning of the cotton and laying it into thin sheets from 40″ to 45″ wide and 48 yards long, and the rolling up of same into "laps," as they are termed.

The functions of the **Breaker Lapper** (16-19) are as follows:

(1). The cotton is first thrown into the **Automatic Feeder** (11) and uniformly fed by it either direct into the Breaker Lapper or through the medium of an **Opener** (11, 12) and suitable **Cleaning Trunk** (12-15).

(2). The loose cotton is received on a pair of revolving cylindrical screens from which the air is being continually exhausted by a fan; it issues from between the screens in the form of a sheet, and is received by a pair of feed rolls, which in turn deliver it to the beater; this revolving knife blade beater strikes the cotton downward and forward, the rough dirt, sand, etc., passing through grids below; from the beater the cotton is caught on another pair of revolving screens and delivered through another pair of feed rolls to a train of calender rolls, which thoroughly condense the sheet and roll it up around a lap roll; the laps are automatically cut off by a knocking off mechanism, so that each one is 48 yards long.

The functions of an **Intermediate Lapper** (20, 21) are to still further clean the cotton, and by evening and doubling to insure a more uniform lap. This is accomplished as follows:

(1). Four laps (usually) are placed on a traveling apron, which unrolls them at a uniform speed, delivering them altogether to the feed rolls in the shape of a four-ply (as it were) sheet of cotton.

(2). Unlike those in the Breaker Lapper, the feed rolls do not receive the cotton at a uniform speed, but at a variable speed controlled by an evener, which is so designed as to cause the feed rolls to run faster where a thin place appears in the sheet going through, and correspondingly slower when the sheet is heavy and thick.

(3). The subsequent operations of the Intermediate are exactly the same as those for the Breaker Lapper above described.

The functions of the **Finisher Lapper** (20, 21, 23) are exactly the same as those just described for the Intermediate Lapper, and the details of operation are practically the same, except that in Finisher Lappers the substitution of the Kirschner Carding Beater (22) for the regular knife blade beater has the effect of still further improving the quality of the lap.

The cleaning accomplished by the different machines in the lapper room then may be said to be as follows:

(a). Where cleaning trunk is used (see pages 12-15, 44, 45) the preliminary separation of the sand and heaviest foreign particles by gravity.

(b). The removal of the dust with the air that is drawn from the revolving screens, and the blowing of the same down through the **Dust Pipes** (44-45) into the "dust room" or chamber underneath the picker room.

(c). The beating of the trash, sand, etc., from the cotton by the "beaters" through the grids into the compartments underneath the machines.

The **"Three Process" System of Picking** (10) is recommended whenever all the circumstances will permit, the openers being connected with the breakers by suitable cleaning trunk (12-15, 44-45). In the case of long staple cotton, however, it is best to omit the cleaning trunk and to attach the feeder directly to the breaker lapper (18); many manufacturers have a preference for the use of a two-beater breaker (19, 38), in this connection. For small mills a combination breaker and finisher lapper (23, 40) can be used to advantage.

Laps.—These are usually designated in ounces per linear yard; for example, a 12 ounce lap is one weighing twelve ounces to the linear yard. Occasionally, however, the weight of the whole lap in pounds is referred to; for instance, a 40 lb. lap.

As picking machinery is set to make laps of a standard length of 48 yards, a 40 lb. lap is one weighing 13 1-3 ounces per linear yard—$40 \times 16 \div 48 = 13\ 1\text{-}3$.

As there is a loss of weight in lappers due to waste, consisting of sand, dust, and other impurities, the necessary allowances must be made in calculations. Of course, the allowances to be made depend entirely upon the quality and cleanness of the cotton, and no set rule can be given for it. A deduction of 5% on the breaker, and 2% each on the intermediate and finisher, will generally cover it, however.

Laps should not only be of a uniform weight, not exceeding a 2% variation, but also when unrolled and held up to the light should be uniform in appearance, without thick and thin places,—the highest results in this respect being obtained by the use of a good evener and the Kirschner carding beater (21, 22).

Production of Lappers, Calculations, Sizes of Pulleys, Speeds, Etc., (26-31).
Floor Spaces and Data Required for Building, (32-41).
Arrangements of Lappers, (42-45).
Horse Power Required to Drive Lappers, (1162).

Waste Machinery.—Every cotton mill should be provided with waste machines of one kind or another, (24-25). Part of the waste is of course suitable for reworking; there is a ready market, however, for that which is not suitable.

Production of Waste Machinery, Sizes of Pulleys, Speeds Etc. (29).

Floor Space Occupied by Waste Machinery (33, 41).

Horse Power Required to drive Waste Machinery (1162).

Cotton Manufacturing, Continued.

CARDING.

The term **Card Room Machinery** embraces everything between the lappers and the spinning frames; such as cards, combers, railways, drawing, slubbers, intermediates, roving and jack frames. The term "Carding," however, applies only to the functions of the card itself.

The **Revolving Top Flat Card** (see pages 46-66) has now superseded all other types. It removes the remaining dirt, sand, etc., from the cotton; also the "motes" or fragments of seed, hulls, leaf, etc.; also the "neps" or matted and immature fibers; a considerable portion of the "fly" or short fibers; and takes the first steps towards straightening out the fibers and laying them more or less parallel to each other in the form of a sliver which it coils in a can. These functions are performed consecutively as follows: (54).

(1). The "lap" is placed in the lap stand at the back of the card, on the lap roll, which unrolls it and delivers the sheet of cotton to the feed roll.

(2). The motion of the feed roll draws the cotton in between it and the feed plate, over the end of which it is delivered to the licker-in, by which it is struck down and carried past the mote knives between the licker-in and the licker-in screen to the cylinder,—the "motes" and leaf dropping between the knives and the division plate, and the "fly" and sand going through the screen, each into separate compartments below. The cleanness of this separation is peculiar to the Whitin card, and is truly a remarkable performance.

(3). The "carding" action pure and simple now takes place, the cotton being received from the licker-in by the cylinder, over the surface of which it becomes uniformly distributed, with the assistance of the back and front plates, the cylinder itself acting simply as a carrier. The cylinder revolves rapidly (165 revolutions per minute) while the top flats travel in the opposite direction very slowly (making one complete revolution in about 45 minutes), thereby carding or combing the cotton fibers into more or less parallelism; the top flats pick out the "neps" with a small proportion of the "fly," the amount of which is regulated by the setting of the stripping plate; the "neps" and "fly" are removed from the top flats in the form of "strippings" by a stripping comb, and either allowed to fall down on the doffer bonnet or rolled up into a small lap by a scavenger roll, according to preference. As the flats leave the stripping comb they are still further cleaned by a revolving brush. The screen underneath the cylinder not only allows a small proportion of the fly and sand to go through, but also acts as a draught preventer.

(4). Cotton is continually removed from the surface of the cylinder by the doffer, from which it is in turn removed in the shape of a thin film or web by the comb; this thin web of cotton is then carried from the doffer between draught plates to the calender rolls, where it is compressed into a sliver, and thence up and over the calender head through the trumpet and calender roll, which still further condenses it, and is coiled down inside a slowly revolving can.

Card Clothing.—(56-59). By this term is meant the covering that is put on the cylinder, doffer, and top flats. It comes in strips termed "fillets," the foundations of which are of various kinds of material, the preference, however, being for a very strong, tough, and pliable woven fabric of alternate layers of cotton and wool, sometimes rubber faced; into this fabric fine tempered steel wire teeth are inserted, standing from 200 to 600 per inch. The number of teeth varies according to the "counts" (58). All clothing to-day is "plow-ground," by which term it is understood that the teeth are not only ground off so that they stand a uniform distance from the foundation, but also the sides of the rows of teeth are ground off until they are wedged-shaped. The cylinder and doffer are covered by winding fillets of clothing spirally around them, (59) which is stretched to a predetermined tension with a clothing machine, and securely tacked down. The clothing is fastened to the top flats by steel clips (48-58).

Card Grinding.—Clothing on the cylinder and doffer is kept sharp by being occasionally ground (every two or three weeks) with traversing grinders faced with emery fillet; in order to economize time it is usually customary to use two traverse grinders at one time, one on each the cylinder and the doffer (66); the top flats are ground (51-53) by a "long grinder," as it is termed, and can be ground either at the same time, or for that matter at any time while the card is in operation. A set of card grinders consist of—

A Long Grinder,
Two Traverse Grinders,
A Burnishing Brush, and
A Stripping Roll,

and will answer for about twenty cards. The burnishing brush is used for smoothing up the points of the wire after grinding, and when in use the teeth of the burnisher should penetrate the clothing only about half way to the heel or bend of the wire. The stripping roll is used for removing the stock from the cylinder and doffer both before grinding and two or three times a day for cleaning purposes.

Card Setting.—The proper setting of a card is a very important matter, and one entirely too delicate to be accomplished other than by a suitable gauge termed a "card gauge:" a four-leaf card gauge, for instance, has its leaves stamped 5, 7, 10, and 12 (meaning thousandths of an inch) respectively.

Cotton Manufacturing, Continued.

It is impossible to state a proper setting for any and all conditions, but the following may be assumed to be a fair average under ordinary conditions:

Feed Roll to Licker-in, ...10-17 (thousandths)
Licker-in to Cylinder, ...10
Motor Knives to Licker-in:
    On the first knife, ...17
    On the second knife, ...22
Screen to Cylinder:
    Where it extends up between
    cylinder and licker-in, ...17
    The rest of the way around
    the cylinder, ...30-34
Doffer to Cylinder, ...7
Top Flats to Cylinder, ...7
Front and Back Plates, ...17-20
Doffer Comb to Doffer, ...10
Licker-in Screen to Licker-in, ...1/8"

The Whitin card is manufactured on the principle of the well-known "flexible bend," resting on three setting points with two intermediate pushing points, so that it is adjustable at five points on each side; it is therefore possible at all times to maintain the desired settings as well after the clothing has been in use and reground a number of years as in the beginning. As the clothing is ground on the cylinder and top flats, the diameter of the cylinder becomes less, and that of the arc of the top flats becomes greater; the flexible bend, therefore, permits the arc of the top flats to be accommodated to the changing requirements of the cylinder. The impossibility of doing this in the case of a "rigid," or "fixed bend" is obvious.

Card Waste.—With the cleanness of separation effected by the modern Whitin card, the only salable waste may be said to be the "fly" and the "strippings" or "toppings," which amount to approximately 5% of the stock worked, and which is salable at in the neighborhood of 60% of the value of good cotton.

Card and Drawing Slivers are usually given in grains per yard; for example, a 60-grain sliver is one weighing 60 grains per yard.

The weight of a sliver is usually taken by cutting off one yard lengths, accurately measured with a yard stick, and weighing it in a roving scale.

Double Carding.—With modern revolving top flat cards, this term is practically obsolete. Better results are obtained by carding lightly with revolving top flat cards rather than by putting the stock through twice.

Calculations.—As a general statement, it may be said that the draught of any machine is obtained by dividing the product of the diameter of the delivering roll times the teeth of the driving gears by the product of the diameter of the receiving rolls times the teeth of the driven gears. For the convenience of those using Whitin cards, however, on pages 60 and 61 will be found Draught Tables for our revolving top flat cards with both 27″ doffers and 24″ doffers. The draughts given are the theoretical draughts; the actual draughts are somewhat more, on account of the waste.

It is not advisable to go to the extreme limits shown on either side; a good average draught is from 80 to 100.

Figuring back from the lapper, and taking a 13 1-3 ounce lap to the card, the following calculations will give the draught required for any desired weight of sliver, say 60 grains:

$$\frac{13\ 1\text{-}3 \times 437\frac{1}{2}}{60} = 97.25 \text{ theoretical draught.}$$

But, as there is approximately a 5% net loss of weight in the card for waste (such as flyings, strippings, etc.), the actual draught would have to be figured as follows:

$$\frac{13\frac{1}{3} \times 437\frac{1}{2} - 5\%}{60} = \frac{5833-292}{60} = \frac{5541}{60} = 92.35 \text{ Actual draft.}$$

Production.—The diameters of the wire of the Whitin cards are respectively 27¾″ and 24¾″. The theoretical production, with no allowance for stoppages, can therefore be calculated by taking the circumference of whichever diameter of doffer is used and multiplying it by the speed of the doffer in revolutions per minute, which will give the number of lineal inches of stock delivered; this divided by 36 equals the yards per minute, which multiplied by 600 minutes in 10 hours will give the production in yards per day of ten hours; multiply the product so obtained by the weight in grains per yard; divide the above by 7000 (grains per pound) for the total number of pounds per day of 10 hours delivered by the doffer. To allow for the draught between the doffer and the coiler, an additional allowance of 7½% must be made, and 5% more for stoppages, cleaning, stripping, etc.

The tables on pages 62-65 give the production in pounds per day of 10 hours for Whitin Revolving Top Flat Cards with both 27¾″ and 24¾″ doffers.

Sizes of Pulleys, Speeds, Floor Spaces, etc. (56, 57).

Horse Power Required to Drive (1163).

COMBING.

While the actual process of combing is performed by the comber itself, in its broader sense the use of the term "combing" embraces also the operations of the machines

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preparatory thereto, viz., the sliver lap machine and the ribbon lap machine.

Only cottons of 1" and more length of staple are usually combed. They contain a very considerable percentage of short fibers, the functions of the comber being to remove them in the shape of a salable waste. Before being combed the card sliver, as well as the roving and yarn produced from it, is comparatively "woolly"; but after combing the resulting sliver is very smooth and silky in appearance, the yarns posessing the same characteristics as well as having its breaking strength improved.

Comber Sliver, like card and drawing sliver, is given in grains per yard. The weight of the sliver equals the weight of each lap, less waste, multiplied by the number of laps up, divided by the draught.

The weight of the lap from the ribbon lap machine equals the weight of the sliver laps multiplied by the number of laps up, divided by the draught of the ribbon lap machine.

The weight of the laps from the sliver lap machine equals the weight of the card sliver multiplied by the number of doublings, divided by the draught of the sliver lap machine.

Sliver Lap Machine.—(67 70) This machine takes twelve to twenty card or drawing slivers from cans grouped behind it, draws them through guides and stop motion spoons to a draw head where they are doubled and given only a slight draught; the cotton is then condensed by passing through two pairs of heavy calender rolls and wound into a small lap similar to that mad by a lapper, only smaller.

Size of Pulleys, Speed, Floor Space, etc. (67-68).
Draft Table for Sliver Lap Machine, (69).
Production Table, (70).
Horse Power Required to Drive (1163).

Ribbon Lap Machine.—(71-74) The object of this machine is so to prepare the laps for the combing macnine that the web of the sliver will be of a more even and uniform structure than that from the sliver lap machine, thus placing the fibers in a better condition for the action of the combers.

This is accomplished by placing six laps from the sliver lap machine, each 7½" wide, in the creel at the back of the machine; each of the six laps is simultaneously unrolled and the web of cotton is drawn its full width toward the front, and over highly polished brass covered curved plate guides down on the ribbon or sliver plate; all six of the webs are "doubled" on the sliver plate into what might be termed a 6-ply ribbon ,which is drawn through several pairs of press rolls to the lap head, where it is condensed and formed into another lap 8¾" wide, ready for the comber. The ribbon machine doubles 6 and also has draught of 6.00, so that the ribbon laps weigh practically the same per yard as the sliver laps, even though they are 1¼" wider. The drawing process straightens the fibers, and the superposing of the six webs from the sliver laps gives a sheet of cotton of perfectly even cross section, so that the comber nipper is better able to hold all of the fibers and consequently reduces comber waste to a minimum.

Size of Pulleys, Speed, Floor Space, Etc., (71-72).
Draft Table for Ribbon Lap Machine, (73).
Production Table, (74).
Horse Power Required to Drive, (1163).

Combers.—(75-81 and 318d). The large eight-head combers take laps 10½" wide instead of 8¾" wide, and are 16'-0" long instead of 13'-1½" long; otherwise they are identical with the standard six-head machines.

The detailed operation is as follows:

(1). The ribbon laps are placed on the wooden fluted lap rolls at the back of the comber, and simultaneously unrolled. The web or sheet of cotton from each lap as it unrolls passes over the polished lap plate, at the lower end of which it is received and drawn between the feed rolls: as the cotton issues from between the pair of feed rolls, it is "nipped" or gripped by the nipper knife from above against the leather covered cushion plate below, the back ends of the fibers being firmly held there while the different rows of comber needles on the half lap as it revolves underneath progressively and consecutively penetrate or "comb" the front or loose end of the fiber,—the comber needles carrying off the short fibers and leaving the long ones of practically uniform length; at this point the nipper knife lifts and the revolving cylinder shaft brings around the fluted segment to a position to where it is met by the leather covered drawing off rolls, between which the front or free ends of the partially combed fibers are gripped; the front ends of the fibers now being held instead of the rear ends, the top comb drops into position, and as the drawing off roll and fluted segment revolve, the rear part of the fibers are drawn through the top comb, thereby completing the operation pure and simple for those fibers: as the fluted segment leaves the leather covered or upper drawing off roll, the combed fibers are partially drawn between it and the steel drawing off roll, leaving the back ends of the fibers sticking through ready for piecing up to the next lot of combed stock coming through.

(2.) It will be observed that long parallel rows of fibers are combed one after the other, and therefore in order to

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obtain a continuous web, these distinct and separate rows of combed stock must be pieced together.

This "piecing up" occurs just after the needles of the half lap have finished combing, leaving the combed ends of one row of fibers free and sticking out in front; as the nipper knife lets go, and the fluted segment approaches, the leather covered drawing off roll rolls back piecing together the loose combed front ends of one row of fibers and the loose combed back ends of the preceding row that have been left ready for the purpose, as above described. The operation of piecing up, then, is performed by the drawing off or detaching rolls,—the forward movement of the leather covered roll advancing the combed stock through the machine, and the backward movement piecing up.

(3). The web of cotton from each lap is delivered through a trumpet and condensed between calender rolls, which deliver them out to a sliver guide plate, where all six or eight of them, as the case may be, are doubled, and led to the draw box and coiler head at the end of the machine, the resulting sliver being coiled into a can.

(4). The waste from the comber is taken care of as follows:

> (a). A revolving brush underneath the cylinder shaft strips the lint from the needles on the half lap as they revolve; the small amount of waste from the top comb is taken care of by falling down through a chute also on to the brush.
>
> (b). The revolving brush in turn delivers the waste on to a revolving doffer cylinder, from which it is stripped by a striking comb, falling into waste boxes underneath the back of the frame,—the action of the doffer and its comb in this case being exactly similar to that in a revolving top flat card.

To Increase Waste.

By setting top comb closer.
By setting cushion plates closer.
By feeding later.

Speed of Combing Machine.

Speed of comber: 80 to 100 nips per minute. Laps should weigh from 260 to 300 grains per yard for short stock, and from 235 to 260 for long stock.

Calculations.—The comber calculations as to the weight of sliver and draughts, are similar to those given on page 1077 for a card. Combers are usually set to take out about 20% waste. Assuming this figure, therefore, for waste, the calculation for draught on an eight-head comber feeding 280 grain laps, would be, to obtain a 50 grain sliver, as follows:

$$\frac{(280 \times 8) - 20\%}{50} = 35.84, \text{ actual draft.}$$

Size of Pulleys, Speed, Floor Space, Etc. (76-77).
Draft Tables for Combers (79-80).
Production Table (81).
Horse Power Required to Drive (1163).

THE NEW WHITIN COMBER.

The Whitin Machine Works commenced building combers by building the six-head Heilman type of comber, such as built by Hetherington. They very soon followed this with their large eight-head machine. In the course of a few years experience in building combers and studying the state of the art, the Whitin shop discovered that there were possibilities in simplifying the machine to its great advantage, and so they now offer a machine that is equally as remarkable in its simplicity as in its capacity.

The new machine takes 12" laps instead of 8¾" laps as used on their old style six-head machine and instead of 10½" laps as used on the old style eight-head machine. As to production, it suffices to say that the new comber will do 250% more than the old six-head machines.

The parts have been simplified and the motions taken off that have given so much vibration to the old style machines; also the lifting cams are done away with so that high speeds are possible. These new machines are run 135 nips per minute against 90 to 95 nips on the old machines; also the construction has enabled the increase of the rows of needles on the half laps from 17 to 20 rows.

The top comb is fixed so that by stopping its lifting motion, the combs can be set much closer, thereby giving clean combing.

The new machine allows of a large production and still the use of a light lap. The condition of the light lap and the close setting of the top comb enables the needles to work on practically all the fibers and gives very much better results in cleaning the cotton.

The machines are fitted with stop motions which enables an operative to run more machines than formerly, and which also prevents breakage which comes on the old style machine from roller laps and winding up in the draw box. There is also a device in connection with the cylinder comb which permits putting five or six times as much waste into the waste box as before, and prevents the waste running up on to the doffer and getting into the half laps and breaking the needles.

It is estimated that with the stop motions one operative will be able to run eight machines, or 64 deliveries instead of 48 deliveries of the old style; also that the operative will be able

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to get much more production than this difference on account of the greater speed of the new machines.

I would again emphasize the fact that the principle on which this new Whitin comber is based is the correct one, viz., the use of a high speed machine and a light lap. All other machines on the market have gone to the opposite extreme, and endeavor with a heavy lap to increase production, with the result that they have a great deal of trouble breaking needles and are not able to clean the cotton nearly as well as if light laps were used.

The Whitin shop has also made many improvements in the preparatory combing machinery, viz., the sliver and ribbon lap machines. These machines make larger laps, 16" or 17" in diameter, which is a great help in putting in the lap as well as reduces the piecings and also reduces the number of poor or thin places in the sliver.

DRAWING.

Under this heading are included the operations of not only the drawing frames, but also the railway heads.

Railway Heads.—The use of the railway head (see pages 82-87) is practically abandoned, as manufacturers prefer to depend upon evening by doubling rather than on railway heads.

But when used, however, the railway head takes the place of the first drawing as a doubling and drawing machine in addition to its evening action.

Drawing Frames.—(88-97). The functions of the drawing frame are:

(1). To straighten out the fibers of the cotton until they lie practically parallel in the sliver.

(2). To obtain a more uniform weight of sliver by doubling, so that thick and thin places in the original sliver when combined, or doubled, will average themselves into one of uniform size and weight.

Drawing frames are built in "heads" of 4, 5, or 6 deliveries; 1, 2, or more heads to the frame; they are installed in either two or three lines, or "processes," according to personal preference,—the modern tendency, however, being possibly toward only two processes. The operation of drawing is very simple:

(a). A number of cans of card sliver (usually six) are assembled behind each delivery of the frame or frames constituting the first process.

(b). The cotton is drawn from the cans through sliver guides at the back of the frame, and over movable spoons actuating the back stop motion, thence through rolls where it is "drawn" (usually a draft of 6.00, so that the drawing sliver will weigh the same as the original card sliver); thence to a trumpet (which actuates the front stop motion), which delivers to the calender roll, by which it is again condensed into a sliver, and delivered through the coiler head into the can.

(c). The cans from the first drawing are drawn up behind the drawing frames constituting the second process, doubled 6 into 1 with a draught of 6.00, exactly as in the first process; so that the drawing sliver from the second process also usually weighs the same as the card sliver and that of the first drawing. The principal advantage of having the drawing sliver weigh the same lies in the fact that if one or more cans from the second process get mixed up with the first, no confusion in weights of sliver will occur.

Calculation.—As already stated, card and drawing slivers are given in grains per yard, the weight of the drawing sliver equaling the weight of each sliver at the back, multiplied by the number of doublings, divided by the draught of the frame.

Sizes of Pulleys, Speeds, Floor Spaces, Etc., (89-91).
Draught of Coiler Drawing Frames, (91-95).
Production of Coiler Drawing Frames, (96-97).
Horse Power Required to Drive, (1163).

SLUBBING AND ROVING.

These operations are performed by machines designated respectively, slubbers, and intermediate, roving and jack frames. (See pages 98-125).

Heretofore the cotton has received no twist whatever, but all the work expended upon it has been in the direction of—

(1). Cleaning it and freeing it from foreign matter and short and immature staple.

(2). Preparing it for subsequent operations by straightening out the fibers and laying them parallel to each other in the form of a sliver of uniform size and weight.

At this point the sliver is very much reduced in weight by "drawing" and is given its first twisting, after which it is wound on bobbins and is designated "slubbing." This operation is performed by the slubber.

The subsequent treatment the cotton receives on the intermediate, roving and jack frames (during which it is termed "roving") is all similar to the above and tends toward the same result, viz., of still further drawing out or attenuating the roving and giving it more and more twist until it resembles a loose soft yarn on a comparatively small bobbin ready for the spinning frame.

Calculations. —As has already been stated, laps are designated in ounces per yard or pounds per lap, and slivers in

Cotton Manufacturing, Continued.

grains per yard. As slubbing and roving, however, it is rated the same as yarns, viz., by the number of hanks to the pound avoirdupois. For example, there are one and fifty-five one-hundredths hanks of 1.55 hank roving to the pound, and 26 hanks of No. 26 yarn to the pound.

7000 grains=1 pound avoirdupois.
840 yards=1 hank.

$$\frac{7000}{840} = \frac{1000}{120} = \frac{100}{12} = 8\ 1\text{-}3$$

8 1-3 is seen, therefore, to be the ratio between weight in grains and length in yards, from which it is also easy to see that

$$\frac{8\frac{1}{3} \text{ x any length in yards}}{\text{Weight of same length in grains}} = \textbf{Hank of Roving or Number of Yarn.}$$

For example:—

$$\frac{8\frac{1}{3} \text{ x } 6}{32.27 \text{ (weight of 6 yards)}} = \mathbf{1.55.}$$

and—

$$\frac{8\frac{1}{3} \text{ x } 12}{64.54 \text{ (weight of 12 yards)}} = \frac{100}{64.54 \text{ (weight of 12 yards)}} = \mathbf{1.55,}$$

from which it will be noticed that dividing 100 by the weight of 12 yards (see pages 123-125) gives the hank of roving, or "hank roving" as it is termed.

Dividing the weight in grains per yard of the stock received, by the draft, gives the weight of stock delivered by any machine.

The notation "hank roving" is, as already explained, the reverse of "weight per yard," so multiplying the hank roving of the stock received by the draft gives the hank roving of the stock delivered by any machine, where there is no doubling; it is obvious that in the case of doublings the delivered hank roving is to be still further divided by the doublings.

Neglecting the process of combing, which is unusual in the average mill, and figuring back from the card:

With a 60-grain card sliver, and having doubled 6 and drawn 6 in each process of drawing, a 60 grain sliver would be brought to the slubber. With a draft of 4, for example, the slubber would deliver stock weighing 15 grains per yard. Therefore,—

$$\frac{100}{15 \text{ x } 12} = \textbf{.55 Hank Roving of Slubbing.}$$

The above is the usual form of calculation, but it is occasionally made by figuring the hank roving of the card sliver and then multiplying it by the draft, as usual. For instance,—

$$\frac{100}{60 \times 12} = .1390 \text{ Hank Roving of Sliver;}$$

which, multiplied by a draft of 4, also = **.55 Hank Roivng of Slubbing.**

It is to be noted that owing to contraction due to the twist, which varies from 1% to 4%, that the actual hank roving will not be exactly the same as theoretically figured; therefore, the above hank rovings should be multiplied by decimal fractions less than unity to correspond to the amount of contraction stated as a percentage.

And so assuming 2% contraction,—

.55 x .98 (contraction) = **.54 Actual Hank Roving on Slubber.**

$$\frac{.54 \text{ (Slubbing H. R.) } \times 4.5 \text{ (intermediate draft)}}{2 \text{ (doubling on intermediate)}} = 1.21 \text{ Intermediate.}$$

1.21 x .98 (2% contraction) = **1.18 Actual Intermediate Hank Roving.**

And—

$$\frac{1.18 \text{ (intermediate H. R.) } \times 5.5 \text{ (fine frame draft)}}{2 \text{ (doubling on fine frame)}} = 3.24 \text{ fine Roving.}$$

3.24 x .98 (2% contraction) = **3.17 Actual Fine Roving.**

And, in a similar manner to obtain the **actual draught**, divide the theoretical draught by 98%.

Roving is usually measured on a small hand roving reel, specially made for the purpose; the reel is slowly turned 24 complete revolutions, each one of which delivers a half yard, making a total of twelve yards. Tests are usually made from four bobbins at once, and either the average taken or separate calculations made for each—the latter is the better practice. The lengths of 12 yards so obtained are weighed on a small yarn or roving scale.

Slubbing, Intermediate, Roving and Jack Frames.—(See pages 98-125). As with drawing frames, there are said to be two, three or four processes of roving, as the case may be:

For coarse numbers there are generally only two, and the machines are termed slubbers and speeders; for medium numbers there are three processes, and the machines are termed slubbers, intermediates, and roving or fine frames; and for the fine numbers there are generally four processes, the machines being termed slubbers, intermediates, roving and jack frames. "Fly-frame" is a generic term often applied to any of them.

A description of the operation of a roving frame applies sufficiently to all machines of this type. The slubber is the only frame differing from the others, it being the first of the series and receives the stock from cans in the form of a sliver as it comes from the drawing frames, delivering it wound on large bobbins; the other frames receive the cotton on the bobbins from the slubber and from each other in a

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natural sequence, the last one delivering it wound on a comparatively small bobbin, ready for the spinning frames.

There is no doubling on slubbers, there being one can of drawing sliver for each slubber spindle; but on all the other frames there is a doubling, there being two bobbins in the creel to each spindle in the frame.

The process may be briefly stated as follows:

Full bobbins from the preceding frame (such as slubbers, intermediates, or roving frames) are placed in the creel at the back, and the roving passed over guide rods through eyes back of the rolls; the ends from two bobbins are run together and drawn between three lines of bottom and top rolls, each of the two front lines being speeded a little faster than the one just back of it. The guide eye just back of the rolls has a slow traverse motion to prevent the roving being fed between the rolls continually at one point, thereby cutting out the leather of the rolls.

The spindles are placed in two rows to economize space, the gauge of the frame being the distance on centers between the spindles in each the inner and outer rows. The flyer, which is fastened to the top end of the revolving spindle, has a hole in the upper end and down through one leg; from the front rolls the combined stand of roving is led through the hole in the top of the flyer, and thence down and through an eye in the presser foot.

The bobbin on which the roving is wound is driven separately from the spindle and flyer, the winding and building of the roving on the bobbin being accomplished by the variation in speed between the bobbin and the flyer and the traverse of the bobbin up and down. The theoretical amount of twist given to the roving is the ratio between the combined revolving of the flyer and bobbin, and the number of inches of roving delivered by the front roll.

By the term "bobbin lead" is meant where both bobbin and flyer revolve right-handed, or "clockwise," and where the bobbin runs faster than the flyer; so that the bobbin winds the roving on itself right-handed. On the other hand, in "flyer lead" the flyer revolves faster than the bobbin, and the presser foot thereby lays the roving on the bobbin in a left-handed direction; but in each case the speed of the flyer remains constant; the bobbin runs faster or slower as the case may be.

Starting empty, as the roving is wound upon the bobbin and its diameter increases, the number of revolutions it makes must be necessarily decreased in the proper ratio to maintain a constant surface speed; this is accomplished by a pair of cones upon which a belt is gradually shifted as is necessary to accomplish the result.

Neither the mathematical nor mechanical details connected with the many calculations necessary for the proper building of a roving bobbin are possible, or for that matter applicable, within the scope of this brief and comprehensive description.

In practice the twist of any roving frame is obtained by dividing the number of revolutions per minute of the flyer by the inches per minute delivered by the front roll (which is of course obtained by multiplying the speed of the front roll in revolutions per minute by its circumference in inches), multiply the theoretical twist obtained by .99 for 1% contraction, .98 for 2% contraction, etc., etc.

Rules for finding **constants**, with tables of the same, for Woonsocket machines fitted with Daly differentials, will be found on pages 110-11.

Rules for finding **change gears** for the same will be found on pages 111-122.

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (108-109).

Draughts of Slubbers, Intermediates, Roving and Jack Frames (110-122).

Production Tables (112-115).

Horse Power Required to Drive (1164).

RING SPINNING.

(See Pages 126-155).

Yarns.—As with slubbing and roving, yarns are rated by the number of hanks to the pound avoirdupois: for example, there are twenty-six hanks of No. 26 yarns to the pound.

Yarns are frequently made two or more ply. For example, No. 26-2 (as it is technically written) is made up of two number 26 yarns twisted together, and it is either "wet" or "dry."

They are either "ring spun" or "mule spun," and are usually offered for sale as "chain warps" made on a link warper; as "ball warps" made on a ball or leese warper; "skein yarns" made on a reel; as "cone yarns" made on a cone winder; as "ball thread or twine" made on a ball winder; etc., etc.

Calculations:—

840 yards = 1 Hank.

1-7 of 840 yards = 120 yards = 1 Skein.

7,000 grains = 1 lb. Avoirdupois.

1-7 of 7,000 grains = 1,000 grains.

$\frac{7,000}{840}$ or $\frac{1,000}{120} = 8\frac{1}{3}$, which, multiplied by the length in yards, and the product divided by its weight in grains, gives Number of Yarn.

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Example.—

Weight of 12 yards 3.85 grains.

$$\frac{8\frac{1}{3} \times 12}{3.85} = \textbf{26 Number of Yarn.}$$

Dividing 7000 by the weight in grains of one hank of 840 yards gives the number of yarn (see pages 149-150). Example,—

$$\frac{7000}{269.23} = \textbf{26 Number of Yarn.}$$

It is also evident that dividing 1000 by the weight in grains of one skein of 120 yards gives the number of the yarn. Example,—

Weight 1 Skein of 120 yards, 38½ grains:

$$\frac{1000}{38\frac{1}{2}} = \textbf{26 Number of Yarn.}$$

The same rules previously given for calculating the hank roving delivered by a fly frame also apply to the number of yarn delivered by a spinning frame.

Example (single roving)—

3.23 (fine roving) x 7.17 (draft on spinning frame)=23.15 theoretical number of yarn.

23.15 x .95 (5 per cent. contraction)=**22 Actual Number of Yarn.**

Or, (double roving),—

$$\frac{3.23 \text{ (fine rov'g)} \times 10.50 \text{ (draft on spin'g f'me)}}{2 \text{ (for double roving)}} = 17. \text{ th't'cal No. of yarn}$$

17. x .95 (5 per cent. contraction)=**16.15 Actual Number of Yarn.**

On pages 145 to 148 are twist tables showing the proper **amount of twist** for different kinds of yarn. It will be noticed that the tables are based upon the following **multipliers**:

Frame Warp Twist,	4.75
Extra Mule Warp Twist,	4.00
Plain Filling Twist,	3.50
Mule Filling Twist	3.25
Twist for doubling,	2.75
Hosiery Yarn,	2.50

In each case the product of the square root of the number of yarn and the multiplier equals the twist per inch.

The twist of a spinning frame is figured by dividing the number of revolutions per minute of the spindle by the number of inches of stock delivered per minute by the front roll. At the same time, as a matter of interest, theoretically the actual twist is a little less than this and varies within small limits between empty and full bobbin. This variation is due to the fact that the traveler lags behind the bobbin, and that therefore its speed divided by the number of inches of stock delivered gives the actual twist. The actual twist is generally from 2% to 3% less than the theoretical twist. In calculating the numbers of yarn produced on a spinning frame, a 4% to 5% contraction is generally allowed due to twist; the theoretical number of yarn being therefore multiplied by .96 to .95 to obtain the actual number of yarn (as shown in the examples on preceding page).

The Operation of Ring Spinning—Comprehensively stated, spinning consists simply in still further drawing out and attenuating the fine roving, and giving it the final twist.

The fine roving bobbins are creeled on the spinning frame, and the roving, single or double as the case may be, passes through a guide eye back of the rear line of rolls; thence between the three lines of top and bottom rolls where the final drawing takes place. So far the operation is not unlike that of the roving frame, though the mechanical construction of the spinning and roving frame is of course different.

As the yarn is delivered from the front rolls it passes down through a thread guide attached to a thread board, and thence down through the traveler to the bobbin.

The bobbin is firmly attached to the spindle, and revolves with it; the spindle itself being driven by a spindle band made of twisted yarn or roving, which passes around the whorl of the spindle and a tin driving cylinder mounted on the main shaft. As the spindle revolves with the bobbin it pulls the yarn being delivered from the front rolls through the traveler, which therefore causes the traveler to follow around on the spinning ring. The traveler lags behind the speed of bobbin so that the yarn is wound on the bobbin in much the same way as the roving is on a fly frame.

The yarn is wound longitudinally in uniform layers on the bobbin by the traverse up and down of the ring rail which contains the rings to which the travelers are attached. The traverse is regulated to produce either a "warp wind" or a "filling wind"; the former being operated by what is termed a warp builder motion, and the latter by a filling builder motion,—a combination builder being sometimes attached to frames to produce either warp or filling. For the warp wind the yarn is laid in concentric layers tapering at both ends; the filling is more difficult to describe, though it may be said to consist of a series of conical layers starting at the bottom and ending with a conical shaped bobbin at the top,—which construction evidently permits of the yarn being pulled off the end of the bobbin or "quill" as it is termed, in the subsequent process of weaving.

When the bobbins are full, the frame is stopped and

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"doffed," the full bobbins being removed and empty ones put into their places.

Owing to the rapid revolution of the spindles, the yarn "balloons" very considerably over the top of the bobbin; it is prevented from whipping together from adjacent bobbins by flat fingered vertical plates termed separators, which automatically maintain their proper position. (See page 135).

In this article it is unnecessary to deal with the details of the mechanical construction of the frame except in the few following instances:

On page 151 will be found the **sizes of rings and bobbins** recommended for Whitin spinning frames on different yarns. The table on the opposite page gives the sizes of travelers recommended.

On page 130 will be found the **weights of the Whitin Gravity spindles** of different sizes mentioned in the table on page 151.

The following table gives the sizes and **weights of the Draper spindles** corresponding thereto:

Kind of Spindle.	Traverse.	Diam. of Whorl.	Weight, ounces.	Remarks.
D No. 2 Filling Spinn. Spindle,	5″	¾″	4⅛	
D No. 2 Warp Spinning Spindle,	6″	13-16″	4 7-16	
D No. 4 Warp Spinning Spindle,	7″	⅞″	7 1-16	
No. 95 Twister Spindle,	5″	1⅛″	8 15-16	up to 2½″ ring.
No. 96 Twister Spindle,	6″	1⅜″	15¾	2½″ to 3¼″ ring.
No. 102 Twister Spindle,	6″	1⅝″	20	3¼″ to 4″ ring.
No. 97 Twister Spindle,	6″	2½″	34⅝	4″ to 4½″ ring and over.

The production of a spinning frame is of course the speed of the front roll in revolutions per minute multiplied by its circumference in inches, which can be reduced to hanks per day by multiplying by the number of minutes in a day and dividing by the number of inches per hank. The production table shown on pages 152-155, inclusive, makes the proper allowance for cleaning, oiling and doffing.

It is to be borne in mind that the better the cotton the greater the production; the production of a frame spinning Sea Island Cotton, for instance, being very considerably more than that of one running on the same numbers of yarn from ordinary upland cotton.

The calculations in connection with a spinning frame are comparatively simple, and the change gears are for draft, twist, and production.

In judging of the quality of yarn, not only does the general appearance of it count, but also it is required to conform to a standard strength. On pages 158-159 will be found both

Traveller Table for Whitin Ring Spinning Frames with Separators.

Warp Yarn.					Filling Yarn.				
Number of Yarn.	Revolutions of Spindles.	Diameter of Ring.	Number of Traveller.	Weight of 10 Travellers in grains.	Number of Yarn.	Revolutions of Spindles.	Diameter of Ring.	Number of Traveller.	Weight of 10 Travellers in grains.
4	4950	2″	14	39	4	4000	1½″	16	44
6	5900		12	33	6	4800		13	36
8	6700		9	23	8	5450		10	26
10	7250		8	20	10	5950		8	20
11	7500		7	18	11	6150		7	18
12	7750		6	16	12	6350		6	16
13	7950		6	16	13	6500		5	14
14	8100		5	14	14	6700		4	13
15	8300		4	13	15	6850		3	12
16	8450		3	12	16	6950		2	11
17	8600		2	11	17	7100		1	10
18	8750		1	10	18	7200		1–0	9
19	8850		1–0	9	19	7300		3–0	8
20	8900		2–0	8½	20	7400		5–0	7
21	9050		3–0	8	21	7500		5–0	
22	9100		4–0	7½	22	7600		6–0	6½
23	9150		5–0	7	23	7700		6–0	
24	9200		6–0	6½	24	7800		7–0	6
28	9500	1¾″	7–0	6	28	7900	1⅜″	8–0	5½
32	9500		8–0	5½	32	7900		9–0	5
34	9600		9–0	5	34	7900		10–0	4½
36	9700		10–0	4½	36	7900		11–0	4
38	9800		11–0	4	38	7900		12–0	3¾
40	9700	1⅝″	12–0	3¾	40	7900	1¼″	13–0	3½
45	9700	1½″	13–0	3½	45	7900		14–0	3¼
50	9700		14–0	3¼	50	7900		15–0	3
55	9600		14–0		55	7900		15–0	
60	9600		15–0	3	60	7900		16–0	2¾
65	9600		15–0		65	7800		16–0	
70	9500		16–0	2¾	70	7800		17–0	2½
75	9500		16–0		75	7800		17–0	
80	9300		17–0	2½	80	7700		18–0	2¼
85	9100		17–0		85	7600		18–0	
90	9100	1⅜″	18–0	2¼	90	7400		19–0	2
95	9000		19–0	2	95	7400		20–0	1¾
100	8700		20–0	1¾	100	7200		21–0	1½
110	8500		21–0	1½	110	6900		22–0	1¼

Note.—Sizes of Travellers will vary from the above table according to the variations in speed, quality of cotton, etc., but the table may serve as a basis to select from.

The higher the speed the lighter the traveller and vice versa, varying in proportion of one or two grades of travellers to each 1,000 revolutions of spindle. Without separators a few grades heavier traveller would be required.

Draper's and Makepeace's tables of the **"Breaking Weight in Pounds per Skein of English and American Warp Yarns."**

Yarns spun in spinning rooms under the most uniform conditions obtainable as to humidity and temperature will be found not only to have a superior breaking strength, but also

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a smoother and more silken appearance. And so the quality of yarn is largely affected by the moisture and the heat conditions under which it is spun. (See pages 306-375, and 959-961, in Vol. II. and pages 1209-1220 in Vol. III.)

Sizes of Pulleys, Speed, Floor Spaces, Etc. (132-133, 136-137).
Draught and Twist Tables and Diagrams (138-148).
Yarn Production Tables (152-155).
Horse Power Required to Drive (1165).

Preparation of Yarn for the Market, or for Weaving.

As shown in the tabulated schedule of operations on page 1064 for "Cotton in Process of Manufacture," the subsequent treatment of the yarn depends entirely upon the purpose for which it is to be used.

It is therefore impracticable to follow any particular system in discussing these subseqeunt operations, except under two general sub-divisions:

(1). Those preparing it in its various forms for sale and shipment.

(2). Those preparing it for the mill's own use to be manufactured into cloth.

As to the order in which these subsequent processes follow one another for the different classes of work, the tabulated schedule above referred to on page 1064 will show.

*THE MANUFACTURE OF SPOOL COTTON THREAD.

I have been asked a number of times during the past two or three years for information concerning the manufacture of spool thread. I have generally given the advice that new mills had best not attempt it, for it is a class of yarn that must be made in comparative perfection to be marketable. It strikes me that the only people who should attempt the manufacture of this class of cotton goods in the South are either those who have been successfully engaged in its manufacture elsewhere and are therefore thoroughly familiar with it and have all the information and data required in the greatest possible detail; and secondly, those mills who are already engaged in fine yarn manufacture and who are willing to experiment and work up to a marketable product of sewing thread.

I wish again to emphasize the extreme necessity for perfection in making this thread. This will easily be seen to be

*The above information was kindly furnished by Mr. Wm. Whittam.

absolutely necessary when you consider the fact that both for sewing and for needle use, the slightest imperfection in the thread will cause it to cut or break. It must be an absolutely smooth, even, uniform product not only as regards size and freedom from irregularities, but must also be free from soft places.

"The thread trade may be conveniently considered under two distinct heads:

(1.) Domestic Threads,
(2.) Manufacturing Threads.

"The domestic division embraces such goods as are generally sold through the retail stores and consists of six and three cords, put up on 200-yard spools; cheap two and three cords, for basting purposes, on 100 and 200-yard spools; and six chord crochet cottons on spools.

"The manufacturing trade uses thread of almost every conceivable variety, put up on spools, tubes and cones, in various lengths, from 100 to 12,000 yards."

Direction of Twist.

"Two cord are made by the twisting spindle being made to revolve in the opposite direction to the spinning spindle.

"Three cord are also made with the direction of revolution of the spinning spindle reversed in the doubling operation.

"Four cord are made either "straight" or "cable."

"'Straight' threads have four strands of single yarn doubled together at one operation, while 'cable' has two single strands doubled and afterwards two of these strands are twisted together, producing a 4-ply 'cable' thread.

"Six cord is always understood to be 'cabled,' i. e., two cord is first made from the single yarn, three of the two-ply threads being then spun to produce a six-cord.

"The single yarn for 2c, 3c, and 4c, may be 'reverse' or 'regular,' the 'regular' indicating that the spinning spindle revolves to the right, or, in other words, the spindle turns as in spinning warp yarns, while for making 'reverse' twisted threads, the spindle bands are turned, thus giving a left hand twist to the yarn. Two cord and four cord are often ordered either 'reverse' or 'regular.'

"The bulk of the demand for three cord is now for the 'reverse' twist. Six cord is twisted with the single yarn 'regular'; the two cord twist for six cord is in the same direction, the finishing six cord twist in the opposite direction to the two previous operations. Six cord crochet cotton is sometimes twisted similar to six chord sewing thread, but with a slacker twist; very generally, however, for this purpose the various twists are reversed from the single yarn up to the six cord."

"Six cord spool cotton is used to some extent for manufacturing purposes, although the volume of business done in

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this branch of the trade is altogether insignificant as compared with the millions of dozens of 200-yard spools sold through the jobbing houses to retailers. An approximately correct estimate of the total American demand for 200-yards six cord is difficult to arrive at. However, a minimum annual output would probably be in the neighborhood of twenty million dozens.

"200-yard goods are packed in cardboard boxes containing one dozen spools each, a dozen box containing but one number and color of thread. Colors are packed both in dozen boxes containing but one color, and in boxes holding five dozens assorted colors.

"Each manufacturer usually has one or more standard assortments, while to meet the constantly changing fashion in colors, special five dozen boxes are arranged, and sold as Spring and Fall shades. Some of the cheaper brands of 6 cord are sent out in paper packages, this method of packing being slightly less expensive to put up than the usual cardboard box. Cabinets specially arranged for spools are supplied; the most common sizes contain 25, 50, and 100 dozens of assorted numbers in white and black."

Proportion of Colors and Ticket Numbers.

"Sewing threads are put up in so many numbers, qualities, lengths, and colors, that it would be neither advisable nor interesting to enter into a detailed analysis of the relative proportion of each number and color required, for every grade, ply and length. It will suffice and at the same time convey a general idea of the market requirements if the average output of domestic 200 yards six-cord of a large mill be given. The 'two hundred yard trade,' as it is generally termed, comprises quite a large proportion of the total spool cotton production. This length is sold in white (bleach), black, and colors, the order of their importance being indicated below.

"The term 'colors' covers all shades other than black and white. The 7.1% of the total yearly output represented by colors consist mostly of 50's ticket number.

Per Cent. of Different Numbers in Colors.

Tickets Numbers—	
8s to 36s	1.77 per cent.
40s	15.98 per cent.
50s	73.80 per cent.
60s	7.99 per cent.
70s and above,	0.46 per cent.

"From the above it will be noticed that the turnover of all colors outside of 40s and 50s is but 10.22% of the total color percentage. Prior to the combination of the leading manufacturers, many concerns put out color cards carrying several hundred shades. Now, however, the number of colors is made much smaller, few more than one hundred being found in any card of standard colors.

"By far the greatest quantity of six cords are sold in the white; a lesser though considerable quantity is in black; while colors, although put up in a considerable number of shades, form a much smaller proportion of the total product.

"The subjoined table gives the per centum each forms of the total annual sales of an average mill:

Per Cent. of Total Sales, 200-6.

White,	56.2 per cent.
Black,	36.7 per cent.
All Colors,	7.1 per cent.

Yarn and Ticket Numbers, Varieties of Cotton Used, Plies, Etc.

"Whenever the term **'Yarn Number'** is used, it refers to the counts of the single yarns forming the component strands of any twister thread.

"**'Ticket Number'** is the number by which the fineness of the finished article is known to the consumer, or its trade designation. These numbers have become established by long use, and do not stand in any direct ratio to the counts of the single yarns from which they are made; for example, 50-6 ticket number is made from six strands of 100s single yarn, while 8-6 ticket number has for its components six strands of 32s single yarn."

Proportion of Spool Cotton Sales.

Yarn Number.	Ticket Number.	Per Cent. Each Number.
	8	3.17
32	10	1.93
36	12	1 68
40	16	1.78
46	20	3.03
50	24	3.66
60	30	7.86
70	36	7.78
80	40	24.48
100	50	30.56
110	60	10.45
120	70	1.93
130	80	
140	90	
150	100	
	110.3	
	120.3	
	130.3	1.69
	140.3	
	150.3	
	180.3	
	200.3	
		100.00

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Space forbids my printing in this article tables showing the yarn and ticket numbers on yard used, for to do this in anything like a complete manner would occupy many pages. Besides, in this article, it is not intended to furnish the detailed information necessary for anyone to manufacture thread, but only to furnish general information on the subject.

The same may be said with regard to a table of twist per inch for different numbers and kinds of threads.

ORGANIZATION FOR MAKING YARNS.

The term "organization" in a cotton mill is used in a different sense from that of any other manufacturing plant. It is technically used to designate a certain schedule of weights and draughts, with attendant detailed data, according to which the machinery in a mill is set to make a certain number of yarn.

As to how this schedule is arrived at, it is necessary only to say that experience has taught that the best results are generally reached by restricting draughts and weights on different machines to within fairly well defined limits; and also that these limits are still further sub-divided according to the character of the yarn that is to be produced—that is, the use that is to be made of it in the subsequent processes of manufacture such as the various classes of weaving, knitting, etc.

In making out an organization sheet, it is immaterial at which end you start, bearing in mind, of course, always the other end of the proposition. Some mill men start with the raw cotton, and as it were, work it successively through the different processes of manufacture up to the completed yarn; others start with the finished yarn and work back to the lappers.

And just here it is well to point out that in making out an organization sheet, there are certain refinements in calculation which are really necessary, but at the same time there are a number of theoretical mathematical wrangles open to the dilettante in manufacturing that sensible mill superintendents let alone. For, after all, when machinery is set according to the most carefully prepared organization, slight changes will be found necessary to adapt it under actual working conditions to produce yarns of the exact construction desired; and it is for this purpose the manufacturers of machinery furnish three sets of change gears, generally differing by one tooth on either side of that which is figured as required for the work to be done.

In making out organization sheets, the following allowances are usually made for waste, not taking into account that which is returned and worked over, such as card sliver, drawing sliver, roving waste, scavenger roll waste, lap ends, etc. (amounting to 3% to 4%).

Opening, ...	Bagging and ties, an average of 22 lbs. to the bale.			
Breaker Lappers,...	4 per ct. to 8 per ct.,	average 5 per ct.	For Waste.	
Intermed'e Lappers,	1½ per ct. to 2½ per ct.,	average 2 per ct.	For Waste.	
Finisher Lappers,...	1½ per ct. to 2½ per ct.,	average 2 per ct.	For Waste.	
Card, ...	4 per ct. to 6 per ct.,	average 5 per ct.	For Waste.	
Sliver Lap Machine,.	Negligible.		For Waste.	
Ribbon L. Machine,.	Negligible.		For Waste.	
Comber, ...	15 per ct. to 25 per ct.,	average 20 per ct.	For Waste.	
Drawing Frame, ...	Negligible.			
Slubber, ...	1 per ct. to 4 per ct.,	average 2 per ct.	For Contraction.	
Intermediate, ...	1 per ct. to 4 per ct.,	average 2 per ct.	For Contraction.	
Roving Frame, ...	1 per ct. to 4 per ct.,	average 2 per ct.	For Contraction.	
Jack Frame, ...	1 per ct. to 4 per ct.,	average 2 per ct.	For Contraction.	
Spinning Frame, ...	2 per ct. to 6 per ct.,	average 4 per ct.	For Contraction.	

The following table shows the limits within which it is desirable to restrict the draughts of the machines, and the sizes and weights of their products, also the customary doublings:

Machine.	Limits of Drafts.	Limits for Weights and Sizes
Lappers,	2 – 6	8 – 18 ounces per yard.
Cards,	70 – 125	40 – 76 grains " "
Sliver Lap Machines,	1.5 – 3	200 – 330 " " "
Ribbon Lap Machines,	4 – 6	200 – 330 " " "
Combers,	20 – 30	40 – 70 " " "
Drawing Frames,	4 – 8	40 – 76 " " "
Slubbers,—		
12″x6″	3.50 – 5.50	.20 – 1.00 Hank Roving.
11″x5½″	3.50 – 5.50	.30 – 1.10 " "
10″x5″	4.00 – 6.00	.40 – 1.20 " "
9″x4½″	4.00 – 6.00	.50 – 1.30 " "
Intermediates,—		
10″x5″	4.50 – 6.00	.80 – 1.60 " "
9″x4½″	4.50 – 6.00	.90 – 1.70 " "
8″x4″	4.50 – 6.00	1.00 – 3.00 " "
Roving Frames,—		
8″x3½″	4.50 – 6.50	1.00 – 6.00 " "
7″x3½″	4.50 – 7.00	2.00 – 6.50 " "
7″x3″	4.50 – 7.00	4.00 – 8.00 " "
Jack Frames,—		
6″x3″	4.50 – 7.50	3.00 – 11.00 " "
6″x2½″	4.50 – 7.50	8.00 – 16.00 " "
5″x2½″	4.50 – 7.50	10.00 – 26.00 " "
4½″x2¼″	4.50 – 7.50	16.00 – 32.00 " "
Spinning Frames,	7.00 – 14.00	4.00 – 120.00 W. 200.00 Fil.

Remarks.—Occasionally 20 oz. laps are made, but they are not desirable.

Card slivers up to 90 grains are also sometimes used, but for ordinary work, lighter weights are preferred.

Three processes of picking are recommended in all cases except where it is desired for special classes of coarse work to clean the cotton as little as possible. The best practice is in favor of three pro-

Cotton Manufacturing, Continued.

cesses of drawing, though many of the best manufacturers use only two processes, even in comparatively fine work, and even one process is used in very coarse work where it is desired to simply get the cotton into shape for the slubber without much regard for doublings or evenness.

Yarns below No. 4s can best be spun on a roving or on a jack frame.

For ordinary work with single roving, two processes of roving only are used up to No. 14s yarns, and above that three processes are used up to No. 40s, and then four processes can be used to advantage.

For hosiery yarn, double roving and three processes of roving are recommended for all numbers up to 36s, and four processes of roving above that.

Filling yarns and hosiery yarns are spun with less draught and less twist than warp yarns.

The exact relationship that should exist between draughts and weights in an organization to make any number of yarn is largely a matter of personal opinion, based upon the previous experience of the spinner. Little can therefore be said along this line that will be of help further than the suggestions given above.

SPOOLING.

The process of spooling (see pages 160-164), is simply one of rewinding the yarn on spools from the bobbins, thereby putting it in better shape for subsequent processes, both by virtue of the evenness of the tension with which it is wound on the spools, and also because of the relatively large amount of yarn held on each spool. (214).

The operation is as follows: The bobbins are held either in inclined bobbin holders which allow them to revolve freely, or fitted on side spindles, as the case may be. The yarn from the bobbin passes through a thread guide on a traverse rod which moves up and down and guides the yarn evenly on the spool.

The spool fits loosely on the spindle and revolves simply by the friction of its weight on the the spindle flange upon which it rests. The spindles are driven by bands from a tin cylinder, as in the case of spinning frames.

The evenness of the tension in spooling is due to the friction of the spool on the spindle flange; on the other hand, this very point becomes a source of weakness and trouble if the speed of the machine is greater than has been found to work best by practical experience. (164).

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (**161-163**).

Production Table for Spoolers (**164**).

Horse Power Required to Drive (**1166**).

TWISTING.

As already stated, yarns may be either "single" or "plied"; 26-2, for instance, consisting of two number 26 single yarns twisted together. Yarns may be either "wet" or "dry" twisted.

In many respects, the operation of a ring twister (see pages 165-181), is similar to that of a ring spinning frame, the chief difference being that there is no draught to the twister.

The spools of yarn are placed on inclined creels, and a number of single yarns corresponding to the ply desired are drawn together through the guide eye and around a pair of rolls; there is usually a single line of bottom rolls, though occassionally a double line of bottom rolls and a single line of top rolls which rest equally on both bottom rolls. From the rolls the single yarns to be plied are now led through a thread guide and traveller to the bobbin.

A lug on the spindle fitted into a corresponding slot on the bobbin positively drives it instead of by friction as in spinning frames; the spindle is driven in the usual manner from a tin cylinder by spindle bands, but drives it in exactly the opposition direction from what spinning is driven. The bottom roll is driven from the shaft by gearing in the head end of the frame, the speed of it being determined by the twist gear. The calculations for finding the twist are similar to those for ring spinning (177-181).

In the case of wet twisted yarns, the construction of the twister frame is slightly altered by the addition of a small trough of water extending longitudinally just beneath the creel and back of the rolls; the yarns are led through the water underneath a glass rod to the rolls, the passage between which squeezes out the surplus water. The rolls on wet twisters are brass covered, as also are the guide eyes, thread guides, travelers, and ring holders, to prevent rusting. On wet twisters, vertical rings are used instead of flanged rings as used in dry twisting and on spinning frames.

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (165 167).
Twist Change Gear Tables (168-171).
Production Tables (172-176).
Horse Power Required to Drive (1166).

REELING.

The process of reeling (184-190), is simply one of rewinding the yarn from either spinning or twister bobbin into skeins.

The operation is an exceedingly simple one,—the bobbins are placed on either live or dead spindles at the back of the reel, in a position slightly inclined from the vertical; the yarns are then led up through a thread guide at the top of the frame, and thence down through thread guides on a traversing bar which spreads the yarn on to revolving "swifts" upon which the skeins are wound. The arms of the swifts are usually adjustable from 54 to 72 inches and from 72 to 90 inches; the standard size skein is 54 inches; or one and a half yards in circumference. Skeins are often speci-

Cotton Manufacturing, Continued.

fied to be of certain weights, but generally they contain simply the amount of yarn contained on one bobbin.

Reels are equipped, if desired, with stop-motions to knock off after a certain amount of yarn is reeled. (See pages 185-188).

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (184-187).
Production Tables (189-190).
Horse Power Required to Drive (1166).

WARPING.

When yarn is to be shipped as "chain warps," it is generally made on Denn warper and linked.

This process is applicable to either single or plied yarns; in either case the yarn to be warped is spooled and the spools creeled in the warper creel. From each spool the end is passed through a drop wire to its eye in the eye-board; in the event of an end breaking back, the drop wire falls and makes an electric contact, stopping the machine—an "indicator" pointing out where the break occurs that it may be pieced up.

Without going into further details of the operation, the ends are finally all led together and passed through calender rolls and a trumpet to the linker by which the mass of yarn is linked together and delivered in the form of a chain on the floor or into a bag, as may be desired. By this method the warp may be handled without tangling. The specification for a chain warp gives the number of ends, the length and leeses, —which in turn are sub-divided into thread leeses, pin leeses, and bouts. The thread leese is sometimes termed the "weaver's leese," each thread being separated in the same way it is by the leese rods in a loom. The pin leese is often known as the "beamer's leese," as the beamer uses it in straightening out the warp at the beam warper. It is particularly convenient in sorting out colors and making patterns; they are inserted at intervals, as the purchaser may specify. The "bouts" are several pin leeses gathered together and tied.

BALING.

As either skeins or chain warps, yarns are generally shipped in bales made on a yarn baling or bundling press. (311 and 316-317). The process is evidently so simple as to require no explanation further than to state that the yarns are not only baled wtih burlap and tied up with rope or iron bands, as the case may be, but also are first covered with paper.

CONE AND PARALLEL TUBE WINDING.

Hosiery yarns are generally made into cones, and are wrapped up in soft paper and shipped in wooden cases.

Plied yarns for carpet warps and other purposes are often wound on parallel tubes . Both the parallel tubes and the cones can be wound on the same machine by the addition of a suitable attachment.

Both the parallel tubes and cones are wound on paper tubes.

The cones are wound on a cone winder of either of the two types described on pages 191-203. The descriptions accompanying the cuts make clear their operation. Cone winders generally wind from bobbins, though occasionally they are wound from skeins.

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (194, 197-199, 202).

Production Tables (196, 203).

Horse Power Required to Drive (1166).

QUILLING.

The description of the operation of the Whitin long chain quiller on pages 206-209, inclusive, makes clear both the purposes of quilling and the operation of the machine.

Horse Power Required to Drive (1166).

WARPING.

The slasher warpers described on pages 210-212 put the warp yarn on to very large spools, or "section beams," as they are termed, ready for sizing preparatory to weaving. The yarn comes to the warper on spools, which are placed in the V-shaped creels at the back. These creels are generally from 400 to 600 spools. The ends are led from the spools through the back comb and over and under a series of rolls; thence through a drop wire and a dent in the expanding front comb to the beam; this beam may be simply described as a very large spool, the different threads being wound round the barrel of it in the form of a sheet; the barrel of the beam rests upon the cylinder, and is turned by friction.

The stop motions are either mechanical or electrical, and in either case are arranged to stop the machines in the event of a broken thread. A stop motion connected with the measuring clock gives any desired length of warp.

The operation of a leese or ball warper (212-214) is similar to that of a beam or slasher warper, except that the sheet of yarn instead of being wound on a beam is led to a pedestal and thence through a trumpet to be wound in a cylindrical shaped "ball," as it is termed, the shape of the ball and direction of layers of yarn being shown in the cut accompanying the description of the warpers above referred to.

Cotton Manufacturing, Continued.

This is the form in which yarns are usually taken to the dye house for either long on short chain dyeing.

On page 214 will be found convenient spool and beam data for warpers.

Rule for finding the number of pounds of yarn on a beam: Multiply the sum of the diameters of the barrel and beam heads by the difference of their diameters, then multiply by .7854, and then multiply by the length between the heads, giving the cubic inches of yarn on the beam when full. For instance, with a beam 9" barrel and 24" head, and 54¼" between heads:

$9+24 \times 15 \times .7854 \times 54\frac{1}{4} = 21090.935+$ cubic inches yarn in full beam.

$21090.935 \div 60 = 351+$ (pounds).

To get the length of yarn on beam, multiply number of yarn by 840, which gives the number of yards in one pound, then multiply by number of pounds of yarn in beam. Divide the product by number of ends run in warper to find the length of warp.

Sizes of Pulleys, Speed, Floor Spaces, Etc. (214, 216-217).

Production Table (215).

Horse Power Required to Drive (1166).

BEAMING.

When the yarn comes from the dye house neither long or short chains, it is put on beams by a beamer, as shown on pages 218 and 219. The operation is simple, and the cuts accompanying the description above referred to are self-explanatory.

SLASHING.

In connection with the description of slashers on pages 220-229, the operation consists,—from the slasher warper the section beams are taken to the slasher and put in the creel frames. The sheets of threads from each beam in rear are wound and joined with those of the beam next in front of it, the consolidated sheet of warp being led through the starch in the size box, and thence around the drying cylinders to the front comb; before reaching the front combs the ends have been divided by leese rods passed through the sheet of yarn.

From the front comb the yarn passes to the loom beam upon which it is wound.

The only other detail of the operation of a slasher that seems advisable to mention in this connection is that there is a cut marker which automatically marks the desired length of cut on the warp; it also rings a bell so that the slasher tender can arrange that when he doffs his loom beam it will be at the end of a cut.

Sizes of Pulleys, Speeds, Floor Spaces, Etc. (224-227).
Capacity (224).
Horse Power Required to Drive (1166).

DRAWING-IN.

The drawing-in frame shown on page 230 is one of the number of types used for this purpose. The loom beam is put on the drawing-in frame, and the sheet of warp drawn over the top rod; an operative with a drawing-in hook reaches through each eye of the harness suspended near the top of the frame and pulls an end through. Extra ends have been allowed and drawn in double on each side of the warp so as to make a selvage on each side of the cloth after it is woven.

WEAVING.

The preparation of the yarn by dyeing either in the long or short chain system for weaving of colored goods has already been described on pages 1100-1.

A description of the operation of a loom is appended to this article, as it is necessary first to take up the calculations required in the preparation of the yarn for weaving. In order to simplify the proposition, they are made upon the basis of plain "brown" goods.

Calculations.

By courtesy of the Draper Company, I am enabled to quote from their "Textile Texts" the accompanying tables, which were prepared by Mr. Elias Richards.

DRAPER'S CLOTH CONSTRUCTION TABLES.

To enable any person having four of the elements of a piece of cloth given, to find the fifth, or to construct a piece of cloth of any required reed, pick and weight.

How to use these tables:—These tables are calculated for cloth 36″ wide, and other widths must be converted to 36″ by making proportion.

For example: If 40″ cloth weighs 4 yards to one pound, what will 36″ cloth weigh?

$$\frac{40'' \times 4 \text{ yds.}}{36''} = 4.44 + \text{yds. to one pound.}$$

Cotton Manufacturing, Continued.

The "decimal equivalent" is the equivalent weight of one yard of cloth expressed in decimals of a pound. For example: If a cloth weighs 4 yards to the pound one yard will weigh

$$\frac{1 \text{ lb.}}{4 \text{ yds.}} = .25 \text{ of a lb.} = \text{"decimal equivalent."}$$

In these tables the "Decimal equivalent" is divided by two, as warp and filling form each one half of the cloth when the cloth has the same number of ends to the inch in the warp and filling, and where the same numbers of yarn are used in the warp and filling. For example: In cloth 36 wide, 48 reed, 48 picks, 20s warp and 20 filling, the weight of warp and filling used is equal. In a cloth where any of these elements differ the weight of warp and filling are in proportion to each other as the number of threads to the inch and the numbers of yarn in the warp and filling.

In all calculations in which these tables are used, the weight of one yard of cloth 36″ wide in pounds (decimal equivalent) must always be used.

The elements of a piece of cloth are in number five, viz.:—

1. Reed or warp threads to the inch.
2. Pick or filling threads to the inch.
3. Warp yarns.
4. Filling yarn.
5. Weight of the cloth expressed in yards to the pound, ounces to the yard or decimal parts of a pound to the yard, which we have called the "decimal equivalent."

If we have any four of these elements given we can find the fifth.

First.

Having given the reed, pick, warp and filling to find the weight.

Find the weight of the warp yarn in the given reed as per table.

Find the weight of the filling yarn in the given pick as per table.

Add these together. The sum is the weight of one yard of cloth expressed in decimals of a pound or its "decimal equivalent." If it is required to convert this weight into yards to the pound consult the table on page 1124. If the weight of one yard is required in ounces, multiply the sum by

16 (the number of ounces in one pound.)

Example—Reed 48, pick 52, warp 18.50s, filling 20s.
Page 1114. Op. 18.50 yarn under 48 reed, is .1250 dec. eq.
Page 1115. Op. 20.03 yarn under 52 reed, is .1250 dec. eq.

These numbers added equal wt. of 1 yard .2500 of a lb.

Page 1124 opposite .2500 we find 4 yards to the lb., which is the weight of the cloth, or $\frac{1 \text{ lb.}}{.2500} = 4$ yards to the pound or one yard weighs 4 ounces.

Second.

Having given the reed, pick, warp and weight, to find the filling number—

Find the weight in decimals of a pound, of one yard of cloth (table page 1124), subtract from this the weight of the warp yarn in the given reed. Opposite the subtrahend, under the given pick, is the number of yarn required for the filling.

Example—Reed 48, pick 52, warp 18.50, weight 4 yards to the pound.

Page 1124 opposite 4 yards is	.2500
Page 1114 opposite 18.50 warp under 48 reed is	.1250
	.1250

On page 1115 opposite .1250, under 52 reed is 20s yarn, filling number required.

Third.

Having given the reed, pick, filling number and weight, to find the warp number required.

Find the weight in decimals of a pound of one yard of cloth, subtract from this the weight of the filling yarn on the given pick. Opposite the subtrahend under the given reed, is the warp number required.

Example—Reed 48, pick 52, filling 20, weight 4 yds.

Page 1124 opposite 4 yard is	.2500
Page 1115 opposite 20 yarn under 52 reed is	.1250
	.1250

Page 1114 opposite .1250 under 48 reed is 18.50. Warp number required.

Fourth.

Having given the reed, filling, warp and weight, to find the pick.

Find the weight in decimals of a pound of one yard of cloth, from this subtract the weight of the warp yarn in the given reed. Opposite the subtrahend find the filling number. At the head of this column is the required number of picks per inch.

Example—Reed 48, filling 20, warp 18.50 weight 4 yards to the lb.

Page 1124 opposite 4 yards is	.2500
Page 1114 opposite 18.50 warp under 48 reed is	.1250
	.1250

Cotton Manufacturing, Continued.

Page 1115. Find opposite .1250 number 20 filling and at the head of the column is 52 reed, the required pick.

Fifth.

Having given the pick, filling, warp and weight to find the reed.

Find the weight in decimals of a pound of one yard of cloth, from this subtract the weight of the filling in the given pick. Opposite the subtrahend find the warp number. At the head of this column is the required reed.

Example—Pick 52, filling 18.50, warp 20s, weight 4 yards to the pound.

Page 1124 opposite 4 yards is	.2500
Page 1115 opposite 20 yarn under 52 reed is	.1250
	.1250

Page 1114. Opposite .1250, find 18.50 warp number and at the head of the column is 48, the required reed.

Sixth.

To find the average yarns in a piece of cloth of which the reed, pick and weight are given.

Add together the reed and picks, divide by two, to find the average number of threads to the inch. Opposite the weight of the cloth in yards to the pound under the average number of threads to the inch is the required yarn number.

Example—Cloth 60 reed, 56 picks, 5 yards to the pound.
$60+56=116\div2=58$ average reed.

Page 1117. Opposite 5 yards to the pound under 58 reed, is 27.92, the required yarn numbers.

Note.—Rules 2 and 3 are alike, substituting warp for filling and vice versa.

Rules 4 and 5 are alike, substituting reed for pick and vice versa.

Many other problems will suggest themselves which can be solved easily by these tables.

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables.

	Reed.	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
Yards per lb.	½ Decimal Equivalent	Numbers.														
1.00	.5000		3.08	3.27	3.46	3.65	3.85	4.04	4.23	4.42	4.62	4.81	5.00	5.20	5.39	5.58
.05	.4762		.23	.43	.64	.84	4.04	.24	.44	.65	.85	5.05	.25	.46	.66	.86
.10	.4545		.38	.60	.81	4.02	.23	.44	.66	.87	5.08	.29	.50	.72	.93	6.14
.15	.4348		.54	.76	.98	.20	.42	.65	.87	5.09	.31	.53	.75	.98	6.20	.42
.20	.4167		.69	.92	4.16	.39	.62	.85	5.08	.31	54	.77	6.00	6.24	.47	.70
.25	.4000		.85	4.09	.33	.57	.81	5.05	.29	.53	77	6.01	.25	.50	.74	.98
.30	.3846		4.00	.25	.50	.75	5.00	.25	.50	.75	6.00	.25	.50	.76	7.01	7.26
.35	.3704		.16	.42	.68	.94	.20	.46	.71	.98	.24	.50	.75	7.02	.28	.54
.40	.3571		.31	.58	.85	5.12	.39	.66	.93	6.20	.47	.74	7.00	.28	.54	.81
.45	.3448		.46	.74	5.02	.30	.58	.86	6.14	.42	.70	.98	.25	.54	.81	8.09
.50	.3333		.62	.91	.20	.48	.77	6.06	.35	.64	.93	7.22	.50	.80	8.08	.37
.55	.3226		.77	5.07	.37	.67	.97	.26	.56	.86	7.16	.46	.75	8.06	.35	.65
.60	.3125		.93	.23	.54	.85	6.16	.47	.77	7.08	.39	.70	8.00	.32	.62	.93
.65	.3030		5.08	.40	.72	6.03	.35	.67	.99	.30	.62	.94	.25	.58	.89	9.21
.70	.2941		.23	.56	.89	.22	.54	.87	7.20	.53	.85	8.18	.50	.84	9.16	.49
.75	.2857		.39	.72	6.06	.40	.74	7.07	.41	.75	8.08	.42	.75	9.10	.43	.77
.80	.2778		.54	.89	.24	.58	.93	.28	.62	.97	.32	.66	9.00	.36	.70	10.05
.85	.2703		.70	6.05	.41	.76	7.12	7.48	.83	8.19	.55	.90	.25	.62	.97	.33
.90	.2632		.85	.22	.58	.95	.31	.68	8.04	.41	.78	9.14	.50	.88	10.24	.61
.95	.2564		6.00	.38	.76	7.13	.51	.88	.26	.63	9.01	.38	.75	10.14	.51	.88

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
Yards per lb.	½ Decimal Equivalent.	Numbers.															
1.00	.5000	5.77	5.97	6.16	6.35	6.54	6.74	6.93	7.12	7.31	7.51	7.70	7.89	8.03	8.28	8.47	8.66
.05	.4762	6.06	6.26	.47	.67	.87	7.07	7.28	.48	.68	.88	8.08	8.29	.49	.69	.89	9.10
.10	.4545	.35	.56	.77	.99	7.20	.41	.62	.83	8.05	8.26	.47	.68	.89	9.10	9.32	.53
.15	.4348	.64	.86	7.08	7.30	.53	.75	.97	8.19	.41	.63	.85	9.08	9.30	.52	.74	.96
.20	.4167	.93	7.16	.39	.62	.85	8.08	8.32	.55	.78	9.01	9.24	.47	.70	.93	10.16	10 40
.25	.4000	7.22	.46	.70	.94	8.18	.42	.66	.90	9.14	.38	.63	.87	10.11	10.35	.59	.83
.30	.3846	.51	.76	8.01	8.26	.51	.76	9.01	9.26	.51	.76	10.01	10.26	.51	.76	11.01	11.26
.35	.3704	.80	8.06	.32	.58	.84	9.10	.36	.62	.88	10.14	.40	.66	.92	11.18	.44	.70
.40	.3571	8.08	.35	.62	.89	9.16	.43	.70	.97	10.24	.51	.78	11.05	11.32	.59	.86	12.13
.45	.3448	.37	.65	.93	9.21	.49	.77	10.05	10.33	.61	.89	11.17	.45	.72	12.00	12.28	.56
.50	.3333	.66	.95	9.24	.53	.82	10.11	.40	.68	.97	11.26	.55	.84	12.13	.42	.71	13.00
.55	.3226	.95	9.25	.55	.85	10.14	.44	.74	11.04	11.34	.64	.94	12.23	.53	.83	13.13	.43
.60	.3125	9.24	.55	.86	10.16	.47	.78	11.09	.40	.71	12.01	12.32	.63	.94	13.25	.55	.86
.65	.3030	.53	.85	10.16	.48	.80	11.12	.44	.75	12.07	.39	.71	13.02	13.34	.66	.98	14.30
.70	.2941	.82	10.15	.47	.80	11.13	.45	.78	12.11	.44	.76	13.09	.42	.75	14.07	14.40	.73
.75	.2857	10.11	.44	.78	11.12	.45	79	12.13	.47	.80	13.14	.48	.81	14.15	.49	.83	15.16
.80	.2778	.40	74	11.09	.44	.78	12.13	.48	.82	13.17	.52	.86	14.21	.56	.90	15.25	.60
.85	.2703	.68	11.04	.40	.76	12.11	.47	.82	13.18	.53	.89	14.25	.60	.96	15.32	.67	16 03
.90	.2632	.97	.34	.71	12.07	.44	80	13.17	.53	.90	14.27	.63	15.00	15.36	.73	16.10	.46
.95	.2564	11.26	.64	12.01	.39	.76	13.14	.52	.89	14.27	.64	15.02	.39	.77	16.14	.52	.90

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
Yards per lb.	½ Decimal Equivalent.	Numbers.														
2.00	.2500	3.85	4.23	4.62	5.00	5.39	5.77	6.16	6.54	6.93	7.31	7.70	8.08	8.47	8.85	9.24
.05	.2439	.94	.34	.73	.13	.52	.92	.31	.71	7.10	.50	.89	.29	.68	9.08	.47
.10	.2381	4.04	.44	.85	.25	.66	6.06	.47	.87	.28	.68	8.08	.49	.89	.30	.70
.15	.2326	.14	.55	.96	.38	.79	.21	.62	7.03	.45	.86	.28	.69	9.10	.52	.93
.20	.2273	.23	.66	5.08	.50	.93	.35	.77	.20	.62	8.05	.47	.89	.32	.74	10.16
.25	.2222	.33	.76	.20	.63	6.06	.50	.93	.36	.80	.23	8.66	9.10	.53	.96	.39
.30	.2174	.42	.87	.31	.75	.20	.64	7.08	.53	.97	.41	.85	.30	.74	10.18	.63
.35	.2128	.52	.97	.43	.88	.33	.78	.24	.69	8.14	.59	9.05	.50	.95	.41	.86
.40	.2083	.62	5.08	.54	6.00	.47	.93	.39	.85	.32	.78	.24	.70	10.16	.63	11.09
.45	.2041	.71	.19	.66	.13	.60	7.07	.54	8.02	.49	.96	.43	.90	.37	.85	.32
.50	.2000	.81	.29	.77	.25	.74	.22	.70	.18	.66	9.14	.63	10.11	.59	11.07	.55
.55	.1961	.91	.40	.89	.38	.87	.36	.85	.34	.84	.33	.82	.31	.80	.29	.78
.60	.1923	5.00	.50	6.00	.50	7.01	.51	8.01	.51	9.01	.51	10.01	.51	11.01	.51	12.01
.65	.1887	.10	.61	.12	.63	.14	.65	.16	.67	.18	.69	.20	.71	.22	.73	.24
.70	.1852	.20	.72	.24	.75	.28	.80	.32	.84	.36	.88	.40	.92	.43	.96	.47
.75	.1818	.29	.82	.35	.87	.41	.94	.47	9.00	.53	10.06	10.59	11.12	.65	12.18	.71
.80	.1786	.39	.93	.47	7.00	.54	8.08	.62	.16	.70	.24	.78	.32	.86	.40	.94
.85	.1754	.48	6.03	.58	.12	.68	.23	.78	.33	.88	.42	.97	.52	12.07	.62	13.17
.90	.1724	.58	.14	.70	.25	.81	.37	.93	.49	10.05	.61	11.17	.72	.28	.84	.40
.95	1695	.68	.24	.81	.37	.95	.52	9.09	.65	.22	.79	.36	.93	.49	13.06	.63

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
Yards per lb.	½ Decimal Equivalent	Numbers															
2.00	.2500	9.63	10.00	10.40	10.78	11.16	11.55	11.94	12.32	12.71	13.09	13.48	13.86	14.25	14.63	15.02	15.40
.05	.2439	.87	.25	.66	11.05	.44	.84	12.23	.63	13.02	.42	.81	14.21	.60	15.00	.39	.79
.10	.2381	10.11	.50	.92	.32	.72	12.13	.53	.94	.34	.75	14.15	.55	.96	.36	.77	16.17
.15	.2326	.35	.75	11.18	.59	12.00	.42	.83	13.25	.66	14.07	.49	.90	15.32	.73	16.14	.56
.20	.2273	.59	11.00	.44	.86	.28	.71	13.13	.55	.98	.40	.83	15.25	.67	16.10	.52	.94
.25	.2222	.83	.25	.70	12.13	.56	13.00	.43	.86	14.30	.73	15.16	.59	16.03	.46	.90	17.33
.30	.2174	11.07	.50	.96	.40	.84	.28	.73	14.17	.61	15.06	.50	.94	.39	.83	17.27	.71
.35	.2128	.31	.75	12.22	.67	13.12	.57	14.03	.48	.93	.38	.84	16.29	.74	17.21	.65	18.10
.40	.2083	.55	12.01	.48	.94	.40	.86	.32	.79	15.25	.71	16.17	.63	17.10	.56	18.02	.48
.45	.2041	.79	.26	.74	13.21	.68	14.15	.62	15.09	.57	16.04	.51	.98	.45	.95	.40	.87
.50	.2000	12.03	.51	13.00	.48	.96	.44	.92	.40	.88	.37	.85	17.33	.81	18.31	.77	19.26
.55	.1961	.27	.76	.26	.75	14.24	.73	15.22	.71	16.20	.69	17.18	.67	18.17	.68	19.15	.64
.60	.1923	.51	13.01	.52	14.02	.51	15.02	.52	16.02	.52	17.02	.52	18 02	.52	19.04	.52	20.03
.65	.1887	.75	.26	.78	.29	.79	.31	.82	.33	.84	.35	.86	.37	.88	.41	.90	.41
.70	.1852	13.00	.51	14.04	.56	15.07	.60	16.12	.64	17.16	.68	18.20	.71	19.24	.78	20.28	.80
.75	.1818	.24	.76	.30	.83	.35	.88	.41	.94	.47	18.00	.53	19.06	.59	20.14	.65	21.18
.80	.1786	.48	14.01	.56	15.09	.63	16.17	.71	17.25	.79	.33	.74	.41	.95	.51	21.03	.57
.85	.1754	.72	.26	.82	.36	.91	.46	17.01	56	18.11	.66	19.21	.75	20.30	.87	.40	.95
.90	.1724	.96	.51	15.08	.63	16.19	.75	.31	87	.43	.99	.54	20.10	.66	21.24	.78	22.34
.95	.1695	14.20	.76	.34	.90	.47	17.04	.61	18.18	.74	19.31	.88	.45	21.02	.68	22.15	.72

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	82	84	86	88	90		Reed.	20	22	24	26	28
Yards per lb.	½ Decimal Equivalent.	Numbers.					Yards per lb.	½ Decimal Equivalent.	Numbers.				
2.00	.2500	15.79	16.17	16.56	16.94	17.33	3.00	.1667	5.77	6.35	6.93	7.51	8.08
.05	.2439	16.18	.58	.97	17.37	.76	.05	.1639	.87	.46	7.04	.63	.22
.10	.2381	.58	.98	17.39	.79	18.20	.10	.1613	.97	.56	.16	.76	.35
.15	.2326	.97	17.39	.80	18.21	.63	.15	.1587	6.06	.66	.28	.88	.49
.20	.2273	17.37	.79	18.21	.64	19.06	.20	.1562	.16	.77	.39	8.01	.62
.25	.2222	.76	18.20	.63	19.06	.50	.25	.1538	.25	.88	.51	.13	.76
.30	.2174	18.16	.60	19.04	.49	.93	.30	.1515	.35	.99	.62	.26	.89
.35	.2128	.55	19.00	.46	.91	20.36	.35	.1493	.45	7.09	.74	.38	9.03
.40	.2083	.95	.41	.87	20.33	.80	.40	.1471	.54	.20	.85	.51	.16
.45	.2041	19.34	.81	20.29	.76	21.23	.45	.1449	.64	.30	.97	.63	.30
.50	.2000	.74	20.22	.70	21.18	.66	.50	.1429	.74	.41	8.08	.76	.43
.55	.1961	20.13	.62	21.11	.60	22.10	.55	.1408	.83	.52	.20	.88	.57
.60	.1923	.53	21.03	.53	22.03	.53	.60	.1389	.93	.62	.31	9.01	.70
.65	.1887	.92	.43	.94	.45	.96	.65	.1370	7.02	.73	.43	.13	.84
.70	.1852	21.32	.84	22.36	.88	23.40	.70	.1351	.12	.83	.55	.26	.97
.75	.1818	.71	22.24	.77	23.30	.83	.75	.1333	.22	.94	.66	.38	10.11
.80	.1786	22.11	.64	23.18	.72	24.26	.80	.1316	.31	8.05	.78	.51	.24
.85	.1754	.50	23.05	.60	24.15	.70	.85	.1299	.41	.15	.89	.63	.38
.90	.1724	.90	.45	24.01	.57	25.13	.90	.1282	.51	.26	9.01	.76	.51
.95	.1695	23.29	.86	.43	.99	.56	.95	.1266	.60	.36	.12	.89	.65

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
Yards per lb.	½ Decimal Equivalent.	Numbers.														
3.00	.1667	8.66	9.24	9.82	10.40	10.97	11.55	12.13	12.70	13.28	13.86	14.44	15.02	15.60	16.17	16.75
.05	.1639	.81	.39	.98	.57	11.16	.74	.33	.92	.51	14.09	.68	.27	.86	.44	17.03
.10	.1613	.95	.55	10.15	.74	.34	.94	.53	13.13	.73	.32	.92	.52	16.12	.71	.31
.15	.1587	9.10	.70	.31	.92	.52	12.13	.74	.34	.95	.55	15.16	.77	.38	.98	.59
.20	.1562	.24	.86	.47	11.09	.71	.32	.94	.55	14.17	79	.40	16.02	.64	17.25	.87
.25	.1538	.38	10.01	.64	.26	.89	.51	13.14	.76	.39	15.02	.64	.27	.90	.52	18.15
.30	.1515	.53	.16	.80	.44	12.07	.71	.34	.98	.61	.25	.88	.52	17.16	.79	.43
.35	.1493	.67	.32	.96	.61	.25	.90	.54	14.19	.83	.48	16.13	.77	.42	18.06	.71
.40	.1471	.82	.47	11.13	.78	.44	13.09	.75	.40	15.06	.71	.37	17.02	.68	.33	.99
.45	.1449	.96	.63	.29	.96	.62	.28	.95	.61	.28	.94	.61	.27	.94	.60	19.26
.50	.1429	10.11	.78	.45	12.13	.80	.48	14.15	.83	.50	16 17	.85	.52	18.20	.87	.54
.55	.1408	.25	.93	.62	.30	.99	.67	.35	15.04	.72	.40	17.09	.77	.46	:9.14	.82
.60	.1389	.39	11.09	.78	.48	13.17	.86	.56	.25	.94	.64	.33	18.02	.72	.41	20.10
.65	.1370	.54	.24	.95	.65	.35	14.05	.76	.46	16.16	.87	.57	.27	.98	.68	.38
.70	.1351	.68	.49	12.11	.82	.53	.25	.96	.67	.39	17.10	.81	.52	19.24	.95	.66
.75	.1333	.83	.55	.27	.99	.72	.44	15.16	.88	.61	.33	18.05	.77	.50	20 22	.94
.80	.1316	.97	.70	.44	13.17	.90	.63	.36	16.10	.83	.56	.29	19.02	.76	.49	21.22
.85	.1299	11.12	.86	.60	.34	14.08	.83	.57	.31	17.05	.79	.53	.27	20.02	.76	.50
.90	.1282	.26	12.01	.76	.51	.27	15.02	.77	.52	.27	18.02	.77	.52	.28	21.03	.78
.95	.1266	.41	.17	.93	.69	.45	.21	.97	.73	49	.25	19.01	.78	.54	.30	22.06

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
Yards per lb.	½ Decimal Equivalent.	Numbers.															
3.00	.1667	17.33	17.91	18.48	19.06	19.64	20.22	20.79	21.37	21.95	22.53	23.11	23.68	24.26	24.84	25.42	26.00
.05	.1639	.62	18.21	.79	.38	.97	.56	21 14	.73	22.32	.90	.49	24.08	.67	25.25	.84	.43
.10	.1613	.91	.50	19.10	.70	20.30	.89	.49	22.09	.68	23.28	.88	.47	25.07	.67	26.27	.86
.15	.1587	18.20	.80	.41	20.02	.62	21.23	.83	.44	23.05	.66	24.26	.87	.48	26.08	.69	27.30
.20	.1562	.48	19.10	.72	.33	.95	.57	22.18	.80	.42	24.03	.65	25.26	.88	.50	27.11	.73
.25	.1538	.77	.40	20.03	.65	21.28	.90	.53	23.16	.78	.41	25.03	.66	26.28	.91	.54	28.16
.30	.1515	19.06	.70	.33	.97	.60	22.24	.87	.51	24.15	.78	.42	26.05	.69	27.32	.96	.60
.35	.1493	.35	20.00	.64	21.29	.93	.58	23.22	.87	.51	25.16	.80	.45	27.09	.74	28.38	29.03
.40	.1471	.64	.30	.95	.60	22.26	.91	.57	24.22	.88	.53	26.19	.84	.50	28.15	.81	.46
.45	.1449	.93	.59	21.26	.92	.59	23.25	.92	.58	25.24	.91	.57	27.24	.90	.57	29.23	.90
.50	.1429	20.22	.89	.57	22.24	.91	.59	24.26	.94	.61	26.28	.96	.63	28.31	.98	.66	30.33
.55	.1408	.51	21.19	.87	.56	23.24	.93	.61	25.29	.98	.66	27.34	28.03	.71	29.40	30.08	.76
.60	.1389	.80	.49	22.18	.88	.57	24.26	.96	.65	26.34	27.04	.73	.42	29.12	.81	.50	31.20
.65	.1370	21.08	.79	.49	23.19	.90	.60	25.30	26.01	.71	.41	28.11	.82	.52	30.22	.93	.63
.70	.1351	.37	22.09	.80	.51	24.22	.94	.65	.36	27.07	.79	.50	29.21	.93	.64	31.35	32.06
.75	.1333	.66	.38	23.11	.83	.55	25.27	26.00	.72	.44	28.16	.89	.61	30.33	31.05	.77	.50
.80	.1316	.95	.68	.42	24.15	.88	.61	.34	27 07	.81	.54	29.27	30.00	.73	.47	32.20	.93
.85	.1299	22.24	.98	.72	.46	25.21	.95	.69	.43	28.17	.91	.66	.40	31.14	.88	.62	33.36
.90	.1282	.53	23.28	24.03	.78	.53	26.28	27.04	.79	.54	29.29	30.04	.79	.54	32.29	33.05	.80
.95	.1266	.82	.58	.34	25.10	.86	.62	.38	28.14	.90	.67	.43	31.19	.95	.71	.47	34.23

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
Yards per lb.	½ Decimal Equivalent.	Numbers.														
4.00	.1250	7.70	8.47	9.24	10.01	10.78	11.55	12.32	13.09	13.86	14.63	15.40	16.17	16.94	17.71	18.50
.05	.1235	.81	.57	.35	.14	.92	.69	.47	.26	14.03	.82	.60	.38	17.15	.94	.72
.10	.1220	.89	.68	.47	.26	11.05	.84	.63	.42	.21	15.00	.79	.58	.37	18.16	.95
.15	.1205	.99	.79	.59	.39	.18	.98	.78	.58	.38	.18	.98	.78	.58	.38	19.18
.20	.1190	8.08	.89	.70	.51	.32	12.13	.94	.75	.55	.36	16.17	.98	.79	.60	.41
.25	.1176	.18	9.00	.82	.64	.45	.27	13.09	.91	.73	.55	.37	17.18	18.00	.83	.64
.30	.1163	.28	.10	.93	.76	.59	.42	.24	14.07	.90	.73	.56	.39	.21	19.05	.87
.35	.1149	.37	.22	10.05	.89	.72	.56	.40	.24	15.07	.91	.75	.59	.43	.27	20.10
.40	.1136	.47	.33	.16	11.01	.86	.71	.55	.40	.25	16.10	.94	.79	.64	.49	.33
.45	.1124	.57	.42	.28	.14	.99	.85	.71	.57	.42	.28	17.14	.99	.85	.71	.56
.50	.1111	.66	.53	.39	.26	12.13	13.00	.86	.73	.60	.46	.33	18.20	19.06	.93	.80
.55	.1099	.76	.63	.51	.39	.26	.14	14.02	.89	.77	.65	.52	.40	.27	20.15	21.03
.60	.1087	.85	.74	.62	.51	.40	.28	.17	15.06	.94	.83	.71	.60	.48	.37	.26
.65	.1075	.95	.85	.74	.64	.53	.43	.32	.22	16.12	17.01	.91	.80	.70	.59	.49
.70	.1064	9.05	.95	.86	.76	.67	.57	.48	.38	.29	.19	18.10	19.00	.91	.82	.72
.75	.1053	.14	10.06	.97	.89	.80	.72	.63	.55	.46	.38	.29	.21	20.12	21.04	.95
.80	.1042	.24	.16	11.09	12.01	.94	.86	.79	.71	.64	.56	.48	.41	.33	.26	22.18
.85	.1031	.34	.27	.20	.14	13.07	14.01	.94	.87	.81	.74	.68	.61	.54	.48	.41
.90	.1020	.43	.38	.32	.26	.21	.15	15.09	16.04	.98	.93	.87	.81	.76	.70	.64
.95	.1010	.53	.48	.43	.39	.34	.30	.25	.20	17.16	18.11	19.06	20.02	.97	.92	.88

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

Yards per lb.	Reed. ½ Decimal Equivalent	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80
		Numbers.															
4.00	.1250	19.26	20.03	20.80	21.57	22.34	23.11	23.88	24.65	25.42	26.19	26.96	27.73	28.50	29.27	30.04	30.81
.05	.1235	.50	.28	21.06	.84	.62	.40	24.18	.96	.74	.52	27.30	28.08	.86	.64	.42	31.20
.10	.1220	.74	.53	.32	22.10	.90	.68	.47	25.26	26.05	.84	.63	.42	29.21	30.00	.79	.58
.15	.1205	.98	.78	.58	.37	23.17	.97	.77	.57	.37	27.17	.97	.77	.57	.37	31.17	.97
.20	.1190	20.22	21.03	.84	.64	.45	24.26	25.07	.88	.69	.50	28.31	29.12	.92	.73	.54	32.35
.25	.1176	.46	.28	22.10	.91	.73	.55	.37	26.19	27.01	.83	.64	.46	30.28	31.10	.92	.74
.30	.1163	.70	.53	.36	23.18	24.01	.84	.67	.50	.32	28.15	.98	.81	.64	.47	32.29	33.12
.35	.1149	.94	.78	.62	.45	.29	25.13	.97	.80	.64	.48	29.32	30.16	.99	.83	.67	.51
.40	.1136	21.18	22.03	.88	.72	.57	.42	26.27	27.11	.96	.81	.65	.50	31.35	32.20	33.05	.89
.45	.1124	.42	.28	23.14	.99	.84	.71	.56	.42	28.28	29.13	.99	.85	.71	.56	.42	34.28
.50	.1111	.66	.53	.40	24.26	25.12	26.00	.86	.73	.60	.46	30.33	31.20	32.06	.93	.80	.66
.55	.1099	.90	.78	.66	.53	.40	.28	27.16	28.04	.91	.79	.67	.54	.42	33.30	34.17	35.05
.60	.1087	22.14	23.03	.92	.80	.68	.57	.46	.35	29.23	30.12	31.00	.89	.78	.66	.55	.43
.65	.1075	.38	.28	24.18	25.07	.96	.86	.76	.65	.55	.45	.34	32.24	33.13	34.03	.92	.82
.70	.1064	.63	.53	.44	.34	26.24	27.15	28.06	.96	.87	.77	.68	.58	.49	.39	35.30	36.20
.75	.1053	.87	.78	.70	.61	.52	.44	.36	29.27	30.19	31.10	32.01	.93	.84	.76	.67	.59
.80	.1042	23.11	24.03	.96	.88	.80	.73	.65	.58	.50	.43	35	33.28	34.20	35.13	36.05	.97
.85	.1031	.35	.28	25.22	26.15	27.08	28.02	.95	.89	.82	.75	69	.62	.56	.49	.43	37.36
.90	.1020	.59	.53	.48	.42	.36	.31	29.25	30.19	31.14	32.08	33 03	.97	.91	.86	.80	.74
.95	.1010	.83	.78	.74	.69	.64	.60	.55	.50	.46	.41	.36	34.32	35.27	36.22	37.18	38.13

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	82	84	86	88	90
Yards per lb.	½ Decimal Equivalent.	Numbers.				
4.00	.1250	31.58	32.35	33.12	33.89	34.66
.05	.1235	.98	.76	.54	34.32	35.10
.10	.1220	32.37	33.16	.95	.74	.53
.15	.1205	.77	.57	34.36	35.16	.96
.20	.1190	33.16	.97	.78	.59	36.40
.25	.1176	.56	34.37	35.19	36.01	.83
.30	.1163	.95	.78	.61	.43	37.26
.35	.1149	34.35	35.18	36.02	.86	.70
.40	.1136	.74	.59	.43	37.28	38.13
.45	.1124	35.13	.99	.85	.71	.56
.50	.1111	.53	36.40	37.26	38.13	39.00
.55	.1099	.92	.80	.68	.55	.43
.60	.1087	36.32	37.21	38.09	.98	.86
.65	.1075	.71	.61	.51	39.40	40.30
.70	.1064	37.11	38.02	.92	.82	
.75	.1053	.50	.42	39.33	40.25	
.80	.1042	.90	.83	.75		
.85	.1031	38.29	39.23	40.16		
.90	.1020	.69	.64			
.95	.1010	39.08	40.04			

	Reed.	20	22	24	26	28
Yards per lb.	½ Decimal Equivalent.	Numbers.				
5.00	.10000	9.63	10.59	11.55	12.51	13.48
.05	.09901	.72	.69	.66	.64	.61
.10	.09804	.82	.80	.78	.76	.75
.15	.09709	.91	.91	.90	.89	.88
.20	.09615	10.01	11.01	12.01	13.02	14.02
.25	.09524	.11	.12	.13	.14	.15
.30	.09434	.20	.22	.24	.27	.29
.35	.09346	.30	.33	.36	.39	.42
.40	.09259	.40	.44	.47	.52	.55
.45	.09174	.49	.54	.59	.67	.69
.50	.09091	.59	.65	.70	.80	.82
.55	.09009	.68	.75	.82	.92	.96
.60	.08929	.78	.86	.93	14.05	15.09
.65	.08850	.88	.97	13.05	.17	.23
.70	.08772	.97	12.07	.17	.30	.36
.75	.08696	11.07	.18	.28	.42	.50
.80	.08621	.17	.28	.40	.55	.63
.85	.08547	.26	.39	.51	.67	.77
.90	.08475	.36	.49	.63	.77	.90
.95	.08403	.45	.60	.75	.89	16.04

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58
Yards per lb.	½ Decimal Equivalent.	Numbers.														
5 00	.10000	14.44	15.40	16.37	17.33	18.29	19.26	20.22	21.18	22.14	23.11	24.07	25.03	26.00	26.96	27.92
.05	.09901	.58	.56	.53	.50	.47	.45	.42	.39	.37	.34	.31	.28	.26	27.23	28.20
.10	.09804	.73	.71	.69	.68	.66	.64	.62	.60	.59	.57	.55	.53	.52	.50	.47
.15	.09709	.87	.87	.86	.85	.84	.83	.82	.81	.81	.80	.79	.78	.78	.77	.75
.20	.09615	15.02	16.02	17.02	18.02	19.02	20.03	21.03	22.03	23.03	24.03	25.03	26.03	27.04	28.04	29.03
.25	.09524	.16	.17	.18	.20	.21	.22	.23	.24	.25	.26	.27	.28	.30	.31	.31
.30	.09434	.31	.33	.25	.37	.39	.41	.43	.45	.47	.49	.51	.54	.56	.58	.59
.35	.09346	.45	.47	.41	.54	.57	.60	.63	.66	.69	24.72	.75	.79	.82	.85	.87
.40	.09259	.60	.63	.58	.72	.76	.80	.84	.87	.92	.96	.99	27.04	28.08	29.12	30.15
.45	.09174	.74	.78	.74	.89	.94	.99	22.04	23.09	24.14	25.19	26.23	.29	.34	.39	.43
.50	.09091	.88	.93	.90	19.06	20.12	21.18	.24	.30	.36	.42	.47	.54	.60	.66	.71
.55	.09009	16.03	17.09	18.07	.24	.30	.37	.44	.51	.58	.65	.71	.79	.86	.93	.99
.60	.08929	.17	.24	.23	.41	.49	.57	.64	.72	.80	.88	.95	28.04	29.12	30.19	31 27
.65	.08850	.32	.40	.39	.58	.67	.76	.85	.93	25.02	26.11	27.19	.29	.38	.46	.55
.70	.08772	.46	.55	.56	.76	.85	.95	23.05	24.15	.24	.34	.43	.54	.64	.73	.83
.75	.08696	.61	.70	.72	.93	21.04	22.14	.25	.36	.47	.57	.67	.79	.90	31.00	32.10
.80	.08621	.75	.86	.89	20.10	.22	.34	.45	.57	.69	.80	.91	29.04	30.16	.27	.39
.85	.08547	.90	18.01	19.05	.28	.40	.53	.66	.78	.91	27.04	28.15	.29	.42	.54	67
.90	.08475	17.04	.18	.31	.45	.59	.72	.86	.99	26.13	.27	.39	.54	.68	.81	.95
.95	.08403	.18	.33	.48	.62	.77	.91	24.06	25.21	.34	.50	.63	.79	.94	32.08	33.23

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	60	62	64	66	68	70	72	74	76	78
Yards per lb.	½ Decimal Equivalent.	Numbers.									
5.00	.10000	28.89	29.85	30.81	31.77	32.74	33.70	34.66	35.63	36.59	37.55
.05	.09901	29.17	30.15	31.12	32.09	33.06	34.04	35.01	.98	.95	.93
.10	.09804	.46	.45	.43	.41	.39	.37	.36	36.34	37.32	38.30
.15	.09709	.75	.74	.74	.73	.72	.71	.70	.69	.69	.68
.20	.09615	30.04	31.04	32.04	33.05	34.05	35.05	36.05	37.05	38.05	39.05
.25	.09524	.33	.34	.35	.36	.37	.39	.40	.41	.42	.43
.30	.09434	.62	.64	.66	.68	.70	.72	.74	.76	.78	.81
.35	.09346	.91	.94	.97	34.00	35.03	36.06	37.09	38.12	39.15	40.18
.40	.09259	31.20	32.24	33.28	.32	.36	.40	.44	.48	.52	.56
.45	.09174	.49	.53	.58	.63	.68	.73	.78	.83	.88	.93
.50	.09091	.77	.83	.89	.95	36.01	37.07	38.13	39.19	40.25	41.31
.55	.09009	32.06	33.13	34.20	35.27	.34	.41	.48	.55	.61	.68
.60	.08929	.35	.43	.51	.59	.67	.74	.82	.90	.98	42.06
.65	.08850	.64	.73	.82	.91	.99	38.08	39.17	40.26	41.35	.43
.70	.08772	.93	34.03	35.13	36.22	37.32	.42	.52	.61	.71	.81
.75	.08696	33.22	.33	.43	.54	.65	.76	.86	.97	42.08	43.19
.80	.08621	.51	.62	.74	.86	.98	39.09	40.21	41.33	.44	.56
.85	.08547	.80	.92	36.05	37.18	38.30	.43	.56	.68	.81	.93
.90	.08475	34.09	35.22	.36	.49	.63	.77	.90	42.04	43.18	44.31
.95	.08403	.38	.52	.67	.81	.96	40.10	41.25	40	.54	.69

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

Yards per lb.	Reed. ½ Decimal Equivalent.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
		Numbers.														
6.00	.08333	11.55	12.71	13.86	15.02	16.17	17.33	18.48	19.64	20.80	21.95	23.11	24.26	25.42	26.56	27.73
.05	.08264	.65	.81	.98	.14	.31	.47	.64	.80	.97	22.13	.30	.46	.63	.79	.96
.10	.08197	.74	.92	14.09	.27	.44	.62	.79	.97	21.14	.32	.49	.67	.84	27.01	28.19
.15	.08130	.84	13.02	.21	.39	.58	.76	.95	20.13	.32	.50	.68	.87	26.05	.23	.42
.20	.08065	.94	.13	.32	.52	.71	.91	19.10	.30	.49	.68	.88	25.07	.27	.45	.65
.25	.08000	12.03	.24	.44	.64	.85	18.05	.25	.46	.66	.87	24.07	.27	.48	.67	.89
.30	.07937	.13	.34	.56	.77	.98	.20	.41	.62	.84	23.05	.26	.48	.69	.89	29.12
.35	.07874	.23	.45	.67	.89	17.12	.34	.56	.79	22.01	.23	.46	.68	.90	28.11	.35
.40	.07812	.32	.55	.79	16.02	.25	.48	.72	.95	.18	.42	.65	.88	27.11	.34	.58
.45	.07752	.42	.66	.90	.14	.39	.63	.87	21.11	.36	.60	.84	26.08	.32	.56	.81
.50	.07692	.51	.77	15.02	.27	.52	.77	20.02	.28	.53	.78	25.03	.28	.54	.78	30.04
.55	.07634	.61	.87	.13	.39	.66	.92	.18	.44	.70	.96	.23	.49	.75	29.00	.27
.60	.07576	.71	.98	.25	.52	.79	19.06	.33	.60	.88	24.15	.42	.69	.96	.22	.50
.65	.07519	.80	14.08	.36	.65	.93	.21	.49	.77	23.05	.33	.61	.89	28.17	.44	.73
.70	.07463	.90	.19	.48	.77	18.06	.35	.64	.93	.22	51	.80	27.09	.38	.66	.97
.75	.07407	13.00	.30	.60	.90	.20	.50	.79	22.10	.40	.70	26.00	.30	.59	.89	31.20
.80	.07353	.09	.40	.71	17.02	.33	.64	.95	.26	.57	88	.19	.50	.81	30.11	.43
.85	.07299	.19	.51	.83	.15	.47	.78	21.10	.42	.74	25.09	.38	.70	29.02	.33	.66
.90	.07246	.28	.61	.94	.27	.60	.93	.26	.59	.92	.25	.57	.90	.23	.56	.89
.95	.07194	.38	.72	16.06	.40	.73	20.07	.41	.75	24.09	.43	.77	28.10	.44	.78	32.12

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
Yards per lb.	½ Decimal Equivalent.	Numbers.														
6.00	.08333	28.87	30.04	31.20	32.35	33.51	34.66	35.82	36.97	38.13	39.29	40.44	41.60	42.75	43.91	45.06
.05	.08264	29.11	.29	.46	.62	.79	.95	36.12	37.28	.45	.61	.78	.94	43.11	44.27	.43
.10	.08197	.37	.54	.72	.89	34.07	35.24	.42	.59	.77	.94	41.12	42.29	.46	.64	.81
.15	.08130	.61	.79	.98	33.16	.35	.53	.71	.90	39.08	40.27	.45	.65	.82	45.01	46.19
.20	.08065	.85	31.04	32.24	.43	.62	.82	37.01	38.21	.40	.60	.79	.99	44.18	.37	.57
.25	.08000	30.09	.29	.50	.70	.90	36.11	.31	.52	.72	.92	42.13	43.34	.53	.74	.94
.30	.07937	.33	.54	.76	.97	35.18	.40	.61	.82	40.04	41.25	.46	.69	.89	46.10	47.32
.35	.07874	.57	.79	33.02	34.24	.46	.69	.91	39.13	.35	.58	.80	44.03	45.25	.47	.69
.40	.07812	.80	32.04	.28	.51	.74	.97	38.21	.44	.67	.90	43.14	.38	.60	.84	48.07
.45	.07752	31.05	.29	.54	.78	36.02	37.26	.51	.75	.99	42.23	.47	.73	.96	47.20	.44
.50	.07692	.29	.54	.80	35.05	.30	.55	.80	40.06	41.31	.56	.81	45.07	46.32	.57	.82
.55	.07634	.54	.79	34.06	.32	.58	.84	39.10	.36	.63	.89					
.60	.07576	.79	33.05	.32	.59	.86	38.14	.40	.67	.94	43.21					
.65	.07519	32.03	.30	.58	.86	37.14	.42	.70	.98	42.26	.54					
.70	.07463	.27	.55	.84	36.13	.42	.71	40.00	41.29	.58	.87					
.75	.07407	.51	.80	35.10	.40	.70	39.00	.30	.60	.90	44.20					
.80	.07353	.75	34.05	.36	.67	.98	.29	.60	.90	43.21	.52					
.85	.07299	.99	.30	.62	.94	38.25	.57	.89	42.21	.53	.85					
.90	.07246	33.23	.55	.88	37.21	.53	.86	41.19	.52	.85	45.18					
.95	.07194	.47	.80	36.14	.47	.81	40.15	.49	.83	44.17	.51					

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
Yards per lb.	½ Decimal Equivalent.	Numbers.														
7.00	.07143	13.48	14.83	16.18	17.52	18.87	20.22	21.56	22.91	24.26	25.61	26.96	28.31	29.65	31.00	32.35
.05	.07092	.57	.93	.29	.65	19.00	.35	.72	23.08	.44	.79	27.15	.51	.87	.23	.58
.10	.07042	.67	15.04	.40	.77	.14	.50	.87	.24	.60	.98	.34	.71	30.08	.45	.81
.15	.06993	.77	.14	.52	.90	.27	.64	22.03	.41	.78	26.16	.54	.91	.29	.67	33.05
.20	.06944	.86	.25	.64	18.02	.41	.78	.18	.57	.96	.34	.73	29.12	.50	.89	.28
.25	.06897	.96	.35	.75	.15	.54	.93	.33	.73	25.13	.53	.92	32	30.71	32.11	.51
.30	.06849	14.05	.46	.87	.27	.68	21.07	.49	.90	.30	.71	28.11	.52	.92	.33	.74
.35	.06803	.15	.57	.98	.40	.81	.22	.64	24.06	.48	.89	.31	.72	31.14	.55	.97
.40	.06757	.25	.67	17.10	.52	.95	.36	.80	.23	.65	27.07	.50	.93	.35	.78	34.20
.45	.06711	.34	.78	.21	.65	20.08	.51	.95	.39	.82	.26	.69	30.13	.56	33.00	.43
.50	.06667	.44	.88	.33	.77	.22	.65	23.10	.65	26.00	.44	.89	.33	.77	.22	.66
.55	.06623	.54	.99	.44	.90	.35	.80	.26	.72	.17	.62	29.08	.53	.98	.44	.89
.60	.06579	.63	16.10	.56	19.02	.49	.94	.41	.88	.34	.81	.27	.73	32.20	.66	35.13
.65	.06536	.73	.20	.68	.15	.62	22.08	.57	25.04	.52	.99	.46	.94	.41	.88	.36
.70	.06494	.83	.31	.79	.27	.76	.23	.73	.20	.70	28.17	.66	31.15	.62	34.10	.59
.75	.06452	.92	.41	.91	.40	.89	.37	.88	.37	.86	.36	.85	.34	.83	.33	.82
.80	.06410	15.02	.52	18.02	.52	21.03	.52	24.03	.53	27.04	.54	30.04	.54	33.04	.55	36.05
.85	.06369	.11	.63	.14	.65	.16	66	.19	.70	.21	.72	.23	.75	.25	.77	.28
.90	.06329	.21	.73	.25	.78	.30	.81	.34	.86	.38	.90	.43	95	.47	.99	.51
95	.06289	.31	.84	.37	.90	43	.95	.49	26.02	.56	29.09	.62	32.15	.68	35.21	.74

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

	Reed.	50	52	54	56	58	60	62	64	66	68
Yards per lb.	½ Decimal Equivalent.	Numbers.									
7.00	.07143	33.71	35.05	36.40	37.74	39.09	40 44	41.79	43.14	44.49	
.05	.07092	.94	.30	.66	38.01	.37	.73	42.09	.45	.80	
.10	.07042	34.18	.55	.92	.28	.65	41.02	.39	.75	45.12	
.15	.06993	.42	.80	37.18	.55	.93	.31	.68	44.06	.44	
.20	.06944	.66	36.05	.44	.82	40.22	.60	.98	.37	.76	
.25	.06897	.90	.30	.70	39.09	.49	.89	43.28	.68	46.07	
.30	.06849	35.14	.55	.96	.36	.77	42.17	.58	.99	.39	
.35	.06803	.39	.80	38.22	.63	41.05	.46	.88	45.29	.71	
.40	.06757	.63	37.05	.48	.90	.33	.75	44.18	.60	47.03	
.45	.06711	.87	.30	.74	40.17	.61	43.04	.48	.91	.35	
.50	.06667	36.11	.55	39.00	.44	.89	.33	.77	46.22	.66	
.55	.06623	.35	.80	.26	.71	42.16	.62	45.07	.53	.98	
.60	.06579	.59	38.05	.52	.98	.44	.91	.37	.84	48.29	
.65	.06536	.83	.30	.78	41.25	.72	44.20	.67	47.14	.61	
.70	.06494	37.07	.55	40.04	.52	43.00	.49	.97	.45	.92	
.75	.06452	.31	.80	.30	.79	.28	.77	46.27	.76	49.21	
.80	.06410	.55	39.05	.56	42.06	.56	45.06	.57	48.07	.52	
.85	.06369	.79	.30	.82	.33	.84	.35	.86	.38	.84	
.90	.06329	38.03	.55	41.08	.60	44.12	.64	47.16	.68	50.11	
.95	.06289	.27	.80	.34	.87	.40	.93	.46	.99	.43	

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Continued.

Yards per lb.	½ Decimal Equivalent.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
	Reed.	Numbers.														
8.00	.06250	15.40	16.94	18.48	20.03	21.57	23.11	24.65	26.19	27.73	29.27	30.81	32.35	33.89	35.43	36.97
.05	.06211	.50	17.05	.60	.15	.70	.25	.80	.35	.90	.45	31.00	.55	34.10	.65	37.21
.10	.06173	.60	.16	.72	.28	.84	.40	.96	.52	28.08	.64	.20	.76	.32	.88	.44
.15	.06135	.69	.26	.83	.40	.97	.54	25.11	.68	.25	.82	.39	.96	.53	36.10	.67
.20	.06098	.79	.37	.95	.52	22.11	.68	.26	.84	.42	30.00	.58	33.16	.74	.32	.90
.25	.06061	.88	.47	19.06	.65	.24	.83	.42	27.01	.60	.19	.77	.36	.95	.54	38.13
.30	.06024	.98	.58	.18	.78	.38	.97	.57	.17	.77	.37	.97	.57	35.16	.76	.36
.35	.05988	16.08	.69	.29	.90	.51	24.12	.73	.33	.94	.55	32.16	.77	.38	.98	.59
.40	.05952	.17	.79	.41	21.03	.64	.26	.88	.50	29.12	.73	.35	.97			
.45	.05917	.27	.90	.52	.15	.78	.41	26.03	.66	.29	.92					
.50	.05882	.37	18.00	.64	.28	.91	.55	.19	.83	.46	31.10					

	Reed.	50	52	54	56	58	60	62	64	66
8.00	.06250	38.52	40.06	41.60	43.14	44.68	46.22	47.76	49.30	50.74
.05	.06211	.76	.31	.86	.41	.96	.51	48.06	.61	51.06
.10	.06173	39.00	.56	42.12	.68	45.24	.80	.36	.92	.37
.15	.06135	.24	.81	.38	.95	.52	47.09	.66	50.23	.69
.20	.06098	.48	41.06	.64	44.22	.81	.37	.96	.54	52.01
.25	.06061	.72	.31	.90						

Cotton Manufacturing, Continued.

Draper Cloth Construction Tables, Concluded.

Table to Facilitate the Conversion of Yards to the Pound to Their Decimal Equivalent.

Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.	Yds. to Lb.	Equivalent.
1.00	1.0000	2.00	.5000	3.00	.3333	4.00	.2500	5.00	.2000	6.00	.1667	7.00	.1429	8.00	.1250
.05	.9524	.05	.4878	.05	.3279	.05	.2469	.05	.1980	.05	.1653	.05	.1418	.05	.1242
.10	.9091	.10	.4762	.10	.3226	.10	.2439	.10	1961	.10	.1639	.10	.1408	.10	.1235
.15	.8696	.15	.4651	.15	.3175	.15	.2410	.15	.1942	.15	.1626	.15	.1399	.15	.1227
.20	.8333	.20	.4545	.20	.3125	.20	.2381	.20	.1923	.20	.1613	.20	.1389	.20	.1220
.25	.8000	.25	.4444	.25	.3077	.25	.2353	.25	.1905	.25	.1600	.25	.1379	.25	.1212
.30	.7692	.30	.4348	.30	.3030	.30	.2326	.30	.1887	.30	.1587	.30	.1370	.30	.1205
.35	.7407	.35	.4255	.35	.2985	.35	.2299	.35	.1869	.35	.1575	.35	.1361	.35	.1198
.40	.7143	.40	.4167	.40	.2941	.40	.2273	.40	.1852	.40	.1562	.40	.1351	.40	.1190
.45	.6897	.45	.4082	.45	.2899	.45	.2247	.45	.1835	.45	.1550	.45	.1342	.45	.1183
.50	.6667	.50	.4000	.50	.2857	.50	.2222	.50	.1818	.50	.1538	.50	.1333	.50	.1176
.55	.6452	.55	.3922	.55	.2817	.55	.2198	.55	.1802	.55	.1527	.55	.1325	.55	.1170
.60	.6250	.60	.3846	.60	.2778	.60	.2174	.60	.1786	.60	.1515	.60	.1316	.60	.1163
.65	.6061	.65	.3774	.65	.2740	.65	.2151	.65	.1770	.65	.1504	.65	.1307	.65	.1156
.70	.5882	.70	.3704	.70	.2703	.70	.2128	.70	.1754	.70	.1493	.70	.1299	.70	.1149
.75	.5714	.75	.3636	.75	.2667	.75	.2105	.75	.1739	.75	.1481	.75	.1290	.75	.1143
.80	.5556	.80	.3571	.80	.2632	.80	.2083	.80	.1724	.80	.1471	.80	.1282	.80	.1136
.85	.5405	.85	.3509	.85	.2597	.85	.2062	.85	.1709	.85	.1460	.85	.1274	.85	.1130
.90	.5263	.90	.3448	.90	.2564	.90	.2041	.90	.1695	.90	.1449	.90	.1266	.90	.1124
.95	.5128	.95	.3390	.95	.2532	.95	.2020	.95	.1681	.95	.1439	.95	.1258	.95	.1117

Cotton Manufacturing, Continued.

Calculations Pertaining to Weaving, Continued.

Cotton cloth is sold on a basis of a certain number of yards to the pound, with a certain number of picks or threads per inch in warp and filling.

Standard print cloths weigh seven yards to the pound, have 64 picks of warp and filling to the inch, and are called 64×64 seven-yard goods. It may also be stated as a matter of interest that print cloths are 28 inches wide and are supposed to be made of 28 warp and 36 filling, though the yarns ordinarily do not size those numbers on account of contraction and sizing.

Both warp and filling take up in weaving, by passing over and under alternate threads; therefore, one yard of warp or filling will fall a percentage short of making a yard of cloth. This percentage varies with each different size of yarn and number of picks per inch, and for other reasons; consequently, the tables have been made, giving the weights of straight yarn, to which must be added the take-up or shrinkage, to obtain the precise weight of a yard of cloth. It may be safe to say that from seven to eight per cent. is an average shrinkage on cotton goods.

Yarn is numbered before it is slashed or sized, and in estimating the weight of finished cloth, the percentage of sizing added to the warp must be allowed for.

To find the number of yards of cloth to the pound avoirdupois:

Multiply its width in inches by the weight in grains of a piece containing 1 square inch; divide 194.44 by the product and the quotient will be the number of yards to the pound. **Example:** Width of cloth 30 inches; weight of 1 square inch, 1.5 grains.

$$\frac{194.44}{30 \times 1.5} = 4.32 \text{ yards per pound.}$$

To find the average number of yarn required to produce cloth of any desired weight, width, and pick:

Add together the number of picks per inch of warp and filling; multiply their sum by the yards of cloth per pound, and this product by the width in inches; divide by 840, and the quotient will be the average number of yarn required.

To the results obtained a suitable allowance must be made for the contraction or take-up in the weaving and the sizing of the warps,—all as stated above. For most purposes warps are increased in weight from 8% to 15% by sizing. The contraction is from 5% to 15%, 7% or 8% being ordinarily taken as a fair average for ordinary counts. A rule of thumb I have seen somewhere for contraction says for cloth woven from yarns under 50's, multiply the pick by 4 and divide by the number of filling yarn: the result is the contraction expressed in per cent. For yarns over 50, use a multiplier of

Cotton Manufacturing, Continued.

only 3.5 instead of 4. In trying some examples by this rule, it seems to me the results are a little high, however..

So much for the different elements entering into the construction of a piece of cloth.

Having decided upon the construction of the goods to be made and working backward, the next question relates to the drawing-in of the reeds and harnesses,—usually two warp ends are drawn into each dent of the reed for plain work. The Reed Table, on the next page, shows the present practice in regard to the spread in inches for plain sheetings and three-harness drills. The standard reed space for Whitin looms is given on page 240, also the distance between swords; when specially ordered the reed space can be cut well up between swords, thereby permitting of a little greater width of cloth to be manufactured on the same loom, not to mention the fact of a slight advantage due to the extra length of the reed which acts as a guide for the shuttle. Reeds are generally designated by the "bier," which, in the common acceptance of the term, means 20 dents.

Harnesses are often designated as two, three, four, or five "shades" per set. In connection with harnesses, the term "bier" denotes 20 eyes to each harness, so that in a set of two-shade harnesses there are forty eyes to the bier. In theoretical calculations and in the accompanying table the number of ends must be increased not only for the selvage but to allow for contraction; the allowance for this increase is often as much as 5 per cent.

For plain sheetings, or two-harness work, the number of ends actually required divided by the eyes in two biers (40) will give the number of biers required in each harness; for three-harness work, divide by the number of eyes in three biers (60), for four-harness work divide by the number of eyes in four biers (80), etc. In ordering harnesses, it is usual to specify the number of eyes per set, spread on a given number of inches, two, three, four or five shades per set as the case may be.

It is not always easy at first glance to determine the proper number of ends to be warped on the section beams, and the number of section beams to be creeled on the slasher to produce the desired number of ends on the loom beam. The matter of waste is one of first consideration in this question: as a general proposition it may be stated that it is better to have more section beams and a less number of ends on each rather than the reverse. The number of ends on a beam will generally be found to figure out to advantage somewhere between 400 and 450.

Draper Reed Table.

Ends per Inch.	Ends in Cloth.	PLAIN CLOTH.			FOR DRILLS.		
		Dents per Inch.	Two Ends per Reed Dent. Total Dents.	Width of Reed or Spread.	Dents in Inch.	Three Ends per Reed Dent. Total Dents.	Width of Reed or Inches Spread.
32	1176	14.67	576	39.25	10.16	392	38.58
34	1248	15.59	612	39.25	10.79	416	38.55
36	1320	16.51	648	39.25	11.42	440	38.52
38	1392	17.42	684	39 25	12.06	464	38.47
40	1464	18.34	720	39.25	12.69	488	38.47
42	1536	19.26	756	39 25	13.33	512	38.40
44	1608	20.17	792	39.25	13 96	536	38 37
46	1680	21.09	828	39.25	14.60	560	38 35
48	1752	22.01	864	39.25	15.23	584	38.34
50	1824	22.93	900	39.25	15.87	608	38.33
52	1896	23.85	936	39.25	16 50	632	38.32
54	1968	24.77	972	39.25	17.14	656	38.27
56	2040	25.68	1008	39.25	17.77	680	38.26
58	2112	26.60	1044	39.25	18.41	704	38.24
60	2184	27 51	1080	39 25	19.04	728	38.23
62	2256	28.43	1116	39.25	19.68	752	38.20
64	2328	29.35	1152	39.25	20.32	776	38.19
66	2400	30.22	1188	39.25	20.95	800	38.18
68	2472	31.18	1224	39.25	21.58	824	38.18
70	2544	32.10	1260	39.25	22 22	848	38.17
72	2616	33.02	1296	39.25	22.85	872	38.16
74	2688	33.94	1332	39.25	23 49	896	38.14
76	2760	34.85	1368	39.25	24 12	920	38.14
78	2832	35.77	1404	39.25	24.76	944	38.13
80	2904	36 69	1440	39 25	25.39	968	38.12
82	2976	37.60	1476	39.25	26.03	992	38.12
84	3048	38.52	1512	39.25	26.66	1016	38.12
86	3120	39.44	1548	39.25	27.30	1040	38.09
88	3192	40.35	1584	39.25	27.94	1064	38.08
90	3264	41.27	1620	39.25	28.58	1088	38 07
92	3336	42.19	1656	39.25	29 22	1112	38.06
94	3408	43.11	1692	39.25	29 86	1136	38.05
95	3480	44 02	1728	39.25	30.50	1160	38.03
98	3552	44.92	1764	39.25	31 14	1184	38.02
100	3624	45.85	1800	39.25	31.78	1208	38 00

This table is made out for cloth 36″ wide—all other widths of cloth, proporion must be made. Twenty-four ends are allowed in every case for selvage.
For two harness plain, eyes on each harness = Total dents.
For three harness drill, eyes on each harness = Total dents.

Loom reeds are numbered by the number of the dents or splits to the inch.
The number of threads in a warp divided by the number of the reed multiplied by the width in inches, will give the number of threads in a dent.

Cotton Manufacturing, Continued.

The Operation of Weaving.

(See Pages 231-271).

For the sake of simplicity, only a plain loom weaving plain goods is described.

In a preliminary way it is necessary to say that the warp is the thread, or yarn as it is better termed, running lengthwise of the cloth; the filling is the yarn running across the cloth. In plain weaving, the warp and filling are alternately crossed over and under each other; to make any kind of fabric, it may generally be stated that weaving consists in intermeshing warp and filling in such a way as to produce the desired design.

In weaving the following terms designate the motions that consecutively take place:

"Shedding."—This is the separation of the warp yarns to admit the shuttle carrying the filling; this is effected by the alternate raising and lowering of each of the two harnesses through which the warp threads have been "drawn in," as previously described.

"Picking."—This is the threading of the filling between the warp yarns. The filling is carried through by the shuttle, which is thrown through the shed (between the warp threads) at each pick, the filling paying off the end of the bobbin or "quill" within the shuttle, as it passes from side to side.

"Beating Up."—This is the action of the reed in beating the filling thread into place snugly up against the woven part of the cloth; it takes place after each passage of the shuttle.

"Letting Off."—The warp yarns on the beam are gradually unwound as the cloth is woven and rolled up; the operation of unwinding the beam is termed "letting-off" and the motion is termed "let-off motion."

"Taking Up."—As the cloth is woven, a "take-up motion" rolls it up at a uniform rate, thereby regulating the number of filling threads per inch of cloth.

With the above brief explanation, the path of yarn, traced as follows, will be readily understood:

The warp threads on the beam at the back of the loom lead up over the whip roll, thence toward the front of the loom where lease rods are put between the warp threads for the purpose of keeping them better separated and for facilitating the finding of broken ends in piecing up; they next pass

Cotton Manufacturing, Continued.

through the rear and front harnesses and reed respectively; at this point by the intermeshing of the filling the yarn has become cloth, which is held in position and at its width by the temples; after which it passes to the front over the breast beam and then back downward around the sand roll, and thence up and around the cut roll, from which it is finally removed to the cloth room.

The loom is geared so that at each revolution of the pulley on the driving shaft there is one stroke of the picker stick, and one filling thread put into the cloth; the number of "picks" at which it is recommended to drive looms is found on pages 243 and 268.

The harnesses are supported by being hung from leather straps to the harness roll attached to the top or arch of the loom; the harnesses are hung one on each side of the roll that alternately turns, the straps winding and unwinding as the harnesses rise and fall. The lower ends of the harnesses are strapped to jack sticks, which are in turn strapped to treadles; these treadles, resting on a rod at the back of the loom as a pivot, are alternately raised and lowered by the cams on the cam shaft.

The reed is carried by the "lay," or lathe, which consists of a stout, wooden piece about 4x5 inches in cross section, and extends about a foot and a half beyond each end or side of the loom; the side supports of the lathe are termed "swords," and are attached to a rock shaft at the bottom of the loom. The lay not only carries the reed, but also the travel of the shuttle is guided on the bottom by a race plate, as it is termed, at the back of the reed. In each end of the lay is a vertical slot through which the picker stick projects by which the shuttle is driven. The shuttle box is formed by front and back binders of iron in front of the slot; when the shuttle is in position in the shuttle box the back binder is forced up against a spring, which securely holds it and prevents a rebound. This movable binder is termed the "swell." As already stated, its usual position is at the back of the shuttle box, though looms are often built with the swell on the front of the shuttle box when designed to receive the "Draper motion" at some future date. The picker sticks, by which the shuttle is thrown from side to side of the loom, as already stated, projects up through the vertical slot in the shuttle box on each side; at the bottom the picker stick is fastened to the sword rock shaft with a parallel motion. Each picker stick is jerked by a picker cam alternately at just the proper moment to propel the shuttle between the

Cotton Manufacturing, Continued.

warp shed. The motion is accomplished through the medium of a picker lever fitted with a roller where it comes in contact with the cam, as the cam raises the roller the other end of the lever carrying the lug strap jerks the picker stick. The term "picker" is applied to a leather pad or buffer attached to the upper end of the picker stick by a "picker loop"; this "picker" absorbs the shock of the blow the stick gives to the shuttle. The shuttle guard filling stop motions are simple devices, the purpose of which is sufficiently explained by its name.

So much for an elementary description of the operation of a loom. Complete technical data relating to the "motions" of the Whitin looms is found on pages 244-260 inclusive.

Tape Selvage.—In lieu of the ordinary selvage, the trade sometimes requires what is termed a "tape selvage," which is simply a narrow twill woven strip from ¼" to ½" wide on each edge of the cloth. It is accomplished by what is termed a "tape selvage motion,"—the harnesses, jacks, cams, etc., for the purpose being termed "baby harnesses, jacks, cams," etc.

As previously explained, **twills**, **drills**, **sateens**, etc., are made by drawing-in three, four, or five harnesses instead of two; and in the operation of weaving these different harnesses are consecutively lifted. (See pages 234-235.)

Where a number of harnesses, say up to twenty-five, are necessary to make a desired pattern, the proper number of harnesses are drawn in and are raised and lowered by a **dobby**. (238-239) and 318b.)

For more elaborate patterns still, **jacquards** are required, which can also be attached to plain looms specially built to receive them.

Box Motions.—In colored work, stripes can be woven in the "single box loom," as the ordinary plain loom is termed; but other variations from plain goods or simple stripes, require a "box motion," and the boxes are termed "drop boxes." They are made from one to six boxes on a side; 2x1, 4x1, and 4x2 being favorite combinations. In each shuttle is a quill containing a different color of yarn. The different boxes are arranged to move up and down by the intervention of a "pattern chain." Dobbies and jacquards can be attached to looms in combination with drop boxes, the same as on single box looms.

Sizes of Pulleys, Speeds, Floor Spaces, Etc., (232-242).
Production Tables, (261-263).
Horse Power Required to Drive, (1166).

Cotton Manufacturing, Concluded.

FINISHING, FOLDING AND BALING.

When the cloth is received from the loom, it is sent either to the finishing department, or to the cloth room, according to the subsequent treatment it is to receive.

Finishing is often divided under two headings, viz., "wet" and "dry" finishing.

By the term "wet finishing" is meant the various kinds of finishing described elsewhere under the head of "Special Finishing." (See pages 1029-1042.)

By "dry finishing" is meant the different operations performed by Curtis & Marble's cloth room and finishing machinery, both the machines and operations of which have been fully described on pages 272-302.

Napping is a variety of special finishing, and has been described under that heading on pages 1043-1044.

The operation of **Baling** is sufficiently explained by the term itself. The size and shape of a bale and the style of making it up vary according to whether it is intended for the home market or for export. In the latter case it is particularly necessary that a specification be obtained from the exporter as to just how he wants the bales made,—giving in detail not only the size of the bales, but also the density or weight per cubic foot. This is necessary, because water rates are figured on cubical contents rather than weights for this class of merchandise. And just here it is not out of place to call attention to the fact that presses putting up goods for export are necessarily more powerful than those for the home trade; this should be borne in mind in making the selection of a press; it is not a bad idea to buy an export press, even though one does not expect actually to use it at the time of its purchase, for a mill is then so fixed that it can cater to foreign trade if the opportunity offers.

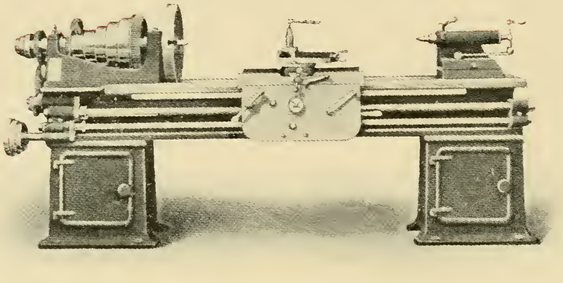
Baling presses are completely described on pages 306-317 inclusive; also on page 1041.

Ordinarily goods are sold in approximately 50-yard cuts, 20 pieces to the bale. The bales are made up by being carefully weighed, and then put in the press upon the table of which has been previously spread, first the burlap covering and then heavy stout paper. Corresponding pieces of paper and burlap are placed on top of the goods, and the pressure is then turned on; the paper and covering are then carefully folded into shape, the ropes tied, the pressure relieved, and the covering sewed up and properly marked and stenciled.

Colored goods instead of being baled are often put up in wooden boxes or "cases."

MACHINE TOOLS.

(For Cotton Mill Repair Shops.)



S. & B. Lathe.

The above cut shows the Standard 18-inch Swing Engine Lathe, specially designed for cotton mill use.

The Reverse Movement, for carrying the feed in either direction, is in the Apron, and when the feed is engaged, mechanism has been provided so that the half-nuts cannot be engaged until the feed is disengaged.

The Cross Feed is operated by pulling a button forward or pushing it back, to engage or to disengage, as the case may be.

The Carriage is firmly locked while the Cross Feed is at work, by moving downward an eccentric clamp.

The Feed Cones are fitted to a bracket, which swivels on a pivot, so that by placing it at the highest point and using an endless belt it will act as a belt tightener.

Lathes are furnished with large and small face plates, Plain or Compound Rest, Center Rests, Change Gears, Wrenches, Countershaft, etc.

Table of Dimensions.

Size of Lathe.	"A"	"B"	"C"	"D"	"E"	"F"	"H"	Revolutions per min. of countershaft.
18″x6′-0″	7′-2″	2′-10″	19″	6′-2″	25″	4″	12″	140
20″x8′-0″	9′-3″	3′-0″	20″	6′-2″	25″	4″	12″	140
22″x8′-0″	9′-6″	3′-6″	24″	8′-3″	34″	4½″	14″	130
24″x8′-0″	9′-6″	3′-6″	24″	8′-3″	34″	4½″	16″	125
26″x10′-0″	11′-6″	3′-10″	26″	10′-4″	36″	5″	18″	110
28″x10′-0″	11′-6″	3′-10″	26″	10′-4″	36″	5″	18″	110
30″x12′-0″	13′-9″	4′-6″	30″	12′-3″	46″	5½″	18″	85
32″x12′-0″	13′-9″	4′-6″	30″	12′-3″	46″	5½″	18″	85
36″x14′-0″	15′-8″	4′-9″	32″	14′-1″	32″	5½″	20″	85
*36″x14′-0″	15′-8″	4′-9″	32″	14′-1″	32″	5½″	20″	85
42″x14′-0″	15′-8″	4′-9″	32″	14′-1″	32″	5½″	20″	85
*42″x14′-0″	15′-8″	4′-9″	32″	14′-1″	32″	5½″	20″	85

Note.—Add 2 feet to "A" & "D" for every additional 2 feet of bed.

*Triple Geared Lathe.

Explanatory Note.—The tabulated figures above correspond to the following dimensions on the lathes:—

(A) length over all; (B) depth over all; (C) depth of pedestal base over all; (D) length over both pedestal bases; (E) length of each pedestal base over all; (F) face of countershaft pulley; (H) diameter of countershaft pulley.

(Number 3 Grinder.)

Emery Grinders.

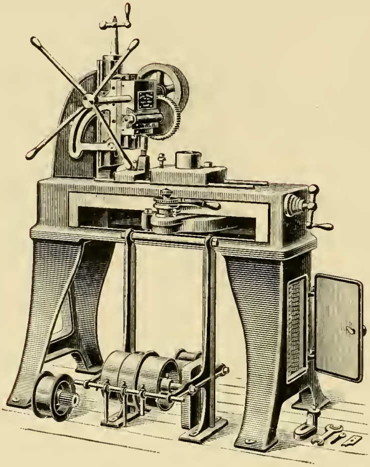
These Grinding Machines are made from new and improved patterns. All material and workmanship are first-class; the spindles are of steel, and the parts are nicely finished. All these Grinding Machines are provided with self-oiling bearings. The boxes and caps are milled together; the pulleys are forced on the spindle.

Table of Dimensions.

(In inches.)

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Diameter of wheels recommended	8	10	12	14	16	20
Distance between wheels	8	10¾	13	17½	20	24
Diameter of Spindle in bearings	¾	⅞	1 1-16	1¼	1⅜	1⅝
Diameter of Spindle between flanges	½	¾	1	1⅛	1¼	1½
Diameter of Pulley on spindle	2¼	3	3½	3&4	4&5	5&6
Width of Pulley	2	2½	3¼	3¼	3¾	4¼
Height from table to centre of spindle	5¼	6	6½	8	9	10½
Height from floor to centre of spindle	38½	38½	38½	37	36	36
T. & L. Pulleys on countershaft	3½x1¾	2½x5	6x3¼	6½x3¼	7½x3¼	9x3¾
Speed of countershaft	740	575	435	485	500	500

Machine Tools, Continued.



Whiton Gear Cutters.

This machine possesses convenience of adjustment and operations upon all varieties of work. It is operated by hand and is so simple and convenient that will produce a large amount of work.

It will cut Spur, Bevel and Worm Gears to 30″ diameter by 6¾″ space, six pitch and finer, and is especially effective on sizes under 15″. The cutter head may be set over at any angle to 90°, allowing the cutter to be fed at right angles to the work spindle if required. In this position the machine will conveniently finish special nuts, bolt heads, etc., by means of side or straddle mills, and will perform any radial milling. With the Center Attachment it will flute taps, reamers, etc., either straight or taper, and all similar milling work. With the Vise Attachment it forms a convenient hand milling machine well adapted to a variety of work.

The spindle fitted to receive standard trade cutters having ⅞″ holes. The machine will divide for all numbers to 100, every even number to 186, and a wide range of higher numbers.

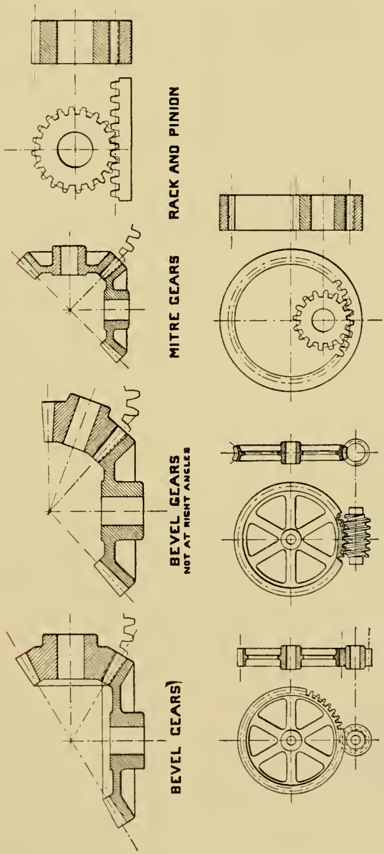
The Countershaft is very compact, and is provided with a simple, effective and self-contained belt-tightening device. Pulleys are 7″ in diameter for 2½″ belt, and should make about 275 revolutions per minute.

The Floor Space required is 27 by 42 inches.

Machine Tools, Concluded.

Gearing.

In calculating for gears, multiply or divide, as the case may be, by the number of teeth. With this modification, the rules for calculating the speed and size of pulleys, given on page 335, also applies to gears.



In ordering gears, the above diagrams illustrating the proper designations of the different kinds of gears, will be found useful. When "diameters" is mentioned, it is understood to be pitch diameter, unless the pitch diameter cannot be determined, in which case it is necessary to specifically state that the outside diameter is given. When ordering a gear or pinion separately, it is advisable to give distance between centers and number of teeth in gear and pinion to be engaged.

In ordering bevel or mitre gearing, it is necessary to give the angle of the shafts and the number of teeth in gear it is to engage; the pitch of the bevel gears is figured at the large pitch diameter.

When ordering a worm gear, give only outside diameter and lead of worm that it is to engage; the diameter of the worm is usually five times the circular pitch.

MILL ARCHITECTURE AND ENGINEERING.

While it is true that mill architecture pertains rather to the buildings themselves, and mill engineering to the technical considerations and problems affecting the installation of machinery and equipment, for the purposes of this article and for the sake of convenience the use of these two terms will be consolidated and discussed under the head simply of "Mill Engineering."

It is manifestly impossible, even in the scope of this work, to do any more than scratch the surface of this very general and very broad subject. In fact, every one of the preceding pages in all these volumes may be said to refer specifically to mill engineering, and the ground covered and data furnished in the same may be considered as sufficient preparation for plunging at once into the discussion of organization and equipment.

Organization.

As for the organization, that has already been covered on pages 1096-8. It seemed most conducive to clearness to let the chapter on that subject follow the one on the manufacture of yarns.

Machinery and Equipment.

The filling out of an organization sheet carries with it the number and kinds of the different machines as well as general specifications for the same.

From such a list of machinery, with the general specifications accompanying the same, the outfit of machinery and equipment is generally bought. The successful bidder then furnishes the purchaser with specification sheet in blank, which the purchaser, or his engineer, is requested to fill out in detail. It is hardly worth while for the purpose of this article to discuss these detailed specifications at length, as it would simply involve rehashing matter that has already appeared in the preceding pages.

It is not out of place, however, and may be found of some assistance to prospective purchasers in preparing their lists of machinery, for me to furnish a set of blank estimate sheets that I have gotten up for the use of my own engineering and machinery offices.

Estimates of Costs of Cotton Mills.

Under this heading, therefore, I append in the following pages blank copies of probably the most complete estimate sheet in use in the cotton mill trade. In our engineering business we have engineered over 125 cotton mills and have equipped complete nearly all of them, as well as have equipped nearly as many more designed by other engineers. In this work I have found it highly desirable that our customers should know in advance the approximate cost, within fairly close limits, of their plants when completed, and so we have gradually worked up to this unusually complete form of "Estimate."

As a matter of general information to the customer, these estimate sheets are preceded by an organization sheet.

Atlanta, Ga., STUART W. CRAMER, Charlotte, N. C.

COTTON MILL MACHINERY

COMPLETE EQUIPMENTS FOR NEW COTTON MILLS

REORGANIZATION OF OLD MILLS A SPECIALTY

STUART W. CRAMER,

ENGINEER AND CONTRACTOR.

AGENT FOR

The Whitin Machine Works.

Woonsocket Machine and Press Company.

Kitson Machine Company.

SOUTH TRYON STREET.
CHARLOTTE, N.C.

EQUITABLE BUILDING.
ATLANTA, GA.

Quotations subject to change without notice

All agreements are contingent upon strikes, accidents and other delays beyond our control

Address all communications to CHARLOTTE, N. C. unless otherwise requested

____________________ 190____

To________________________________

____

DEAR SIR: We Herewith Append Estimated Cost________________

Organization.

(Allowance made for contraction, waste, etc.)

Starting with a..........oz. lap.
Card Sliver ....grains, with....draft.
Sliver Lap ....grains, with....draft, doubling......into one.
Ribbon Lap ....grains, with....draft, doubling......into one.
Comber Sliver ....grains, with....draft, doubling......into one.
1st Drawing Sliver ....grains, with....draft, doubling......into one.
2nd Drawing Sliver....grains, with....draft, doubling......into one.
3rd Drawing Sliver ....grains, with....draft, doubling......into one.
Slubbing ....hank roving,....draft, doubling......into one
Intermediate Roving ..hank roving,....draft, doubling...... into one.
Fine Roving .... hank roving, ...draft, doubling......into one.
Jack Roving ....hank roving,....draft, doubling......into one.
Warp No. ....yarn,...........draft,.......... .....roving.
Filling No. ....yarn,...........draft,................roving.
To make **Yarns** ....average number,

....

Goods.. ....yards to the pound,........wide, ...Picks.

....

Estimated Production.

(Allowance made for stoppages, etc.)

Warp Spindles ....at......lbs. per spindle,................lbs.
Filling Spindles,..........at......lbs. per spindle,................lbs.
Total pounds per day of 10 hours ....
Looms ....
Total yards per day of 10 hours ....

Mill Engineering, Continued.

PICKING MACHINERY.

...... **Automatic Feeder,** .... @...... $..........

....**Opener,** .... @...... ....

....**Opener,** with **Automatic Feeder** attached .... @...... ....

....inch......**Beater Breaker Lapper** with **Automatic Feeder** attached, ... @...... ....

....inch......**Beater Breaker Lapper** with Screen Section, ... @...... ....

....inch......**Beater Breaker Lapper** with Condenser and Gauge Box, ... @...... ....

....inch......**Beater Intermediate Lapper,** .... @...... ....

....inch......**Beater Finisher Lapper,** .... @...... ....

...... **Kirschner Carding Beater on Finishers,** extra, ... @...... ....

....inch......**Beater Finisher** with **Feeder** attached, being **Combination Breaker and Finisher** .... @...... ....

Trunks and Dust Piping:

........ft. Robinson's Patent Automatic Cleaning Trunk, ... @...... ....

........ft. Perham's Patent Inclined Cleaning Trunk, ... @...... ....

........ft. Plain Conducting Trunk, ... @...... ....

........ft. Galvanized Iron Piping, ... @...... ....

.... **Roving Waste Opener,** .... @...... ....

...... **Card and Picker Waste Cleaner,** .... @...... ....

...... **Thread Extractor,** with **Condenser,** .... @...... ....

...... **5-Cylinder Cop Waste Breaking-up Machine,** .... @...... ....

Cotton Blowing Systems, ... Condensers, ... fans, ... piping,

Total, ... $..........

CARD ROOM MACHINERY.

.... **Improved Revolving Top Flat Cards,** ....cylinders, ...doffers, clothed and ground, ...coilers, ...hand, @...... $..........

Mill Engineering, Continued.

Card Room Machinery, Concluded.

Amount brought forward, $..........

Grinding Tackle as follows:......Traverse Grinders, ... @...... ....
........Long Roll Grinders, ... @...... ....
........Burnishing Brush, ... @...... ....
........Stripping Brush, ... @...... ....

...... **Lap Machines,** ....hand, @...... ....

...... **Ribbon Lap Machines,** ....hand, @...... ....

...... **Combers,** .... heads, ...hand, @...... ....

...... **Improved Railway Heads,** ....with ....inch coilers, @...... ....
..........Deliveries .... rolls for R. W. Heads, extra per delivery, @...... ....

...... Del. **1st Drawing,** ....coilers,........frames of......heads of.......del. each, @...... ....

...... Del. **2nd Drawing,** ....coilers,........frames of......heads of.......del. each, @...... ....

...... Del. **3rd Drawing,** ....coilers,........frames of......heads of.......del. each, @...... ....
..........Deliveries ....rolls, extra per delivery, @...... ....

...... **Slubbers,**.......... spindles each, ...bobbin, ...gauge,
..........total number of slubber spindles,..........per spindle, @...... ....
.... top rolls on slubbers, extra, per spindle, @...... ....

...... **Intermediates,**.......... spindles each, ...bobbin, ...gauge,
..........total number of intermediate spindles,..........per spindle, @...... ....
.... top rolls on intermediates, extra, per spindle, @...... ....

...... **Roving Frames,** .... spindles each, ...bobbin, ...gauge,
..........total number of roving frame spindles,..........per spindle, @...... ....
.... top rolls on roving frames, extra, per spindle, @...... ....

...... **Jack Frames,** .... spindles each, ...bobbin, ...gauge,
..........total number of jack frame spindles,..........per spindle, @...... ....
.... top rolls on jack frames, extra, per spindle, @...... ....

Roving Extras,
..........Parker Self-Oiling Steps on all frames,..........extra, per spindle, @...... ....
..........Contact Gearings on all frames, ...extra, per frame, @.. ....
Total, ... $..........

Mill Engineering, Continued.

SPINNING AND TWISTING MACHINERY.

Amount brought forward, $............

...... **Ring Warp Spinning Frames**, ... spindles each, ... traverse, ... gauge, ...double adjustable ring, rails bored for ....rings, single boss rolls, solid top rolls covered, scavenger rolls covered, 5 per cent. spare top rolls, 3 sets change draft and twist gears, common saddles, levers and lever screws, warp or combination builder, ... creels for ....roving, ... spindle, per spindle, @...... ....

...... **Ring Filling Spinning Frames**, ...spindles each, ... traverse, ... gauge, ...double adjustable rings, rails bored for ....rings, single boss rolls, solid top rolls covered, scavenger rolls covered, 5 per cent. spare top rolls, 3 sets change draft and twist gears, common saddles, levers and lever screws, filling or combination builder, ... creels for ....roving, ... spindle, per spindle, @...... ....

Spinning Extras:

........Automatic Separators on ....frames, per spindle, @...... ....

........Patent Lubricating Saddles, ... per spindle, @...... ....

........Patent Lever Screws, ... per spindle, @...... ....

.... @...... ....

.... @...... ....

.... @...... ....

...... **Wet Twisters**, ...spindles each, ...gauge, ... ring, creels .... spindle; per spindle, @...... ....

...... **Dry Twisters**, ...spindles each, ... gauge, ... ring, single line bottom rolls, creels .... spindle; per spindle, @...... ....

Twister Extras:

. ... Double Line Bottom Rolls, ...extra, per spindle, @...... ....

.... @...... ....

...... **Packing Charge on Spinning and Twisters**, extra, 2 per cent. of cost ....

Total, ... $............

Mill Engineering, Continued.

Amount brought forward, $..........

SPOOLING, WINDING, WARPING AND SLASHING MACHINERY.

...... **Spoolers**, ...spindles each, ...spools, ... gauge with
Prest Thread Guides and Wade Bobbin Holders,....................per spindle, @...... $..........
...... **Spoolers**, ...spindles each................spools, ... gauge, with
Prest Thread Guides and Side Spindles, ... per spindle, @...... ....
...... **Reels**, ...spindles each, to make.......skeins.......................... @...... ....
...... **Parallel Winders**, ...drums,............. traverse, per spindle, @...... ....
...... **Multiple Winders**, ...spindles each,.............ends up .... @...... ....
...... **Cone Winders**, ... spindles,............ traverse, per spindle, @...... ....
...... **Cop Winders**, ... spindles,........... traverse, per spindle, @...... ....
...... **Ball Winders**, ... spindles,........... traverse, per spindle, @...... ....
...... **Long Chain Quillers**, 378 spindles each, ... per spindle, @...... ....
...... **Quiller Extras:** ....reeds, @ ....; ....friction drums, @........... ....
..... **Beaming Machines**, ... @...... ....
...... **Slasher Warpers, with Creel**, for ....ends,.................................. @...... ....
...... **Leese Warpers, with Creel**, for .... ends,.................................. @...... ....
...... **Ballers**, ... @...... ....
...... **Multiple Ballers**, for making .... balls,............................... @...... ....
...... **Beams**, ... inch heads,............inches between heads, @...... ....
...... **Slashers** cylinders ....feet in diameter, creel for .... back beams,
............size boxes, ... headway,.............................. @...... ....
.... **Tape Dressing Machines**, cylinders ....feet diameter, creel for ....
..........back beams, ...size boxes,...................... headway, @...... ....
...... **Size Kettle**, ... gallons capacity,................................ @...... ....
...... **Size Pump**, ... @...... ....
...... Sets **Overhead Tramway, Carriage**, and **Differential Pulley Block**,.................. @...... ....
Total, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

WEAVING MACHINERY.

...... **Looms,** .... Pattern,..................inch reed space, @...... ....
...... **Looms,** .... Pattern,..................inch reed space, @...... ....
...... **Looms,** .... Pattern,..................inch reed space, @...... ....
...... **Looms,** .... Pattern,..................inch reed space, @...... ....
....
....
...... **Looms,** .... Pattern,..............................
.... @...... ....
...... **Dobbies,** ....index, for.............................. harness, @...... ....
...... **Dobbies,** ....index, for.............................. harness, @...... ....
...... **Dobbies,** ....index, for.............................. harness, @...... ....
....
....
....
....
....
....
....
....
Total, ... $..........

CLOTH ROOM AND DRY FINISHING MACHINERY.

...... **Railway Sewing Machine,** for ....inch width of goods, @...... $..........
...... **Railway Sewing and Rolling Machine,** for ....inch goods,
.... measuring attachment, ... @...... ....
...... **Inspecting and Trimming Machine,** for ....inch goods, @...... ....

Mill Engineering, Continued.

Amount brought forward, $..........

Amount Cloth Room Machinery brought forward,.. .... $..........

...... **Shearing and Brushing Machine,** No..........,for ....inch goods, ...emery rolls and........steel blade beaters, in front;......... card rolls, brushes and ....sets of shear blades for under side or face of goods, on top; ....card rolls, ...brushes, and.........sets of shear blades for the upper side or back of goods, on top; and........rolling brackets in rear, ... @...... ....

...... **Brushing Machine,** No........, for ....inch goods: ....emery rolls and ....steel blade beaters, in front; ....card rolls and ....brushes for each side of the goods .... @...... ....

...... **Calender Rolling Machine,** for ......inch goods; with ....steam calender rolls........inch and ....inch, ...steam vapor attachment, ...measuring attachment,........revolving stretch roll, with .... @...... ....

...... **Gas Singeing Machine,** for........inch goods; with ....burners for .... gas, to singe ....side of goods,................folding attachment, ...rolling attachment, ... @...... ....

..... **Gas Machine,** No........, ... @...... ....

...... **Loop Cutting Machine,** for ....inch goods, ... @...... ....

...... **Float Thread Shearing Machine,** for ....inch goods, ... stretch roll, @...... ....

...... **Nappers,** ....inch working width.. @...... ....

...... **Folding Machines,** for ....inch goods, with...................... frames and ....curved apron for the cloth, to fold............and.......... yard folds, ...automatic drop center attachment .... @...... ....

...... **Heavy Double Knuckle Jointed Baling Press** No............., ... Class, for baling ...., width tables............inches x ....inches in the clear between columns,........... inch piling room for goods, ...tons pressure, ... @...... ....

...... **Yarn Screw Baling Press,** .... @...... ....

Total, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

SPECIAL FINISHING MACHINERY.

Special Finishing Machinery for ....in goods:

(No. 1 OUTFIT.)

...... **Starch Mangle** with iron frames containing one bottom electro-deposited copper roll and one top rubber covered roll ....face x ....diameter, pressure attachment, attachments for receiving the goods, starch box with immersion roll, driving, etc. .... @...... $..........

...... **Back Starching Mangle** with iron frame, and nip stands containing one bottom electro-deposited copper roll and one top rubber covered roll............ face x .... diameter. pressure attachments, large wooden drum with necessary attachments for back starching the goods, means for receiving the goods, starch tub and driving, ... @...... ....

...... **Upright Drying Machine**, with .... cylinders, ...inch face x 23" diameter fitted with patent spiral scoops, complete ready for the piping to be brought to it, ... @...... ....

...... **Return Tenter**, ...feet long; tenter for goods up to ....inch wide, fitted with ....chain, with either 2-drum winder for batching up the goods or folder for plaiting them down, ... @...... ....

...... Set of **Automatic Feeding Attachments for Tenter**, ... @...... ....

....inch **Blower** with ....feet of 1" steam heating pipes and galvanized iron pipe for conducting hot air to tender,.................... @...... ....

...... Pair of **3-Step Cone Pulleys** with necessary counters, hangers, etc., and friction clutch to drive tenter,.................... @... ....

...... **Double 5"x6" Angle Engine**, ... @...... ....

...... Pair of large Iron **Cone Pulleys** with counters, hangers and belt shipped to drive tenter in connection with dryer, ... @...... ....

...... Pair of small Iron **Cone Pulleys** with belt shipped to drive dryer in connection with starch mangle, ... @...... ....

Total, as above, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

Special Finishing Machinery, Continued.

(No. 2 OUTFIT.)

...... **Starch Mangle** with iron frames containing one bottom copper electro-plated roll and one top rubber covered roll........ face x........diameter pressure attachments, attachments for receiving the goods, starch box with immersion roll, driving, etc., ... @...... $..........

...... **Horizontal Drying Machine,** with ....cylinders, each ....face x ....diameter, fitted with patent spiral scoops; dryer to be complete with driving by tight and loose pulley, ready for the piping to be brought to it .... @...... ....

...... **Expansion Pulley** ....diameter x ....face, to drive the starch mangle in connection with the drying machine, ... @...... ....

...... **2-Drum Winder** for batching up the goods, or a folder for plaiting down the goods, @...... ....

...... Pair of **3-Step Cone Pulleys,** with counters, hangers, and friction clutch for driving the drying machine .... @...... ....

...... **Double 5″x6″ Angle Engine,** .... @...... ....

Total, as above, ... $..........

(No. 3 OUTFIT.)

...... **Sprinkling Machine** for goods up to........in width, consisting of iron frame, wood drum for batching up the goods, water box with bristle brush, necessary attachments for receiving the goods, driven by a tight and loose pulley, ... @...... $..........

.... **Roll Calender,** heavy iron frame, containing ......rolls ....on the face x 18″ in diameter, 1 top chilled iron roll 14″ in diameter, one bottom chilled iron roll 16″ in diameter, one intermediate chilled iron roll 12″ in diameter, all iron rolls fitted for steam; attachments for lifting and separating the rolls, attachments for receiving and delivering the goods, driven by iron gear and pinion and friction pulley 28″ x 8″ .... @...... ....

...... **Bronze Covered Barrel Stretcher** 16″ in diameter .... @...... ....

Total, as above, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

Special Finishing Machinery, Concluded.

(MISCELLANEOUS.)

...... **Roll Calender**, with heavy iron frame, containing......rolls .... face x...... diameter and ...... chilled iron rolls ....diameter, fitted for steam; pressure by compound levers through the frames, or by compound levers over the frames, top screws and hand wheels; attachments for receiving and delivering the goods; to be driven by friction pulley .... diameter x ....face, ... @...... $..........

.......**Doubling Machine**, ..., delivering .... inch goods, @...... ....

...... **Board Winders and Measurers**, ... @...... ....

...... **Hydraulic Press**, with ram ......in diameter to work under ....tons pressure; table to be ....x ....in the clear between columns; columns to be made from the best picked scrap and necessary length so that the press will show.... inches of daylight when the table is way down,.............................. @...... ....

...... **3=Plunger Hydraulic Pump** to operate under........pounds pressure to the square inch, complete with iron tank, piping to connect it with the press, provided it is not placed more than 15 feet away; necessary gauges, valves, etc., ... @...... ....

...... **Steam Actuated Pump**, ... x........ x.......... to work against .... pounds pressure, to have the necessary iron tank, piping, provided it is not placed more than 15 feet away from the press, valves, gauges, etc., ... @...... ....

....

....

....

....

....

....

Total, as above, ... $..........

Mill Engineering, Continued.

Amount brought forward, $.........

DYE HOUSE MACHINERY.

(FOR RAW STOCK.)

...... **Raw Stock Dyeing Machines,** .... @...... $.........
...... **Hydro Extractors,** ....driven, ...inch........................ basket, @...... ....
...... **Raw Stock Dryers,** .... sections, tinned,........................ @...... ....
...... **Blower Systems,** for handling dyed and dried stock .... @...... ....
...... **Cotton Press,** for handling dyed and dried stock,........................ $.........
Total, as above, ...

(LONG CHAIN OR SCOTCH SYSTEM.)

...... **Warp Boiling-out Machine,** ....iron tanks, each with nip stands containing one bottom iron roll 15" diameter and one top rubber covered roll ....diameter, pressure attachments; hot water compartment to have nest of ....copper cylinders .... face x ....diameters on iron frame; cold water compartment, one copper cylinder on iron frame ....face,........diameter; complete with driving, overhead rigging, reels, pin rails, etc., to run through .....warps at once, @...... $.........

...... **Warp Doubling Machine** to hang from ceiling, complete with traverse motion and folder to plait down the warps; driving by tight and loose pulley,............... @...... ....

...... **Scotch Dye Tubs** each with wooden tubs 54" diameter, with nip stands containing 2........ rolls 18" face x........ diameter, brass immersion frame supporting 5 brass rolls..........inch diameter, and brass guides, square tin beater rolls for entering the warp and a roll to deliver; driving by tight and loose pulley, ... @...... ....

...... **Warp Splitting Machine,** ....feet long, to split ....warps at once, complete with drag rolls and hanger and necessary counter and pulleys; driving by tight and loose pulleys .... @...... ....

Mill Engineering, Continued.

Amount brought forward, $..........

Dye House Machinery, Continued.

Amount Long Chain Dye Machinery brought forward,...................... $..........

...... **Upright Warp Drying Machine,** ....cylinders ....face x 23″ diameter, arranged in.......... columns of ....cylinders each, cylinders fitted with patent spiral scoops; to have necessary small wood rolls, pin rail, etc., to receive and deliver ....warps at once; complete with driving by tight and loose pulley, ready for piping to be brought to it, ... @...... ....

Total, as above, ... $..........

(**FOR INDIGO WARP DYEING.**)

...... **Warp Boiling-out Machine,** ....iron tanks, each with nip stands containing one bottom iron roll 15″ diameter and one top rubber covered roll ....diameter, pressure attachments; hot water compartment to have nest of..... .. copper cylinders .... face x........ diameter on iron frame; cold water compartment, one copper cylinder on iron frame........ face,.........diameter; complete with driving, overhead rigging, reels, pin rails, etc., to run through ....warps at once, ... @...... $..........

...... **Sets of Iron Tanks,** ....tanks to each set; each tank 8 ft. long x 7 ft. deep x 30″ wide made up of cast iron plates ....complete overhead riggings, to be operated with the indigo vats consisting of wooden frame, brass carrier rolls, necessary pin rail, nip rolls and driving,.. @...... ....

...... **Upright Warp Drying Machine,** ....cylinders ....face x 23″ diameter, arranged in.......... columns of ....cylinders each, cylinders fitted with patent spiral scoops; to have necessary small wood rolls, pin rail, etc., to receive and deliver ....warps at once; complete with driving by tight and loose pulley, ready for piping to be brought to it, ... @...... ....

...... **Indigo Grinding Machine,** with iron frame, supporting iron cylinder 60″ face with weights, driving, etc., ... @...... ....

Total, as above, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

Dye House Machinery, Concluded.

(SHORT CHAIN OR ENGLISH SYSTEM.)

...... **Warp Boiling-out Machine,** ....iron tanks, each with nip stands containing one bottom iron roll 15" diameter and one top rubber covered roll ....diameter, pressure attachments; hot water compartment to have nest of........ copper cylinders .... face x........ diameter on iron frame; cold water compartment, one copper cylinder on iron frame........ face,........diameter; complete with driving, overhead rigging, reels, pin rails, etc., to run through......warps at once, @...... $..........

...... **Warp Dyeing Machine, Single Compartment,** with wood tubs 50" long x 30" deep x ....wide, supported in iron frame with nip stands bolted to the iron frame, or else no supporting iron frame and nip stands bolted to wood tub; nip stands containing two........rolls........face x........diameter, with pressure attachments, lever........, immersion rolls,.......inch diameter; driving by tight and loose pulley; pipe overhead rigging with pin rail, bars, reels, etc., to receive and deliver........warps at once.. @...... ....

...... **Warp Dyeing Machines**................ **Compartment** with wooden tubs, each 50" long x 30" deep x..........wide, supported in iron frame and nip stands bolted to wood tub; nip stands containing two ....roll ....face x .... diameter; driving by tight and loose pulley; pipe overhead rigging with pin rail, bars, reels, etc., to receive and deliver ....warps at once .... @...... ....

...... **Single Warp Sizing Machine,** wooden tub, each compartment 12 ft. long x 24" deep x 14" wide, supported on iron legs; nip stands containing 2.......... .... rolls .... diameter, with pressure attachments; each compartment to have four brass immersion rolls supported on brass frame with brass guides for the warps; machine to be driven by tight and loose pulley, and to have pipe overhead rigging with rolls, pot eyes and reels for receiving and delivering two warps at a time in each compartment, ... @...... ....

...... **Upright Warp Drying Machine,** ....cylinders ....face x 23" diameter, arranged in.......... columns of ....cylinders each, cylinders fitted with patent spiral scoops; to have necessary small wood rolls, pin rail, etc., to receive and deliver ....warps at once; complete with driving by tight and loose pulley, ready for piping to be brought to it, ... @...... ....

Total as above, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

POWER PLANT.

(STEAM)

Engine: .... Corliss Engine, cylinders........ inch and ....inch, stroke........inch, wheel ...., to develop ....I. H. P. at ......cut-off, ...lbs. steam pressure, and ....inch vacuum, when running at .. ..revolutions per minute, ...

Boilers: .... tubular, each with ....inch tubes, (........ high), designed for steaming at ....lbs and set for..........lbs. ....sq. ft. heating surface, rated at..........H. P. each ....

Superheaters ....

Condensing Apparatus, ...
....

Feed Water Heater: ....

Feed Water Pumps: ....

Fuel Economizers: ....

Mechanical Draft: ....

Fuel Handling Apparatus: ....

Overhead Traveling Crane: ....

Piping: ....

In General: ....
....
....
....
....

Total, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

Power Plant, Concluded.

(WATER.)

Turbines: .... wheels, each developing ....H. P. at ....revolutions per minute under ....feet head ....

.... aggregating ....H. P.,

Rotary Fire Pump: ....

Sheaves and Pulleys: ....

Gearing and Trusses: ....

Governor: ....

Flumes and Casings: ....

Gates and Gearing: ....

Total, ... $..........

(ELECTRIC.)

Steam Turbines: .... direct connected to ....generators, steam at .... lbs. pressure and ....degrees F. superheat, vacuum ....inches,

Generators: ....K. W. ....Volt, ...Cycle ....Phase ....Generator, designed to run at ....revolutions; arranged for ....

Exciters: ....

....

Switchboards: ....

....

Transmission Circuits: ....

....

Transformers: ....

....

Motors: ....

....

Total, ... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

SUNDRY EQUIPMENT.

Electric Lighting: ....

.... $..........

Shafting, Pulleys, and Hangers: ....

....

Fire Protection: ....

....

..........gallons Underwriter fire pump,.......... ....

Heating: ....

Humidifying Systems: .... Inside Type Air Conditioners,..........

.... Ventilating Type Air Conditioners, ...

Conditioners .... .driven.......... ....

Automatic Regulation for Heating and Humidifying Systems:.......... ....

Time Detector: ....

Electric Pumping Outfit: ....

....

....

Telephone System: ....

....

Auxiliary Engine: ....

....

....

Machine Tools: ....

....

....

Mill Engineering, Continued.

Amount brought forward, $..........

Sundry Equipment, Concluded.

Sundry Equipment brought forward, ... $..........

Belting and Supplies: ....
....
....
....
....
....
....
....
....

Total, ... $..........

Machinery and Equipment, as per foregoing estimate, ... $..........

FREIGHTS AND ERECTION.

Estimated car loads ....

Estimated time required to install, erect and put into operation after buildings are completed ....

....

Cost on above basis, including services and traveling expenses of men to erect where not already included in the foregoing prices, common labor, etc., ... $..........

Incidentals, ... $..........

Estimated Cost of Machinery and Equipment Installed Complete and ready to operate, (not including buildings or real estate) .... $..........

Mill Engineering, Continued.

Amount brought forward, $..........

BUILDINGS AND SITE.
(INSIDE DIMENSIONS.)

Main Mill: .... stories, ...wide, ... long,

....

....

....

Opening Room, ...

Lapper Room, ...

Card Room, ...

Spinning Room, ...

Slasher Room, ...

Weave Room, ...

Cloth Room, ...

Main Tower, ...gallon tank,

Elevator Tower, ... elevator,

Water Closet Tower, ... plumbing,

Belt or Rope Way, ... $..........

Power House: ....

....

Engine Room, ...

....

Repair Shop, ...

Boiler Room, ...

Fan Room, ...

Pump Room, ...

Stack, ...

Mill Engineering, Continued.

Amount brought forward, $..........

Buildings and Site, Concluded.

Amount Buildings and Site, brought forward, ... $..........

Dye House ....

Mill Office, ...

Warehouse, ... stories, ... compartments;

each .... wide,.......................... long,

Opening Room, ...

....

Waste House, ...

Reservoir, ...

Steel Tower, ... feet high, with...............gallons steel tank,...... ....

Operatives Houses:

Superintendent's House, ...

........Overseers' Houses,.................. .... @ ....

........Four Room Houses, ... @ ....

........Three Room Houses, ... @ ....

Site and Development .... acres, ...

Dam, Head and Tail Races, Masonry Work, etc., for water power development,............ ....

Buildings, Site and Development .... $..........

TOTAL ESTIMATED COST, ... $..........

REMARKS:

....

....

Respectfully submitted,

STUART W. CRAMER,

Per..

Mill Engineering, Continued.

SHIPMENTS OF TEXTILE MACHINERY.

For the general information of Southern buyers it is perhaps well to mention that cotton mill machinery takes the same rates from practically all New England points. The classification is 6th Class Specific, and applies to cotton mill machinery peculiar to cotton mills, also to roving cans; in straight or mixed car loads released; minimum car load 20,000 pounds;—does not apply on electrical machinery, engines, boilers, blowers, shafting or pulleys. For estimating purposes the rate can generally be taken at fifty cents per hundred pounds. Also it makes very little difference whether an order comes from one single shop, or is split up and comes from two or three different shops, for it will almost always happen that there will be at least one car load from each one of the different points, and anything over but still less than a car load can be billed with the full car at the same rate. Occasionally small shipments can be made to the machine shops and reshipped with the machinery to advantage; this practice is peculiarly the case in regard to roving cans,—at the same time, I question whether it pays, because the cans are often damaged in transit by being bruised or mashed out of round, too little to make a claim on the railroad for damages and yet enough to render their use more or less undesirable.

It is manifestly impracticable to attempt to give a schedule of the weight of different kinds of cotton mill machinery, as there are differences in weights peculiar to each builder, not to mention differences in weight according to specifications by the same builder. At the same time, as our customers have often asked for information as to the number of machines of each kind constituting a car load, I herewith append an approximate schedule as follows:

Picking Machinery.—Generally three one-beater finishers, or three machines of like size.

Cards.—Four 40″ or 45″ revolving top flat cards.

Sliver Lap Machines, Ribbon Lap Machines, Combers.—Four 6-head combers, two sliver lap and two ribbon lap machines: or, ribbon lap machine in place of 6-head comber; all set up.

Four 8-head combers, boxed, make a car load; cannot ship them set up.

Drawing.—Four 6-delivery heads, crated.

Slubbers, Intermediates, Roving and Jack Frames.—Four frames are usually considered a car load, but if they are not too long, five can be squeezed into a large car; in the case of six, however, the shipment would be divided into two cars, as three machines will exceed the minimum car load rate.

Mill Engineering, Continued.

Machinery Car Loads, Concluded.

Spinning, Twisters and Spoolers.—Six frames of average length constitute a car load.

Reels.—Fifteen to twenty, knocked down and boxed.

Cone Winders.—Two machines of 100 spindles each, shipped in sections; the weight will be only 14.000 or 15,000 pounds but it will pay to ship at minimum car load rate of 20.000 pounds.

Slashers.—One standard slasher is usually shipped as a car load, and must be placed on a flat car; sometimes in a shipment of say five slashers, the ten cylinders can be placed on two flat cars and the rest of the machinery in two box cars, thereby saving one car. The actual weight per machine is only 12,000 pounds to 15.000 pounds, but it pays to bill it as a car load.

Warpers.—Eight complete slasher warpers with creels; or
Six complete slasher warpers with creels and fifty beams; or,
Twelve slasher warpers without creels; or,
Six leese warpers complete with creels and ballers; or,
Eight leese warpers including ballers without creels; or,
Twenty beamers complete with tension ends..

Quillers.—Four quillers set up; six or more boxed.

Looms.—Twenty plain heavy pattern 40″ looms; other sizes in proportion.

Cloth Room Machinery.—Roughly stated, two sets of cloth room machinery of average size for 40″ goods constitute a car load, viz.,

Two sewing machines,
Two brushers with calender rolling machines,
Two folders, and
Two inspecting machines.

Presses.—These are strictly matters of weight ,as they are relatively very small and compact. It will generally pay to have a First Class Heavy Press billed as a car load, whether it weighs 20,000 pounds or not. The small and lighter machines, however, can best be shipped at actual weight, less than car loads.

Nappers.—Two or three nappers.

Mill Engineering, Continued.

THE "HAND" OF TEXTILE MACHINERY.

The foreign and domestic practice in regard to the designation of the hand of different machines are diametrically opposite. Generally speaking, in America the observer stands facing the front or delivery end of the machine, noting whether the driving pulley is on the right or left, and designates the hand of the machine accordingly; abroad the custom is usually just the opposite, and the observer stands facing that part of the machine into which the cotton is fed.

It is well to point out, however, that in the case of picking machinery the question even in this country is in doubt. Lappers are generally built only one way, as the countershaft is overhead attached to the machine; at the same time, it is the custom for picker shops to face the feeding-in end of the machine and to term the parts to the left of the observer "left hand" and those on the right hand side of the machine "right hand." Cards, drawings, sliver lap machines, ribbon lap machines, combers, slubbers, intermediates, roving and jack frames, quillers, warpers, slashers, looms, and reels, all follow the regular American custom of designation. Spinning frames, spoolers, twisters, winders, and other two-sided machines are of course not referred to either as right or left hand; but for convenience of reference, the driving end is termed the head end and the opposite end the foot or tail end.

In cloth room machinery the custom is again uncertain, and the hand of the machine is usually reckoned from the "feeding-in" end (where the cloth enters), when referring to inspecting machines, sewing machines, brushers, shearers, calender rolling machines, singeing machines, etc.: on folders it is usually reckoned from where the operator stands,—as on gray goods the cloth is generally fed in from the back of the crank shaft, while on finished goods it is fed in from back of the operator.

*POWER REQUIRED TO DRIVE COTTON MACHINERY.

It is a curious fact that until the introduction of the electric drive into cotton mills, the question of the amount of power required to drive cotton machinery had not been given the attention that it would seem to have merited regardless of the method of driving. Engineers and mill men seemed satisfied with a comparatively meager knowledge of the actual

*The friction load of the shafting, belting, etc., is not to be lost sight of in making power calculations and varies from 15 per cent. to 25 per cent. in modern mills,—even 35-40 per cent. being by no means unheard of in old mills.

power required to drive different machines as long as they had fairly accurate data on the total horse power reuirqed to drive the complete complement of machinery in mills on different classes of goods. This statement can be confirmed by consulting the various tables of horse power heretofore published in the catalogues issued by the different shops, and elsewhere.

It is easy to see how this condition of affairs came about when we reflect that in proportioning the sizes of shafting, pulleys, and belting, not only was sufficient leeway allowed to cover variations within comparatively wide limits, but also there was no convenient method of checking up the power actually consumed by the different machines, sections, or even departments,—inaccuracies and errors in judgment in determining the size of belts showing themselves generally in the shape of unequal slippage of belts with attendant irregularity and loss in production. The only checking up of the amount of power consumed in mechanically driven mills consisted of indicating the engine from time to time both for the full load and the friction load,—and even any attempt at system in this respect was confined to relatively few mills.

As above indicated, the advent of electric driving, however, has introduced two new factors into the engineering problem that make it at once apparent that something more is desired in the way of definite knowledge as to the amount of power required to drive individual machines; these factors are,

(1). Meters indicating at all times the amount of power consumed not only in each department and each section, but by each motor; and

(2). The subdivision of power whereby the different departments, sections, and even individual machines are driven by separate motors.

In our own first work in connection with electric drives, we found difficulty in securing anything like reliable data on which to base an intelligent and correct apportionment of the size of motors, and so two or three years ago when we were called upon to do the engineering work for the Highland Park Manufacturing Company not only in connection with their new No. 3 Mill, but to design and install their large central station power plant, I determined to thoroughly investigate this question of the power required to drive cotton machinery.

I found that the Kitson Machine Company, in response to this same demand for better power data, had just completed a series of tests on the power required to drive picking machinery, but had not yet published the results obtained.

The Woonsocket Machine & Press Company had several years ago made a fairly complete series of tests showing the horse power required to drive slubbers, intermediate, roving and jack frames, of both the old and the new type. This series

Mill Engineering, Continued.

Power Required to Drive, Continued.

of tests had been made by them to show that among other advantages their new frames with vertical shaft consumed considerably less power than frames of their own or other makes using the old style horsehead.

The Whitin Machine Works made a series of tests in 1897, 1898, and 1899, which showed a number of interesting details, but the tests were really more interesting as an analysis of power, and consequently more useful to the manufacturer of machinery than to the mill engineer. These tests were deemed sufficient at the time, however, and the general deductions as to the horse power required to drive were published in the Whitin catalogues.

The Draper Company had also published in their "Textile Texts" a very complete discussion of the power consumed in driving spinning, accompanied by analytical tables showing the sub-divisions of the power in a most interesting manner.

The above constituted the stock of up-to-date and reliable data available at that time.

I then brought the whole subject to the attention of Mr. G. M Whitin, of the Whitin Machine Works, who immediately arranged to have a complete series of tests made covering all the machinery built at the Whitin shop. Very complete preparations were made for conducting these tests that the engineering staff to which it was entrusted might have at their disposal every facility not only for making the many tests that would be required expeditiously but also with the greatest of accuracy. The Whitin shops being largely electrically driven, it was comparatively easy to duplicate in their testing rooms the normal conditions under which the machinery should be electrically driven in the cotton mills themselves. Special motors and and electric testing sets were ordered to check the readings of the mechanical power scale and dynamometers.

The following tables of "Horse Power Required to Drive" have been compiled from the reports, tabulated results, and observations made in the tests conducted as above described by the Whitin, Kitson and Woonsocket shops, with such slight modifications that have been suggested in the light of subsequent observation. Unfortunately, it has been impracticable to obtain from the manufacturers of sundry and miscellaneous equipment equally reliable data; but no pains have been spared to obtain this data from as many different sources as possible and to check it up in every available way, the result being that the figures that we have adopted will, we believe, represent a fair average of what will actually be required under normal conditions.

It is not out of place to call attention at this point to a phase in the general subject of power required to drive, of which no account will be taken in this discussion for obvious reasons; I refer to the well-known fact of the increased power required at all times to start up machinery when it is cold, this being particularly noticeable on Monday mornings. Mention of this has already been made elsewhere.

Nor is it necessary to more than call attention to the simple fact that the power required to drive machinery depends upon its cleanliness, its being set level or plumb, as the case may be, its alignment, and in short, its general conditions. The tables are of course prepared on a basis of machines properly set, oiled, cleaned and otherwise cared for.

Just here I feel it my duty to emphasize one thing in connection with electric driving to which proper attention is not being paid:

It is better to err on the side of underloading motors than overloading them. Up to within the past year or two the builders of electric machinery rated their motors very liberally,—overload capacities of 25 to 33⅓ per cent. being the usual thing. Under the stress of competition, however, this condition of affairs has changed until it is not safe to count upon a motor carrying more than its rated load without undue heating. A spinning room will run hot normally because of the frictional heat; when to the frictional heat of the machinery is added the heat thrown off from an overloaded motor, it is impossible without a considerable expense to keep such a room from being frightfully hot in summer time,—each overloaded motor acting as a big stove and throwing off an amount of heat that could not be appreciated until actually experienced.

Caution!

In using the following tables it should be borne in mind that they are based upon the machinery being in perfect condition, whereas machinery in actual operation in the average mill is not kept so by any means. An allowance of 10% to 15% should be made on this item alone,—particularly in the case of spinning and twisting.

As already stated, the friction of the shafting should also be allowed for, and varies from 10% to 25%, depending upon the layout, its alignment, condition as to lubrication, etc.

As has been noted elsewhere, the effect of excessive humidity on the power required to drive is considerably more than is generally supposed to be the case. Sufficient humidity to cause the work to run well is not only desirable, but absolutely necessary. Excessive humidity is costly, not only on account of the work's not running so well, breakages in spinning, for instance, being more frequent, but also on account of the extra amount of power required to drive,—the extra power being due to the "drag" of the fibre in its unnecessarily moistened condition, and to the increased band pull due to the effect of excessive moisture on the spindle bands. In the case of a mill in which the humidity and temperature are not regulated and uniformly maintained, an extra allowance of at least 10 per cent. in motor capacity should be provided for.

Mill Engineering, Continued.

Power Table for Picking Machinery.

(Temperature 70° F.; Relative Humidity 50%.)

Kind of Machine.	Horse Power Based on the following production per day of 10 hours.			
	Production.		Horse Power	
	40″	45″	40″	45″
Automatic Feeder	4000		.5	
0.7 Opener with Automatic Feeder	3000		2.5	
Cylinder Opener with Automatic Feeder	3000		3.5	
One-Beater Breaker Lapper with Automatic Feeder attached	3000	3500	4.5	5
Two-Beater Breaker Lapper with Automatic Feeder attached	3500	4000	7	7.7
One-Beater Breaker Lapper with Condenser and Gauge Box	3000	3500	7.5	8
Two-Beater Breaker Lapper with Condenser and Gauge Box	3500	4000	10	10.5
One-Beater Breaker Lapper with Screen Section	3000	3500	6	6.5
Two-Beater Breaker Lapper with Screen Section	3500	4000	8.5	9
One-Beater Intermediate Lapper	2000	2500	5	5.5
Two-Beater Intermediate Lapper	2500	3000	7.5	8
One-Beater Finisher Lapper with Kirschner Carding Beater	2000	2500	4.5	5
Two-Beater Finisher Lapper with Kirschner Carding Beater	2500	3000	7	7.5
Card and Picker Waste Cleaner with Automatic Feeder	2500		3	
No. 3 Roving Waste Opener (two sections)	2000		5	
Cop Waste Breaking up Machine (five sections)	900		15	
Thread Extractor with Condenser	500		1.5	

Working cotton from compressed bales requires more power.
Increasing the production increases the power required to drive.
In dry weather considerably less power is required than in damp or rainy weather, the cotton working "heavy," as is termed.

Power Table for Blowing Systems.

(For Conveying Cotton from the Warehouse to Lapper Room.

Type of Machines.	Capacity per day of 10 hours	Horse Power.
1 O. S. Condenser, with self-contained Fan	15,000	2.00
1 No. 6 Fan,		5.25
1 Amoskeag Condenser,	25,000	.50
2 No. 6 Fans, each		5.25

Mill Engineering, Continued.

Power Table for Revolving Top Flat Cards.

(Temperature 70% F.; Relative Humidity 65%.)

Production in Pounds per day of 10 hours.		Weight of Card Sliver in grains per yard.	Horse Power.	
40″	45″		40″	45″
72	80	36	.76	.84
81	90	38	.81	.90
90	100	40	.90	1.00
99	110	46	.95	1.06
108	120	48	1.01	1.12
126	140	52	1.07	1.19
133	148	56	1 12	1.24
142	158	60	1.17	1.30
159	177	64	1.23	1.37
171	190	68	1.26	1.40
180	200	72	1.31	1.45
198	220	76	1.38	1.53

Revolutions per minute of Cylinder, in each case, 165.

Power Table for Combing Machinery.

(Temperature 70° F.; Relative Humidity 65%)

Machine.	Production in lbs. per day of 10 hours.	Horse Power.
Sliver Lap Machine,	750	.50
Ribbon Lap Machine,	750	1.
Comber, 6 heads,	75	.50
Comber, 8 heads,	100	.60

Power Table for Railway Heads and Drawing Frames.

(Temperature 70° F.; Relative Humidity 65%.)

Machine.	Revolutions of front roll.	Production in pounds per day of 10 hours.	Horse Power per Delivery.
Railway Head, shell rolls,	430	300	.33
Railway Head, Metallic rolls,		390	.50
Drawing Frame, Head of 6 deliveries, shell rolls,	350	185	.20
Drawing Frame, head of 6 deliveries, Metallic rolls,		240	.25

Increasing or diminishing the production correspondingly affects the power required to drive.

While the question of humidity very markedly affects the performance of this machinery, it but slightly affects the power required to drive.

Mill Engineering, Continued.

Roving Machinery.

(Temperature 76° F.; relative humidity 65%.)

Frame.	Number of Spindles.	Size of Bobbin, in inches.	Gauge, in inches.	Revolutions of Spindles, per minute.	Revolutions of Main Shaft, per minute.	Number of Roving.	Horse Power, per Frame.	Spindles, per Horse Power.	Type of Frame.
Slubbers,	*48	12 x 6	10	660	344	.50	1.00	48	New
	48	11 x 5½	9	657	343	.60	.83	58	New
	48	11 x 5½	9	638	333	.58	1.00	48	Old
Intermediates,	108	9 x 4½	6½	938	460	1.47	1.75	62	New
	90	9 x 4½	6½	969	475	1.47	1.72	52	New
	90	9 x 4½	6½	1000	490	1.47	2.08	43	Old
Roving Frames	160	7 x 3½	5¼	1207	393	4.75	1.62	99	New
	160	7 x 3½	5¼	1176	383	4.75	1.67	96	Old
	160	7 x 3½	5	1382	450	3 33	2.31	69	Old
	160	7 x 3½	5	1428	465	5.10	1.83	87	New
	160	7 x 3½	5	1443	470	5.10	2.13	75	Old
Jack Frames.	160	6 x 3	4½	1520	495	8.33	1.80	89	New
	200	6 x 2½	4¼	1538	503	15.00	1.92	104	New
	200	6 x 2½	4¼	1480	484	15.00	1.76	114	New
	200	6 x 2½	4¼	1477	483	15.00	1.76	114	New
	200	6 x 2½	4¼	1446	473	15.00	1.80	111	New
	184	6 x 2½	4¼	1556	509	15.00	1.69	109	Old
	176	6 x 2½	4¼	1544	505	15.00	1.68	105	Old

Notes.

All of the results with the exceptions noted, were obtained in actual tests from frames regularly running in a cotton mill; the results show very distinctly how much less horse power is required to drive the frames with the vertical shaft than those with the old style horse head. Frames marked "new" contain the vertical shaft; frames marked "old" contain horse heads.

Power taken at intervals shows only a slight variation from empty to full bobbins.

Increased production obtained either by speeding up or heavier hank roving will cause a corresponding increase in the power required.

The question of humidity is not as important as with cards or spinning, but still should be carefully regulated.

*Calculated.

See page 1161 for allowances to be made for friction, etc.

Power Table for Ring Spinning Frames.

(Temperature 76° F.; Relative Humidity 50%; Band Pull two pounds.)

Warp Yarn (Standard Warp Twist).									Filling Yarn (Standard Filling Twist).									
Number Yarn.	Space of Frame.	Size of Spindle.	Diameter of Ring.	Length of Traverse.	Front Roll Revolutions per min.	Spindle Revolutions per min.	Cylinder Revolutions per min.	No. of Spindles per horse power.	Space of frame.	Size of Spindle.	Diameter of Ring.	Length of Traverse.	Front Roll Revolutions per min.	Spindle Revolutions per min.	Cylinder Revolutions per min.	No. of Spindles per horse power.	Number Yarn.
6	3″	Large Whitin Gravity	2″	7¼″	161	5900	814	85	2¾″	Medium Whitin Gravity	1½″	7½″	178	4800	662	142	6
8					158	6700	920	74					175	5450	752	140	8
10					154	7250	1000	68					171	5950	821	125	10
12		Medium Whitin Gravity		7″	150	7750	1069	76				7″	166	6350	876	122	12
14					146	8100	1124	72					162	6700	924	120	14
16					141	8450	1166	70					158	6950	959	116	16
18					138	8750	1207	72					154	7200	992	110	18
20					134	8950	1280	74					150	7400	1021	98	20
24				6½″	125	9200	1280	76					144	7800	1070	87	24
28	2¾″	Standard Whitin Gravity	1¾″		120	9500	1140	76		Standard Whitin Gravity	1⅜″	6½″	140	7900	949	86	28
32					114	9500	1140	78					135	7900	949	88	32
36					108	9700	1164	73					129	7900	949	90	36
40			1⅝″	6″	106	9700	1164	80			1¼″	6″	122	7900	949	90	40
45			1½″		100	9700	1164	83					115	7900	949	91	45
50					94	9700	1164	86					109	7900	949	93	50
60					86	9500	1140	90				5½″	100	7900	949	97	60
70					80	9500	1140	94					92	7800	936	100	70
80					76	9300	1130	100					87	7700	924	104	80
90			1⅜″	5½″	72	9100	1090	108					80	7400	888	110	90
100					66	8700	1044	114					75	7200	864	117	100
110					64	8500	1020	127					70	6900	830	132	110

Notes.—See pages 366-375, 959-961 and 1209-1220 for effect of humidity on power; and page 1161 for allowances to be made for friction, etc. The 3 inch space frame was of 240 spindles; the frame of 2 3-4 inches space was of 256 spindles.

Mill Engineering, Continued.

Power Tables for Twisters, Spoolers, Reels, Quillers and Looms.

Machine.	Number of Spindles to Frame.	Cylinder Revolutions per minute.	Production in pounds per spindle per day of 10 hours.	Spindles per horse power.
Spooler (6″ x 4″ spools)	100	184	4.00 on No. 24	200
Spooler (4½ x 3½ spools)	100	184	2.40 on No. 40	300
Reel (54″ skein)	50	135	2.25 on No. 24	300
Long Chain Quiller	378	320	.36 on No. 24	190

Twisters: Dry Twisters consume practically the same power, as warp spinning frames on the same numbers of yarn, bearing in mind that 28 | 2 is the same as 14 | 1, that 40 | 5 is the same as 8 | 1, etc., etc.

Wet Twisters will require probably 10% more power than dry twisters.

Style of Loom	*Cloth Woven			Picks per Minute	Horse Power Per Loom
	Width	Count	Yards to the pound		
Plain Heavy Pattern single Box Loom	40-inch	68 x 72	4.75	165	.25
Wide Loom	92-inch	56 x 60		102	1.00
Four Box Loom with Dobby,	40-inch		4.00	145	.33

*20% greater or less width of loom will not vary materially from these results, as the increased or diminished speed offsets the greater or less width as the case may be.

Of course, the above results are on medium weight goods; lighter and heavier weights affect the power in corresponding proportion, as also does a change in the counts.

Power Table for Winders, Warpers, Slashers, and Nappers.

Machine	Basis	Horse Power
Cone Winder, Foster Latest Improved "Open Wind" machine,	100 Spindles	2.75
"Close Wind" machine of the Universal type,	6 Spindles	.50
Slasher or Section Warper.	500 ends in creel, and 36 revolutions per minute of cylinder,	.40
Leese or Ball Warper.	700 ends,	.50
Slasher	7′-0″ and 5′-0″ cylinders, and 8 back beams in creel	3.00
Nappers,	Average Speed	3.00-4.00

Mill Engineering, Continued.

Power Table For Cloth Room Machinery.

Machine.	Horse Power.
Inspecting Machine	1.00
No. 23 Sewing Machine,	1.00
No. 25 Sewing and Rolling Machine,	1.00 – 2.00
Brusher and Calender	3.00 – 4 00
Gas Singeing Machine	3.00 – 4.00
Nappers	1.00 – 2.00
Winder and Measurer	2.00
Folder	1.00 –

Power Table for Belt Power Presses.

Style Press.	Horse Power.
No. 1 to No. 15-A,	4.00 – 6.00
No, 17 to No. 37,	6.00 – 8.00
No. 37 to No. 42,	8.00 – 10.00
No. 45 to No. 59,	10.00 – 12.00
No. 81 to No. 115,	12.00 – 14.00
Yarn Press,	3.00

Note.—The maximum power required to drive a press is used only for an exceedingly short period of time.

In proportioning the sizes of shafting, pulleys, and belting, the maximum power must be provided for, but if the mill is electrically driven, considerable of this power can very easily be carried as an overload on the motor.

Approximate Horse Power Required for Dyeing and Special Finishing Machinery.

Cramer Raw Stock Dyeing Machines,	3-H. P.
Klauder-Weldon Raw Stock Dyeing Machines,	See page 967.
Hydro-Extractors,	" " 989.
Automatic Dryers,	" " 991.
Complete Warp Boiling Out Machine,	2. H. P.
Warp Doubling Machine,	1.5
Warp Splitting Machine,	1
Scotch Dye Tub,	1.
18-Cylinder Warp Drying Machine,	4.
1-Compartment Dyeing Machine,	1.
Yarn Sizing Machine,	.75
21-Cylinder Horizontal Drying Machine, 80″ face with Starch Mangle,	5.
Tenter, Dryer and Mangle,	6.
3-Roll Calender,	4.
5-Roll Calender,	5.
Hydraulic Pump,	1.
Indigo Dyeing Machine,	1.
Indigo Grinders,	.5
Fries Dyeing Machine, direct colors,	2.50
Fries Indigo Dyeing Machine,	5.33
Fries Combination Dyeing Machine,	5.33

Mill Engineering, Continued.

Horse Power Required to Drive, Concluded.

Machine Tools.

Machine.	Horse Power.
Gear Cutter,	.50
Drill Press,	.20
Shaper,	.25
18″ x 12′ Lathe,	1.50
20″ x 12′ Lathe,	2.00
24″ x 12′ Lathe,	4.00 – 5.00
26″ x 12′ Lathe,	5.00 – 7.00
30″ x 12′ Lathe,	7.00 – 10.00
36″ x 12′ Lathe,	15.00 – 20.00

Sturtevant Cotton Conveying Fans.

Size.	Speed.	Horse Power.
4	1800	2.5
5	1570	3.
6	1330	5.25
7	1160	7.5
8	1010	10.

The above table is based on running two and one-half ounce with dry stock. Of course, on heavy work with wet stock these speeds and horse powers are largely exceeded.

Miscellaneous.

For Horse Power Required to Drive: See Page:

Fan for Cooling Towers, ... 605

Direct Connected Electrically Driven Triplex Boiler Feed Pumps, ... 568

Fans in Connection with Mechanical Draft, ...552-553

Scrapers on Fuel Economizers, ...522-523

Electric Lighting:

For small direct current generators, allow 1 1-3 H. P. to 1 K. W.

The usual rule for estimating lamps to the horse power is as follows:

16 c. p. incandescent lamps, ...12 to 1 H. P.

1200 c. p. arc lamps, each ....¾ H. P.

Square Feet of Floor Space per Spindle.

(This table shows the relative floor space per spindle of a number of mills on a variety of different classes of work. No attempt is made to analyze these figures; they merely stand for themselves.)

Mill.	Engineer.	Stories	Square feet.	Spindles.	Sq. ft. per Spindle.
YARN MILLS.					
Arlington Cotton Mills........	Cramer	2	31,458	8,064	3.90
Cox Manufacturing Co...	Cramer	2	81,417	21,840	3.72
Harriet Cotton Mills,..........	Cramer	2	67,500	20,216	3.33
Hudson Cotton Mfg. Co.	Cramer	1	18,975	4,992	4.00
Ide Cotton Mills...............	Cramer	2	37,612	11 000	3.41
Lenoir Cotton Mill Co.	Cramer	1	22,461	6,720	3.34
Ozark Mills,....................	Cramer	2	39,048	10,332	3.77
Wiscassett Mills Co.	Cramer	2	142,000	44,160	3.24
SPINNING AND WEAVING MILLS.					
Aiken Manufacturing Co.....			71,900	14,326	5.01
American Pad & Textile Co. ..	Makepeace		178,920	35,840	4.99
Anderson Cotton Mills, No. 1..	Makepeace		89,900	18,000	4.96
Anderson Cotton Mills, No. 2..	Makepeace		157,080	35,360	4.44
Anderson Cotton Mills, No. 3..	Makepeace		211,000	50,000	4.22
Aragon Mills	Makepeace		102,245	18,000	5.67
Arcadia Mills..................	Makepeace		55,650	10,652	5.22
Barker Cotton Mill Co.........		2	66,560	9,984	6.66
Brogon Cotton Mills..........	Makepeace		272,353	50,176	5.42
Clifton Mfg. Co., No. 2........	Makepeace		121,920	26,880	4.53
Clifton Mfg. Co., No. 3........	Makepeace		220,800	52,000	4.25
Chiquola Manufacturing Co...	Sirrine	4	161,000	40,320	3.99
Dallas Manufacturing Co...	Greene	4½	156,312	25,000	6.24
Dwight Manufacturing Co.....	Greene	3	174,336	25,000	6.97
Exposition Cotton Mills......	Greene	4	126,000	20,000	6.30
Fulton Bag & Cotton Mills	Greene	5	175,240	25,000	7.00
Gibson Manufacturing Co.....	Cramer	3	62,470	16,640	3.75
Henderson Cotton Mills......	Cramer	2		17,264	
Highland Park Mfg. Co, No. 3	Cramer	1 & 2	141,018	30,000	4.66
Laurel Cotton Mills............	Cramer	2 & 3	108,673	18,304	5.93
Lanett Cotton Mills.... .	Greene	4	151,008	25,000	6.04
Lynchburg Cotton Mill Co			199,200	43,208	4.61
Mass. Mills in Georgia	Greene	3	176,640	30,000	5.88
McComb City Cotton Mills	Cramer	2	54,385	10,400	5.22
Newnan Cotton Mills..........	Sirrine	2	154,100	33,000	4.67
Pacolet Mfg. Co..............	Greene	5	202,800	28,480	7.15
Pee Dee Mfg. Co., No. 2.	Cramer	2	53,858	8,736	6.16
Pelzer Mfg. Co................	Greene	4½	291,456	55,000	5.30
Piedmont Mfg. Co., No. 3....			119,008	22,848	5.20
Revolution Cotton Mills......	Makepeace		131,915	28,896	4.56
Revolution Cotton Mills......	Makepeace		65,520	14,944	4.38
Sanford Cotton Mills..........	Cramer	2	43,071	9,024	4.77
Scottdale Mills...	Cramer	2	52,495	10,232	5.13
Spartan Mills....	Greene	4	202,752	40,000	5.06
Toxaway Mills.......	Makepeace		67,731	14,112	4.82
Trion Mfg. Co., No. 3..........	Makepeace		127,869	23,296	5.05
Tucapau Mills	Greene		282,808	51,000	5.54
Tucapau Mills,................	Makepeace		235,536	56,080	4.20
Washington Mills..............	Makepeace		436,800	104,000	4.20
Watts Mills	Sirrine	2	95,761	30,640	3.12

MILL ARCHITECTURE AND ENGINEERING.

Technically considered, there is a distinction between the purely architectural and engineering problems involved in cotton mill work; yet, for the sake of convenience, in this article they will be consolidated and considered under the head simply of "Mill Engineering," as already stated.

Standard Mill Construction.

After practically a century of evolution, a type known as **"Slow Burning Construction"** has become generally adopted for textile factories, not to mention many other industrial plants.

The Factory Mutuals and the Factory Insurance Association not only approve this type of construction, but give their most favorable rates to mills so constructed. In fact, the insurance companies have probably done more to bring about its adoption than the mill engineers, or even the mill men themselves.

Under the head of "Mill Fire Protection" (pages 404-432) will be found not only the insurance companies' requirements for fire protection, but also those for building construction. The following points may be emphasized as the characteristic features of this type of construction:

Walls.—All walls, including fire walls, to be of brick, starting with 12 inches in thickness for the top story; for next to the top story a 16 inch wall will be required; for the next one below, a 20 inch wall; and so on for each succeeding floor, with properly constructed footings either of concrete or brick laid in cement, of dimensions to suit the character of the foundation soil. Fire walls should be parapeted through the roof, and extend at least 36 inches above; and also project at least 36 inches beyond the walls on each side.

Wooden Columns.—Either round or square in cross section should support each floor independently; this is accomplished by placing cast iron caps on top of columns to receive the floor timbers and cast iron pintles on top of the caps to support the columns in the story above.

Floors.—Floors are generally three-ply, all resting on heavy timbers placed 8 feet to 10 feet 8 inches apart; the width of these "bays," as they are termed, and the size of timbers and thickness of floors vary according to the service required. The first floor laid is termed the rough or heavy flooring, and is laid across the timbers extending longitudinally of the mill; this floor is generally 3 inches in thickness (sometimes 4 inches), and is made tight either by being ship-lapped or grooved and fitted with splines. The intermediate flooring

Mill Engineering, Continued.

is generally surfaced, and tongued and grooved to make a tight job; it is best laid diagonally. Asbestos or other suitable paper is often placed between the intermediate and top or finished flooring, though not absolutely required. The top or finished flooring is generally of hard rock maple or edge grain yellow pine laid in narrow widths (3 to 4 inches),— the edges not being tongued or grooved or fastened in any manner so that they may easily be taken up and replaced: this top flooring is best laid lengthwise of the alleys.

Roof.—This consists of 2 or 3 inch plank (preferably the latter) laid on timbers similar to the floors; roofs are generally covered with either gravel, tin or copper. The standard pitch is one-half inch to the foot.

Cornices and Gutters.—No cornices are permitted; the gutters may be either cut into the ends of the timbers as they project over the roof, or made of metal fastened on to the ends of the timbers.

Stairs and Elevators.—These should be separated in brick towers and openings to the mill protected by standard automatic fire doors.

Belt or Rope Ways.—These should be cut off from the main mill by fire walls and shafting openings at each floor should be covered with metal coverings closely fitted to shaft.

Picker Rooms, Engine and Boiler Rooms.—These should be either located in separate buildings apart from the main mill, or separated by standard fire walls with openings protected by standard automatic fire doors on both sides.

Waste House.—These should be entirely and separately detached from the main mill.

Lighting.—Electric lighting is recommended; the installation of the dynamos and wiring to be subject to insurance inspection and approval.

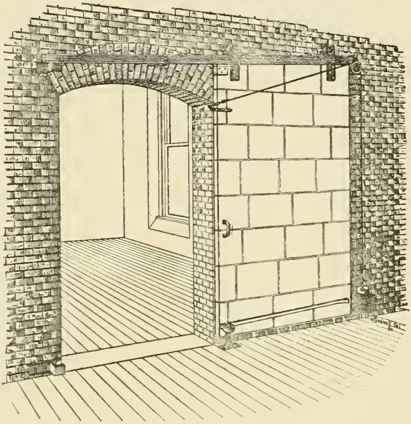
Heating.—Direct steam heating by overhead pipes, or indirect heating and ventilating by hot air blast carried from the heater apparatus by brick flues underground and in walls (or galvanized iron piping.)

Fire Protection.—All as per requirements and descriptions page 404-432, already referred to.

Objectionable Features.—Joisted construction; roof planks less than 2 inches, or any roofing which is not grooved and splined; any hollow spaces in the roofs, floors, or walls; box cornices of every kind; open elevators; open stairways; iron doors and shutters; and picker rooms not cut off by fire walls.

Mill Engineering, Continued.

*STANDARD FIRE DOORS.



The above cut shows a door and all the trimmings, with the rope, pulley, and balance weight; also the fusible link which travels with the door and is always in the opening.

The link fuses at about 160 degrees, disconnecting the balance weight, when the door by its own weight runs down the inclined track, and by the aid of the stops and guides is wedged firmly and tightly over the opening.

While this door is automatically released by heat, until the link is melted it may be opened and closed with ease, being on "frictionless hangers" and balanced with a weight.

The track is a common flat bar of rolled steel, 3½ inches wide, ⅜ of an inch thick. It is bolted every three feet with ¾-inch bolts running through the wall, having nut and flanged washers on the opposite side.

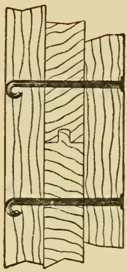
The distance of the track from the wall is fixed by the wall plates to suit the standard thickness of the door, viz.: 2½ inches.

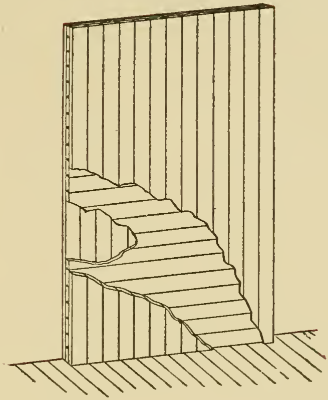
The hanger is what is known as the "Frictionless Hanger." The Insurance Companies call for special weight, much heavier than the common size.

The Metal Sill is recommended,—consisting of wrought-iron or steel plate set into, and flush with top of floor, fastened in place with countersunk screws. The metal protecting and forming a wearing surface over brick or cement filling, as well as a non-combustible separation between floors.

*By courtesy of Factory Insurance Association.

Standard Fire Doors, Concluded.





Wood work.—A uniform thickness of 2½ inches is adopted for doors of all sizes in order that there may be no possible confusion in ordering trimmings and putting up the doors.

The door should be made of three thicknesses of ⅞-inch narrow, matched, thoroughly seasoned stock, preferably white pine, which, when dressed, will make thickness 2½".

The illustration above shows how these three layers should be put together at right angles, the two outside courses being perpendicular.

The door should be large enough to overlap the opening four inches at sides and top.

The top of the door must conform in shape to the incline of the track, viz.: pitch ¾ of an inch to the foot.

Nailing.—The above cut illustrates how the nails should be driven so as to clinch without leaving a rough surface on either side of wood work to injure the tin. This is best accomplished by nailing on a heavy iron plate, thus sinking both head and point into the wood.

Every board should be securely fastened as shown, using wrought-iron clinch nails.

Tin Covering.—The tin plates should be 14″x20″ I. C. standard, 108 pounds to box.

Never use zinc to cover a fire door. All joints should be double locked or lapped and well nailed under seams.

Avoid air space between tin and wood. Use no solder. Attach all trimmings after tinning is completed.

Mill Engineering, Continued.

Safe Loads. Uniformly Distributed, for Rectangular Yellow Pine Beams.

(One Inch Thick.)

Span in Feet.	DEPTH OF BEAM (One Inch Thick).										
	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″	16″
10	500	683	883	1117	1383	1683	2000	2350	2717	3133	3550
11	450	617	817	1017	1267	1533	1817	2133	2483	2850	3233
12	417	567	733	933	1150	1400	1667	1967	2267	2600	2967
13	383	517	683	867	1067	1300	1550	1800	2100	2400	2733
14	350	483	633	800	983	1200	1433	1684	1950	2233	2550
15	333	450	600	750	933	1117	1333	1567	1817	2083	2367
16	317	433	550	700	867	1050	1250	1467	1700	1967	2217
17	300	400	517	667	817	983	1183	1383	1600	1833	2100
18	283	383	483	617	767	933	1117	1300	1517	1733	1983
19	267	350	467	600	733	883	1050	1233	1433	1650	1883
20	250	333	450	567	700	850	1000	1183	1367	1567	1750
21	233	317	433	533	650	800	950	1117	1300	1483	1700
22	233	317	400	517	633	767	900	1067	1233	1417	1617
23	217	300	383	483	600	733	867	1017	1183	1350	1533
24	217	283	367	467	583	700	833	983	1133	1300	1483
25	200	267	350	450	550	683	800	933	1100	1250	1433
26	183	267	350	433	533	650	767	900	1050	1200	1367
27	183	250	333	417	517	617	733	867	1017	1150	1317
28	183	233	317	400	500	600	717	833	967	1117	1267
29	183	233	300	383	483	583	683	817	933	1067	1233

To obtain the safe load for any thickness: Multiply values for one inch by thickness of beam.

To obtain the required thickness for any load: divide by safe load for for one inch.

Loads on Mill Floors.

In proportioning mill floors it should be borne in mind that not only it must carry its own weight and the weight upon it, but that it must do so without undue flexure; also that its construction must be such as to absorb undue vibration.

The average weight of the machinery and stock in process in a cotton mill, including also the weight of the operatives, will average probably 25 pounds to the square foot. In slasher rooms and at other points where yarn is piled up this weight may run up to 50 pounds to the square foot, but in such cases there is little or no rapidly revolving machinery and the load is merely a dead weight. Of course the weights of mill floors vary, but it may be roughly stated that the average floor weighs 25 pounds to the square foot, including beams.

It is well just here to distinguish between the motions of

Safe Load in Pounds for Steel I Beams.

(Carnegie.)

C=Coefficients given below.
L=Sale Load in pounds, uniformly distributed.
D=Span in feet, or distance between supports.

$$L = \frac{C}{D}$$

(Co-efficients of Strength for fibre stress of 16,oco pounds per square ineh.)

Standard I Beams						Stand'd Special I B'ms		
Depth of Beam inches.	Weight per foot pounds	Co-efficient	Depth of Beam inches	Weight per foot pounds	Co-efficient	Depth of Beam inches	Weight per foot pounds	Co-efficient
3	5.5	17600	10	25.	260500	12	40	478100
	6.5	19100		30.	286300		45	507900
	7.5	20700		35.	312400		50	539200
4	7.5	31800		40.	338500		55	570600
	8.5	33900	12	31.5	383700	15	60	866100
	9.5	36000		35	405800		65	904600
	10.5	38100	15	42	628300		70	943800
5	9.75	51600		45	648200		75	983000
	12.25	58100		50	687500	15	80	1131300
	14.75	64600		55	726800		85	1163000
6	12.25	77500	18	55	943000		90	1202300
	14.75	85300		60	997700		95	1241500
	17.25	93100		65	1044800		100	1280700
7	15.00	110400		70	1091900	20	80	1564300
	17.50	119400	20	65	1247600		85	1609300
	20.00	128600		70	1301200		90	1661600
8	18.00	151700		75	1353500		95	1713900
	20.50	161600	24	80	1855900		100	1766100
	23.00	172000		85	1927600			
	25.50	182500		90	1990300			
9	21.	201300		95	2052900			
	25.	217900		100	2115800			
	30.	241500						
	35.	265000						

the walls and floors in a cotton mill in operation: It may be briefly stated that the swaying of the whole building is dangerous, and is due to bad design or weak construction; the simple vibration of elastic floors and beams, however, caused by the motion of the machinery is to be expected as a matter of course, and is dangerous only when the impulse of such vibration becomes synchronous with the key-note of the building,—in which event it can generally be stopped by even some minor change in the building that will change the pitch of its key-note.

It is obvious that undue vibration can cause machinery to run badly. It is also obvious that undue deflection of beams and floor plank can throw machinery out of line and damage it in that manner. The limit for deflection of beams 25 feet long is approximately ¾ of an inch; the limit for the floor plank between the beams is 1-13 of an inch for an 8 foot bay. 1-12 of an inch for a 9 foot bay, 1-11 of an inch for a 10 foot bay and 1-10 of an inch 11 foot bay.

Mill Engineering, Continued.

Loads on Floors, Concluded.

The following table will be found convenient showing the weights of the cotton and cotton goods.

Material.	Floor Space in sq. feet.	Weights. Gross.	Weights. Per sq. ft.
Cotton.			
Bale	8.1	515	64
Compressed	4.1	550	134
Cotton Goods.			
Piece Duck	1.1	75	68
Bale Brown Sheetings	3.6	235	65
Case Bleached Sheetings	4.8	330	69
Bale Print Cloth	4.0	175	44
Case Prints	4.5	420	93
Bale Tickings	3.3	325	99
Skein or warps, Yarns	5.0	400	80
Burlaps	2.0	130	65
Jute Bagging	1.4	100	70

It should be unnecessary to state that a tar—or asphalt—concrete floor, either with or without a wooden top floor, is the best foundation on which to place machinery, especially cards and looms.

The above remarks are rather meager for this subject; but while the scope of this work prevents further elaboration, it is believed that the above notes emphasize its most salient points.

The Strength of Columns.

Wooden mill columns, if figured on a basis of theoretical strength, would be found too light for practical purposes, because they would not sufficiently absorb the variations set in motion by the machinery. Experience is the best judge, therefore, as to the size of columns; it is sufficient to say that ordinarily the practice is to start with from 8 to 8½ or 9 inches, as may be selected, for the top story, and to increase the diameter by one-half an inch or 1 inch for each succeeding lower story.

A core should be bored longitudinally through the center of the column for the purpose of preventing checking; this core should be from 1½ to 2 inches.

As a matter of interest, the average crushing load per square inch on round cylindrical columns has been found to be about 4,500 pounds.

Columns are either round or square with chamfered edges, —the former preferred.

Miscellaneous Building Data.

Weight in Pounds of a Cubic Foot.

Common soil,	124	Clay and stones,	160
Strong soil,	127	Cork,	15
Loose earth or sand,	95	Tallow,	59
Clay,	135	Bricks,	125
Lead	708¾	Marble,	171
Brass,	534¾	Granite	165
Copper,	555	Sea-water	64.3
Wrought-iron,	486¾	Oak wood,	55
Anthracite coal,	50-55	Red pine,	42
Bituminous coal,	45-55	White pine,	30
Charcoal (hardwood)	18½	Charcoal (pine wood)	18

Measurements and Estimates.

A cubic yard of earth is called a load.

Bricks are of various dimensions. The average size is 8 inches long, 4 inches wide, 2 inches thick. 27 bricks make a cubic foot, when laid dry. Laid in mortar 1-8 to 1-10 is allowed for mortar. Some bricks are 8¼×4 1-8×2 3-8 inches.

Brick work is generally estimated by the 1000. When measured by square measure the work is understood to be 12 inches thick.

Board and Lumber Measure.—All estimates are made on one inch in thickness.

Board feet are changed to cubic feet by dividing by 12. Cubic feet to board by multiplying by 12.

In material only is allowance made for windows, doors and cornices. No allowance being made in estimating the work. The size of a cellar or wall is estimated by the measurement of the outside. No allowance for corners.

By the square foot, as in glazing, stone-cutting, etc. By the square yard, as in plastering, painting, etc.

By the square, (100 sq. ft.), as in flooring, roofing, slating, paving, etc.

Painting of mouldings, cornices, etc., the estimate is by measuring the entire surface.

One pound of paint will cover about four superficial yards the first coat, and about six yards each additional coat.

About one pound of putty for stopping, will be required for every twenty yards.

One gallon of tar and one pound of pitch will cover about twelve yards superficial the first coat, and about seventeen yards each additional coat.

Mill Engineering, Continued.

Amount of Mortar Required For a Cubic Yard of Masonry.

Description of Masonry.	Volume of Mortar, (Cubic yards.) Minimum.	Maximum.
Concrete broken stone--no screenings or gravel	0.50	0.55
Rough rubble	0.33	0.40
Rubble with joints rough hammered-dressed	0.25	0.30
Squared stone masonry	0.15	0.20
Ashlar with 12″ to 20″ courses and ⅜ to ½ inch joints	0.07	0.08
Ashlar with 20″ to 30″ courses and ¼ to ⅜ inch joints	0.05	0.06
Ashlar, largest blocks and closest joints	0.03	0.04
Brickwork ⅝ to ½ inch joints	0.35	0.40
" ⅜ to ⅛ inch joints	0.25	0.30
" ⅛ inch joints	0.10	0.15

EXAMPLE:—How much cement and sand will be required to lay 10 cubic yards of best rubble masonry, using a mortar composed of 1 part packed cement and 3 parts sand? By the preceding table, it is seen that the best rubble will require 0.33 yards of mortar per yard of masonry; hence 10 yards of masonry will require 3.3 cubic yards of mortar. From the table on page 1179, it is seen that 1 cubic yard of the above mortar will require 2 barrels of cement and 0.9 cubic yards of sand; hence 3.3 cubic yards of mortar will require 6.6 barrels of cement and 2.97 cubic yards of sand.

Handy Thumb Rules:

Three and one-half barrels of lime will do 100 square yards plastering, two coats.

Two barrels of lime will do 100 square yards plastering, one coat.

One and one-half bushels of hair will do 100 square yards plastering.

One and one-quarter yards good sand will do 100 square yards plastering.

One-third barrel of plaster (stucco) will hard finish 100 square yards plastering.

One barrel of lime will lay 1,000 bricks. (It takes good lime to do it.)

Two barrels of lime will lay one cord rubble stone.

One-half barrel of lime will lay one perch rubble stone (estimating quarter cord to perch.)

To every barrel of lime estimate about five-eights yards of good sand for plastering and brick work.

One and one-quarter barrels cement and three-quarters yard sand will lay 100 feet rubble stone.

Mill Engineering, Continued.

Ingredients Required for a Given Quantity of Mortar of Different Proportions.

Composition of the Mortar by Volumes.		Cement and Sand Required to Produce One Cubic Yard of Mortar.					
		Mortar proportioned by volumes of packed cement and loose sand.			Mortar proportioned by volumes of loose cement and loose sand.		
		Cement, barrels			Cement, Pounds.		
Cement	Sand.	Portland or Ulster Co., Rosendale.	Western Rosendale.	Sand, cubic yds.	Portland.	Rosendale.	Sand, cubic yds.
I	0	7.14	6.43	0.00	2,675	2,140	.00
I	I	4.16	3.74	0.58	1,440	1,150	.67
I	2	2.85	2.57	0.80	900	720	.84
I	3	2.00	1.80	0.90	675	540	.94
I	4	1.70	1.53	0.95	525	420	.98
I	5	1.25	1.13	0.97	425	340	.99
I	6	1.18	1.06	0.98	355	285	1.00

The left-hand side of the table gives the quantity required when a commercial barrel of cement, i. e., a barrel of packed cement is mixed with a given number of barrels of sand.

When the cement is shipped in bulk, the right-hand side of the table is to be employed in making estimates. The quantities of cement in this side of the table can be translated into barrels by remembering that the net weight per barrel of cement, although varying somewhat with manufacturers, size of barrels, fineness, etc., is about as follows: Portland, 375 lbs., Eastern Rosendale, 300 lbs., Western Rosendale, 265 pounds.

Cement is also sometimes shipped in bags. Frequently the bags contain an aliquot part of a barrel, in which case either side of the table may be used, according to the method to be employed in mixing the cement and sand. Sometimes the bags contain an even number of hundred weight, in which case the right-hand side of the table is most convenient.

Size of Nails.

2-penny—1	in.,	557	nails per lb.	12-penny—3	ins.,	54	nails per lb.
4-penny—1¼	ins.,	353	" "	20-penny—3½	"	34	" "
5-penny—1¾	"	232	" "	Spikes—4	"	16	" "
6-penny—2	"	167	" "	Spikes—4½	"	12	" "
7-penny—2¼	"	141	" "	Spikes—5	"	10	" "
8-penny—2½	"	101	" "				
10-penny—2¾	"	68	" "				

Mill Engineering, Continued.

*Car Load and Track Data.

Spur Track Data.—The limit of curve for a spur track is 12 degrees (478 ft. radius); a 3 per cent. grade is permissible on that curve, and a 3.5 per cent. grade on the tangent or straight track.

To unload cars conveniently, mill floors should be four feet above the rail, and their platforms 3 feet 9 inches above the rail.

Lumber.—Approximate Number of Feet in Minimum Car Load, (20,000 Lbs.)

9,000 feet of solid boards.
17,000 feet of siding.
13,000 feet of flooring.
½ less of hard lumber.
¼ less of green lumber.
1-10 less of joists, scantling and other large timbers.

Nails.—Car Load.

100 lbs. to the keg; 300 kegs to the car load.

Sewer Pipe.—Approximate Number of Feet in Minimum Car Load (30,000 Lbs.)

Size, inches	3	4	5	6	8	9	10	12	15	18	20	24
Number of feet	4285	3000	2300	1765	1250	1035	885	715	525	405	340	240

Wrought Iron Pipe.—Approximate Number of Feet in Minimum Car Load (30,000 Lbs.)

Size, inches	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3
No. of feet	125000	71430	53575	35715	26785	17965	13390	11195	8310	5230	3980
Size, inches	3½	4	4½	5	6	7	8	9	10	12	14
No. of feet	3335	2815	2400	2070	1600	1290	1065	890	750	615	520

Brick, Lime and Cement.—Car Loads.

An ordinary brick weighs about 4¾ pounds, and there are 8,000 to the car load.

A barrel of lime contains 200 pounds, and 120 barrels constitute a minimum car load.

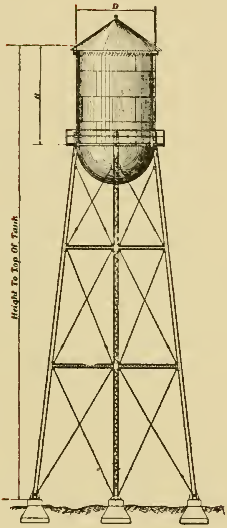
There are 95 pounds in a sack of Portland cement, and 400 pounds in a barrel; and 300 pounds in a barrel of Rosendale cement. There are 75 barrels of Portland to the car load, and 100 barrels of Rosendale.

*See also pages 1156-1157 for car loads of Textile Machinery.

Mill Engineering, Continued.

*CHICAGO "TANKS AND TOWERS."

(See also pages 414-417)



Dimensions of Standard Tanks.

Capacity Gallons.	Diameter Feet D	Height Feet H	Width of Balcony Inches.
15,000	12	14	18
20,000	13	16	18
25,000	14	17	18
30,000	15	18	24
35,000	16	18	24
40,000	17	18	24
45,000	17	21	24
50,000	18	20	24
55,000	18	23	24
60,000	19	22	24
65,000	19	24	24
70,000	20	23	24
75,000	20	25	24
80,000	21	24	37
85,000	21	26	27
90,000	21	28	27
95,000	22	26	27
100,000	22	28	27
105,000	23	26	27
110,000	23	28	27
115,000	24	26	30
120,000	24	28	30
125,000	24	29	30
130,000	25	27	30
140,000	25	30	30
150,000	25	33	30
175,000	26	35	30
200,000	28	35	30
250,000	30	37	30
300,000	32	40	30

Stock Material for the Following Complete Structures.

Capacity.	Height to Top of Tank.		
30,000	72	100	129
40,000	72	100	129
50,000	76	110	144
60,000	78	112	146
80,000	80	114	148
100,000	98	140	182

*As required by the Factory Mutuals for one source of Water Supply in connection with equipments for fire protection.

Mill Engineering, Continued.

PROPERTIES OF METALS.

	Melting Point. Degrees Fahr.	Weight in Lbs. per Cubic Foot.	Weight in Lbs. per Cubic Inch	Tensile Strength.
Aluminum	1140	166.5	.0963	15,000– 30,000
Antimony	810–1000	421.6	.2439	1,050
Brass (average)	1500–1700	523.2	.3027	30,000– 45,000
Copper	1930	552.	.3195	30,000– 40,000
Gold (pure)	2100	1200.9	.6949	20,380
Iron, cast	1900–2200	450.	.2604	20,000 35,000
Iron, wrought	2700–2830	480.	.2779	35,000– 60,000
Lead	618	709.7	.4106	1,000– 3,000
Mercury	–39	846.8	.4900	....
Nickel	3000	548.7	.3175	....
Silver	1800	655.1	.3791	40,000
Steel	2370–2685	489.6	.2834	50,000–120,000
Tin	475	458.3	.2652	5,000
Zinc	780	436.5	.2526	3,500

Note.—The wide variations in tensile strength are due to the different forms and qualities of the metal tested. With steel it varies with the proportion used in mixing, which is varied according to the grade required.

Coefficients of Expansion.

Name of Substance	Linear Expansion	Surface Expansion	Cubic Expansion
Cast Iron	.00000617	.00001234	.00001850
Copper	.00000955	.00001910	.00002864
Brass	.00001037	.00002074	.00003112
Silver	.00000690	.00001390	.00002070
Bar Iron	.00000686	.00001372	.00002058
Steel, untempered	.00000599	.00001198	.00001798
Steel, tempered	.00000702	.00001404	.00002106
Zinc	.00001634	.00003268	.00004903
Tin	.00001410	.00002820	.00003229
Mercury	.00003334	.00006668	.00010010
Alcohol		.00038518	.00057778
Gases			.00203252

A wrought iron bar 22 ft. long is heated from 70° to 300°. How much will it lengthen?

$22 \times (300-70) \times .00000686 = .0347116$ ft. $= .41654$ inches.

Properties of Metals, Concluded.

Weight of one Square Foot of Sheet Iron or Steel.

No. of gauge B. & S.	Thickness in in.		Iron	Steel	No. of gauge	Thickness in in.		Iron	Steel
	In Dec.	In Frac				In Dec.	In Frac.		
0000	.46	15-32	18.63	18.87	10	.102	7-64	4.12	4.18
000	.41	13-32	16 58	16 8	11	.091	3-32	3.67	3.72
00	.365	23-64	14.77	15.0	12	.08	....	3.27	3.31
0	.325	21-64	13.15	13 32	13	.072	5-64	2.92	2.95
1	.289	19-64	11 7	11.86	14	.064	1-16	2.59	2.63
2	.257	17-64	10.43	10.57	15	.057	....	2.31	2.34
3	.229	15-64	9 29	9.42	16	.050	....	2.05	2.08
4	.204	13-64	8.27	8.38	17	.045	3-64	1.83	1.86
5	.182	3-16	7 37	7.46	18	.040	....	1.63	1.65
6	.162	11-64	6.56	6.64	19	.036	....	1.45	1.47
7	.144	9-64	5 84	5.92	20	.032	1-32	1.29	1.31
8	.128	1-8	5.20	5 27	21	.028	....	1 15	1.16
9	.114	.....	4.63	4 69	22	.025	...	1.03	1 04

Handy Rule.—To ascertain the weight of three linear feet of any size of iron:

ROUND IRON: Multiply size by itself and product by 7.85.

Example.—2 inches round.

2 x 2=4 x 7.85=31.40 lbs. to three feet.

SQUARE IRON: Multiply size by itself and product by ten.

Example.—2 inches square.

2 x 2=4 x 10=40 lbs. to three feet.

FLAT IRON: Multiply width in inches by the thickness in eighths and divide the product by four. The sum of product and quotient will give the weight.

Example.—2 x ½ flat.

2 x (½=4-8)
2 x 4=8
4) 8
——
2
8 + 2=10 lbs to three feet.

To Keep Machinery from Rusting.

Take an ounce of camphor, dissolve it in one pound of melted lard; take off the scum and mix with as much fine black lead as will give it an iron color.

Clean the machinery and smear it with this mixture, after 24 hours rub clean with a soft linen cloth.

Vaseline will keep polished tools from rusting better than anything else.

A thin coating of glycerine on both sides of a pane of glass will prevent the condensation of steam which would otherwise obscure it.

A permanent and durable joint can be made by the use of asbestos mixed with sufficient white lead to make a stiff putty. It will resist any amount of heat and is unaffected by steam or water.

PROPERTIES OF NUMBERS.

No. or Diameters.	Number				Circle	
	Square	Cube	Square Root	Cube Root	Area	Circumference
.1	.01	.001	.3162	.4642	.007854	.31416
.15	.0225	.0034	.3873	.5313	.017671	.47124
.2	.04	.008	.4472	.5848	.031416	.62832
.25	.0625	.0156	.500	.6300	.049087	.78540
.3	.09	.027	.5477	.6694	.070686	.94248
.35	.1225	.0429	.5916	.7047	.096211	1.09956
.4	.16	.064	.6325	.7368	.12566	1.2566
.45	.2025	.0911	.6708	.7663	.15904	1.41371
.5	.25	.125	.7071	.7937	.19635	1.5708
.55	.3025	.1664	.7416	.8193	.23758	1.72787
.6	.36	.216	.7746	.8434	.28274	1.8850
.65	.4225	.2746	.8062	.8662	.33183	2.04203
.7	.49	.343	.8367	.8879	.38485	2.1991
.75	.5625	.4219	.8660	.9086	.44178	2.35619
.8	.64	.512	.8944	.9283	.50266	2.5133
.85	.7225	.6141	.9219	.9473	.56745	2.67035
.9	.81	.729	.9487	.9655	.63617	2.8274
.95	.9025	.8574	.9747	.9830	.70882	2.98451
1.	1.	1.	1.	1.	.7854	3.1416
2.	4.	8	1.4142	1.2599	3.1416	6.2832
3.	9.	27	1.7321	1.4422	7.0686	9.4248
4.	16.	64	2.	1.5874	12.5664	12.5664
5.	25.	125	2.2361	1.7100	19.6350	15.7080
6.	36.	216	2.4495	1.8171	28.2743	18.8496
7.	49.	343	2.6458	1.9129	38.4845	21.9911
8.	64.	512	2.8284	2.	50.2655	25.1327
9.	81.	729	3.	2.0801	63.6173	28.2743
10	100	1000	3.1623	2.1544	78.5398	31.4159
11	121	1331	3.3166	2.2240	95.0332	34.5775
12	144	1728	3.4641	2.2894	113.0973	37.6991
13	169	2197	3.6056	2.3513	132.7323	40.8407
14	196	2744	3.7417	2.4101	153.9380	43.9823
15	225	3375	3.8730	2.4662	176 7146	47 1239
16	256	4096	4.	2.5198	201.0619	50.2655
17	289	4913	4.1231	2.5713	226 9801	53.4071
18	324	5832	4.2426	2.6207	254.4690	56.5486
19	361	6859	4.3589	2.6684	283.5287	59.6903
20	400	8000	4.4721	2.7144	314.1593	62.8319
21	441	9261	4.5826	2.7589	346.3606	65.9734
22	484	10648	4.6904	2.8020	380.1327	69.1150
23	529	12167	4.7958	2.8439	415.4756	72.2566
24	576	13824	4.8990	2.8845	452.3893	75.3982
25	625	15625	5.	2.9240	490.8739	78.5398
26	676	17576	5.0990	2.9625	530.9292	81.6814
27	729	19683	5.1962	3.	572.5553	84.8230
28	784	21952	5.2915	3.0366	615.7522	87.9646
29	841	24389	5.3852	3.0723	660.5199	91.1062
30	900	27000	5.4772	3.1072	706.8583	94.2478
31	961	29791	5.5678	3.1414	754.7676	97.3894
32	1024	32768	5.6569	3.1748	804 2477	100.5310
33	1089	35393	5.7446	3.2075	855.2986	103.6726
34	1156	39304	5.8310	3.2396	907.9203	106.8142
35	1225	42875	5.9161	3.2711	962.1128	109.9557
36	1296	46656	6.	3.3019	1017.8760	113.0973
37	1369	50653	6.0828	3.3322	1075 2101	116.2389
38	1444	54872	6.1644	3.3620	1134.1149	119.3805
39	1521	59319	6.2450	3.3912	1194.5906	122.5221
40	1600	64000	6.3246	3.4200	1256.6371	125.6637
41	1681	68921	6.4031	3.4482	1320.2543	128.8053

Properties of Numbers, Concluded.

No. or Diameters.	Number				Circle	
	Square	Cube	Sq. Root	Cube Root	Area	Circumference
42	1764	74088	6.4807	3.4760	1385.4424	131.9469
43	1849	79507	6.5574	3.5034	1452.2012	135.0885
44	1936	85184	6.6332	3.5303	1520.5308	138.2301
45	2025	91125	6.7082	3.5569	1590.4313	141.3717
46	2116	97336	6.7823	3.5830	1661.9025	144.5133
47	2209	103823	6.8557	3.6088	1734.9445	147.6550
48	2304	110592	6.9282	3.6342	1809.5574	150.7964
49	2401	117649	7.	3.6593	1885.7409	153.9380
50	2500	125000	7.0711	3.6840	1963.4954	157.0796
51	2601	132651	7.1414	3.7084	2042.8206	160.2212
52	2704	140608	7.2111	3.7325	2123.7166	163.3628
53	2809	148877	7.2801	3.7563	2206.1834	166.5044
54	2916	157464	7.3485	3.7798	2290.2210	169.6460
55	3025	166375	7.4162	3.8030	2375.8294	172.7876
56	3136	175616	7.4833	3.8259	2463.0086	175.9292
57	3249	185193	7.5498	3.8425	2551.7586	179.0708
58	3364	195112	7.6158	3.8709	2642.0794	182.2124
59	3481	205379	7.6811	3.8930	2733.9710	185.3540
60	3600	216000	7.7460	3.9149	2827.4334	188.4956
61	3721	226981	7.8102	3.9365	2922.4666	191.6372
62	3844	238328	7.8740	3.9579	3019.0705	194.7787
63	3969	250047	7.9373	3.9791	3117.2453	197.9203
64	4096	262144	8.	4.	3216.9909	201.0620
65	4225	274625	8.0623	4.0207	3318.3072	204.2035
66	4356	287496	8.1240	4.0412	3421.1944	207.3451
67	4489	300763	8.1854	4.0615	3525.6524	210.4867
68	4624	314432	8.2462	4.0817	3631.6811	213.6283
69	4761	328509	8.3066	4.1016	3739.2807	216.7699
70	4900	343000	8.3666	4.1213	3848.4510	219.9115
71	5041	357911	8.4261	4.1408	3959.1921	223.0531
72	5184	373248	8.4853	4.1602	4071.5041	226.1947
73	5329	389017	8.5440	4.1793	4185.3868	229.3363
74	5476	405224	8.6023	4.1983	4300.8403	232.4779
75	5625	421875	8.6603	4.2172	4417.8647	235.6194
76	5776	438976	8.7178	4.2358	4536.4598	238.7610
77	5929	456533	8.7750	4.2543	4656.6257	241.9026
78	6084	474552	8.8318	4.2727	4778.3624	245.0442
79	6241	493039	8.8882	4.2908	4901.6699	248.1858
80	6400	512000	8.9443	4.3089	5026.5482	251.3274
81	6561	531441	9.	4.3267	5152.9973	254.4690
82	6724	551367	9.0554	4.3445	5281.0173	257.6106
83	6889	571787	9.1104	4.3621	5410.6079	260.7522
84	7056	592704	9.1652	4.3795	5541.7694	263.8938
85	7225	614125	9.2195	4.3968	5674.5017	267.0354
86	7396	636056	9.2736	4.4140	5808.8048	270.1770
87	7569	658503	9.3276	4.4310	5944.6787	273.3186
88	7744	681472	9.3808	4.4480	6082.1234	276.4602
89	7921	704969	9.4340	4.4647	6221.1389	279.6017
90	8100	729000	9.4868	4.4814	6361.7251	282.7433
91	8281	753571	9.5394	4.4979	6503.8822	285.8849
92	8464	778688	9.5917	4.5144	6647.6101	289.0265
93	8649	804357	9.6437	4.5307	6792.9087	292.1681
94	8836	830584	9.6954	4.5468	6939.7782	295.3097
95	9025	857375	9.7468	4.5629	7088.2184	298.4513
96	9216	884736	9.7980	4.5789	7238.2295	301.5929
97	9409	912673	9.8489	4.5947	7389.8113	304.7345
98	9604	941192	9.8995	4.6104	7542.9640	307.8761
99	9801	970299	9.9499	4.6261	7697.6893	311.0177
100	10000	1000000	10.	4.6416	7853.9816	314.1593

Mill Engineering Continued.

WEIGHTS AND MEASURES.

Avoirdupois, or Ordinary Commercial Weight, United States and British,—"Long" Ton.

16 ounces=1 pound.
112 pounds=1792 ounces=1 hundredweight.
20 cwt.=2240 pounds=1 ton.
1 pound=27.7 cubic inches of distilled water at its maximum density (39 degrees Fahrenheit.)

"Short" Ton,—U. S. Only.

437.5 grains=1 ounce.
16 ounces=1 pound=7000 grains.
25 pounds=1 quarter.
4 quarters=1 hundredweight=100 lbs.
20 hundredweight=1 ton=2000 lbs.

Troy Weight.

1 pennyweight=24 grains.
20 pennyweights=1 ounce=480 grains.
12 ounces=1 pound Troy=5760 grains.

Apothecaries' Weight.

1 scruple=20 grains.
3 scruples=1 dram=60 grains.
8 drams=1 ounce=480 grains.
12 ounces=1 pound=5760 grains.

Liquid Measure,—U. S. Only

The unit of volume is the gallon=231 cubic inches. The gallon is subdivided and multiplied as follows:
4 gills=1 pint=28.875 cubic inches.
2 pints=1 quart=57.750 cubic inches.
4 quarts=1 gallon=231 cubic inches.
31½ gallons=1 barrel.
2 barrels=63 gallons=1 hogshead.
2 hogshead=1 pipe or butt.
2 pipes=1 tun.

Dry Measure,—U. S. Only.

2 pints=1 quart=67.2 cubic inches.
4 quarts=8 pints=1 gallon,=268.8 cubic inches.
2 gallons=8 quarts=1 peck=537.6 cubic inches.
4 pecks=8 gallons=1 bushel,=2150 cubic inches.
A heaped bushel=1¼ struck bushels. The cone in a heaped bushel must not be less than 6 inches high.
To reduce U. S. dry measures to British imperial of the same name, divide by 1.032.

Mill Engineering Continued.

Linear Measure.

12 inches=1 foot.
3 feet=1 yard.
5½ yards, or 16½ feet=1 rod, pole, or perch.
40 poles, or 220 yards=1 furlong.
8 furlongs, or 1760 yards, or 5280 feet=1 mile.

or,

12 inches=1 foot.
3 feet=36 inches=1 yard.
2 yards=6 feet=1 fathom.
2.75 fathoms=16.5 yards=1 perch.
40 perches=110 fathoms=1 furlong.
8 furlongs=320 perches=1 mile.

Nautical Measure.

6086.07 feet=1 nautical mile=1.152664 statute or land miles.
3 nautical miles=1 league.
20 leagues=60 nautical miles=1 degree=69.19 English miles.

Old Land Measure.

7.92 inches=1 link.
100 links, or 66 feet, or 4 poles=1 chain.
10 chains=1 furlong.
8 furlongs=1 mile.
10 square chains=1 acre.

Square Measure.

144 inches=1 foot.
9 feet=1296 inches=1 yard.
30¼ yards=272¼ feet=1 perch.
40 perches=1210 yards=1 rood.
4 roods=160 perches=1 mile.
An acre is 69.57 yards square, or 208.740321 feet square.
A township is 6 miles square=36 sections.
A section is 1 mile square=640 acres.
¼ section is ½ mile square=160 acres.
1-16 section is ¼ mile square=40 acres.

Cubic or Solid Measure.—U. S. and British.

1728 cubic inches=1 cubic foot.
27 cubic feet=1 cubic yard.
A cord of wood=4′×4′×8′=128 cubic feet.
A perch of masonry=16.5′×1.5′×1′=24.75 cubic feet, but is generally assumed at 25 cubic feet.

COMMON MEASURES AND WEIGHTS WITH THEIR METRIC EQUIVALENTS.

Com. Measures.	Equivalents.	Com. Measures.	Equivalents.	Com. Measures.	Equivalents.
An Inch	2.54 Centimeters	An Acre	.4047 Hectare	A Dry Quart	1.101 Liters
A Foot	.3048 Meters	A Sq. Mile	258.99 Hectares	A Peck U. S.	8.809 Liters
A Yard	.9144 Meter	A Sq. Inch	6.451 Sq. Centim's	A Bushel, U. S.	35.24 Liters
A Rod	5.029 Meters	A Cubic Inch	16.39 Cub. Centim's	An Oz.-Av.	28.35 Grams
A Mile	1.6093 Kilometers	A Cubic Foot	.02832 Cubic Meter	A Lb.-Av	.4536 Kilogram
A Square Inch	6.4513 Sq. Centimeters	A Cubic Yard	.7645 Cubic Meter	A Ton	.9071 Tonneau
A Square Foot	.0929 Square Meter	A Cord	3 624 Steres	A Crain, Troy	.0648 Gram
A Square Yard	.836 Square Meter	A Liquid Qt.	.9464 Liter	An Oz., Troy	31 104 Grams
A Square Rod	25.29 Square Meters	A Gallon	3.785 Liters	A Lb., Troy	.3732 Kilogram

In the French Metric System, the Meter is the base of all the weights and measures which it employs.

The Meter was intended to be, and is very nearly one ten-millionth part of the distance measured on a meridian of the earth from the equator to the pole, and equals about 39.37 inches or nearly 3 feet, 3⅜ inches.

The Meter is the primary unit of length.

Upon the Meter are based the following primary units: The Square Meter, the Are, the Cubic Meter or Stere, the Liter and the Gram.

The Square Meter is the unit of measure for small surfaces: as the surface of a floor, table, etc.

The Are is the unit of land measure; this is a square whose side is ten meters in length and which contains one hundred square meters.

The Cubic Meter or Stere, is the unit of volume; this is a cube whose edge is one meter in length.

The Liter is the unit of capacity; this is a capacity of a cube whose edge is one-tenth of a meter in length.

The Gram is the unit of weight; this is the weight of distilled water contained in a cube whose edge is the one-hundredth part of a meter.

From these primary units, the higher and lower orders of units are derived decimally.

The prefixes denoting multiples are derived from the Greek language and are: Deka, ten; Hecto, hundred; Kilo, thousand; Myria, ten-thousand. Those denoting sub-multiples are from the Latin and are: Deci, tenth; Centi, hundredth; and Mili, thousandth.

The money system of France is connected with that of Metric weights by an authorized coin of silver (the standard being 9 parts silver and 1 of alloy), representing the unit called the Franc and weighing 5 grams. The other coins are multiples and sub-multiples of the franc. The ratio of value of gold and silver is fixed by law at 15½ to 1. The 20-franc gold piece, therefore, weighs 100 grams, divided by 15½=6.4516 grams of standard gold.

MENSURATION.

Area.

Parallelogram	=base × perpendicular height.
Trapezoid	=half the sum of the parallel sides × perpendicular height.
Triangle	=base × half perpendicular height.
Circle	=diameter squared × .7854 or circumference squared × .07958.
Sector of a Circle	=length of arc × half radius.
Segment of a Circle	= { area of sector of equal radius— triangle when segment is less, and + area of triangle when segment is greater than the semi-circle.
Side of a Square of equal area as Circle	=diameter × .8862 or circumference × .2881.
Diameter of a Circle of equal area as square	=side × 1.1284.
Parabola	=base × 2-3 height.
Ellipse	=long diameter × short diameter × .7854.
Regular Polygon	=sum of sides × half perpendicular distance from center to sides.
Cylinder	=circumference × height + area of both ends.
Sphere	=diameter squared × 3.1416, or diameter × circumference.
Segment of Sphere	=height of segment × circumference of sphere of which it is a part; + area of base.
Pyramid or Cone	=circumference of base × ½ slant height + area of base.
Frustum of a Pyramid	=sum of circumference at both ends × ½ slant height + area of both ends.

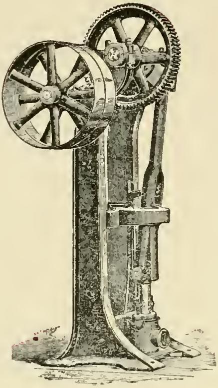
Length.

Circumference of circle=diameter × 3.1416.
Diameter of circle=circumference × .3183.
Side of square of equal periphery as circle=diameter × .7854.
Diameter of circle of equal periphery as square=side × 1.2732.
Side of an inscribed square=diameter of circle × .7071.
Length of arc=number ot degrees times diameter × .008727.
Circumference of circle whose diameter is 1= 3.14159265.
English statute miles=lineal feet × .00019.
English statute miles= lineal yards × .000568.

Solid Contents.

Prism or cylinder=area of end × length.
Sphere=cube of diameter × .5236.
Segment of sphere=(height squared + three times the square of radius of base) × (height × .5236).
Side of an equal cube=diameter of sphere × .806.
Length of an equal cylinder=diameter of sphere × .6667.
Pyramid or cone=area of base × 1-3 altitude.
Frustrum of cone= { Multiply area of two ends together, extract the square root; add to this root the two areas and × 1-3 altitude.

Mill Engineering, Continued.



THE MOFFATT DEEP WELL PUMP.

Where mill water supplies are furnished by deep well pumps, these machines are recommended.

The frame is a heavy, straight line cast iron frame of the box type; the crank-shaft is placed directly over the center of the lift, and distributes the load evenly throughout the machine. The cylinders, valves and piston are all of highly polished brass. The piston rod is coupled with a combination brass coupling and guide, which holds the rod stiff in the center of the discharge pipe. The discharge pipe from the cylinder in bottom of well is a fraction larger in diameter than the cylinder, so, when it becomes necessary to renew piston packing, the piston is drawn up by simply disconnecting the rod at the crank and drawing out the piston rod through the discharge pipe, and is replaced in the same manner without disturbing any part of the pump.

Table of Sizes Deep Well Pumps.

Number.	Capacity gallons per min.	Discharge Pipe.	T. & L. Pulleys.		
			Diameter.	Face.	Revs. per Min.
1	10	1¼″	14″	4″	160
2	25	2½″	18″	4″	150

*CHIMNEYS.

Chimneys or "stacks," as they are termed, are generally built either of brick or of sheet metal (iron or steel), and in the latter case are either self-supporting or guyed.

Under this heading will be considered stacks for use only in connection with natural draft; stacks for use with mechanical draft being properly considered as a part of the apparatus for that purpose.

Guyed Stacks are seldom recommended, and when used at all, the recommendations in conection therewith given on page 492 can be followed to advantage. (See also tables on pages 481 and 485.)

Self-Supporting Iron or Steel Stacks (occasionally referred to as steel plate chimneys) are decidedly better than guyed stacks, but the use of any metal stack can generally be avoided to advantage; in localities where ordinary brick for stacks are not obtainable of sufficiently good quality or at reasonable prices, it will generally be found to the mill's advantage to ship in radial brick of the Custodis type.

Brick Chimneys or Stacks are either square, octagonal or round in cross section, the preference being decidedly for the latter; in fact, only round stacks will be herein considered.

The question of a good chimney is not to be lightly considered; a good draft should be provided, ample for all emergencies, as it can be regulated by a damper as the occasion may require. The chimney should be large enough in cross section to carry off all the gases and high enough not only to deliver them at a sufficient height so as not to become a nuisance to surrounding buildings, but also high enough to produce sufficient draft to burn the amount of coal desired.

In proportioning chimneys the height is generally assumed with due regard to the height of the surrounding buildings, and the contour of the land with reference to hills in the immediate vicinity, the length of the smoke flues, the character of coal to be used, etc.; then the diameter required for this assumed height and the horse power desired is calculated by formulas or taken from tables.

Without going into too technical a discussion and into the details of mathematical calculations, the rules generally applying to stacks may be stated as follows:

Draft pressure is caused by the difference in weight between a column of hot gases in the chimney and a column of air of equal height and area outside the chimney.

To find the maximum force of draft in any given chimney

*For the convenience of those making Power Plant specifications, it has seemed desirable to publish this chapter in this volume, rather than in Vol. II.

Mill Engineering, Continued.

Chimneys, Continued.

Rate of Combustion for Different Total Draft Pressures.

Height of chimney above grate, in feet.	Total draft pressure in inches of water.	Rate of combustion per hour per square foot of grate in pounds.	Height of chimney above grate, in feet.	Total draft pressure in inches of water.	Rate of combustion per hour per square foot of grate in pounds.
25	0.182	10	130	0.948	30
50	0.364	16	140	1.029	34
60	0.437	17	150	1.095	40
70	0.512	18	180	1.313	50
80	0.583	19	200	1.459	60
90	0.657	20	225	1.641	70
100	0.729	22	250	1.825	80
110	0.802	24	300	2.189	90
120	0.875	27	400	2.553	112

the external air being 60 degrees Fahrenheit, and the column of heated gases being 600 degrees Fahrenheit, multiply the height above the grate in feet by .0073, the product being the force of the draft expressed in inches of water.

The draft power of the chimney varies as the square root of the height.

The draft power also varies directly as the effective area.

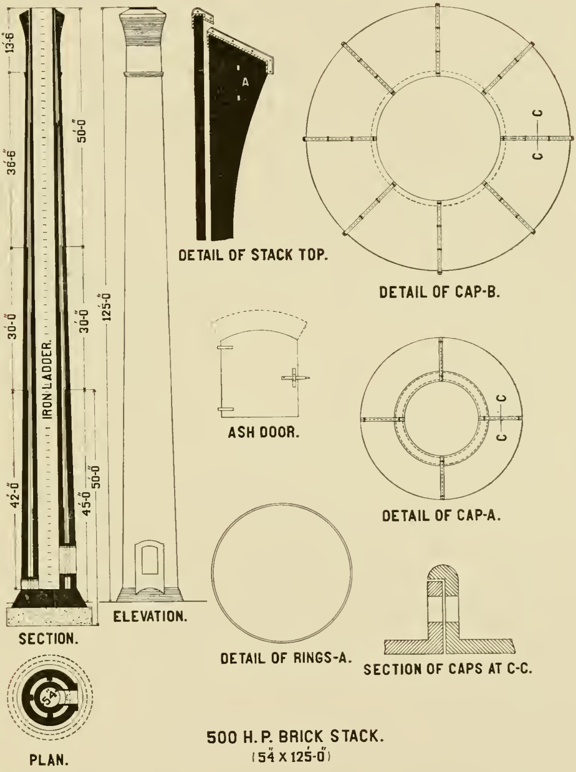
The retarding of the ascending gases by friction may be considered as equivalent to a diminution of the area of the chimney, or to a lining of the chimney by a layer of gases which has no velocity. The thickness of this lining is assumed to be two inches for all chimneys, or the diminution of area equal to the perimeter multiplied by two inches. The effective area is therefore the actual calculated area less a quantity which may be approximately taken as six-tenths of the square root of the actual area.

All chimneys should be proportioned so as to be capable of giving sufficient draft to cause the boiler to develop much more than its rated power in case of emergency, the usual practice being to provide for a combustion of five pounds of fuel per rated horse power per hour.

The power of the chimney varying directly as the effective area, and as the square root of the height, the formula for the boiler horse power of any given size of chimney will therefore involve these two variables multiplied by a certain con-

Chimneys, Continued.

stant, the average value of which has been found by actual practice to be 3.33. (See the accompanying table of "Size of Chimneys.")



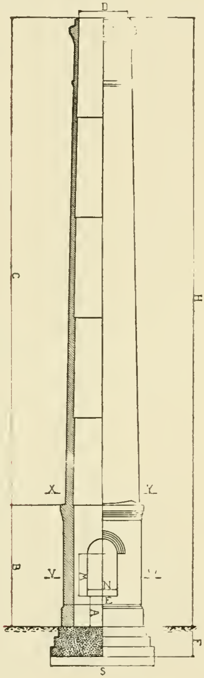
500 H. P. BRICK STACK.
(54" x 125'-0")

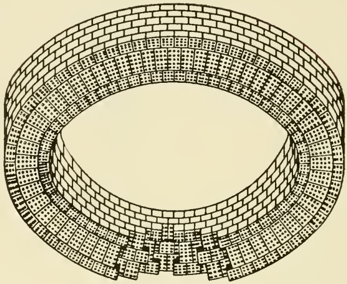
The above cut illustrates one of the many brick chimneys for Southern cotton mills that have been erected from our plans, with ordinary hard-burned locally made brick. The erection of the round stack is really much simpler than of the square or octagonal stack when it is properly understood,—the use of a simple device known as a "tram" at all times securing the maintenance of the proper "batter" and the trueness of the circle as the work progresses.

Mill Engineering, Continued.

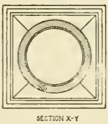
Custodis Chimney Construction.

Unquestionably the most desirable chimney that can be built is of the perforated radial blocks of the well known Custodis type.

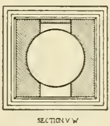




Enlarged Section in Perspective.



Cut showing half elevation and half vertical section.



Also cross-sections X Y aud V W.

The advantage of this style of construction can best be given by quoting from their trade literature as follows:

"In addition to being so shaped, the blocks are moulded with vertical holes, or perforations, to permit of more thorough burning in manufacture, thus increasing their density and strength while reducing the weight. Perforations also serve to form a dead air space in the walls of the chimney, preventing the rapid heating and cooling of the wall causing maximum draft by conserving the heat."

"In laying the blocks the mortar is worked into the perforations about one-half inch, effectively locking the blocks together, and making the wall of the tightest possible construction."

Kent's Table of Size of Chimneys for Steam Boilers.

Formula: $H.P. = 3.33 (A - 0.6\sqrt{A})\sqrt{H}$. (Assuming 1 H. P.=5 lbs. of coal burned per hour.

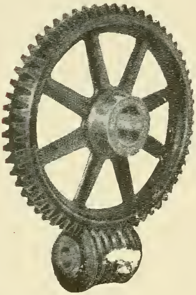
Diameter, Inches.	Area, A Sq. feet.	Effective Area, $E=A-0.6\sqrt{A}$, Square feet.	Height of Chimney. 50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.	225 ft.	250 ft.	300 ft.	Equivalent Sq. Chimney. Side of Square, $\sqrt{E}+4$ inches.
			Commercial Horse Power of Boiler.														
18	1.77	.97	23	25	27	29	...	...	...	...	...	...	...	...	...	...	16
21	2.41	1.47	35	38	41	44	...	...	...	...	...	...	...	...	...	...	19
24	3.14	2.08	49	54	58	62	66	...	...	...	...	...	...	...	...	...	22
27	3.98	2.78	65	72	78	83	88	...	...	...	...	...	...	...	...	...	24
30	4.91	3.58	84	92	100	107	113	119	...	...	...	...	...	...	...	...	27
33	5.94	4.48	...	115	125	133	141	149	156	...	...	...	...	...	...	...	30
36	7.07	5.47	...	141	152	163	173	182	191	204	...	...	...	...	...	...	32
39	8.30	6.57	...	...	183	196	208	219	229	245	...	...	...	...	...	...	35
42	9.62	7.76	...	...	216	231	245	258	271	289	316	...	...	...	...	...	38
48	12.57	10.44	...	...	...	311	330	348	365	389	426	...	...	...	...	...	43
54	15.90	13.51	...	...	...	...	427	419	472	503	551	595	...	...	...	...	48
60	19.64	16.98	...	...	...	...	536	565	593	632	692	748	...	...	...	...	54
66	23.76	20.83	...	...	...	...	...	694	728	776	849	918	981	...	...	...	59
72	28.27	25.08	...	...	...	...	...	835	876	934	1023	1105	1181	1253	...	...	64
78	33.18	29.73	...	...	...	...	...	...	1038	11 7	1212	1310	1400	1485	1565	...	70
84	33.48	34.76	...	...	...	...	...	...	1214	1294	1418	1531	1637	1736	1830	2005	75
90	44.18	40.19	...	...	...	...	...	...	...	1496	1639	1770	1893	2008	2116	2318	80
96	50.27	46.01	...	...	...	...	...	...	...	1712	187[illegible]	2027	2167	2298	2423	2654	86
102	56.75	52.23	...	...	...	...	...	...	...	1944	2130	2300	2459	2609	2750	3012	91
108	63.62	58.83	...	...	...	...	...	...	...	2090	2399	2592	2771	2939	3098	3393	96
114	70.88	65.83	...	...	...	...	...	...	...	...	2685	2900	3100	3288	3466	3797	101
120	78.54	73.22	...	...	...	...	...	...	...	...	2986	3226	3448	3657	3855	4223	107
132	95.03	89.18	...	...	...	...	...	...	...	...	3637	3929	4200	4455	4696	5144	117
144	113.10	106.72	...	...	...	...	...	...	...	...	4352	4701	5026	5331	5618	6155	128

Mill Engineering, Continued.

MORSE WILLIAMS & COMPANY'S ELEVATORS.

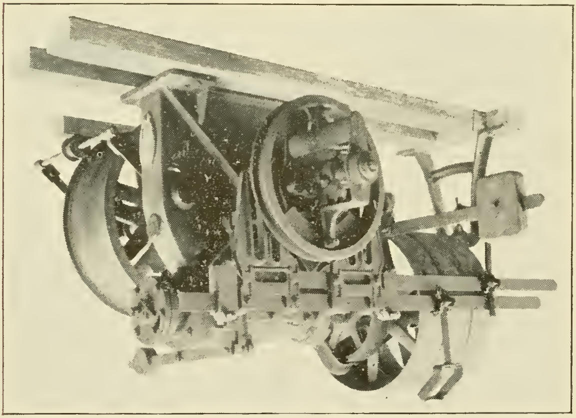
Belt Power Machines.

The Improved Hindley Worm and Gear is used on all belt power machines of this make. As these are the main features of the hoist, special attention is paid to them.



The shape of this worm and gear is shown in the marginal cut. The worm is cut from a solid blank, curved to correspond to the arc of the wheel, so that there is a variation of pitch from point to root of tooth. This variation of distance from center to center of teeth in the worm exactly corresponds to the two diameters of teeth of the wheel, thus giving a perfect bearing surface on the whole length of the worm. An efficiency of 25 per cent. over and above that of the ordinary screw and gear is claimed for this type.

Next in importance to the gearing is the belt shifter and brake. There is no rack, gearing or link motion, and it is so arranged that while either of the belts is being shifted to the fast pulley, the other remains undisturbed. The brake does not touch the pulley until brought into use, and



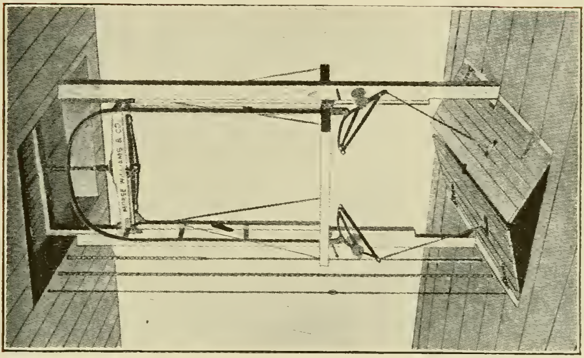
by means of a compound lever and weight the wear is taken up automatically. The loose pulleys are made with large hubs and a liberal chamber for lubrication, and are bushed with Ajax metal composition.

All these machines are fitted with slack cable shifters, thereby stopping the machine as soon as the suspension cable slacks up when caused by the car being obstructed in its descent.

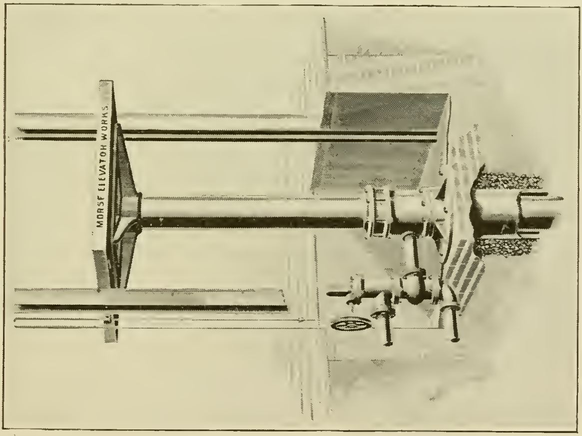
An automatic stop placed on the drum shaft can be set to stop the machine at any point.

Mill Engineering, Continued.

Elevators, Concluded.



Various types of automatic hatch doors can be used, but those shown in the accompanying cut are to be recommended.

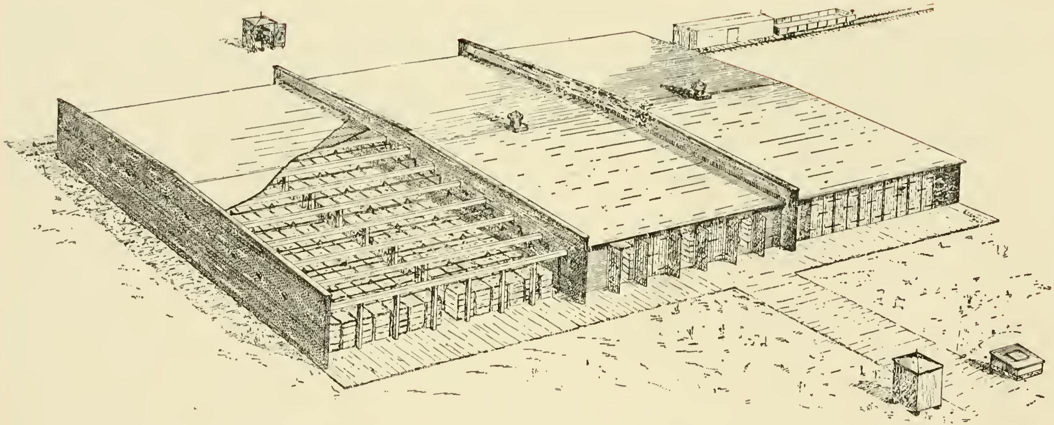


Hydraulic Elevators.

(Plunger Type.)

The above cut shows only the general arrangement of this type of elevators. Any type of cage, automatic doors, etc., can be attached, as may be desired. Also the platform may be counterweighted, thereby reducing the dead lift.

STANDARD WAREHOUSES.



In estimating warehouse capacity, each compartment 50x100′=5000 square feet floor space, has a capacity of uncompressed bales standing on end, one bale deep, allowing practically 10% for alley ways.

Each bale occupies a floor space approximately 30x40 inches, or 9 square feet.

The standard bale weighs from 400 to 600 pounds, averaging about 500 pounds gross.

Bagging and ties weigh about 20 to 30 pounds to the bale, the average probably being 22 pounds.

Warehouse floors should be built four feet above the track rails and platform three feet nine inches above rails, to come right for unloading cars.

Mill Engineering, Continued.

Kitson Machine Company's BLOWING SYSTEM FOR HANDLING COTTON

From the

Warehouse to the Opening Room.

It very frequently happens that it is not feasible to locate the warehouse of the cotton mill so that a platform can conveniently be carried from it to the picker room. The question of transferring the cotton from one to the other, therefore, has been the subject of considerable thought. The best practice to-day favors an arrangement devised by the Kitson Machine Company, to accomplish this by carrying the cotton from the warehouse to the picker room through a galvanized iron pipe, either placed under ground in a box and covered up, or overhead, according to choice.

When intended to be used in this manner, the warehouse is built with a small opening room ten to twenty feet square, cut-off from the rest of the warehouse by a fire wall. In this small warehouse opening room is placed a cone hopper into which the loose cotton is thrown from the open bales by hand. In the picker room it is received by the galvanized piping by a breaking-up fan and discharged into a condenser fitted with exhaust fan for removing the air and dust, with the result that the cotton drops from the condenser in a light flaky mass at any convenient point in the picker room or even right into the hopper of automatic feeder.

Any amount of cotton can be handled this way in a very short time, and the cost of opening and transferring the cotton from the warehouse to the picker room becomes an exceedingly small item. Incidentally, mill men will appreciate that the cotton is greatly improved by this preliminary "opening," as it were.

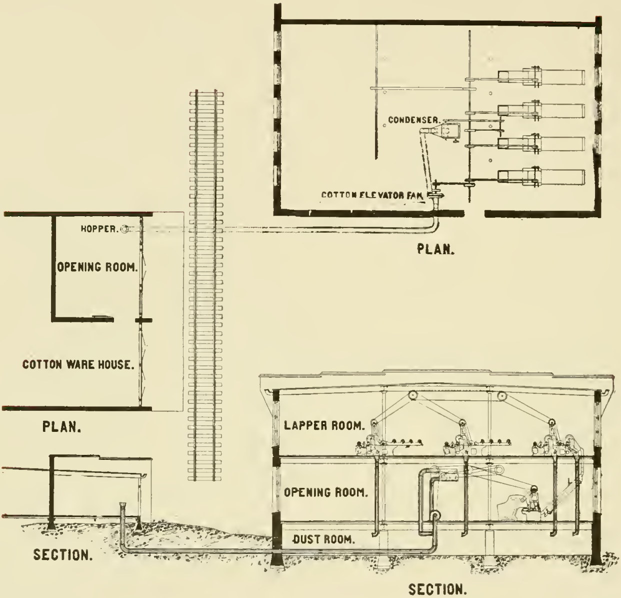
It is immaterial whether the storage warehouse with its opening room is as near to the picker room as insurance requirements will permit, or whether it is several hundreds yards away.

Condensers.

These are made in two different types, according to the amount of cotton to be conveyed. Both are of the same general construction, and both are equipped with automatic

Mill Engineering, Continued.

Kitson Blowing Systems, Continued.



(System showing hopper for Hand Feeding in Warehouse Opening Room, and O. S. Condenser in Lapper Opening Room.)

sprinklers; the small one is fitted with self-contained fan, and the larger one is not.

The O. S. Condenser with self-contained fan and countershaft has a capacity of 10,000 to 15,000 pounds per day. The self-contained fan is simply for the purpose of exhausting the air from the condenser. A separate No. 6 fan with countershaft is required for drawing the cotton from the opening room in the warehouse and blowing it into the condenser.

The Amoskeag Condenser has no self-contained fan and requires no countershaft. Two separate No. 6 fans with countershafts are required; one to convey the stock from the warehouse and blow it into the condenser, and the other to exhaust the air from it. Roughly speaking, this condenser has a capacity of 20,000 to 25,000 pounds per day.

Kitson Blowing Systems, Continued.

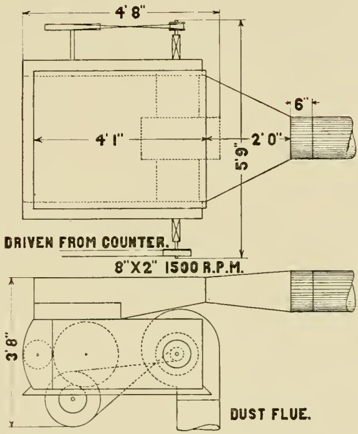


Diagram and Floor Plan, O. S. Type Condenser.

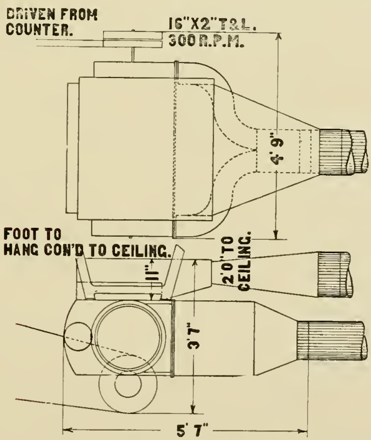
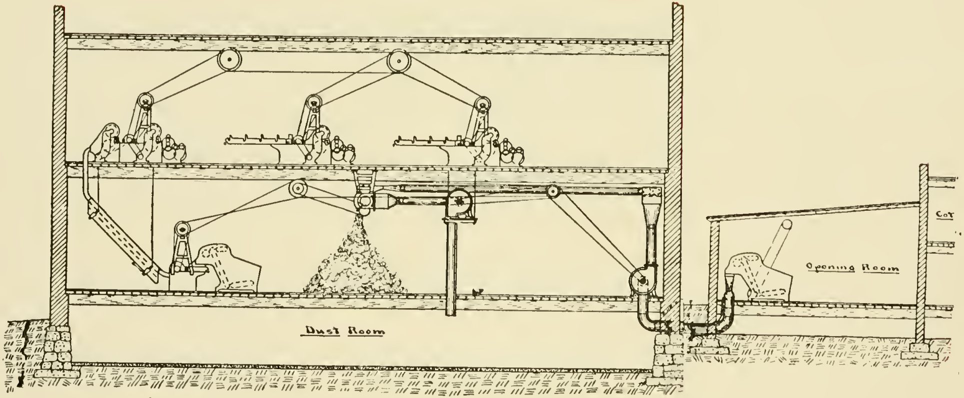


Diagram and Floor Plan, Amoskeag Type Condenser.

Mill Engineering, Continued.



While one condenser really has capacity enough to handle 20,000 to 30,000 pounds per day, as a matter of convenience, two condensers should be put in where there are over five openers to be fed, as it is more convenient to have the cotton drop on the floor behind the openers in two piles instead of one in such cases. The condensers are hung overhead to ceiling with hangers varying in length from 15″ to 36″, according to whichever length fills the existing conditions.

For a small system handling only 3,000 to 5,000 per day capacity, a feeder for feeding the hopper in the cotton storage warehouse is necessary; but for larger plants it is desirable to feed the pipe with an automatic feeder in the warehouse, as shown in the above cut.

Mill Engineering, Continued.

Kitson Blowing Systems, Concluded.

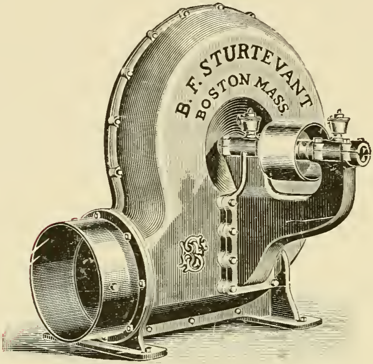
The illustration on the opposite page shows a plant, with store-house on the right, having a fire-proof opening room annexed, in which are placed two specially-constructed feeders for opening bale cotton. Bales of different grades are run in from store-house behind feeders, and the operator in filling the hoppers from first one, then the other, ensures a perfect mixing of the stock. From the doffer end of feeders the cotton passes into a galvanized iron conducting pipe running through an underground protection to a breaking-up exhaust fan located on picker room floor, which blows the same through a similar pipe and two-way valve in equal quantities to two Amoskeag condensers located overhead in picker opening room, or the whole product of conducting pipe can be blown to either condenser at will. A fan located on shelf near ceiling, and connected by exhaust pipes to each condenser removes the air and dust blown along with the cotton into the condensers by the conveying exhaust fan, so that the opened cotton drops by its own weight free from air and dust ready for the subsequent operation—filling the six hoppers of open feeders. Not only is this handling of cotton a great labor saving device, but the mixing and passing of air through it in transit is worth weeks of ageing by hand mixing and piling up the old way. The use of feeder in store-house opening room is recommended particularly when a large amount of stock is to be handled; but when it is impossible to get power at this point, they can be dispensed with and cone hoppers for hand feeding attached to conducting pipe, depending wholly upon the breaking-up exhaust fan to convey the stock and open it up too.

Installations conveying from 5,000 to 30,000 pounds per ten hours through a single pipe are now in operation.

See also diagram elsewhere for outfit installed in the Highland Park No. 3 Mill.

Mill Engineering, Continued.

COTTON ELEVATOR FANS.



The above cut illustrates the "Monogram" type of fan, which is specially adapted to handling cotton.

The speeds and capacities for dry cotton at moderate distances are approximately as follows:

No. 5, 1600 revolutions, 1200 pounds.
No. 6, 1300 revolutions, 1800 pounds.
No. 7, 1300 revolutions, 3000 pounds.
No. 8, 1150 revolutions, 4000 pounds.
No. 9, 900 revolutions, 5000 pounds.

Of course, the above speeds and capacities can be used with judgment according to the distances, and whether it is hand or automatic feed, and other such things. For wet stocks the speeds would be increased somewhat. For very light or dry work with automatic feed, they might be decreased somewhat. The speeds given would ordinarily be all right for hand feed on any of the fans, but we do not advise the use of a No. 5 fan on hand feed work.

Construction.—This type of fan is distinctly designed as a volume blower or exhauster. The blower has two inlets; the shaft extends through the fan wheel and is supported by a bearing upon each side of the case. An exhauster has but one inlet, which is provided with an extension over which a pipe may be slipped; both bearings are upon the blank side of

Cotton Elevator Fans, Concluded.

the case, through which the shaft projects sufficiently far to support the wheel. In both types the case is of cast iron, to which is bolted an outlet of the same material. The wheel is of steel plate with hub of brass, malleable iron or of cast iron with steel T arms. The shaft is of steel, and is supported in continuous self-oiling journal bearings. Blowers are regularly made right hand, but can be made left hand to order; exhausters are regularly made either hand. Either can be made down or up blast, or top horizontal discharge, though the following table gives the data for bottom horizontal discharge machines:

Table of Sizes and Details.

Sturtevant Monogram Fans with Horizontal Bottom Discharges.

No of Blower or Exhaus	Outside diameter of inlet of Exhauster, in inches.	Outside Diameter of Outlet, in inches.	Diameter and face of Pulley, in inches.	Approximate Overall Dimensions. (In inches.)			
				Height.	Length.	Width Blower.	Width Exhauster
5	12¼	12¼	6⅞x 5¼	36	32	28	30
6	15	14⅝	8 x 6½	42	38	32	33
7	16⅝	16⅝	8⅞x 7½	50	44	38	39
8	18⅝	18¾	10¼x 8⅞	57	50	46	46
9	21½	21¾	12 x10½	66	58	51	52

Countershafts.

Under the usual conditions, in order to obtain the requisite speed, countershafts are required. The following table gives the sizes of countershafts specially designed for this purpose. The boxes are babbitted, adjustable, and provided with oil drip chambers and continuous oiling devices. When desired, they can be equipped with tight and loose pulleys in place of the usual single pulley driven from the line shafting.

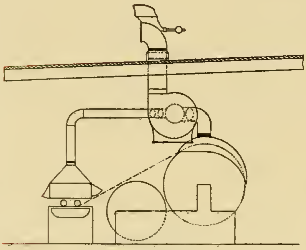
Number of Blower.	Diameter of Pulley Driving Blower, in inches.	Diameter of Pulley driven by Main Belt from Line Shaft in inches.	Diameter of Shaft in inches.
5	32	12, 14, 16	1¾
6	36	12, 14, 16, 18,	1 15-16
7	42	14, 16, 18, 20,	2 7-16
8, 9	48	18, 20, 22, 24,	2 15-16

In ordering fans with countershafts, it is necessary to give the speed of the line of shafting from which it is to be driven, and the largest pulley that can be used thereon, with a statement of the class of work the fan is to do.

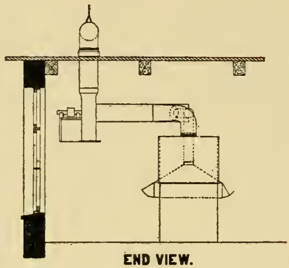
Mill Engineering, Continued.

SLASHER VENTILATING OUTFITS.

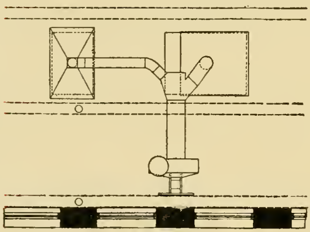
(Sturtevant.)



SIDE VIEW.



END VIEW.



PLAN.

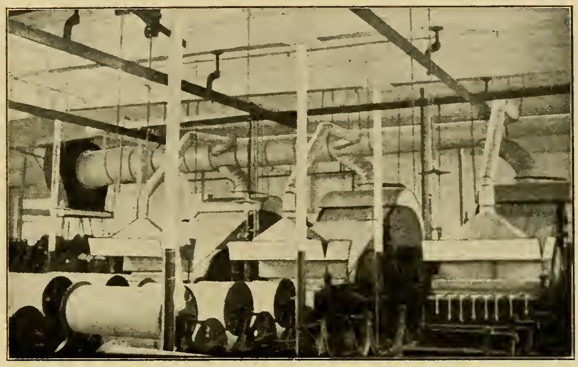
(As applied to one slasher, in either a one story building, or located on the top floor where it can ventilate directly up through the roof.)

The method of application of the Exhaust System is shown above from a working drawing.

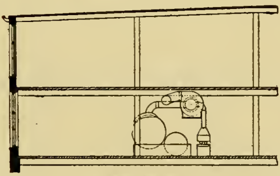
Experience with this form of application has shown that the rooms are kept entirely clear of steam; the windows, walls and ceiling are not continually bedewed and dripping; and more efficient work can be done because of the clear atmosphere. In addition, the time of drying is lessened, and consequently the output rendered greater for a given investment.

A modern equipment is usually as follows:
1-45" Steel Plate Pulley Exhaust Fan.
1-Set of special galvanized iron slasher hoods (a set consisting of one hood for a large cylinder and one for size box.)
1-18" galvanized iron swinging roof hood with roof piece.
Galvanized iron suction pipe from slasher hoods to inlet of fan.
Galvanized iron delivery pipe from outlet of fan to roof.

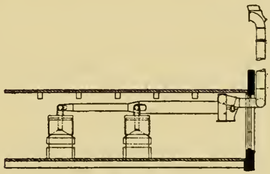
Slasher Ventilating Outfits, Concluded.



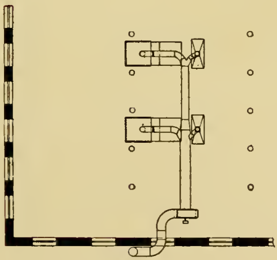
(From a photograph illustrating outfit applied to four slashers—three only showing, however.)



SIDE VIEW.



END VIEW.



PLAN.

Where there are two or more slashers in one room to be taken care of, as shown above, they are all connected up to one fan, which is either single or duplex; the branch pipes to each slasher are arranged with 17″ cut-off gates. Sometimes, however, two gates are used, one 10″ and the other 15″, on the connection from the size box hood and the main cylinder hood respectively.

Mill Engineering, Continued.

APPARATUS FOR AIR CONDITIONING.

(See pages 366-375, inclusive, Vol. II. for chapter on **Humidifiers,**—for Moistening the Air in Textile Factories.)

(See also pages 959-961 in Appendix to Vol. II., entitled **Cramer System of Air Conditioning.** Humidity and Temperature Automatically and Positively Regulated According to any Predetermined Scale.)

*Recent Development in Air Conditioning.

"At first sight, the title chosen for this paper seems to be rather comprehensive when it is considered that I intend to limit my remarks largely to the description and application of my new Automatic Regulator, the function of which is the automatic control of humidifying and heating systems. A description of the apparatus itself, however, would not be complete without at least a statement of the requirements for automatic regulation."

"In the building and equipping of mills, you are accustomed to consider heating and humidifying separately, without regard to that interdependence which is so strikingly brought to notice upon even the crudest effort at hand regulation. And the moment you attempt the refinement of automatic regulation, you are confronted with another problem, and that is ventilation. Parenthetically, I would also mention air cleansing, which, however, is a problem largely solved by an efficient humidifying system. And so, I have used the term 'Air Conditioning' to include humidifying and air cleansing, and heating and ventilation. That there have been recent developments along these lines individually, I do not now intend to discuss; but, as already stated, will confine myself largely to automatic regulation and, so far in as is pertinent, to the combined proposition of air conditioning."

* * * * * *

"**Humidification.**—By this term is meant the artificial moistening of the atmosphere in a mill in order to produce conditions most favorable to the proper working of the materials in process of manufacture, with due regard to the health of the operatives.

"Mr. Joseph Winward, a mill manager of Bolton, England, has well stated the considerations affecting what he terms

*Being extracts with slight modifications from an address delivered by me before the Tenth Annual Convention of the American Cotton Manufacturers Association, Asheville, N. C., May 16-17, 1906. This complete address will be furnished upon application.

Cramer Air Conditioning, Continued.

'humidification,' but what I prefer to term 'air conditioning.' These considerations are:

(1). Humanity employed in the manufacture.
(2). The materials that are to be manufactured.
(3). The possibility of bringing about conditions suitable to both.

"In England the work people are protected by an Act of Parliament, which regulates not only the maximum percentage of humidity allowable at different temperatures, but also defines the legal standard of purity of the air that must be maintained."

* * * * * *

"As to the conditions most favorable to the materials to be manufactured: The structure of the cotton fibre, its hollow spiral or collapsed tubular form, with its delicate waxy walls, and its wonderful adaptitude for draughting and twisting and manipulating under proper atmospheric conditions, are well known, as well as its refractory nature under adverse conditions of humidity and temperature, and its fretful disposition in the presence of static electricity."

"Cotton contains about 8 per cent. natural moisture, a part of which is lost in the process of manufacture even when the proper percentage of humidity is maintained in the atmosphere of the different rooms. This source of loss is often ignored, but included under the head of 'invisible waste.' The installation of an efficient system of humidification, however, will reduce this item of invisible waste easily from 1 per cent. to 3 per cent., 2 per cent. being probably a fair average. Humidity is essential to allay the electricity; moist air is a good, and dry air is a poor conductor of electricity. A dry and electric lade atmosphere shortens the threads, weakens the fibres, and causes numerous breakages, with the result that more waste is made. With a proper amount of humidity, the fibres become more adhesive and pliant, and the yarn is consequently softer, smoother and stronger. The same applies to weaving. breakages become rare and the cloth has a more even and regular texture, any size that is put in the yarn being retained in a softened state."

"We are all agreed, therefore, upon one point, and that is upon the desirability of bringing about and maintaining a proper standard of both humidity and temperature."

"The question that next arises, then, is what shall be that standard of humidity and temperature? Obviously, it will

Cramer Air Conditioning, Continued.

vary in each room of a mill to suit the particular requirements of the processes of manufacture carried on in that room—one room requiring a higher or lower scale than another. And it is equally obvious that whether the scale in a room be high or low, it will be a variable scale, the humidity decreasing in percentage as the temperature of the room increases. Observation and experiment have shown within comparatively narrow limits what the scale should be for the best results in each department of cotton manufacturing."

"Mr. J. H. M. Beaty, while head of the Textile Department, and Mr. B. M. Barker, Instructor of Carding and Spinning, Clemson College, S. C., have conducted probably the most complete series of tests made in this country along this line, and, as was to be expected, they agree very closely with those of other reliable observers who have taken records both in an experimental way and from actual experience in mills themselves. The effects of humidity on yarns, and the conclusions that were drawn from the Clemson tests, have been stated by Mr. Barker in a recent article in the Textile World Record as follows:

"First. As a rule, the higher the humidity, the higher the breaking strength of the yarn.

"Second. That the percentage of broken ends was less with the humidity at about 65 to 75.

"Third. The fibers in the yarns lay closer together as the humidity was increased, producing a more compact and less fuzzy yarn, also a yarn that looked smaller. After the humidity was raised to about 70 there was scarcely any difference in the appearance in the yarns.

"Fourth. The higher the humidity the less fly collected on the frames.

"From these four conclusions it would apear that, all things being taken into consideration, a humidity between 65 and 75 would give the best results in the spinning room. Above this a little stronger yarn might be obtained, but its appearance would not be any better and the chances are that broken ends would increase in number."

"Assuming, then, that a humidity of 65 per cent. to 75 per cent. would give the best results in a spinning room, it remains only to prepare according to well-known laws a variable scale of humidity percentages to be maintained for a range of temperature likely to be encountered, and then to maintain approximately that scale, and the closer the better."

"This scale of humidity is decidedly lower than most people suppose it to be. While generally manufacturers realize that the card room requires less humidity than the spinning room, they generally fall into the error of trying to keep their spinning rooms up to the limits established by the English Cotton Cloth Factories' Act, which was never intended for use in a spinning room, but for weave rooms, where tremendously high percentages of humidity were often maintained to enable certain manufacturers to make goods with abnormally high percentages of size."

"By a careful collection of data from all available sources, and from talking with mill men and others who have given thought and study to this subject, and from my own experiments and observation, I have adopted three scales, one for a card room, one for a spinning room, and one for a weave room, which I believe will meet with the approval of most mill men. These scales will be found in tabular form, appended to this chapter. In this connection I would remark by way of explanation—

Cramer Air Conditioning, Continued.

"In card rooms with combers, I do not think a higher scale of humidity is necessary, but there may be others who would differ with me and advise carrying a slightly higher percentage of humidity than I have recommended.

"In the case of spinning rooms, however, I would most strongly urge rigid adherence to the scale that I have recommended; there is not the slightest need for exceeding that scale for any class of work whatsoever, though I am quite well aware that there are a few people who advocate an extremely high humidity with a temperature of even 90 to 100 degrees for spinning very fine numbers.

"As for weave rooms, the practice will necessarily vary according to the character of the work done in those rooms. The table I have recommended is high enough for most purposes. Occasionally, however, the maximum scale allowed in the English Cotton Cloth Factories' Act can be substituted to advantage."

The Influence of Humidity and Temperature upon Power.—It has long been known that excessive humidity increases the power required to drive cotton machinery, especially ring spinning and twisting. This has been attributed to two causes: The first being the increased tension of the spindle bands, and the second being the general "drag" of the fibre in an abnormally moistened condition . The exact extent of this increase has, however, not been looked into and published to the extent that one would naturally expect, considering its importance, until the appearance recently of an article by Mr. Wm. F. Parrish, Jr., Yorkhouse, London, W. C., England. A few extracts from his paper are herewith quoted, and will no doubt be found interesting:

"One of the great influencing factors upon the power of a mill is the temperature. It is the effect of this that makes a mill start up hard in the morning, especially on Monday. The reason is improper lubrication, largely affected by temperature, with the further influence of relative humidity."

"Upon a single ring spinning frame the effect of humidity far outvalues that of temperature. A test was made upon a frame of old Sawyer spindles, which are lubricated similarly to mule spindles, where temperature readings were taken every fifteen minutes from 7 a. m. until 4:45 p. m. The day was one of those known in America as "dog days," which occur in August, and during which peculiar feats are performed by both the temperature and the relative humidity."

"(From 8:15 a. m. to 3 p. m.)

Temperature increased,	12.5%
Relative humidity increased,	13.0%
Power increased,	8.2%

"(Another day's showing.)

Temperature increased,	10.0%
Relative humidity decreased,	7.0%
Horse Power decreased,	8.7%

"Temperature increase can be considered as being practically the same in both tests.

"(Another peculiar test.)

Temperature decreased,	5.6%
Humidity increased,	12.1%
Horse Power decreased,	5.0%

Cramer Air Conditioning, Continued.

"This is exactly opposite to what the opinion of mill men and all of our previous experience would lead us to believe. The 480 cards taken during the three days of test were carefully checked, and the areas were found to compare exactly with the admission, pressure and point of cut-off. This last observation was the one that allowed us to solve the difficulty. The engine was well loaded, the main driving belt not being sufficiently large to carry more than an ordinary load on a normal day, and the increase of relative humidity of 12.1% added to the power required by the spinning frames so that the belt slip increased to such a point that the engine did not transmit over 95% of the power it would have given under normal conditions."

Mr. Sidney B. Paine, of the General Electric Company, a well-known expert on electric driving, has also recently called my attention to some very remarkable cases of increase of power required to drive machinery that have come under his observation, directly traceable to excessive humidity.

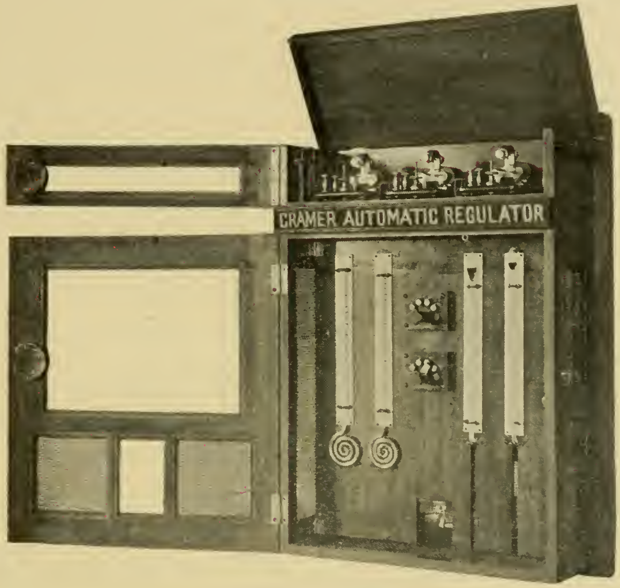
The Cramer Automatic Regulator.

"From an inspection of the hygrometrical tables, pages 372-5, inclusive, Volume II.,the necessity for regulating both humidity and temperature is made apparent. The slightest change in the temperature requires the corresponding change in the humidity. As the temperature rises, the percentage of relative humidity should be decreased, but the actual amount of water present in the atmosphere must be increased. That it is practically impossible to effect these changes promptly by hand, goes without saying. I have talked with successful mill men who have in more than one instance made it the duty of one man to look after the heating and humidifying systems, with nothing else whatever to attend to. The results were so unsatisfactory in each case that the effort was abandoned. I have sold a great many equipments of humidifiers during the past ten or fifteen years, and I have both experimented myself and had the experience of my friends among the mill men who have made observations for me in their mills; and about two years ago I devised an instrument, which I have been perfecting since, that has demonstrated its ability to do this work. I have designated it as an Automatic Regulator.

"The Automatic Regulator itself may be technically termed a combined hygrostat and thermostat, as it serves in a dual capacity as the controlling element of both the humidifying and the heating systems.

"It involves the well-known principles of the wet and dry bulb thermometer type of hygrometer, which is recognized the world over as the only type of standard instrument for that purpose. Many attempts have been made to devise instruments that would take the place of this wet and dry bulb type of hygrometer, but they have all been ignominious failures, they generally depending upon the behavior or misbehavior of vegetable or animal fibres or materials under different atmospheric conditions. For convenience I refer to this type of hygrometer as the mechanical type. Their lack of trustworthiness is due to two causes: The first being that humidity affects them to a different degree at different temperatures; and the second is the susceptibility of the surface pores of the sensative substances to being choked up by dust, lint, etc., etc., a thin coating of which causes the indications to become both sluggish and erratic."

Cramer Air Conditioning, Continued.



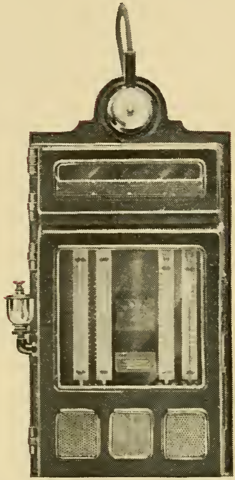
Type A Regulator.

"The above cut illustrates the general appearance of the first Automatic Regulator made, the doors being opened to give an idea of the construction. It will be noticed that the case is of wood, but I would state that the instruments as now manufactured are contained in durable metal cases, as illustrated above."

It is seen that the case to these instruments is really only a frame work with panels of wire netting to provide for a free and uninterrupted circulation of the air.

It will be observed that there are two dry bulb thermometers and two wet bulb thermometers, and also that they are electrically connected. The duplication of the wet and dry bulb thermometers is simply for mechanical reasons, this construction thereby permitting of a more sensitive instrument. The electric current sent through the thermometers is exceedingly minute in both quantity and voltage, but quite sufficient to actuate relays, which in turn throw 12 volt current through the magnets operating the electrically operated valves.

Cramer Air Conditioning, Continued.



Type B Regulator.

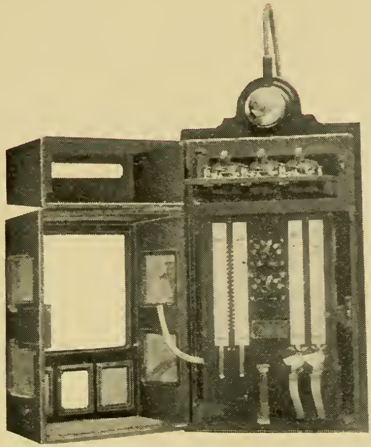
The first instruments made, in wooden cases, are termed Type A.

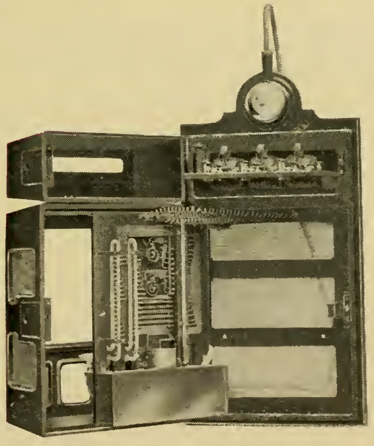
The Type B instruments are those in metal cases, but also like Type A, they require changing of the wicks on the wet bulb,—not to mention the occasional supplying of distilled water to the water reservoir supplying the wicks. These two types of instruments are based on the hygrometric principle.

In the tables appended to this chapter, however, it will be noticed that there are both hygrometric and psychrometric readings. My Type C instruments are based on a new principle in the construction of wet and dry bulb instruments for indicating humidity; and the peculiarity of this new principle is that psychrometrical tables can be used in computing the relative humidity from the readings of the instruments so constructed. The advantages are obvious: In the first place, at one stroke the troublesome changing of the wicking and covering on the wet bulb thermometers is done away with as well as the use of distilled water; the water used being simply that regularly in use in the humidifier pipes. Also the psychrometer may truly be said to be the scientific equivalent of the hygrometer, its readings being perfectly accurate all the time, whereas with the hygrometer they are accurate only when a fresh new wicking is put on, and are open to doubt any time after that, due to the clogging up of the pores of the wicking and to its correspondingly lessened evaporative power and consequent cooling effect.

It may well be said just here that the psychrometer is the standard instrument in use by the U. S. Weather Bureau for measuring humidity, and not the hygrometer.

Cramer Air Conditioning, Continued.





Interior Views of Type B Regulators, showing not only the arrangement and disposition of the thermometers, temperature switches, etc., but also the electrical connections in the back.

Cramer Air Conditioning, Continued.

"Automatic regulation is accomplished by the co-ordination of the following elements:

"The Automatic Regulator electrically connected with a source of electricity (the generator) to electrically operated valves, one in connection with the humidifying system and one or more in connection with the heating system in each room; each electrically operated valve is in turn connected pneumatically to main shut-off valves in either the heating or humidifying systems, as the case may be. In the case of direct steam or hot water heating, one electrical valve can act as a controller for two or more cut-off or main valves. And similarly, in the case of a fan or blower system of heating, one supplemental valve can close any number of dampers,—the dampers can even be closed in sections alternately, or all at once, as may be desired."

"Of course, in the summer time the temperature in the different rooms can only be modified; it can not be controlled. The thermostatic function of my Regulator is only to cut off the heat when artificial heating is taking place. Summer heat is a matter that can only be modified by proper ventilation and air cooling with an approved systems of humidifiers."

"For controlling heating systems, connections are made between the limits of 65 and 85 degrees, as this range of temperature will certainly provide for all if not more than any mill man could wish. The thermostat connections I have made to two switches, which you will notice on the front of the board in the first and second illustrations. I have done that so that a part of the heating system in a mill may be cut off at one temperature, and the remainder of it cut off only in case the temperature goes higher. This is desirable to prevent any abrupt changes of temperature by cutting off on a cold day the whole heating system. The range of temperature and points at which each half of the heating system can be cut off are within the control of the superintendent, as he sets the switches at each point that he chooses."

"The energy required for automatic regulation is both electrical and pneumatic. The electric current required is insignificant, being furnished by a small dynamo or generator of low voltage, and ranging from ¼ H. P. in small mills to 1 H. P. in large mills. It is therefore unfailing, and it is not dependent upon the vagaries and uncertainties of batteries."

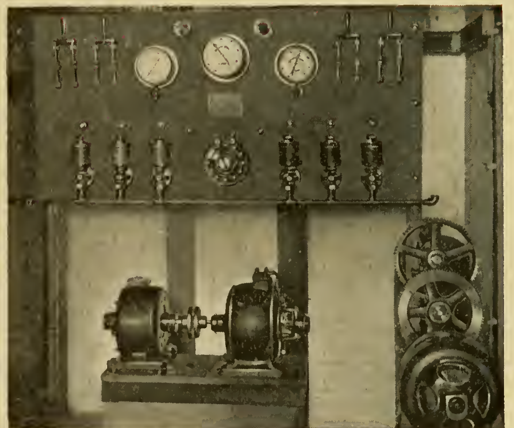
"The pneumatic energy, or air pressure, required is furnished by an exceedingly small air compressor, the power required to drive which is even less than that required to drive the electric generator, and will not average all day long in a large mill ⅛ H. P., the consumption of air being only intermittent and in exceedingly small quantities of a foot or two at a time."

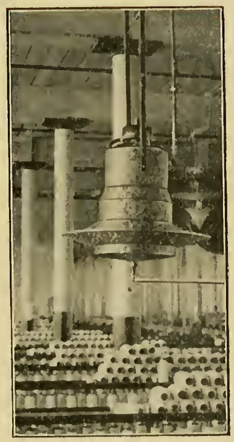
Cramer Air Conditioners.

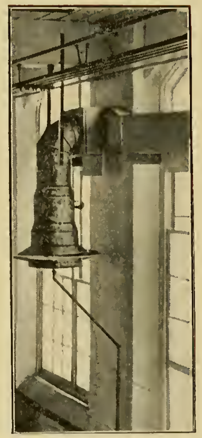
Without going into an elaborate description of these devices, owing to lack of space available, I would say that they are made in two types: **Type I** for inside ceiling suspension, and **Type W** for ventilation by a connection to the outside atmosphere —both types being humidifiers, and the latter being also ventilators, with a cooling feature in connection therewith (by forced evaporation) that is truly surprising.

(Full particulars on application.)

Cramer Air Conditioning, Continued.







The above cuts illustrate views showing a **typical installation of an automatically regulated system of Air Conditioners** as installed **in a** modern cotton mill.

The view on the left at the bottom of the page illustrates the switchboard control with small motor-generator set to furnish electric current for the electrically operated valves, and small motor-driven air compressor to furnish compressed air for operating the shut-off valves. The cut in the middle of the page illustrates an inside, or Type I, Air Conditioner. The cut on the right, at the top of the page, illustrates a ventilating Type W, Air Conditioner.

Cramer Air Conditioning, Continued.

Cramer Scale for Spinning Rooms.

*Hygrometer Readings.		**Psychrometer Readings.		Humidity.	
Dry Bulb	Wet Bulb.	Dry Bulb.	Wet Bulb.	Relative %.	Actual. (In grains per Cubic foot).
60	56	60	55⅔	76	4.4
61	57	61	56⅔	77	4.6
62	58	62	57⅔	77	4.7
63	59	63	58½	77	4.9
64	60	64	59½	77	5.1
65	61	65	60½	78	5.3
66	62	66	61½	78	5.5
67	63	67	62½	78	5.6
68	64	68	63½	78	5.8
69	65	69	6 ⅓	78	6.1
70	66	70	65⅓	78	6.3
71	66½	71	65¾	76	6.3
72	67½	72	66½	75	6.5
73	68	73	67⅓	74	6.6
74	69	74	68	74	6.8
75	69½	75	68½	73	7.6
76	70½	76	69½	73	7.0
77	71	77	70	71	7.1
78	72	78	71	71	7.3
79	73	79	72	71	7.6
80	74	80	72¾	71	7.8
81	74½	81	73½	70	7.8
82	75½	82	74⅓	70	8.1
83	76	83	74⅔	68	8.2
84	77	84	75⅔	68	8.5
85	77½	85	76⅓	66	8.5
86	78½	86	77	66	8.7
87	79	87	77½	65	8.8
88	80	88	78⅓	65	9.1
89	81	89	79¼	65	9.4
90	81½	90	79¾	64	9.5
91	82½	91	80⅔	64	9.8
92	83	92	81⅓	63	9.9
93	84	93	82¼	63	10.2
94	84½	94	82⅔	62	10.3
95	85½	95	83⅓	62	10.5
96	86	96	83¾	60	10.7
97	87	97	84⅔	60	11.0
98	87½	98	85⅓	59	11.1
99	88½	99	86¼	59	11.4
100	89	100	86⅔	58	11.5

*These two columns are applicable to the ordinary wet and dry bulb type of hygrometer, in the use of which the instrument is to be screened from any draughts.

**These two columns are strictly applicable only to wet and dry bulb thermometer styles of instruments that are to be subjected to a strong current of air, the velocity of which is to be not less than 15 ft. per second.

Cramer Air Conditioning, Continued.

Cramer Scale for Card Rooms.

(See "Recent Development in Air Conditioning," by Stuart W. Cramer, read at Asheville meeting of American Cotton Manufacturers' Association, May 16-17, 1906.)

*Hygrometer Readings		**Psychrometer Readings.		Humidity.	
Dry Bulb.	Wet Bulb.	Dry Bulb.	Wet Bulb.	Relative %.	Actual. (In grains per Cubic foot).
60	54	60	53⅔	66	3.8
61	55	61	54⅔	67	4.0
62	56	62	55⅔	67	4.1
63	57	63	56½	67	4.3
64	58	64	57½	67	4.5
65	59	65	58½	68	4.6
66	60	66	59½	68	4.8
67	61	67	60⅓	68	5.0
68	62	68	61⅓	68	5.2
69	63	69	62⅓	68	5.3
70	64	70	63¼	69	5.5
71	64½	71	63¾	67	5.6
72	65½	72	64½	67	5.7
73	66	73	65¼	66	5.8
74	67	74	66¼	66	6.0
75	67½	75	66¾	65	6.1
76	68½	76	67½	64	6.2
77	69	77	68	63	6.3
78	70	78	69	63	6.5
79	70½	79	69½	62	6.7
80	71½	80	70	61	6.8
81	72	81	70¾	60	6.8
82	73	82	71⅔	60	7.1
83	73½	83	72⅓	59	7.1
84	74½	84	73	59	7.3
85	75	85	73½	58	7.4
86	76	86	74⅓	58	7.6
87	76½	87	75	57	7.7
88	77½	88	76¼	57	7.9
89	78	89	76⅔	56	8.0
90	79	90	77⅓	56	8.3
91	79½	91	78	55	8.3
92	80½	92	78⅔	55	8.5
93	81½	93	79½	55	8.9
94	82	94	80	54	9.0
95	83	95	80¾	54	9.3
96	84	96	81⅔	54	9.6
97	84½	97	82⅓	53	9.7
98	85½	98	83	53	9.9
99	86	99	83½	52	10.0
100	87	100	84⅓	52	10.4

*These two columns are applicable to the ordinary wet and dry bulb type of hygrometer, in the use of which the instrument is to be screened from any draughts.

**These two columns are strictly applicable only to wet and dry bulb thermometer styles of instruments that are to be subjected to a strong current of air, the velocity of which is to be not less than 15 ft. per second.

Cramer Air Conditioning, Concluded.

Cramer Scale for Weave Rooms.

*Hygrometer Readings.		**Psychrometer Readings.		Humidity.	
Dry Bulb.	Wet Bulb.	Dry Bulb.	Wet Bulb.	Relative %.	Actual. (In grains per Cubic foot).
60	58	60	57¾	88	5.1
61	59	61	58¾	88	5.2
62	60	62	59¾	88	5.4
63	61	63	60⅔	88	5.6
64	61¾	64	61½	87	5.7
65	62½	65	62¼	86	5.8
66	63¼	66	62⅔	84	5.9
67	64	67	63½	83	6.0
68	64¾	68	64⅓	82	6.2
69	65½	69	65	81	6.3
70	66½	70	65¾	80	6.5
71	67¼	71	66½	79	6.6
72	68	72	67¼	79	6.7
73	68¾	73	68	78	6.9
74	69½	74	68¾	77	7.0
75	70¼	75	69½	75	7.1
76	71	76	70¼	75	7.3
77	72	77	71	75	7.5
78	72¾	78	71¾	74	7.7
79	73½	79	72½	73	7 8
80	74¼	80	73¼	72	7.9
81	75	81	74	72	8.1
82	75¾	82	74⅔	71	8.3
83	76½	83	75⅓	70	8.4
84	77¼	84	76	69	8.6
85	78	85	76⅔	68	8.7
86	79	86	77½	68	9.0
87	79¾	87	78⅓	68	9 2
88	80½	88	79	67	9.4
89	81¼	89	79⅔	66	9.5
90	82	90	80⅓	66	9.9
91	83	91	81¼	66	10.1
92	83¾	92	82	65	10.3
93	84½	93	82⅔	64	10.5
94	85¼	94	83⅓	64	10.7
95	86	95	84	63	10.9
96	86¾	96	84⅔	62	11.1
97	87½	97	85⅓	62	11.3
98	88¼	98	86⅓	62	11.6
99	89	99	87	61	11.7
100	90	100	87⅔	61	12.1

*These two columns are applicable to the ordinary wet and dry bulb type of hygrometer, in the use of which the instrument is to be screened from any draughts.

**These two columns are strictly applicable only to wet and dry bulb thermometer styles of instruments that are to be subjected to a strong current of air, the velocity of which is to be not less than 15 ft. per second.

Mill Engineering, Continued.

SOME REMARKS ON THE PRESENT METHODS OF DRIVING, SPINNING, AND A PROPOSED NEW DRIVE.*

The usual methods of **Mechanically Driving Spinning** are as follows:

(1). With countershafts in sections one bay long, generally driving two pairs of frames, each with four belts, each two frames being driven by separate belts from a double crown pulley, each crown being generally separated with a flange. The countershafts are driven either directly or indirectly from a line shaft extending the length of the spinning room. In order to get the proper length of belts, this drive is more complicated than it seems from the simple statement, because it is generally from the main line shaft to the second or third counters away, and then backward and forward, as the case may require, acording to the width of the mill and the number of frames across it. It will thus be seen that there are a varying number of belts interposed in this drive so that there will be more slippage on the drive to some of the frames than to others, because of the varying number of belts required.

(2). Spinning frames are sometimes placed crosswise of the mill, and long lines of shafting are run lengthwise of the rooms from which the spinning frames are driven in pairs. The efficiency of this type of drive is decidedly low, because of the long belts required, which are practically quarter-turn belts running over idlers, and are naturally of varying tension, even though they must of necessity be run very tight. This type of drive has been multiplied, whereby four frames can be driven in the same manner, which is even a less efficient drive than the other one.

Now, as for the methods of driving spinning in **electrically driven mills**:

(1). This class compares to class one in the mechanical drive given above, the electric motors simply being substituted for the line shafting, but no other countershafting and counterbelts are done away with.

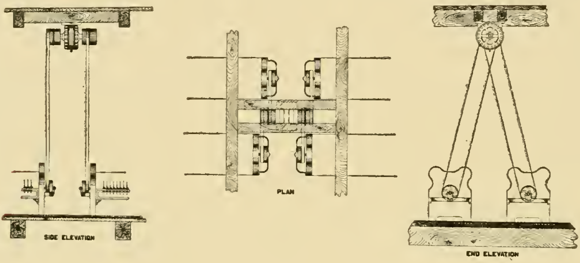
(2). This class is also similar to that of its corresponding number in the mechanical drive given above, the motor simply being direct connected in the line shafting itself, thereby doing away with nothing whatever in the spinning room, but simply getting rid of the head-shafting and heavy pulley in the belt tower of the mechanically driven mill.

*See also American Cotton Manufacturer, April 26, 1906, in which issue I first suggested this new drive.

Mill Engineering, Continued.

Cramer Spinning Drive, Continued.

(3). This is the only new type of drive that the introduction of electric power has so far brought out. It consists of mounting an individual motor either directly on a bracket at



the end of one spinning frame, and direct coupling it to the cylinder shaft; or of mounting one motor on a joint bracket between the head ends of two spinning frames, and coupling it with friction couplings direct to the cylinder shaft of each one of the frames. The objection to this type of drive is evident in either case. It is impossible to change the speeds of the spinning, which is occasionally desirable, for A. C. motors may be said to be of the constant speed type. It is true that some of them are of the variable speed type, but they are not likely ever to be used in mill work, and are both special and expensive. Also driving only one or two frames requires a very small size motor, which is not relatively as high in efficiency and power factor as the larger sizes.

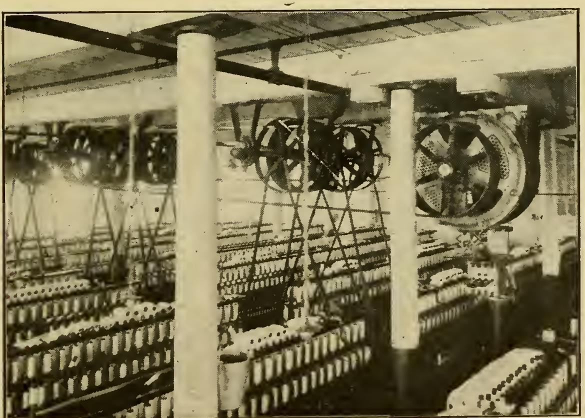
The new drive that I refer to is one that I am laying out for a number of new mills to be electrically driven, and for which I am doing the engineering work. I do not know whether this method of driving spinning has been used elsewhere or not. I myself have not seen it, nor have any of my friends with whom I have discussed the matter. The advantages of it are so obvious that I feel the trade will generally be interested in the proposition, and therefore I take the liberty of calling attention to it.

The above cut shows a side elevation, end elevation and a plan, making clear what is proposed, with comparatively little description.

Mill Engineering, Continued.

Cramer Spinning Drive, Continued.

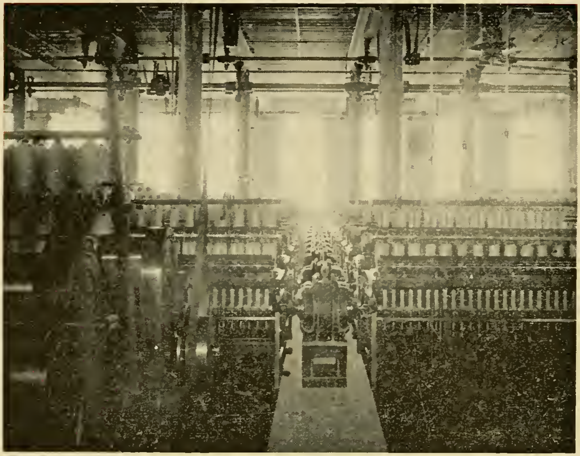
It will be seen that this method of driving is what might be termed the natural evolution of the method of driving spinning frames mechanically, as designated in class one above. In fact, it seems to me to be the only rational application of the electric motor to driving spinning if the class 1 type of driving is to be employed. For, in this new drive, all the main line shafting is done away with, and all the countershafts and counter-belts are done away with, an electric motor with extended shaft and a double crowned pulley on each end of it being simply substituted for the countershafts themselves, the frames being driven in blocks of four, as in class one of the mechanical drive. The only belts are those from the motor pulleys direct to the frames. Friction is therefore almost entirely eliminated. Or, to state it more exactly, friction is reduced from 16% to 22% down to 4% to 5%. There are advocates of the old methods of electric driving spinning that will no doubt take exception to the statement that there is 16% to 22% friction in such drives. In reply I would simply say that readings on this subject from a number of mills disclose the fact that my statement is borne out in actual practice.



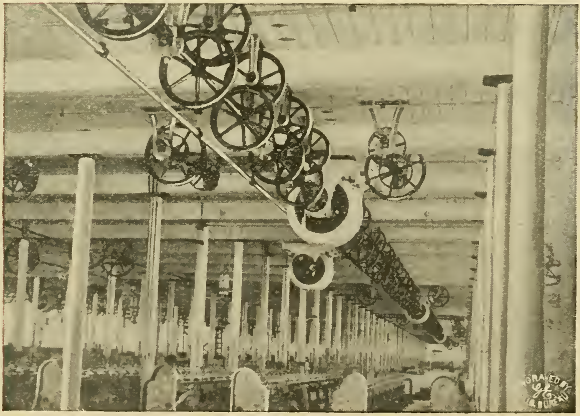
The above cut illustrates **Class 1** referred to in this article for driving spinning.

Mill Engineering, Continued.

Cramer Spinning Drive, Continued.

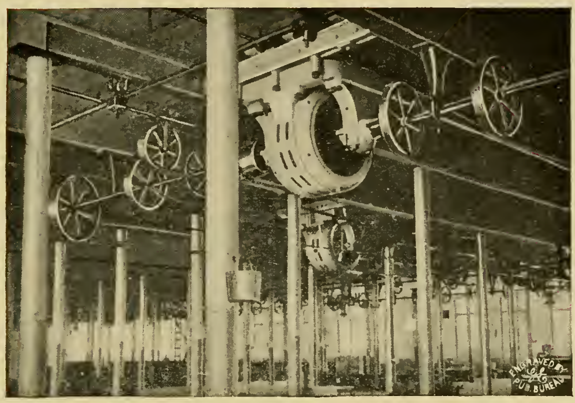


The above cut illustrates **Class 3** for driving spinning.



The above cut illustrates **Class 2** referred to in this article for driving spinning.

Cramer Spinning Drive, Continued.



A closer view of the motor shown in the preceding illustration.

As to the proper size of motor to install for each set of four frames, it of course depends upon the specifications of the frames themselves and the class of work to be done on them. It will suffice, therefore, simply to say that these motors in our practice generally are of the 15 and 20 H. P. sizes.

As the average spinning frame pulley is driven at about 1100 revolutions per minute, the peculiar adaptability of these sizes of motors for that work is evident at once, for the speeds of the 15 and the 20 H. P. are both 1120 R. P. M. This gives in each case a full semicircular belt contact. Furthermore, owing to the speeds of the motors and the spinning frames being practically the same, large sizes of pulleys can be run on the spinning frames to advantage. Again, attention is called to the fact that as there is but one belt between each motor shaft and spinning frame all over the room, regardless of the size of the room and the number of spindles it contains, that the slip will be approximately the same in each case, and consequently the front rolls on each frame will run at exactly the same speeds. That there is considerable variation in speeds of front rolls on the different frames otherwise driven, there is no question; this is due to the fact that there are varying numbers of belts, running from two and three to four, between the frames and the motor shafts; which would cause a considerable variation of speeds, even though the slippage of each belt was assumed to be the same, which would not always be the case. It might be said that the method of driving two spinning frames by one belt from a long line shaft, with the

Mill Engineering, Continued.

Cramer Spinning Drive, Concluded.

use of idlers, gives as even speeds as this proposed new drive gives. To this statement I would take exception, for the reason that in such drives the belts are practically long quarter turn belts, with idlers, and naturally vary considerably in tension, which means they vary correspondingly in slippage,—not to mention the fact that this type of drive is of very low efficiency, the friction being immense.

Besides, with this new drive, the frames can be placed crosswise of the mill instead of lengthwise, just the same as they can be placed crosswise with this old method of driving two frames from one shaft with idlers,—and, as already stated, the friction is reduced to very little, indeed, and the efficiency of the drive is very high.

The question of the relative efficiencies of the large and small motors will naturally arise just at this point. An examination of the data sheet of a well-known manufacturer of induction motors discloses the fact that both the efficiencies and power factors of the 20 H. P. motors and 100 H. P. motors are practically the same, not only at full load but at three-quarters load, and so the small motors are just as efficient and desirable in every respect as the large motors.

It is true that the smaller sizes of motors will cost slightly more per horse power than the larger sizes, but this is practically offset by the additional cost of shafting, pulleys, hangers, counterbelts, and iron motor supports required for the larger sizes of motors, but which are done away with in the use of the smaller sizes subdivided as above indicated, even to the extent of iron motor supports. That it is necessary to suspend the large motors, weighing two to three tons, from iron motor supports, there is no difference of opinion among mill engineers. On the other hand, I do not believe that any one of them will claim that an iron motor support is necessary for such a drive as the one I have indicated, of a light 15 or 20 H. P. motor, weighing not over 500 or 600 pounds. All that is necessary to support these small motors is to interpose between the large timbers in the mill short timbers suitably secured thereto, and then simply to lag screw the light motors to them.

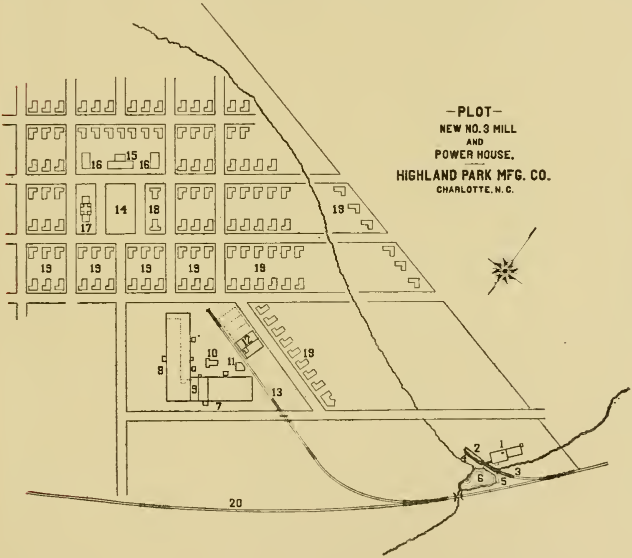
And so, summing up the advantages of this drive, it may be said, firstly, that considering everything, the cost of installation is practically no more for subdividing and applying the power to drive spinning in this manner than in the other types of drives heretofore in use; and secondly, that there is a net saving in friction of 10% to 15% over that of other kinds of drives.

Mill Engineering, Continued.

A NOTABLE EXAMPLE.

There are many things about mill engineering that can best be illustrated by a set of mill plans. It has therefore seemed desirable and convenient to wind up this section by reductions from a set of working drawings of a mill actually built.

I have selected for this illustration the new No. 3 Mill and power plant of the Highland Park Manufacturing Company, which has just been erected at Charlotte, N. C., and for which



Key to Plot Shown Above.

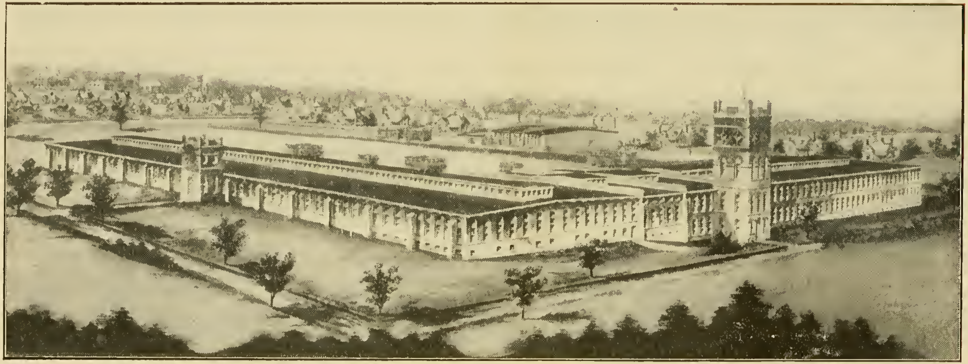
(1) Power House. (2) Coal Chute. (3) Spur Track. (4) Coal Haulage Tracks. (5) Dam. (6) Reservoir. (7) Main Mill, consisting of Lapper, Card and Spinning Rooms. (8) Weave Mill. (9) Dye House. (10) Transformer House. (11) Boiler House for Heating Plant. (12) Cotton Storage Warehouse. (13) Spur Track. (14) Village square. (15) Hotel. (16) Stores. (17) School. (18) Churches. (19) Tenement Houses. (20 Main Line Southern Railway.

Only a hundred or more tenement houses are shown on the plot, the remainder being located along the brow of the hill to the Eastward. The open space left in front of the weave room is for future extensions to the plant.

None of the levels shown on the original plot are here given for lack of space.

Mill Engineering, Continued.

No. 3 Mill of the Highland Park Manufacturing Company.



(Engineered and Equipped by Stuart W. Cramer.)

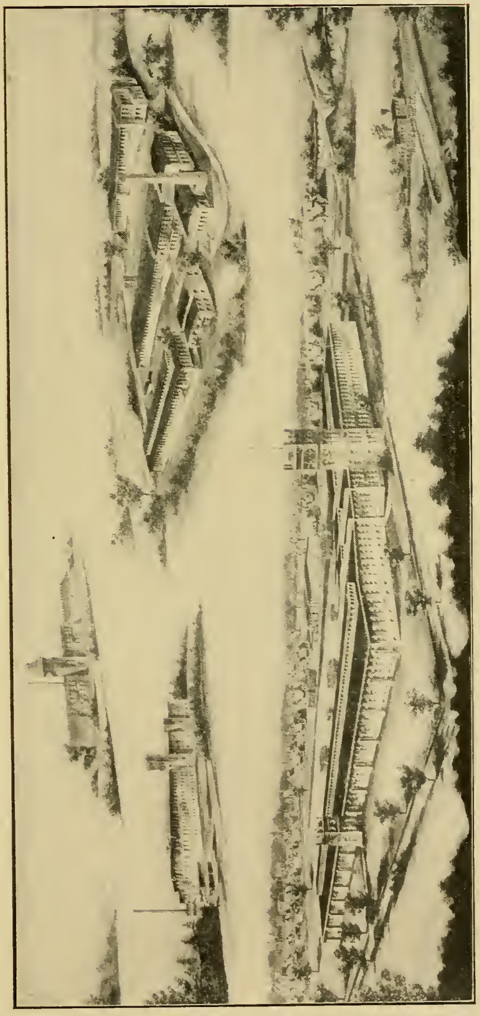
I not only furnished all the machinery and equipment, but also made the plans and specifications and superintended the construction of the same.

In this connection it is not out of place to point out that practically no dimensions could be given on drawings of this kind because of the amount of reduction necessary. Any attempt at making figures would either obscure the details of the drawings, or the figures would be so small as to be illegible.

It is not without pardonable pride that I submit this set of plans as representing not only one of our latest and best jobs, but also a mill and power plant that will bear comparison with any in the country.

Mill Engineering, Concluded.

Highland Park Manufacturing Company's Mills and Power Plant.



No. 2 Mill at Rock Hill, S. C. Oil Mill at Rock Hill, S. C. No. 1 Mill at Charlotte, N. C.

No. 3 Mill and Power Plant at Charlotte, N. C.

HIGHLAND PARK MAN'F'G COMPANY'S NEW NO. 3 MILL AND POWER PLANT.

The following set of plans is not to be understood as complete; while they represent the principal drawings that were made for this work, they by no means represent the many details and special sketches that have been furnished to assist in the proper carrying out of the plans. In point of fact, there have been nearly one hundred drawings all told made for this job.

As for the specifications accompanying the plans, it is of course out of the question to furnish more than a brief outline of them owing to the space they would occupy.

One peculiarity of our work, which I believe is not practiced by the profession generally, is the furnishing to our customers of lists of the building material required. This many have found convenient in a great number of ways, particularly in case the mill officers erect their buildings themselves with the aid of a superintendent; and even when it is intended to let the erection of the building by contract, the lists of material are found convenient for the mill officers to get local prices; all the bidders can then be furnished with this list, the mill people often reserving the right to furnish the material at the prices named. A sample page of such a list is appended.

Specifications of Work to be Done and Material to be Furnished in the Erection of a New Mill Designed to be Built for the HIGHLAND PARK MANUFACTURING COMPANY, According to Plans and Specifications Made for Same by STUART W. CRAMER, Charlotte, N. C., May 15, 1903.

(Extracts for purposes of illustration only.)

Index.

GENERAL CONDITIONS.

Duties of Contractor.—The contractors for the different work will be required to employ sufficient skilled labor and to expedite the work without any unnecessary delay, and to furnish the best materials of the different kinds hereinafter specified as may be in their contract.

Responsibilities.—The contractor for any of the work will be held responsible for all damage caused by neglect or from any cause connected with his contract, to make good any damage to other property, and to comply with all demands of this specification.

Highland Park Specifications, Continued.

Delivering Up of Work.—The contractor will be required to deliver up his work in first-class style, agreeable to the drawings and specifications, to remove all rubbish, revise all work throughout, to see that all openings work well, and to complete the contract satisfactorily to superintendent, and to leave the building broom-clean upon completion.

Sub-Contracting.—No sub-contracting will he allowed upon the within specified work, except by written consent of the owners. The same if allowed, will be required to be audited in writing with him.

Alterations.—The owner reserves the right to make any changes or alterations that he may deem necessary during the progress of the work. The same will in no wise vitiate the contract, but the price of such work is to be added to or deducted from the contract price, as the case may be, and entered in writing at the time such changes may be decided upon. Any changes and prices therefor are to be submitted to the architect for approval and criticism before being adopted or carried out.

Superintendent.—The building will be provided with a superintendent who will represent the owners, and through whom all orders will be executed. The said superintendent will have full power to direct all work through the contractor, to demand the removal of all labor or material not in strict accordance with the plans and specifications; and who will settle all disputes. Appeals therefrom will be the exception and will be settled by the Treasurer of the Mill, whose decision will be final and binding to all parties to the contract.

Payments.—Payments will be made from time to time during the progress of the work, to the extent of seventy-five per cent. of the estimated value of the work done, as may be agreed upon in the contract, the said payments to be based upon the estimate of the superintendent who will issue certificate of amount due at such stated time.

Bond.—The contractor will be required to execute a good and sufficient bond for the amount of his contract to indemnify the company against all losses properly chargeable to him, or failure to carry out his contract.

Scaffolding.—All scaffolding of whatsoever kind will be furnished by the contractor: except for carpenter work, material for which will be furnished by owners and put up by contractors.

Plans and Specifications.—The plans and specifications and drawings accompanying them are to be used conjointly and anything shown in one of them is to be executed the same as though fully shown in all. The scales of drawings are indicated on the different sheets.

The following principal plans comprise the set for building purposes, and will be supplemented by further details from time to time as is necessary for a proper understanding of the requirements:

Front Elevation Card and Spinning Room, End Elevation Weave Room.

Front Elevation Weave Room.

Rear Elevation Card and Spinning Room, End Elevation Weave Room.

End Elevation Card and Spinning Room, Rear Elevation Weave Room.

Foundation Plan.

First Floor Plan.

Second Floor Plan.

Roof Plan Spinning Room.

Foundation Plan Weave Room.

Floor Plan Weave Room.

Roof Plan Weave Room.

Section A-B, Weave Room, Dye Room, Warper and Lapper Rooms, Spinning and Card Rooms.

Highland Park Specifications, Continued.

Section C-D, Card and Spinning Rooms and Towers.
Monitor and Heat Duct Details.
Window Details.
Door Details.
Iron Work Details.

Floor Levels:—

Card Room, 123-0.
Spinning Room, 138-0.
Dust Room, 117-0.
Dye Room, 132-0.
Beaming and Quiller Room, 127-0.
Weave Room, 138-0.
Siding at End, 128-0.
Ware Room Floor, 132-0.

Note.—The contractor will be required to obtain a thorough knowledge of the plans and specifications before starting the work, and should same be found to disagree, the attention of the architect shall be called to the fact, and his decision obtained before the work proceeds; for any damage resulting from not having complied with this clause, the contractor will be held responsible.

GENERAL SPECIFICATIONS.

Excavations and Grades.—Sheet No. 1 of the plans shows the grade levels of the property on which the mill is to be located.

* * * * * * * * *

In tendering a proposal for the erection of these buildings, each bidder will make a price for each of the items mentioned below, which shall be used in adjusting the amount to be paid for extra work done by the contractor or for making allowance to the owner for the work omitted:

Excavations per cubic yard earth or sand, as per specifications.
Brick foundation work per cubic yard, as per specifications.
Brick per thousand laid in cement mortar, as per specifications.
Brick per thousand laid in lime mortar, as per specifications.
Painting, one, two and three coat work, per square yard, as per specifications:

Cold water paint,
White lead and oil,
Hard oil finish,
Byrd & Company's Paint.

These specifications are to be and are a part of the contract for the erection and finishing of these buildings mentioned herein, and we, the Owner and Contractor, so understanding, hereto affix our signatures:

....

....

Witnesses:

....

....

Note.—Similar specifications, with complete estimates of materials, lists of windows, doors, details, etc., were furnished for warehouses, heater building, tenement houses, hotel, power house, transformer house, finishing building, etc., etc.

Estimate of Material for Highland Park Manufacturing Company, Mill No. 3, Charlotte, N. C.

(Extracts for purposes of illustration only.)

(1st Story Beams in Card Room and Dye Room.)

38—Beams 10″ x 14″ x 25′-8″ rough, sq. sawed.
57—Beams 10″ x 14″ x 25′-0″, rough, sq. sawed.
8—Beams 12″ x 16″ x 25′-8″ D. 4 S., over dust room.
125—Joists 2½″ x 12″ x26′-0″.
125—Joists 2½″ x 12″ x 18′-0″.

Floor Beams of Spinning Room.

84—Beams 12″ x 16″ x 26′-0″, D. 4 S., sq. sawed.
126—Beams 12″ x 16″ x 25′-0″, D. 4 S., sq. sawed.

Spinning, Warper and Dye Room Roof Beams.

84—Beams 10″ x 14″ x 28′-0″, D. 4 S., sq. sawed.
126—Beams 10″ x 14″ x 25′-0″, D. 4 S., sq. sawed.
14—Roof forms 6¼″ x 10″ x 25′-0″, D. 4 S., beveled both ways from center ½″ per foot.
125—Joists 2½″ x 12″ x 18′-0″ sized.
125—Joists 2½″ x 12″ x 17′-0″ sized.
125—Joists 2½″ x 12″ x 9′-3″ sized.
6000—Feet board measure 1″ x 6″ bottom floor.
4—Beams 10″ x 14″ x 16′-0″ D. 4 S., sq. sawed (headers).

Monitor Beams, etc., over Spinning, Dye and Warper Rooms.

34—Beams 8″ x 14″ x 29′-0″, D. 4 S., sq. sawed.
68—Posts 6″ x 6″ x 5′-8″ D. 4 S.
156—Pieces 2″ x 6″ x 5′-8″ D. 4 S.
156—Pieces 2″ x 6″ x 5′-8″ D. 4 S.
34—Pieces 6″ x 6″ x 16′-0″, sill for monitor, D. 4 S.
646—Lineal feet 3″ x 4″ x 16′-0″, D. 4 S., window sill support.
646—Lineal feet 1″ x 7″ x 16′-0″, D. 4 S., sill casing.
500—Lineal feet 2″ x 6″ x 16′-0″, D. 4 S., ground for frieze.
646—Lineal feet 1″ x 12″ x 16′-0″, D. 4 S., frieze.
150—Pieces 3″ x 8½″ x 4′-0″ D. 4 S., (see detail) for sill.
936—Lineal feet sash stop for monitor detail.

* * * * * * * * *

FLOORING.

First Story.

776—Pieces 3″ x 8″ x 16′-6″ D. 1 S. 2 E., grooved for splines.
2522—Pieces 3″ x 8″ x 16′-0″ D. 1 S. 2 E., grooved for splines
776—Pieces 3″ x 8″ x 16′-6″ D. 2 S. 2 E., grooved for splines.

* * * * * * * *

96000—Feet board measure ⅞″ x 3″ No. 2 hard stock maple flooring, dressed and jointed, hollow backed, sides and ends bored for nailing; not less than 4′-0″ lengths.
223900—Lineal feet ¾″ x 1¼″ splines, beveled one edge.

COLUMNS.

144—Columns 9″ diameter finished size, 13′ -8″ long, first story.
70—Columns 8½″ diameter, 16′-4″ long, second story.
70—Columns 8½″ diameter, finished size, 17′-4″ long, second story.
10—Columns 9″ diameter, finished size, 22′-4″ long, dye room.
10—Columns 9″ diameter, finished size 23′-4″ long, dye room.
All above columns to be 1½″ center bored, ½″ cross bored top and bottom.

* * * * * * * * *

Estimate of Windows, Doors and Iron Work, Highland Park Man'f'g Company, Mill No. 3, Charlotte, N. C.

(Extracts for purposes of illustration only.)

Windows.

(See page 1248.)

274—Windows and frames per detail "A."
47—Windows and frames per detail "B".
10—Windows and frames per detail "C".
36—Windows and frames per detail "D".
31—Windows and frames per detail "E".
36—Windows and frames per detail "F".
376—Sash per detail "G".

Doors.

(See page 1249.)

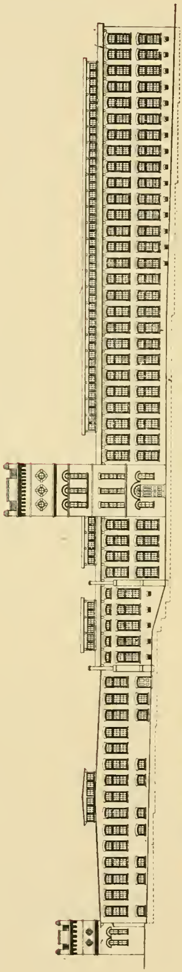
2—Doors and frames complete per detail "A".
3—Doors and frames complete per detail "B".
1—Door and frame complete per detail "C".
2—Doors and frames complete per detail "D".
1—Door and frame complete per detail "F".
11—Doors and frames complete per detail "H."
24—Doors and frames complete per detail "I".
6—Doors and frames complete per detail "I".

Iron Work, Main Mill.

(See page 1250.)

244—C. I. base plates per detail "A".
52—C. I. base plates per detail "B".
92—C. I. base plates per detail "C".
254—P. W. plates per detail.
204—C. I. hook wall plates per detail.
60—C. I. pintles per detail "A".
12—C. I. pintles per detail "B".
132—C. I. pintles per detail "C".
236—C. I .pintles per detail "D".
144—C. I. caps per detail "A".
194—C. I. caps per detail "B".
194—C. I. caps per detail "C".
52—C. I. caps per detail "D."
10—C. I. caps per detail "E".
10—C. I. caps per detail "F".
196—W. I. Anchor straps per detail.
42—Beams per detail, steel.
1—C. I. lid.
1—C. I. strainer.
14—C. I. caps for heat flues per detail.
39—C. I. ventilators per detail.
1700—W. I. dogs per detail.

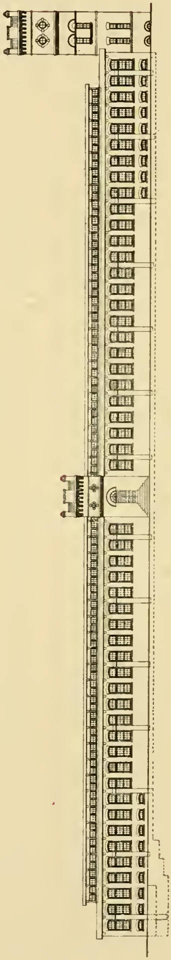
Highland Park No. 3 Mill Plans, Continued.



FRONT ELEVATION-CARD AND SPINNING ROOM.

END ELEVATION-WEAVE ROOM.

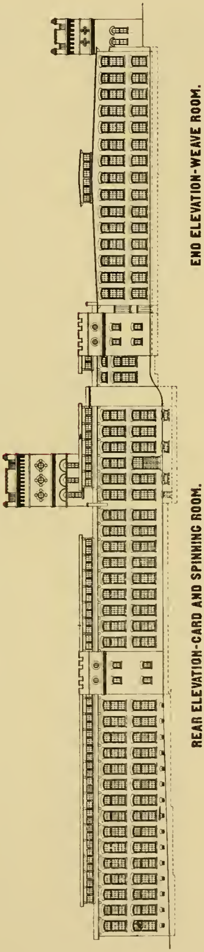
North West Front.



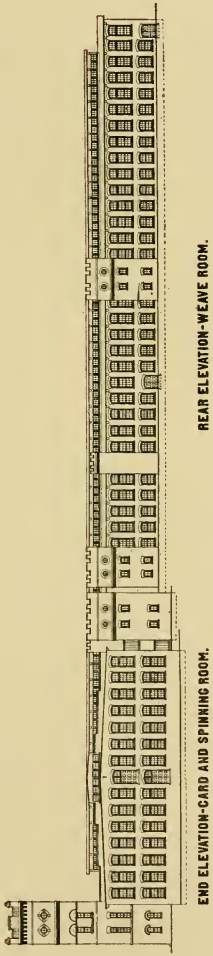
FRONT ELEVATION-WEAVE ROOM.

North East Front.

Highland Park Mill No. 3, Continued.

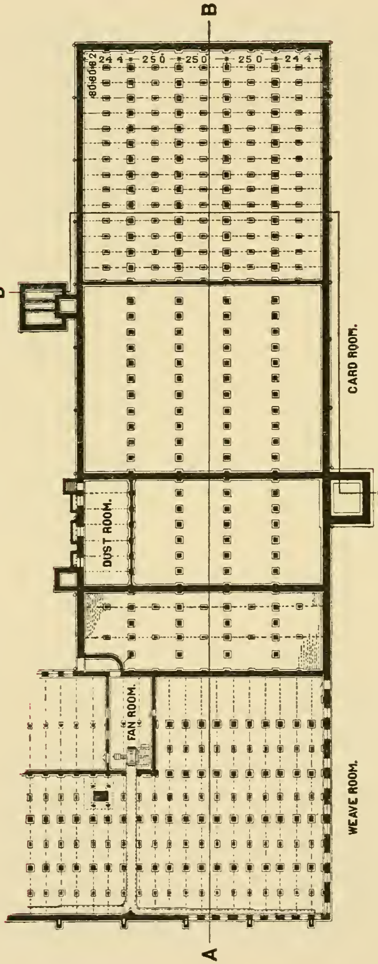


South West Elevation.



South East Elevation.

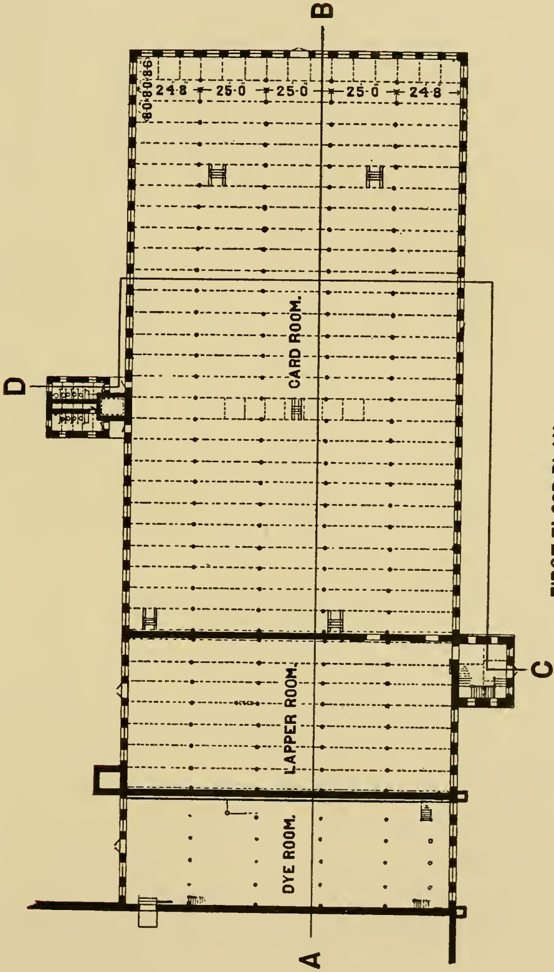
Highland Park Mill No. 3, Continued.



FOUNDATION PLAN.

The above is intended to show the foundation plan under weave room, card room, picker and dye room, indicating location of dust room and fan room with fan connections to ducts. Dotted lines show beams overhead and piers; balance of space is intended for tar concrete floor.

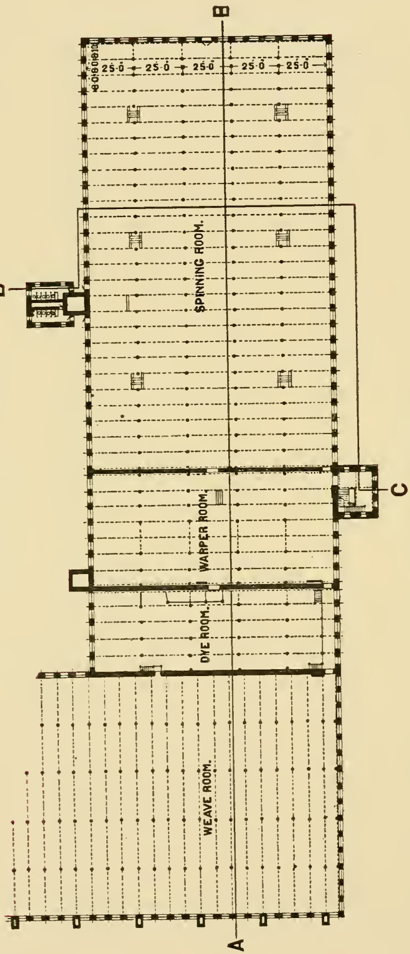
Highland Park Mill No. 3, Continued.



FIRST FLOOR PLAN.

Floor plan of card room, lapper room and dye room, showing location of motors, beams and columns.

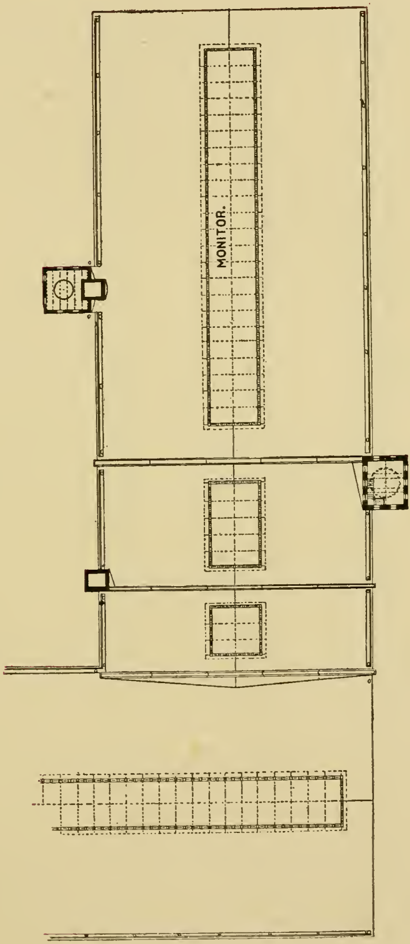
Highland Park Mill No. 3, Continued.



SECOND FLOOR PLAN.

The above plan shows the second story over card room, which is intended to show spinning and warper rooms. Same are on a level with weave room floor, the dye room floor being about six feet below, connected with elevated passage joining the warper and weave room.

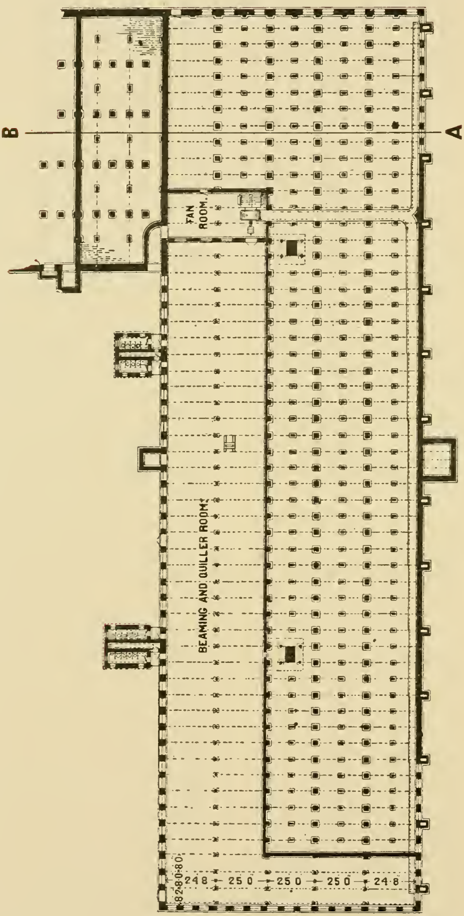
Highland Park Mill No. 3, Continued.



ROOF PLAN-SPINNING ROOM.

The above plan is intended to describe the construction of roof over spinning room, warper room, dye room and one end of weave room. The plan shows location of monitor and down spouts and floor plan of sprinkler tower and closet tower together with elevator shaft and dust chimney.

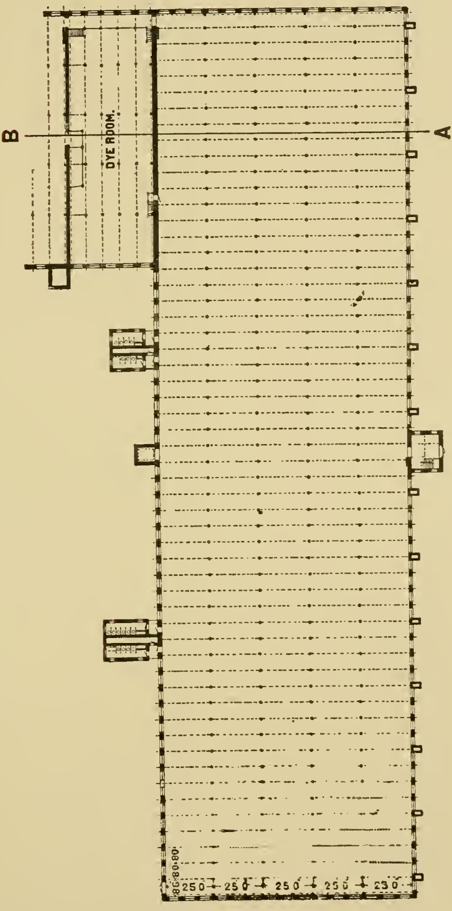
Highland Park Mill No. 3, Continued.



FOUNDATION PLAN-WEAVE ROOM.

The above plan represents the foundation under weave room with basement in rear of same, giving position of fan room, beaming and quiller room with basement of closet tower, also position of heat ducts and risers.

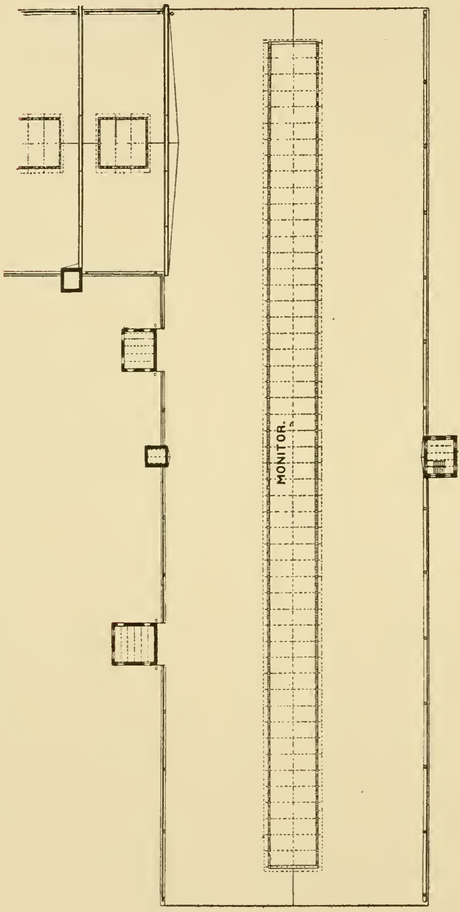
Highland Park Mill No. 3, Continued.



FLOOR PLAN-WEAVE ROOM.

The above plan represents the weave room showing connection with dye room and spinning room wing connected by elevated passage, also position of towers and elevator shaft. Beams and columns are located by dots and dotted lines.

Highland Park Mill No. 3, Continued.



ROOF PLAN-WEAVE ROOM.

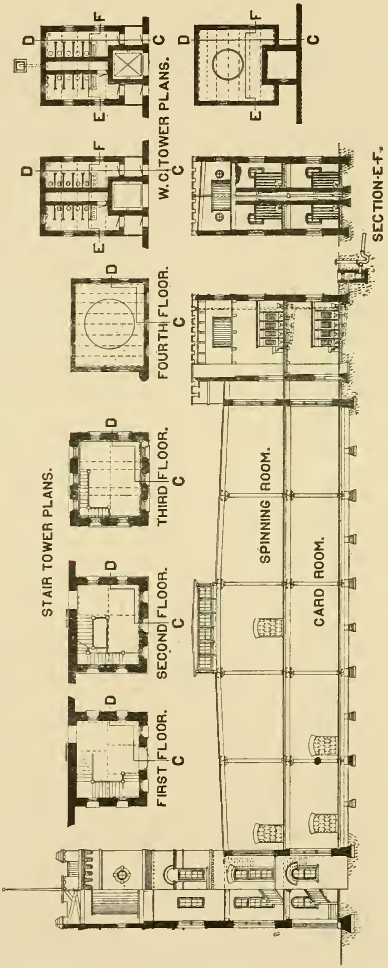
The above plan represents the roof over weave room, showing location of monitor and connection with spinning room wing and giving location of towers and down spouts.

Highland Park Mill No. 3, Continued.

The above cut represents the longitudinal section of warper, lapper, card and spinning rooms and dye room with tranverse section of weave room. Levels are as follows:

Weave Room and Spinning Room,	138.00
Dye Room,	132.00
Card Room,	123.00
Beaming and Quilling Room,	127.00
Dust Room,	117.00

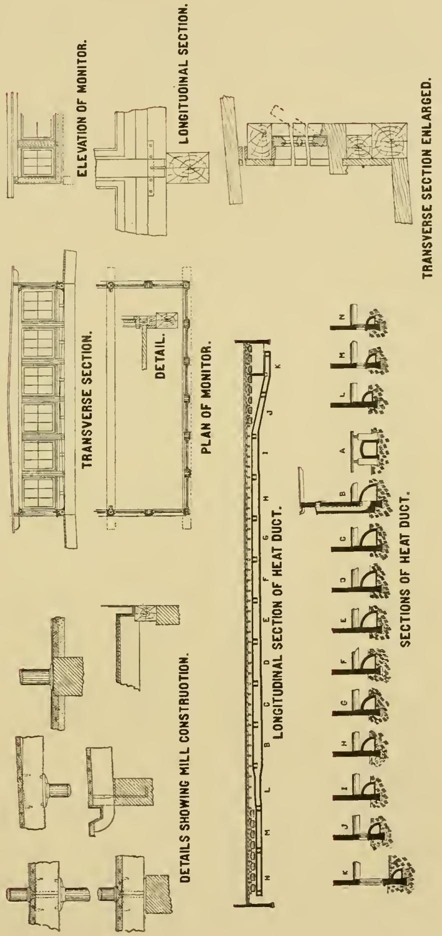
Highland Park Mill No. 3, Continued.



SECTION C-D.

The above represents the transverse section of card and spinning room, with a partial section and elevation of main tower showing location of sprinkler tank; also plans of main tower and water closet tower with sections of same, and location of elevator shaft connecting closet tower with main mill.

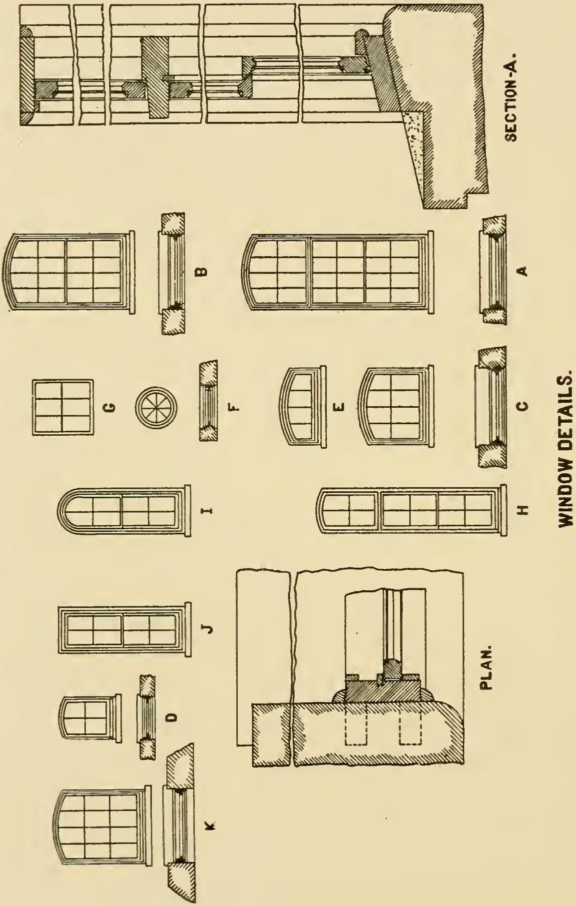
Highland Park Mill No. 3, Continued.



Monitor and Heat Duct Details.

The above details show mill construction and details of monitor and heat ducts.

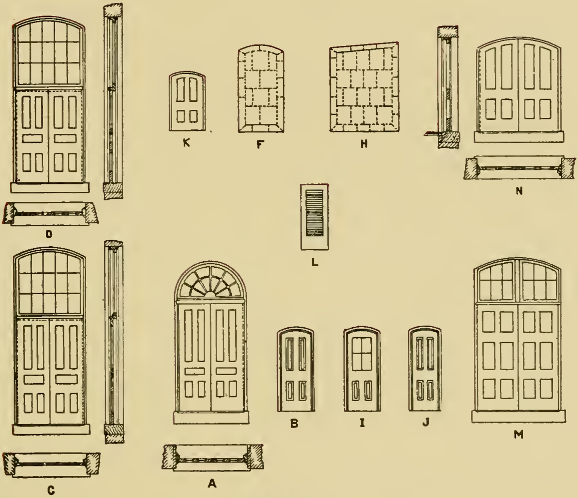
Highland Park Mill No. 3, Continued.



A, B, C, D, E, F, G, H, I, J and K show elevation and plan of mill and tower windows.

Section A and large plan are details of parts.

Highland Park Mill No. 3, Continued.

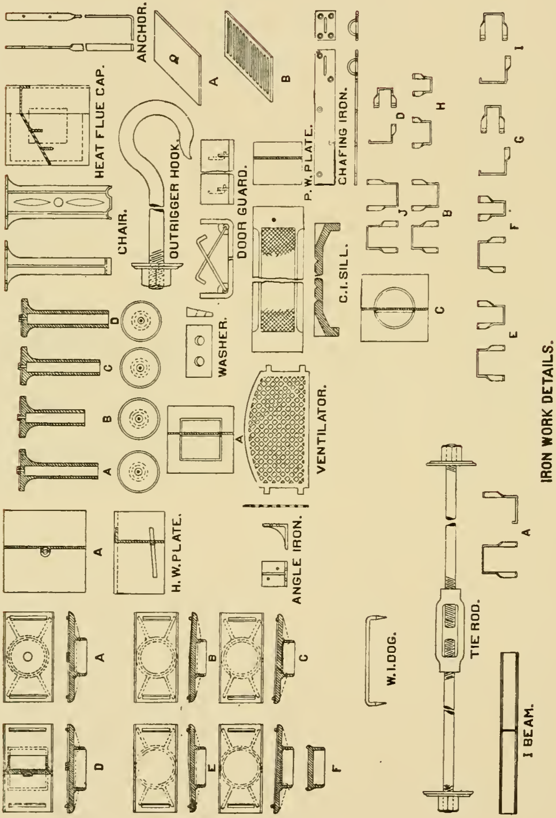


DOOR DETAILS.

A, B, C, D, E, F, H, I, J, K, L, M and N show plans and elevation of mills doors and fire doors.

All details are lettered separately according to the above, and are intended to be located on plan where corresponding letters are to be shown and to fit openings as figured at the various points. All doors are made up of the very best No. 1 heart stock and all transoms are made to line up to window heads throughout. The fire doors are made up according to the rules and regulations of the Southeastern Tariff Association and tinned with very best grade of tin. All doors throughout have O. G. raised and beveled panels.

Highland Park Mill No. 3, Continued.



A, B, C, D, E and F post Caps.
A, B, C, D and E Pintles.
A, Base Plate.
A, B, E, F, G, H, I and J, Anchor Straps.

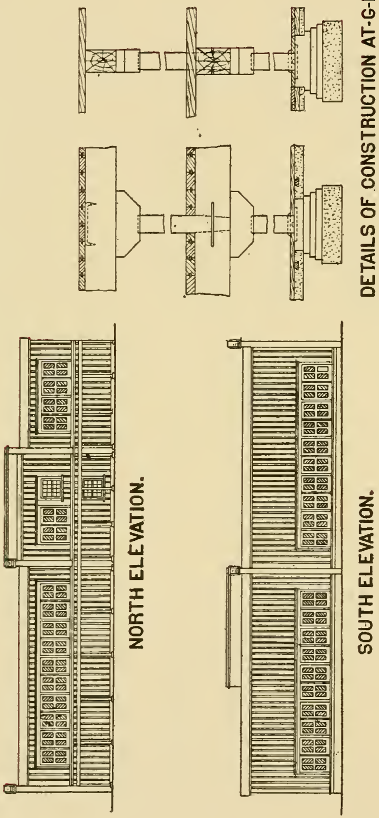
Highland Park Mill No. 3, Continued.

OVERSEERS HOUSE.

A few are of this type of overseer's house, though the bulk of the operatives' houses are on a cheaper plan.

This plan comprises a house of five rooms composed of living-room, two bed rooms, dining room and kitchen, closets, hall and porches; with brick fire places and plastered throughout. Finished in yellow pine, hard oiled. Foundation latticed between piers on front and sides.

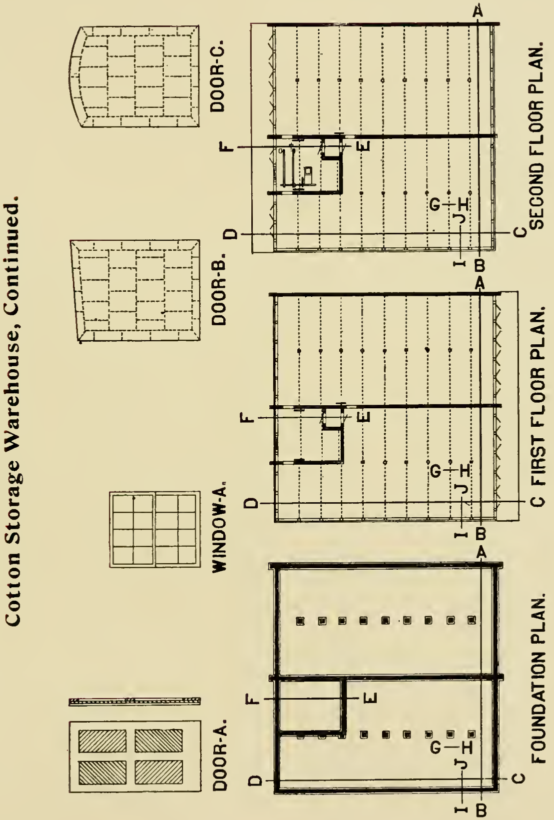
Highland Park Mill No. 3, Continued.



Cotton Storage Warehouse and Opening Room.

The above cut shows the front and rear elevation of a two story cotton warehouse, together with details of construction, the second story coming on a level with the car floor and basement story on a level with platform of roadway.

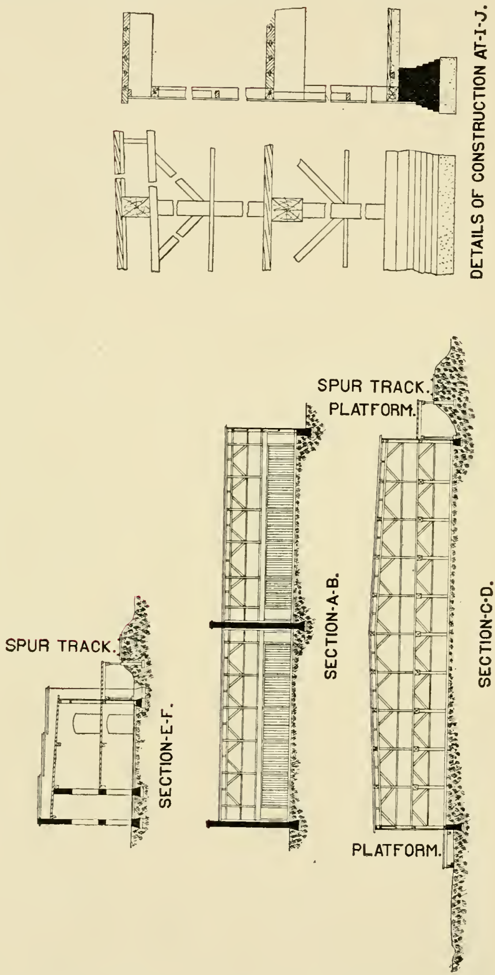
Highland Park Mill No. 3, Continued.



The above gives the foundation, first and second floor plans, together with details of windows, panel doors and fire doors. The opening room is located between the two warehouses, connecting the first and second stories with elevator.

Highland Park Mill No. 3, Continued.

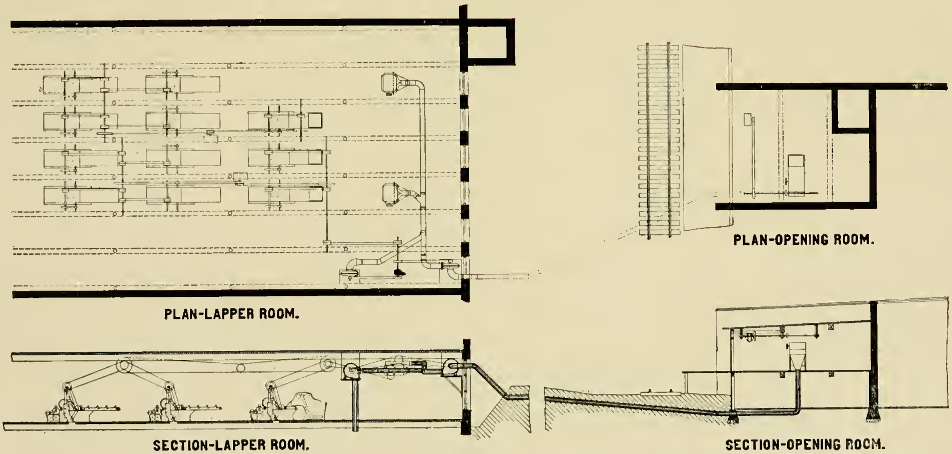
Cotton Storage Warehouse, Concluded.



The above cut shows the transverse and longitudinal sections of warehouse, with section through opening room, which gives an idea of the various levels in front and rear, also details of side wall construction.

Highland Park Mill No. 3, Continued.

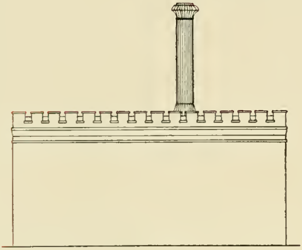
Cotton Conveying System from Opening Room in Warehouse to Lapper Room.



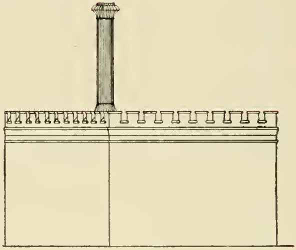
The above cut is intended to show the connection between lapper room and opening room of warehouse. The arrangement is shown both in plan and section showing the line of pipe as it is run and connected with the opener and blower.

Highland Park Mill No. 3, Continued.

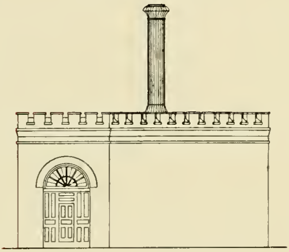
BOILER HOUSE.



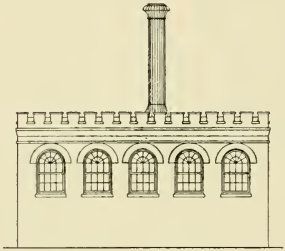
WEST ELEVATION.



EAST ELEVATION.



SOUTH ELEVATION.



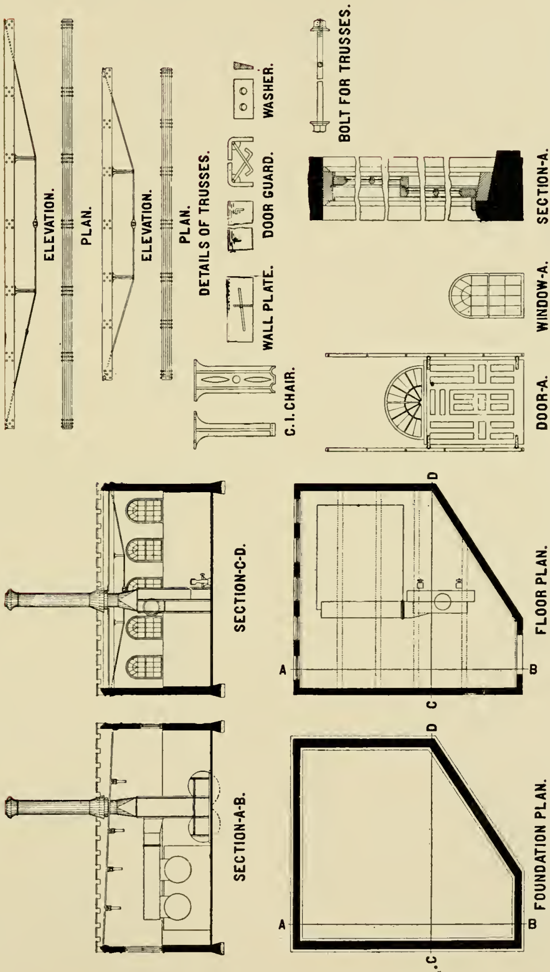
NORTH ELEVATION.

In this boiler house are two 66″ x 16′ Lookout horizontal return fire tubular boilers for furnishing steam for heating the mill, dye house, pumps, etc.

Also a Sturtevant induced draft apparatus consisting of duplicate fan arrangement, each with direct connected engine; either fan running alone is capable of producing draft for the plant.

The boiler house is located in the most advantageous position for supplying steam for the various points herein mentioned, being accessible to the side track, under which an ample coal chute is located, making it convenient to transfer coal to the boilers. The boiler room is constructed with a truss roof in which are located large and ample ventilators, and these in connection with the windows shown on North elevation (which are made to pivot) afford abundance of ventilation for the room. The large door shown on South elevation is intended to raise and lower on a sheave which leaves a large and ample opening for various needs.

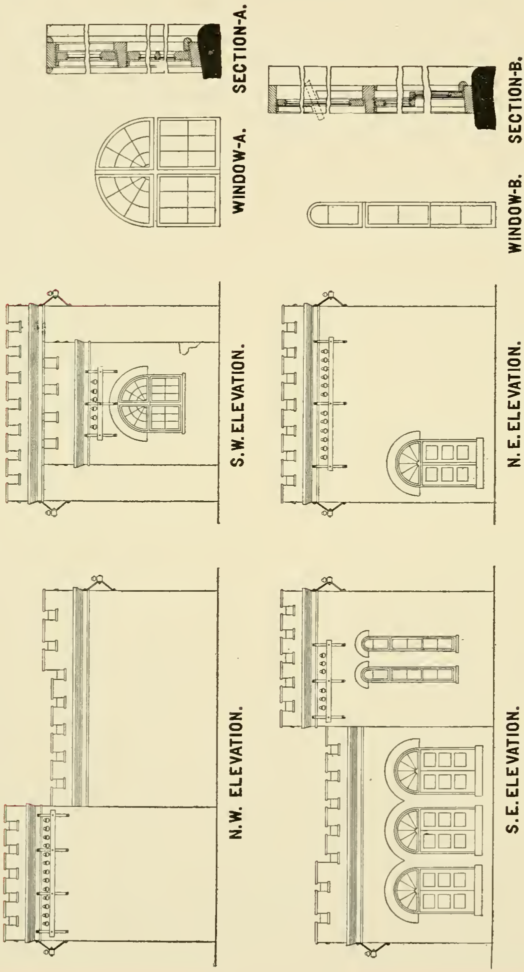
Highland Park Mill No. 3, Continued.



The above cut shows foundation and floor plan together with section and details showing construction of boiler house.

Highland Park Mill No. 3, Continued.

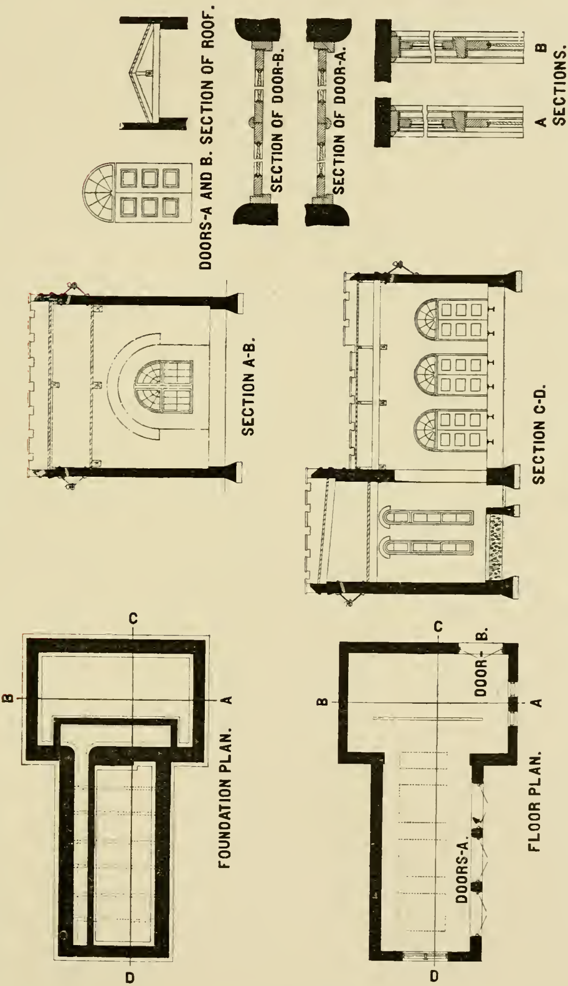
HIGHLAND PARK TRANSFORMER HOUSE.



The above drawing shows the various elevations with location in same of openings for wires to pass through; also details for windows.

Highland Park Mill No. 3, Continued.

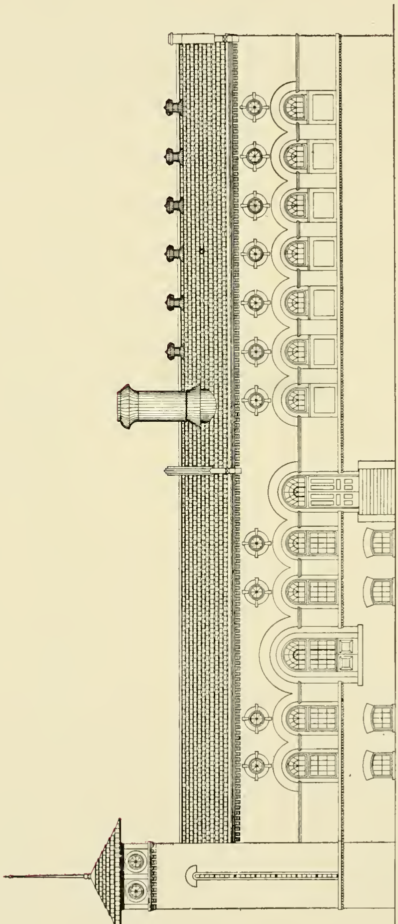
Highland Park Transformer House, Concluded.



The above cut shows the foundation and floor plan together with sections and details with location of transformers and switchboard in same.

Highland Park Mill No. 3, Continued.

HIGHLAND PARK POWER HOUSE.

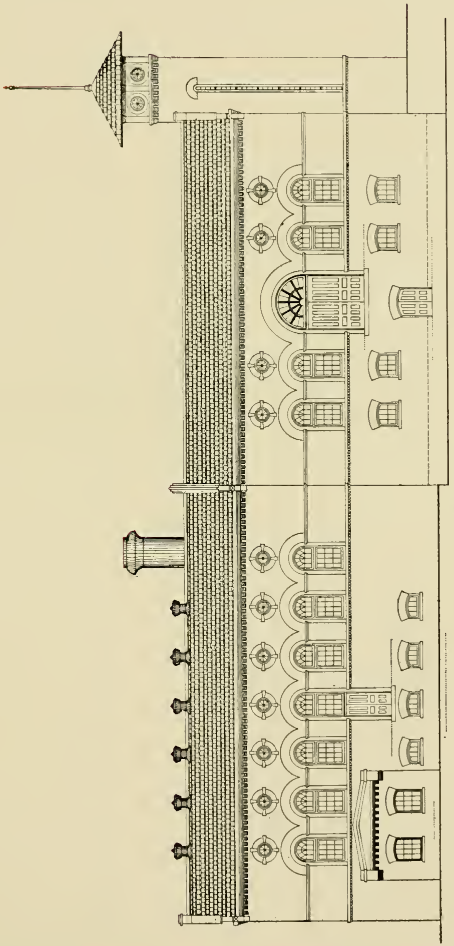


FRONT ELEVATION.

The above cut shows front elevation of power house. The roof is covered with Spanish tile, and gutters finished with galvanized iron and corbel brick courses, provided with down spouts sufficient to carry off rain water. The entrance to front of engine room is composed of granite steps and coping cut to a neat design. The boiler room is ventilated with large galvanized iron ventilators operated with dampers.

Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued

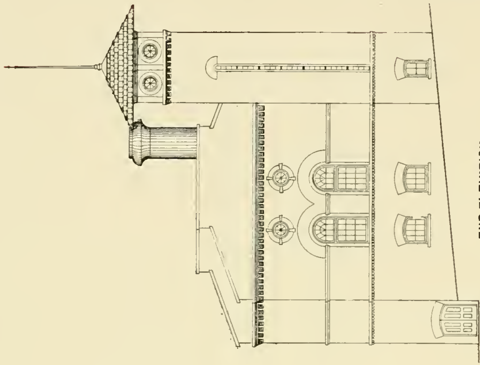


REAR ELEVATION.

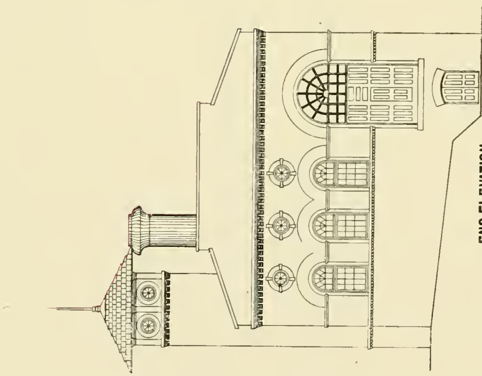
The above cut shows rear elevation of power house house which shows one story more than the front, the same being located on a grade, making it possible for the basements which are provided under the boiler room and engine room. The small building to the left is the pump house in which the fire pumps are located.

Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued.



END ELEVATION



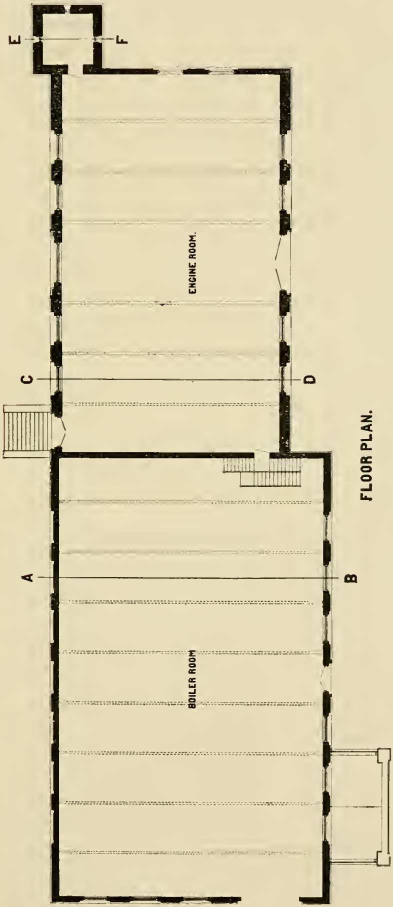
END ELEVATION.

The above cuts represent the two end elevations which show the entrance to boiler room and boiler room basement, with levels as follows:

Engine Room Floor,	104.00
Engine Room Basement,	90.00
Boiler Room,	98.50
Boiler Room Basement,	87.50
Pump House,	90.00

Highland Park Mill No. 3, Continued.

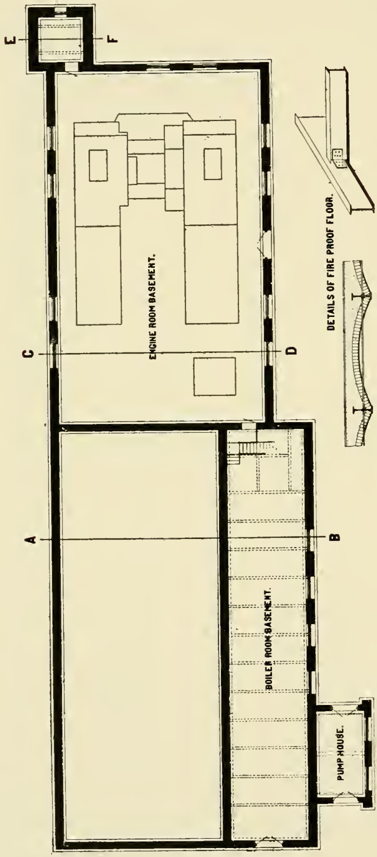
Highland Park Power House, Continued.



The above cut represents the floor plan of power house with roof trusses dotted on same. These trusses are constructed of steel of sufficient capacity to support the tile roof with a clear span. The walls of engine room are plastered throughout with wood fibre plaster. White enameled brick wainscoting extends around entire room four feet high. Walls of boiler room are plain and finished with white cold water paint.

Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued.

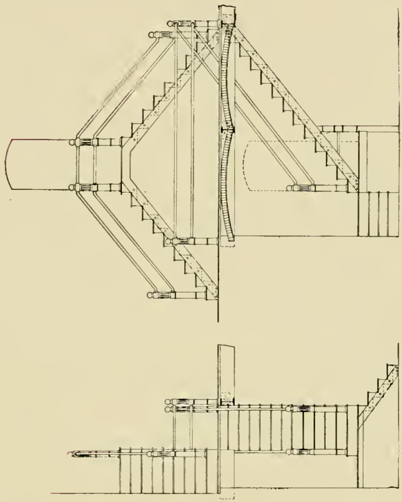


FOUNDATION PLAN.

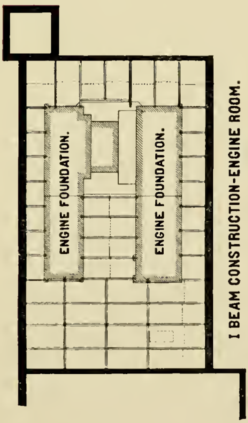
The engine and boiler rooms are constructed with fire proof floors composed of "I" beams, tie rods and corrugated iron arches covered with concrete. The top of boiler room floor is finished in cement and the top of engine room floor is finished in septic tile.

Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued.



IRON STAIR CASE DETAILS.



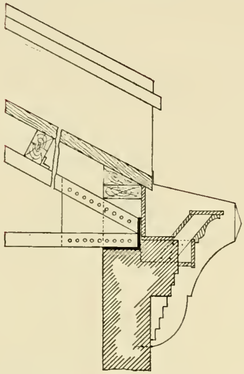
I BEAM CONSTRUCTION-ENGINE ROOM.

I BEAM CONSTRUCTION-BOILER ROOM.

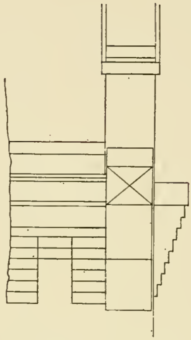
The above cut represents plan for I beams in engine and boiler rooms, also front and side elevations of iron stair case connecting the boiler room basement and boiler room with engine room and engine room basement.

Highland Park Mill No. 3, Continued.

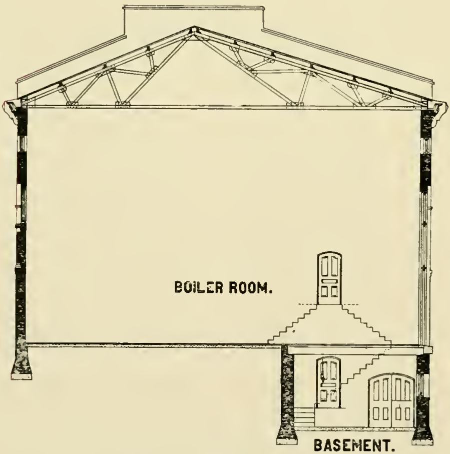
Highland Park Power House, Continued.



DETAIL SECTION OF GUTTER:



DETAIL ELEVATION OF GUTTER.

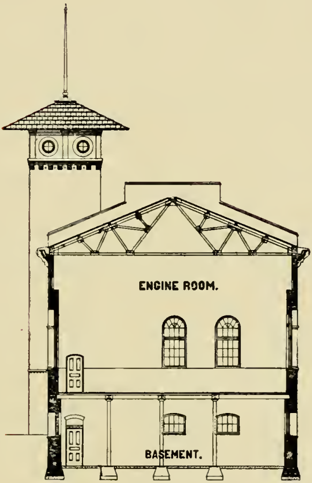


SECTION A-B.

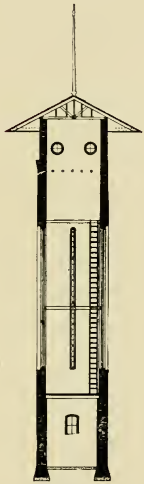
The above cut shows transverse section of boiler room and basement together with details of cornice.

Highland Park Mill No. 3, Continued.

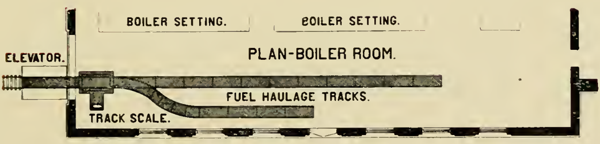
Highland Park Power House, Continued.

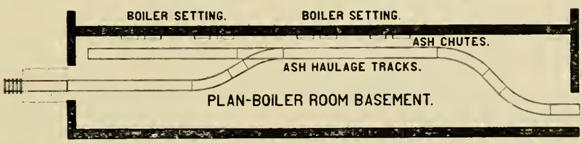


SECTION C-D.



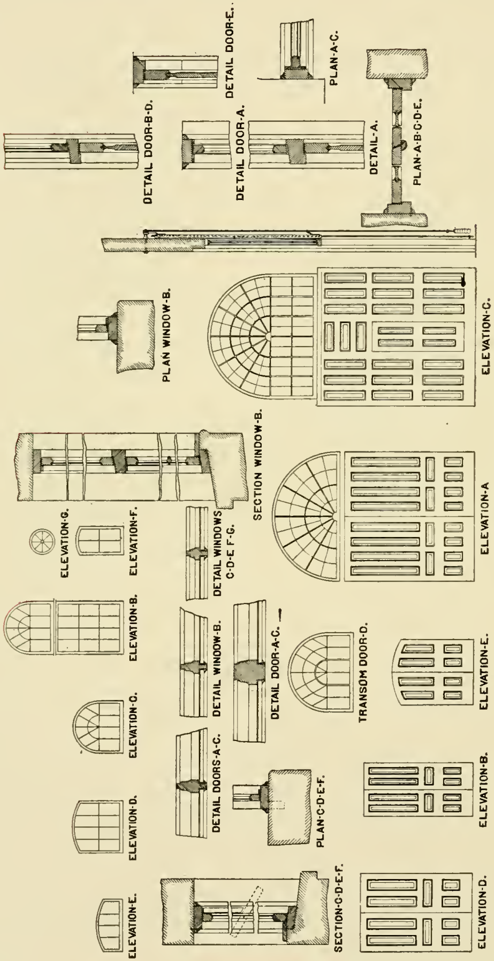
TOWER.
SECTION E-F.





Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued.

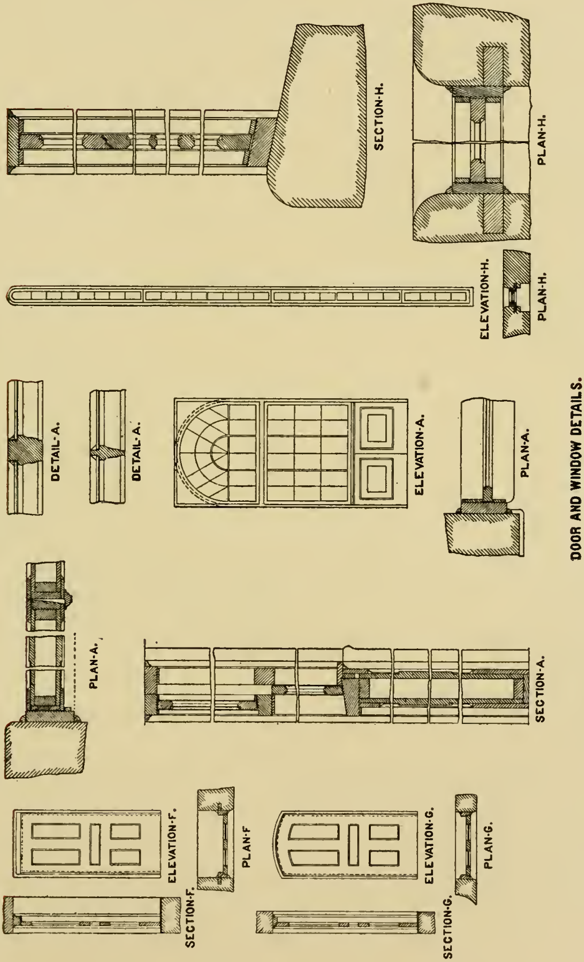


DOOR AND WINDOW DETAILS.

The above represents the details of doors and windows for power house, showing in larger scale the sections and plans. All doors are heavy No. 1 stock O. G. raised and bevel panels.

Highland Park Mill No. 3, Continued.

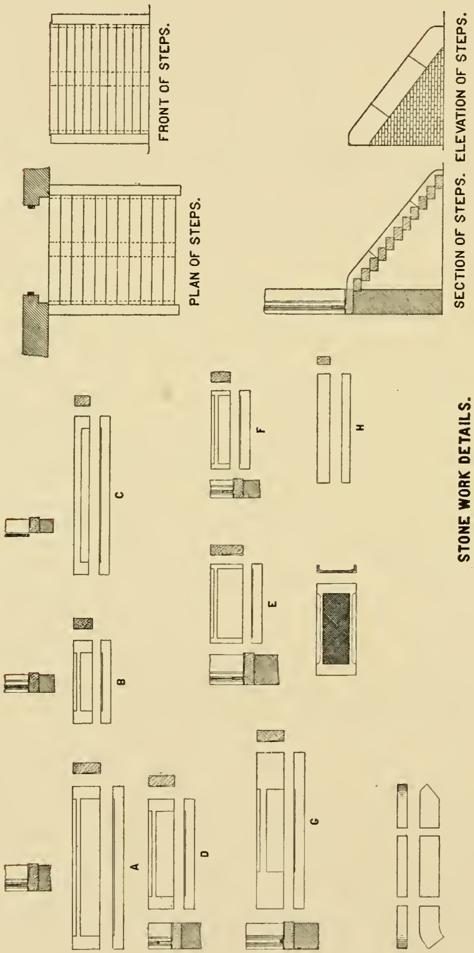
Highland Park Power House, Continued.



The above is an additional sheet of doors and windows for power house.

Highland Park Mill No. 3, Continued.

Highland Park Power House, Continued.



STONE WORK DETAILS.

A, B, C, D, E, F, G and H, are plans and sections of door sills. The balance of details are elevation, plan and section of stone stairway to engine room, and one detail shows cast iron sill for inside door.

Estimate of Doors, Windows, Stone and Iron Work.

Doors.

1—Door with transom and frame complete per detail "A".
1—Door and frame to connect with top sash, per detail "B".
1—Door frame with transom, per detail "C".
1—Door with transom complete per detail "D".
3—Doors and frame complete per detail "E".
3—Doors and frames complete per detail "G".
1—Door and frame complete per detail "H".
2—Doors and frames complete per detail "I".

Windows.

1—Window complete with frame per detail "A".
20—Windows complete with frames per detail "B".
7—Windows complete with frames per detail "C".
10—Windows complete with frames per detail "D" .
5—Windows complete with frames per detail "E".
1—Window complete with frame per detail "F".
35—Windows complete with frames per detail "G".
2—Windows complete with frames per detail "H".

Stone Work.

1—Stone sill per detail "A".
1—Stone sill per detail "B".
1—Stone sill per detail "C".
1—Stone sill per detail "D".
3—Stone sills per detail "E".
1—Stone sill per detail "H".

Iron Work.

14—Steel roof trusses per detail.
3—C. I. sills per detail.
12—12"Steel "I" beams 31½ pounds per foot, 18' long.
2—12" Steel channel beams 20½ pounds per foot, 18' long.
1—12" Steel "I" beam 31½ pounds per foot, 7'-10" long.
2—12" Steel "I" beams 30½ pounds per foot, 14' long.
8—7" Steel "I" beams 15 pounds per foot, 7' long.
8—5" Steel "I" beams 9¾ pounds per foot, 5½' long.
5—15" Steel "I" beams 42 pounds per foot, 12' long.
1—15" Steel "I" beam 31½ pounds per foot, 12' long.
1—12" Steel "I" beam 31 pounds per foot, 10' long.
5—15" Steel "I" beams 42 pounds per foot, 14' long.
3—12" Steel "I" beams 21 pounds per foot, 14' long.
9—9" Steel "I" beams 21 pounds per foot, 10½' long.
1—C. I. Plate 6"x⅜", 12' long.
1—9" Steel channel beam 13¼ pounds per foot, 10' long.
2—12"Steel channel beams 20½ pounds per foot, 12' long.
5—6" Steel "I" beams 12¼ pounds per foot, 6' long.
93—C. I. Plates 10"x10"x⅝".
1—Steel stair case per detail.
38—¾" tie rods, per lengths shown on plans.

Highland Park Mill No. 3, Continued.

HIGHLAND PARK POWER HOUSE EQUIPMENT.

It is a noteworthy fact that since the installation of this magnificent power plant the Highland Park Mfg. Company have arranged with the Catawba Power Company for their electric power. This power is generated on the Catawba River between Charlotte and Rock Hill, at which two points the mills of the Highland Park Mfg. Company are located. As is customary in the case of water power companies furnishing municipal lighting and power in particular, the Catawba Power Company found it necessary to provide a duplicate steam driven electric power plant that could be started up at a moment's notice in case of interruption to the service on account of trouble with the transmission circuits at the water power plant. The opportunity to secure the use of such a modern and up-to-date equipment proved so attractive that the Catawba Power Company made it greatly to the advantage of the Highland Park Mfg. Company to lease to them this power plant; and so, the function of this superb plant now is simply that of duplicate emergency service and supplementing secondary power to make it primary.

A description of the Power Plant of the Highland Park Manufacturing Company is best given by the following plan and sectional diagrams, with key explaining the same.

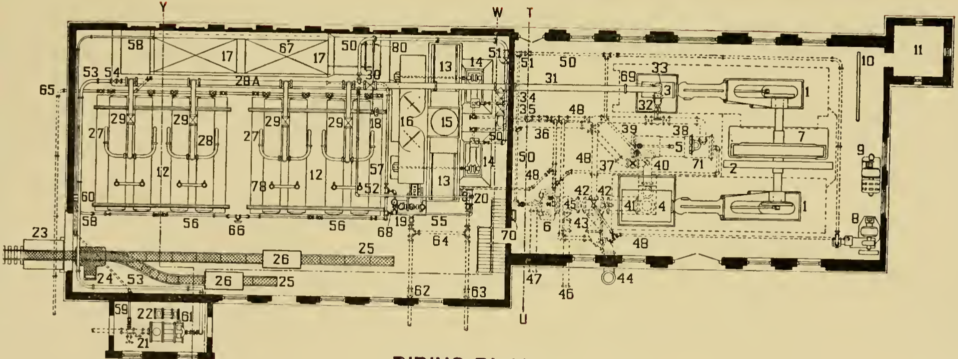
(Key to Diagrams.)

(1) 30″ and 64″x60″ Reynolds Cross Compound Condensing Engine: designed to operate at 150 degrees superheat and at 180 pounds pressure, at which it will develop at ¼ cut-off and 82 revolutions per minute, 2470 I. H. P.

(2) 22′ Fly Wheel.
(3) 30″ High Pressure Cylinder.
(4) 64″ Low Pressure Cylinder, with valves in the head.
(5) Reheated Receiver.
(6) Blake Vertical Twin Jet Condenser, 14″ and 35″x18″.
(7) 1500 K. W. Westinghouse 60-cycle (7200 alternations) Revolving Field Engine Type Alternator: designed to develop at 82 revolutions per minute 1500 K. W. at 2200 Volts and 90% Power Factor; and a regulation of 8% from full load to no load, and with a rise in temperature not exceeding 35 degrees Centigrade; when subjected to a 25% overload the rise in temperature will not exceed 45 degrees Centigrade.
(8) Steam Driven Exciter, consisting of 7″ and 12″x8″ Tandem Compound Buffalo Automatic Engine, with direct connected Westinghouse Multipolar Engine Type 25 K. W. 125 Volt D. C. Generator.

Highland Park Mill No. 3, Continued.

Highland Park Power House Equipment, Continued.



PIPING PLAN.

(9) Motor-Generator Exciter Set, consisting of 40 H. P. 400 Volt Westinghouse Induction Motor, direct connected to 30 K. W. Westinghouse 125 Volt D. C. Engine Type Generator.

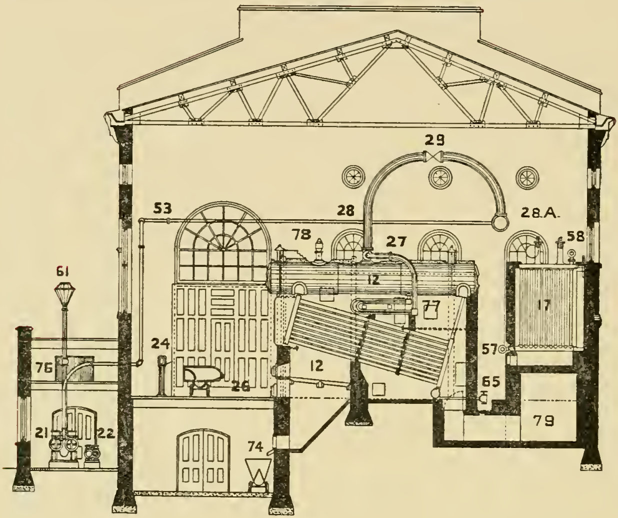
(10) Power Plant Switchboard, of Vermont Marble, consisting of Generator Panel, Exciter Panel, and two Feeder Panels,—one to the No. 1 Mill and the other to the No. 3 Mill.

(11) Wiring Tower from which the Feeders are distributed to the No. 1 and No. 3 Mills.

(12) 1500 H. P. Babcock & Wilcox Horizontal Water Tube Boilers of the High Pressure Inclined Wrought Steel Header type, 10 tubes high; with Superheating Coils; set in two batteries, two 375 H. P. boilers to each battery.

(13) Induced Draft Apparatus, in duplicate; each side consisting of two 10′ x 5′ Sturtevant Fans, with—

Highland Park Power House Equipment, Continued.



SECTION X-Y.

(14) 8″x10″ Direct Connected Horizontal Center Crank Sturtevant Engines.

(15) 72″ Steel Self-Supporting Stack.

(16) Dampers.

(17) Green Fuel Economizers.

(18) 5 H. P. Westinghouse 400 Volt Induction Motor, driving Economizers. (See 80.)

(19) Blake Triplex 6″ x 8″ High Pressure Boiler Feed Pump, direct driven through double reduction of gears, of 15 to 1 by a 15 H. P. 400 Volt Westinghouse Induction Motor.

(20) Worthington Admiralty Pattern High Pressure Boiler Feed Pump, 9″ x 6″ x 6″.

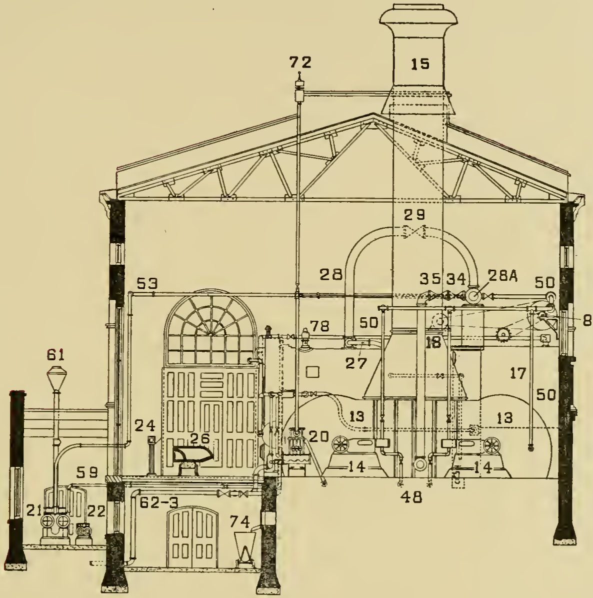
(21) One 1,000 Gallon Worthington Underwriter Fire Pump, with—

(22) Auxiliary Pump, 9″x4½″x10″, for maintaining constant pressure on the hydrant system, and supplying three plunger elevators, two at the No. 3 Mill and one at the Power House.

(23) Plunger Elevator for raising and lowering the coal charging cars from boiler room to tracks leading to coal chutes and bins.

(24) Track Scale.

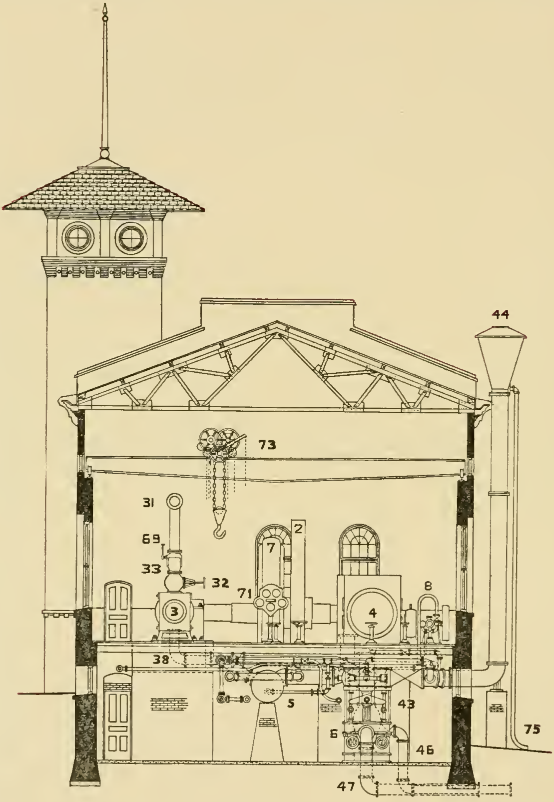
Highland Park Power House Equipment, Continued.



SECTION V-W.

(25) Fuel Haulage Tracks.
(26) Coal Charging Cars.
(27) Steam Connections to Superheaters, coupled in pairs to—
(28) Steel Bends, leading to—
(28-A) Steam Header.
(29) Non-Return Stop Valves.
(30) Foster Combination Emergency Stop Valve, that can be shut down from three different stations,—boiler room, engine room, and engine room basement.
(31) Main Steam Pipe.
(32) Main Throttle Valve.
(33) Automatic Safety Stop Valve.
(34) Gate Valve.
(35) Pressure Reducing Valve.
(36) Emergency Main Steam Pipe for running low pressure Cylinder High Pressure.
(37) Valve in Emergency Main Steam Pipe, with Floor Wheel and Stand.
(38) Exhaust from High Pressure Cylinder into Receiver.

Highland Park Power House Equipment, Continued.



SECTION T-U.

(39) Auxiliary Exhaust from High Pressure Receiver direct to Condenser or to atmosphere.
(40) Connection from Receiver to Low Pressure Cylinder.
(41) Exhaust from Low Pressure Cylinder.
(42) Gate Valves.
(43) Back Pressure and Automatic Relief Valve.
(44) Exhaust to Atmosphere.
(45) Exhaust into Condenser.
(46) Injection to Condenser.

(47) Ejection from Condenser.

(48) Exhaust from Auxiliaries (Fan Engines, Steam Boiler Feed Pump, and Exciter Engine) into main exhaust leading to Condenser.

(49) Exhaust from Condenser into Receiver, thereby Compounding it through the Low Pressure Cylinder and Condensing it.

(50) Steam Main to Auxiliaries,—High Pressure to Condenser Reducing Pressure to Fan Engines and Exciter Engines.

(51) Reducing Valves.

(52) Steam Pipe to High Pressure Steam Boiler Feed Pump.

(53) Steam Main to Underwriter and Auxiliary Pumps, with—

(54) Gate and Reducing Valves.

(55) Discharge from Boiler and Pumps.

(56) Same Leading Direct to Boilers.

(57) Same Leading to Economizers.

(58) Same Leading from Economizers and connected with direct boiler feeds (56).

(59) Auxiliary Boiler Feed Connection from Fire Pump connected into regular Boiler Feed Service Pipes at (60).

(61) Pump Exhausts to Atmosphere.

(62) Boiler Feed Suction from Reservoir.

(63) Boiler Feed Suction from Hot Well.

(64) Cross Connection between Boiler Feed Suctions.

(65) Blow-off Pipes.

(66) Temperature Recording Thermometer.

(67) Temperature Indicating Thermometer on Economizer Discharge to Boilers.

(68) Worthington Hot Water Meter.

(69) Temperature Indicating Thermometer.

(70) Recording Pressure Steam Gauge.

(71) Gauge Board, containing
Steam Gauge,
Receiver Gauge,
Vacuum Gauge,
Revolution Counter, and
Engine Type Clock.

(72) Chime Whistle.

(73) Traveling Crane.

(74) Ash Cars.

(75) Drip from Exhaust Head.

(76) Priming Tank to Underwriter Pump.

(77) Superheaters.

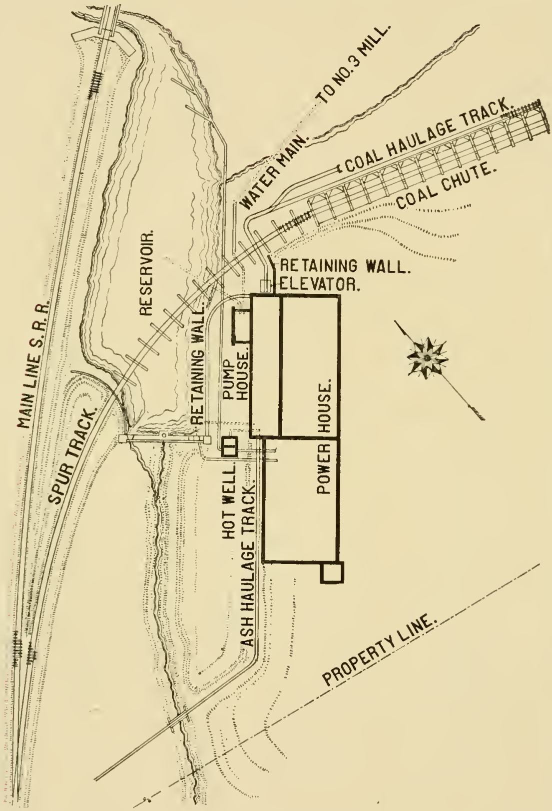
(78) Safety Valves.

(79) Main Smoke Flue.

(80) Counter Shaft Driving Fuel Economizers (See 18.)

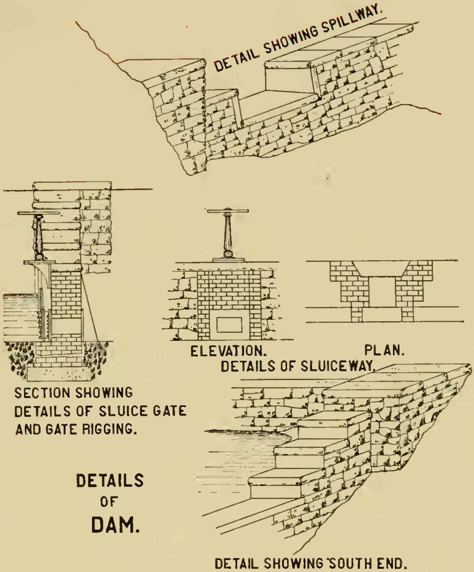
Highland Park Mill No. 3, Continued.

Highland Park Power House Equipment, Continued.

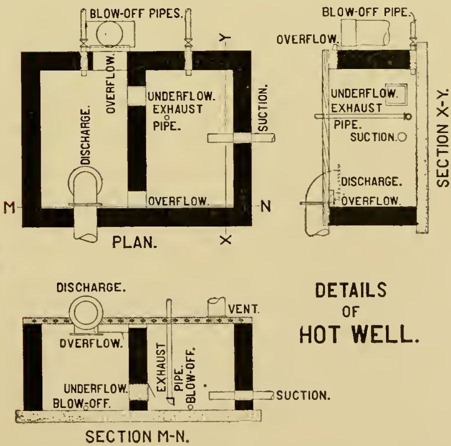


Plot Showing Dam, Reservoir and Hot Well, Coal Chute, Coal and Ash Haulage Tracks.

The above plot is for the purpose of locating the power house, track and reservoir, also coal chute and fuel haulage track. The fuel haulage track is operated along side the coal chute and the cars are conveyed to the boiler room floor by elevator at end of building. Ash haulage track extends away from the opposite end of building. The dam is located directly across from the bulding and constructed of hill stones.



Details of Dam, etc.

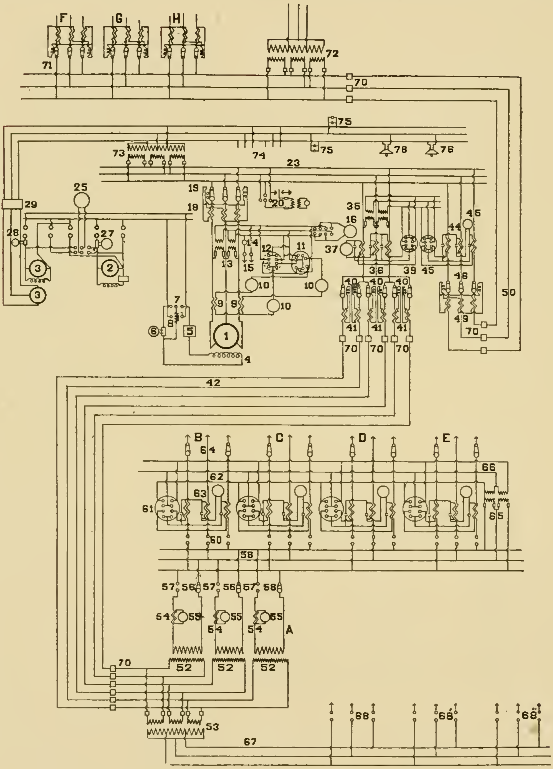


These illustrate the Details of Construction of the Hot Well.

The above cut illustrates the dam required for the reservoir or pond. The sluice gate is fitted on upper side of dam with wall plate and brackets for the support of wall stand and shaft. A spillway is provided on one end of dam for carrying off overflow.

Highland Park Mill No. 3, Continued.

Highland Park Power House Equipment, Continued.



General Wiring Diagram.

Highland Park Mill No. 3, Continued.

Explanatory List to Accompany General Wiring Diagram and the following Switchboard Diagrams for the Power House and Mills Nos. 1 and 3 of the Highland Park Manufacturing Company.

(The same notation appears on the general wiring diagram and the front and rear switchboard diagrams for the power house and the transformer house shown on succeeding pages, commencing with page 1284.)

POWER HOUSE.

(1) 1500 K. W., 2200 volt, 7200 alternations (60 cycles), 3-phase, A. C. Generator.
(2) Steam Driven Exciter, 30 K. W. D. C. Generator, 125 volts.
(3) Motor-Generator Exciter Set, 40 H. P. Motor and 30 K. W. Generator.
(4) Generator Field.
(5) Generator Field Resistance.
(73) Transformers for Lighting.
(74) Wires to Motors.
(75) Incandescent Lights.
(76) Arc Lights.

(Generator Panel "C", Power House Switchboard.)

(6) Field Ammeter.
(7) Field Switch.
(8) Field Discharge Resistance.
(9) Instrument Series Transformers.
(10) Ammeters.
(11) Integrating Wattmeter.
(12) Indicating Wattmeter.
(13) Shunt Transformers.
(14) Synchronizing Lamp.
(15) Synchronizing Plugs.
(16) Voltmeter.
(17) Voltmeter Receptacles and Plug.
(18) Circuit Breaker Series Transformers.

Highland Park Power House Equipment, Continued.

(19) 3-Pole Automatic Oil Circuit Breaker.
(20) Ground Detector.
(21) Ground Detector Receptacles and Plug.
(22) Ground Detector Push Button.
(23) Bus Bars.
(24) Pilot Lamps.

(Exciter Panel "D", Power House Switchboard.)

(25) Voltmeter.
(26) Voltmeter Receptacles and Plug.
(27) Ammeter.
(28) Ammeter.
(29) Auto-starter.
(30) Field Rheostat.
(31) Field Rheostat.
(32) Exciter Switches.
(33) Equalizer Switch.
(34) Pilot Lamp.

(Feeder Panel "B", to Mill No. 3, Power House Switchboard.)

(35) Shunt Transformers.
(36) Instrument Series Transformers.
(37) Ammeter.
(38) Ammeter Plugs.
(39) Indicating Wattmeter.
(40) Three 2-pole single throw Automatic Oil Circuit Breakers.
(41) Circuit Breaker Series Transformers.
(42) Transmission Line to Mill No. 3.
(43) Pilot Lamps.

(Feeder Panel "A", to Mill No. 1, Power House Switchboard.)

(44) Instrument Series Transformers.
(45) Indicating Wattmeter.
(46) 3-Pole Automatic Oil Circuit Breaker.
(47) Ammeter.
(48) Ammeter Plugs.
(49) Circuit Breaker Series Transformers.
(50) Transmission Line to Mill No. 1.
(51) Pilot Lamp.

TRANSFORMER HOUSE, MILL No. 3.

(52) Three 375 K. W. 2200-400 volt oil-cooled transformers,—power.

(53) Three 37.5 K. W. 2200-210-105 volt oil-cooled transformers,—lighting.

Highland Park Power House Equipment, Continued.

(Load Panel "A" Transformer House Switchboard.)

(54) Instrument Series Transformers.
(55) Ammeters.
(56) Circuit Breakers.
(57) Three Single Pole Single Throw Unit Blade Switches.
(58) Low Tension Bus Bars.
(59) Pilot Lamps.

(Feeder Panel "B" Transformer House Switchboard.)

(60) Three Single Pole Single Throw Unit Blade Switches.
(61) Indicating Wattmeter.
(62) Ammeters.
(63) Instrument Series Transformers.
(64) Circuit Breakers.
(65) Shunt Transformers.
(66) Voltmeter Bus Bars.
(67) Lighting Bus Bars.
(68) Lighting Switch (card room).
(68′) Lighting Switch (spinning room).
(68″) Lighting Switch (weave room).
(69) Pilot Lamp.

(Feeder Panel "C" Transformer House Switchboard.)

Same as Panel "B" with the exception of item No. 65, shunt transformers, which is to be left out.

(Feeder Panel "D" Transformer House Switchboard.)

Same as Panel "C".

(Feeder Panel "E" Transformer House Switchboard.)

Same as Panel "D".
(70) Lighting Arresters.

MILL No. 1.

(72) Lighting Transformers,—three 15 K. W. 2200-210-105 volt oil-cooled transformers,—lighting.

(Feeder Panel "F" No. 1 Mill.)

(71) 3-Pole Automatic Oil Circuit Breaker.

(Feeder Panel "G" No. 1 Mill.)

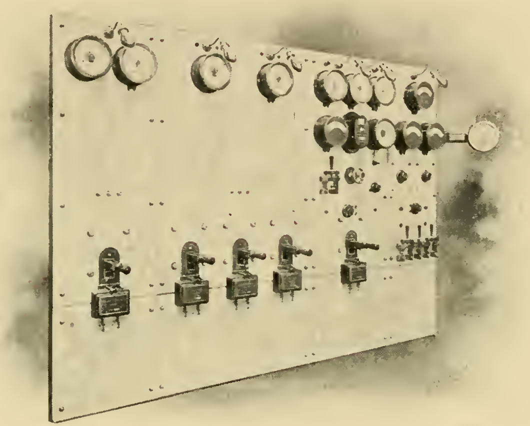
Same as Panel "F".

(Feeder Panel "H" No. Mill.)

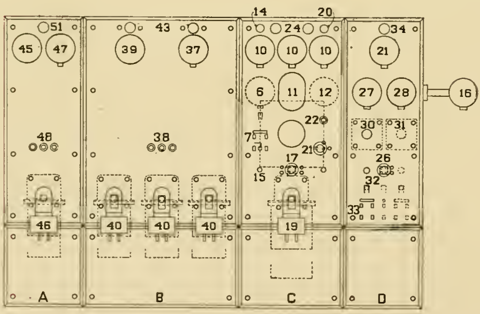
Same as Panel "G".

Highland Park Mill No. 3, Continued.

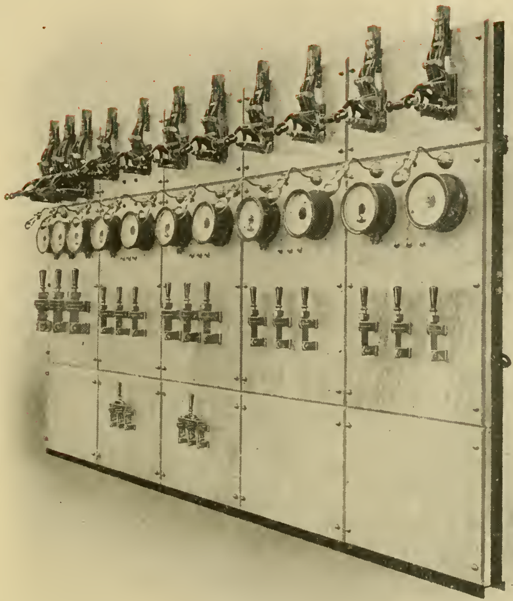
Highland Park Power House Equipment, Continued.



Front View of Power House Switchboard.



Diagram



Front View of Transformer House Switchboard.

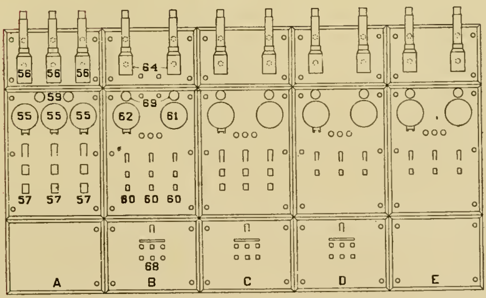
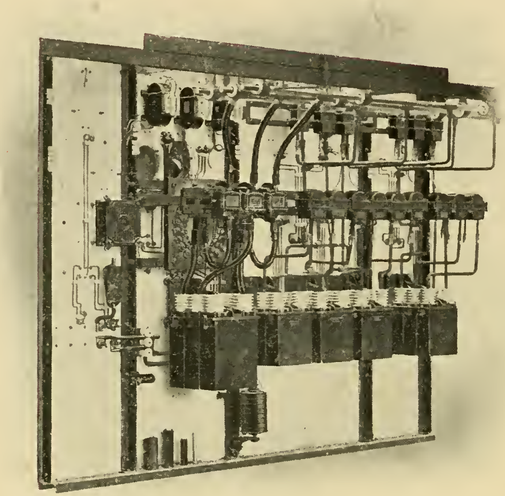
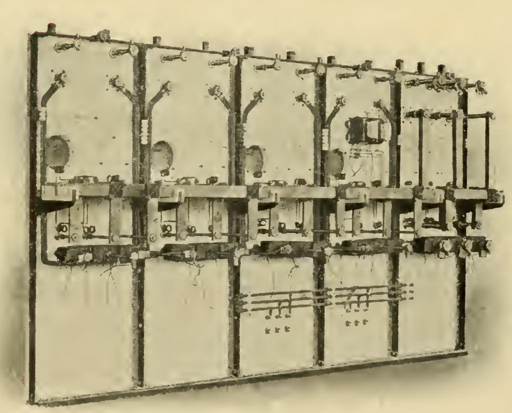


Diagram.

Highland Park Mill No. 3, Continued.



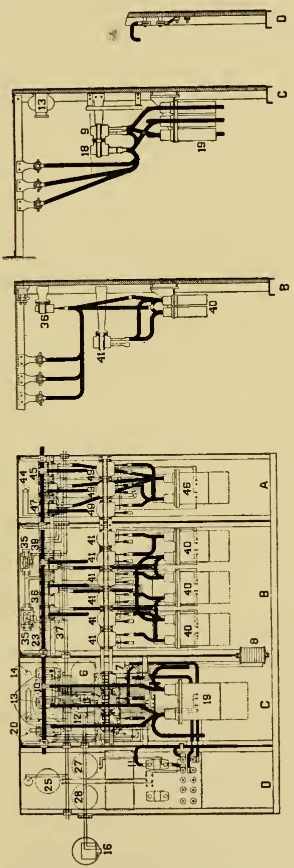
Rear View of Power House Switchboard.



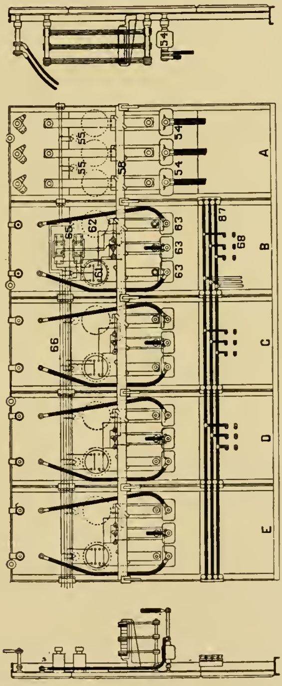
Rear View of Transformer House Switchboard.

Diagrams of Switchboards, Showing Rear Views and Panels.

(The letters and numerals thereon illustrate the explanation on pages 1281-83.)



Power House Switchboard.



Transformer House Switchboard.

Highland Park Mill No. 3, Continued.

Summary of and Memoranda Regarding Equipment.

Power House Equipment.

1—Westinghouse 1500 K. W. 2200 volt 3-phase 60 cycle A. C. generator direct connected to an Allis-Chalmers 2250 horse power compound condensing Corliss engine running at 82 revolutions per minute.

1—Steam driven exciter set consisting of Westinghouse 25 K. W. 125 Volt D. C. generator direct connected to a 40 horse power Buffalo tandem compound condensing automatic engine running at 325 revolutions per minute.

1—Duplicate exciter set consisting of motor generator comprising one Westinghouse 30 K. W. 125 Volt D. C. generator, direct coupled to a Westinghouse 40 horse power 400 volt 3-phase induction motor.

1—Power house switchboard of blue Vermont marble consisting of generator panel, exciter panel and two feeder panels, complete with all necessary instruments as enumerated in connection with diagrams of switchboards illustrated elsewhere.

3—Westinghouse 15 K. W. 2200-400 volt oil-cooled transformers for supplying motors in power house.

1—Westinghouse 7½K. W. 2200-110 volt oil-cooled transformer for furnishing current for power house lighting.

1—Westinghouse 15 horse power 400 volt 3-phase induction motor direct connected to Blake triplex boiler feed pump.

1—Westinghouse 5 horse power 400 volt 3-phase induction motor for driving economizer scrapers.

Power house lighting equipment consisting of General Electric enclosed arc lights for engine room and incandescent lighting for boiler room.

Motor Equipment for No. 1 Mill.

1—Westinghouse 300 horse power 2000 volt 3-phase induction motor for driving spinning mill.

1—Westinghouse 200 horse power 2000 volt 3-phase induction motor for driving weave mill.

1—Westinghouse 100 horse power 2000 volt 3-phase induction motor for driving finishing works.

3—Westinghouse 15 K. W. 2200-110 volt, type "M" transformers for lighting at No. 1 Mill.

Transformer House Equipment for No. 3 Mill.

3—Westinghouse 375 K. W. 2000-400 volt oil-cooled transformers for supplying power to induction motors.

3—Westinghouse 37½ K. W. 2000-110, type "M" transformers for lighting at No. 3 Mill.

1—Sub station blue Vermont marble switchboard consisting of one load panel and four feeder panels, all as enumerated in connection with the diagram of switchboard illustrated elsewhere.

Motors and Lighting Equipment at No. 3 Mill.

Westinghouse 400 volt induction, type "C" motors as follows:

Lapper Room,	1- 40 and 1- 30 H. P.
Cards,	1- 50 and 1- 30
Drawing,	1- 20
Roving,	1- 75
Spinning,	3- 75 and 3- 100
Spooling,	2- 3
Warpers,	1- 10
Elevator and Openers,	1- 5 (in warehouse)
Dye Room,	1- 30
Weave Room,	2- 150
Beaming and Quilling,	1- 40
Machine Shop,	1- 5
Electric Pump,	1- 15
Economizer Scrapers,	1- 5

General Electric Outfit for Lighting at the No. 3 Mill as follows.

For weave room 1200 candle power enclosed are lights with concentric diffusers.

For card room, spinning room, picker room, dye house, etc., etc., 16 c. p. incandescent lights.

Cables and Transmission Circuits.

Cables to the switchboard in the power house to be rubber insulated lead covered of the following dimensions:

Generator Mains, 500,000 C. M. (61 No. 11 stranded).

Copper diameter	=	.820
Rubber diameter	=	1.133
Tape diameter	=	1.196
Lead diameter	=	1.384

Exciter Mains, No. 0000 B. & S. (37 No. 12 stranded).

Copper diameter	=	.570
Rubber diameter	=	.820
Tape diameter	=	.867
Lead diameter	=	1.023

Leads to Field of Generator, No. 000 B. & S. (37 No. 12 stranded).
Leads to Field of Exciter, No. 6 B. & S.

Copper diameter	=	.162
Rubber diameter	=	.350
Tape diameter	=	.397
Lead diameter	=	.522

Cables from feeder panels to pole No. 1 after passing through floors run along basement ceiling to tower, thence upwards to opening in top and out to pole lines. Are supported by porcelain cleats fastened to dressed wood pieces attached firmly to wall or ceiling and go through floors and walls and porcelain tubes.

Transmission Lines to Mill No. 1.

(One three-phase 3-wire circuit.)

Conductors: Three feeders each for pole line to Mill No. 1, No. 000 B. & S. (37 No. 12 stranded).

Copper diameter	=	.570
Rubber diameter	=	.875
Braid diameter	=	1.000

Poles are of sound durable wood properly barked, and trimmed, and roof shaped to shed water; one way sweep not exceeding 1″ in 5′; 30′ in length, 6″ diameter at the top, 5′ in ground and spaced 140 feet apart. Terminal poles are extra heavy, well braced, and guyed and gained for one cross arm, gain to be 4¼″ wide by ¾″ deep, 30″ from the top.

Two pin *cross arms* Southern pine, 3¼″x4½″x36″, 28″ beween pins, bored for two ½″ lag screws, and painted with two coats of weather proof paint. Pins 1½″ locust wood. Third wire carried on pin at top of pole forming approximately an equilateral triangle of 28″ side.

Insulators D. P. glass, good for 2200 volts. Lag screws 7″x½″. Three conductors stranded aluminum bare, equal in conductivity to No. 000 B. & S. copper. Aluminum to be not less than 59% conductivity of copper. To be tied with B. & S. soft aluminum.

Transmission Line to Mill No. 3.

(Three single phase 2-wire circuits.)

Conductors: Six feeders for pole line to Mill No. 3, 37 No. 12 (No. 0000 B. & S.).

Specifications for poles same as that for pole line to Mill No. 1, except that diameter at top 7″, distance in ground 5½ feet. There are two cross arms, one two pin 9″ from tip of pole, and one four pin

Highland Park Mill No. 3, Continued.

cross arm 18″ from center of first forming two equilateral triangles.

Cross arms—four pin, 3¼″x4¼″x6′, 4″ end, 24″ center, 20″ side; two pin. 3¼″x4¼″x4′-4″, 4″ end, 44″ center, bored for two ½″ lag screws, and painted with two coats weather proof paint. Cross arms supported by 28″x1¼″x¼″ galvanized iron braces. Pins 1½″ locust wood. Insulators D. P. Glass, good for 2200 volts. Two lag screws 7″x½″.

Six *conductors* stranded aluminum bare, equal in conductivity to No. 00 B. & S. copper. Conductivity of aluminum to be not less than 59% that of copper. To be tied with No. 4 soft aluminum. These six conductors to form three single phase circuits in order that any transformer in sub-station may be cut out from the power house, and still leave two in V across the line.

Transformer House Wiring.

(Not including leads from transformer house to mill.)

High tension current is brought in through six rubber *insulated cables* of the following dimensions:

37 No. 12 (No. 000 B. & S.) Copper diameter,= .570
Rubber diameter,= .875
Braid diameter,=1.000

These cables are run on porcelain cleats along ceiling timbers and taps are dropped to high tensions leads on side next doors. Secondaries lead covered and run in cement trench, placed below "I" beams supporting transformers. Primaries and secondaries are connected that any one transformer may be cut out from power house without interrupting service.

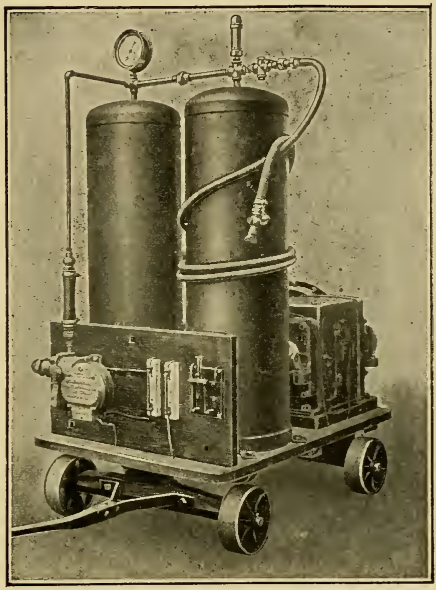
Secondary Cables:

2--each 3—61 No. 11 (1,500,000 C. M.)
2—each 3—61 "
2—each 3—61 "

Switchboard to be located 8′ from and facing wall. Lighting transformers between switchboard and power transformers and five feet from former.

Highland Park Mill No. 3, Continued.

Auxiliary Equipment.



Westinghouse Portable Blowing Outfit.

1—Motor driven air compressor, mounted on trucks for blowing out the lint, etc., that collects in the motors as follows:

1—Westinghouse Motor driven Compressor, with A. C., three phase, 400 to 440 volt motor, 60 cycles, 7200 alternations.

1—Insulating hose connection with fittings to insulate motor from reservoir.

1—Form "E" electric pump governor, for three phase current.

1—Insulating hose connection with fittings, to insulate governor from reservoir.

2—Reservoirs (14"x48").

1—Single pointer air gauge.

1—Safety valve.

1—Discharge hose.

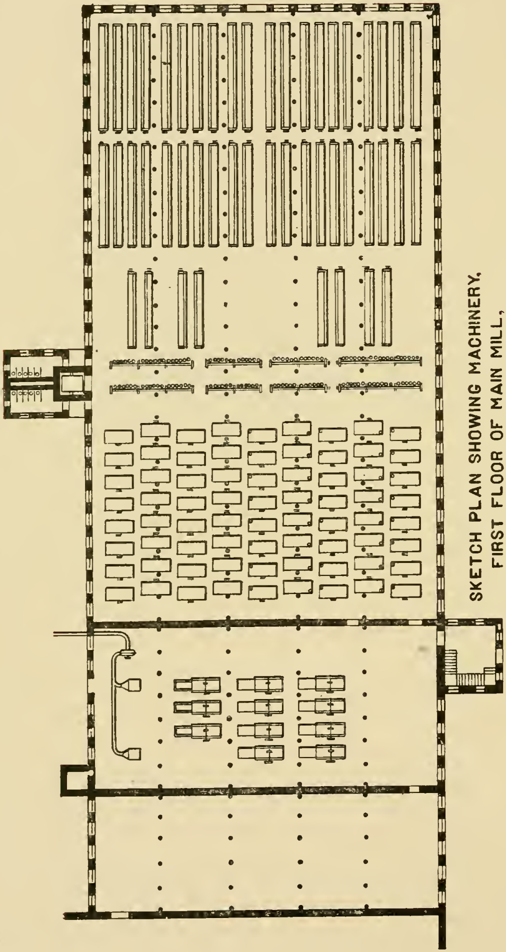
1—Nipple.

1—Nozzle.

1—4-Wheel Truck.

Pipe, fittings and sundry material to make a complete blowing outfit.

Highland Park Mill No. 3, Continued.



SKETCH PLAN SHOWING MACHINERY.
FIRST FLOOR OF MAIN MILL,
DYE HOUSE, LAPPER ROOM AND CARD ROOM.

120—Deliveries Drawing.
8—Slubbers.
12—Intermediates.
28—Fine Frames.

2—Condensers.
3—Breaker Lappers.
4—Intermediate Lappers.
4—Finisher Lappers.
72—40" Revolving Top Flat Cards.

Highland Park Mill No. 3, Continued.

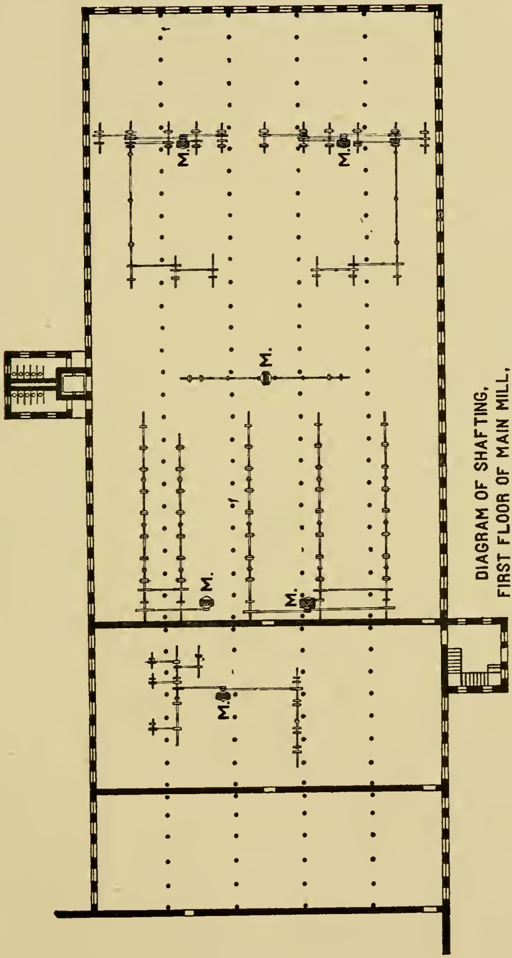
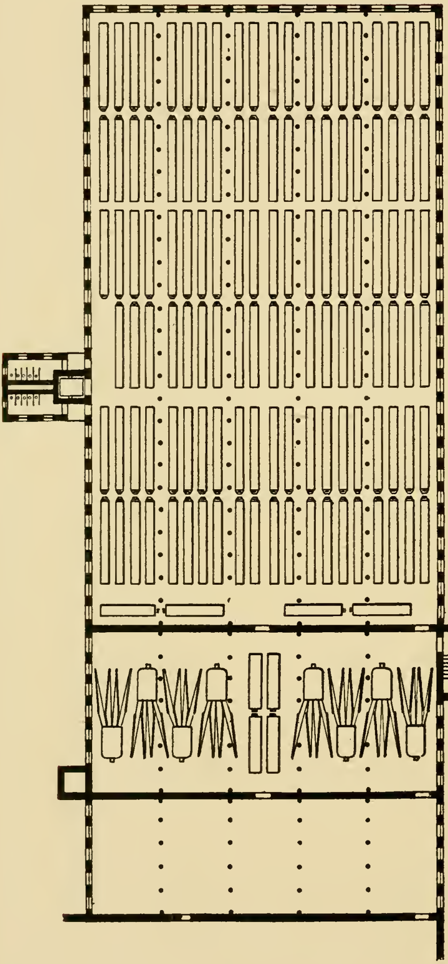


DIAGRAM OF SHAFTING,
FIRST FLOOR OF MAIN MILL,
DYE HOUSE, LAPPER ROOM AND CARD ROOM.

*1—75 H. P. Motors driving roving frames.
1—50 H. P. Motor driving cards.
1—40 H. P. Motor driving drawing frames.
1—30 H. P. Motor driving cards.
1—40 H. P. Motor driving lappers.

*Only 1-75 H. P. Motor required for Roving Frames as it was found the Woonsocket Roving Machinery ran way below the scheduled amount of power required to drive.

Highland Park Mill No. 3, Continued.



SKETCH PLAN SHOWING MACHINERY,
SECOND FLOOR OF MAIN MILL,
DYE HOUSE, WARPER ROOM AND SPINNING.

119—Ring Spinning Frames.
8—Warpers.
8—Spoolers.

The mill was started up with only half the equipment of 15,000 spindles and 500 looms. The second installment of 15,000 spindles and 500 looms was installed after the first installation was well in operation.

Highland Park Mill No. 3, Continued.

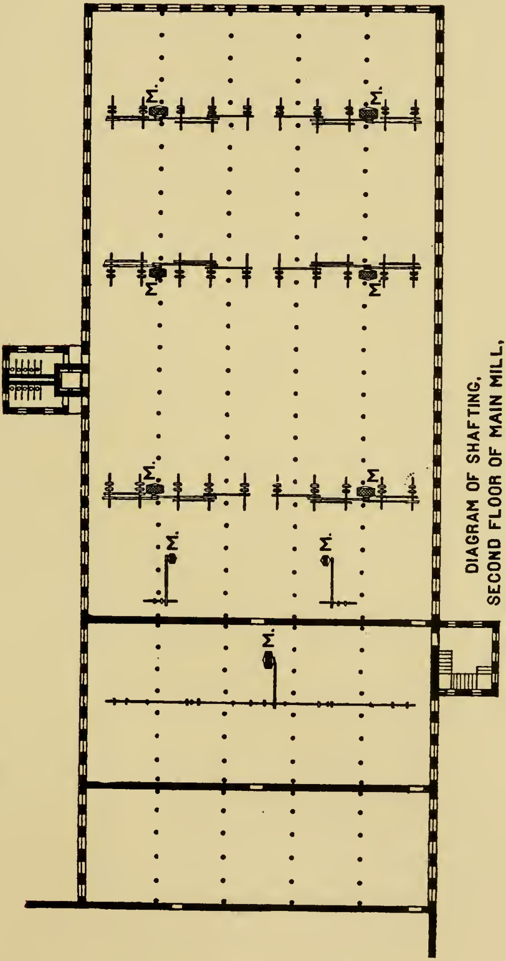
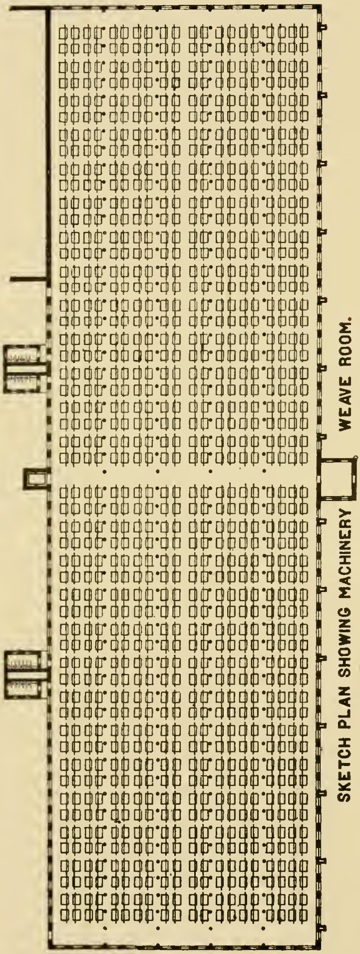


DIAGRAM OF SHAFTING,
SECOND FLOOR OF MAIN MILL,
WARPER ROOM AND SPINNING ROOM.

3-75 and 3-100 H. P. Motors driving spinning frames.
2—3 H. P. Motors driving spoolers.
1—10 H. P. Motor driving warpers and spoolers.

Highland Park Mill No. 3, Continued.



1000—36" looms, 2 and 3 box.

Highland Park Mill No. 3, Continued.

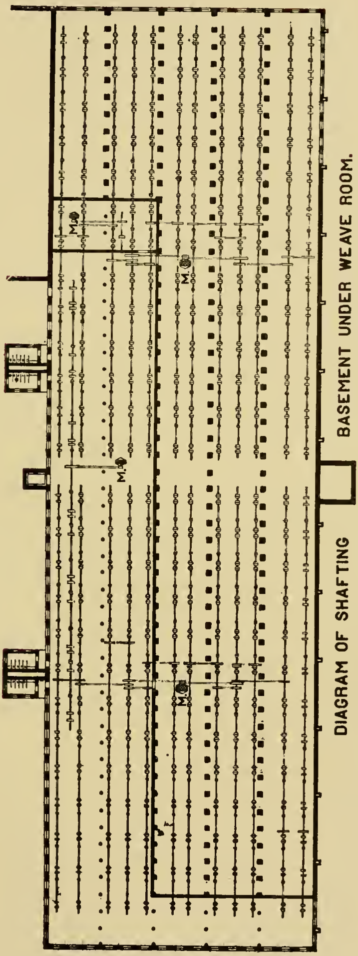
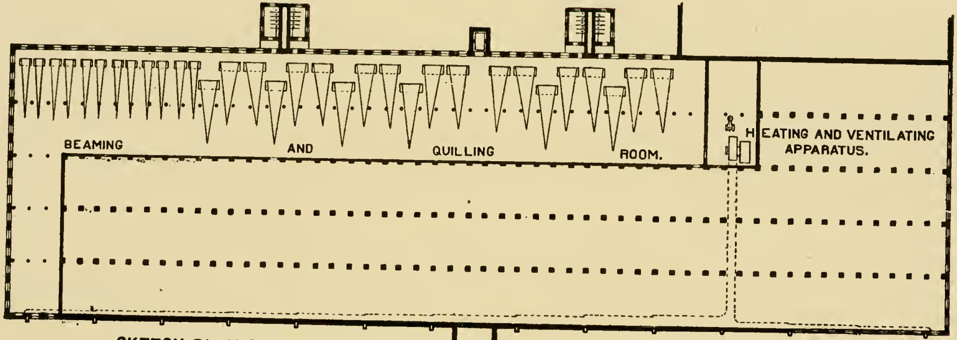


DIAGRAM OF SHAFTING BASEMENT UNDER WEAVE ROOM.

1—40 H. P. Motor for heating and ventilation.
1—150 H. P. Motor driving looms.

1—40 H. P. Motor for quilling and beaming.
1—150 H. P. Motor for looms.

Highland Park Mill No. 3, Continued.



SKETCH PLAN SHOWING MACHINERY BASEMENT UNDER WEAVE ROOM.

12—Beamers. 20—Quillers.

For obvious reasons the Highland Park Mfg. Co. object to our publishing a list of the special processes peculiar to their work, such as special dyeing, finishing, etc.

Still, the foregoing diagrams show enough of the Highland Park equipment to answer for the purposes of illustrating this article so far in as it relates to mill engineering in general.

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General Index, Continued.

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