COTTON SPINNING:

THE QUESTIONS

SET AT THE MAY EXAMINATION OF THE CITY AND GUILDS OF LONDON, 1889,

WITH ANSWERS;

ALSO,

AN APPENDIX OF USEFUL RULES AND EXAMPLES CONNECTED WITH THE TRADE.

SECOND EDITION,

REVISED AND ENLARGED;

.. BY ..

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1st Honors Certificate, Cotton Manufacture.
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PROVIDENCE, R. I.:
C. A. M. PRARAY & CO., . BANNIGAN BUILDING.
CHARLOTTE, N. C.:
C. A. M. PRARAY & CO., TRYON STREET.

THE [illegible] COMPANY,
PRINTERS,
PROVIDENCE, R. I.

PREFACE TO FIRST EDITION.

This book is primarily intended for the use of students of Cotton Spinning, to aid them in their preparation for the examinations in this subject, held by the City and Guilds of London.

Technically education has made rapid strides in this country during the last decade, and this has given rise to many excellent works on the various technological subjects, and also to the formation of classes for the study of these subjects.

Though it may be, as has been asserted—and not without reason—that the subject of cotton spinning has been dealt with in a manner too abstract and speculative, and that too great value is often attached to theoretical knowledge; still, it cannot be doubted that a knowledge of the elements of the theory is of considerable value to those who are mainly concerned with practical results. Technical classes and text books are undoubtedly valuable aids to the acquisition of a sound knowledge of the science, but it is to the factory that the student must apply himself for the most useful part of his training, and text books should be used as guides to the intelligent study of the different departments. In asserting this we seek to do no more than support the old truism, "*experientia docet*"

The answers to the examination questions are as complete as the limits of the works will allow, and in many of them there will be found much that the questions do not ask for, the object being to make the work more useful than it would have been, had the bare and brief answers required been given, in fact they are intended to be not only of use to the student, but it is hoped that they will be found of value to the practical man.

In the appendix there is a treatise on "Cone Drums," by the present writer, reprinted from the "Textile Educator," also various rules, with examples, which will be found useful to those who occupy, or are aspiring to, the more responsible positions in a cotton spinning mill.

W. W., Jr.

Preston, October, 1889.

PREFACE TO SECOND EDITION.

In submitting a second edition of this work, which with the exception of the last few pages was originally published in England, the author trusts that it may find a place among the textile works of the country; and if it should assist in even a small degree toward a more thorough knowledge of the science of cotton spinning, its object will have been attained.

A glossary is introduced to explain several terms used in the work which are more or less local to the Lancashire cotton trade.

W. Whittam, Jr.

Charlotte, N. C., April 9, 1898.

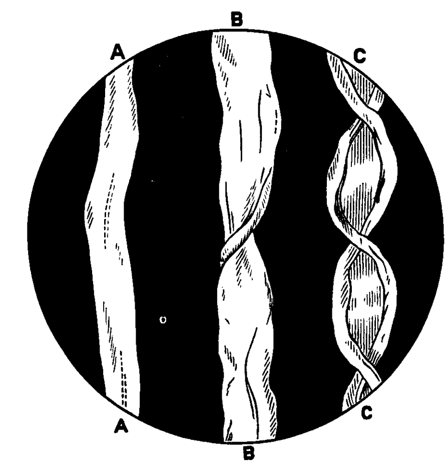


Fig. 1.

A.— Unripe Fibre, (Longitudinal view).
B.— Half ripe imperfectly developed Fibre, " "
C.— Fully matured and ripe Fibre, " "

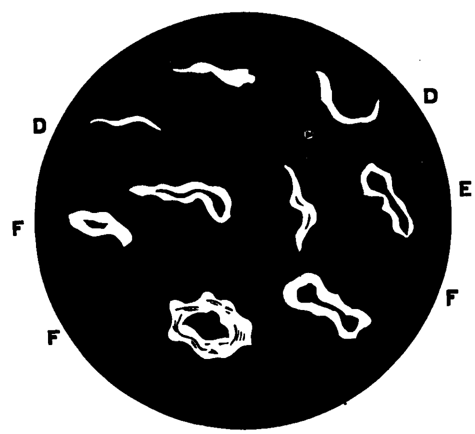


Fig. 2.

D.— Unripe Fibre, (Transverse sections).
E.— Half ripe imperfectly developed Fibre, " "
F.— Fully matured and ripe Fibre, " "

COTTON SPINNING;

The Question set at the May Examination of the City and Guilds of London, 1889, with Answers.

ORDINARY GRADE.

QUESTION 1.—Describe a cotton fibre in words or by sketch, and say how its natural configuration becomes useful in making yarn.

ANSWER.—From the illustration figs. (1 and 2), which represents a magnified typical cotton fibre, both longitudinally and in transverse section, it will be seen that a cotton fibre somewhat resembles a flat twisted ribbon with corded edges, when viewed longitudinally. In section it appears as an irregular hollow cylinder with thick laminated walls. It is, in fact, an elongated cellular filament, having thick, well-defined walls, and a central cavity extending almost to its apex; the walls being thickened, and the cavity partially filled with substances termed secondary deposits. It is greatest in diameter at the base, or that end by which it has been attached to the seed; from this point its diameter is approximately uniform for about three-fourths of its length, when the central cavity disappears, and it gradually tapers to a point.

The mean length of the fibre varies in different species from 1.80 inches in the finest Sea Islands to .85 inches in East Indian cottons. The number of convolutions or twists per inch vary from 500 to 800. Its diameter is subject to similar variations, being about $\frac{1}{1500}$ inch in the former and $\frac{1}{1100}$ of an inch in the latter variety. It consists entirely of a substance known to scientists as "cellulose," the chemical formula for which is $C^6 H^{10} O^5$, *i. e.*, 6 atoms of carbon chemically combined with five molecules of water. The natural configuration of the fibre becomes useful in making yarn owing to the fact that in the spinning process, by the action of the spindle, the convolutions of the fibre are interlocked; the ridge or corded edge of one fibre being laid in the depression of another, thus enabling the thread to withstand a much greater tensil strain than could otherwise be the case.

Q. 2.—Describe the difference between a perfectly developed and ripe cotton fibre, an unripe one, and an imperfectly developed one.

A.—The answer to the previous question describes a fully-developed and ripe cotton fibre. An unripe fibre differs from one that is fully ripe in having few, if any, convolutions, and the corded edges of the ripe fibre are also absent, and it appears as a thin, attenuated, semi-transparent, ribbon-like filament of homogenous structure. It is also much weaker and more brittle than the ripe fibre, and is incapable of taking dyes, except mechanically, *i. e.*, on the surface. Many defects in colored fabrics are frequently attributable to the presence of an abnormal proportion of these unripe and imperfectly developed fibres. Figs. 1 and 2 give a magnified view of this class of fibre, both longitudinally and in section. The imperfectly developed fibre, while showing some evidence of internal structure, does not possess so many "twists," and these are more irregular than those seen in the fully-developed variety; the fibre is not so round or strong, and the thickness of the corded edges is less, and while the cylindrical structure is apparent, it is not so marked as it is in the case of the typical fibre. Figs. 1 and 2 also give representations of this kind of fibre.

Q. 3.—Give a brief description of the following cottons, and say what yarns they are most suitable for: Sea Island, Middling American, Brown Egyptian, and Hingunghat.

A.—Sea Islands cotton is the finest cotton grown, having the longest staple of any variety. The fibres are very regular and of small diameter. It is a very silky staple of a creamy tinge, and has a large number of twists or convolutions per inch. It is suitable for the finest yarns spun, from 160's upwards. Its price is generally from 12d. to 22d. per pound, (equal to 24 to 44 cents American,) according to its quality, and the scarceness or otherwise of the crop.

Middling American is a most useful cotton of a white color; generally it is the most in demand of the American cottons, and is fairly clean. It possesses one peculiar characteristic, which is its adaptability to mix with cottons having a longer or shorter staple than its own; suitable for counts ranging from 40's to 60's twist or weft. Price from 5⅞d. to 6¾d. per pound. (11¾ to 13½ cents American.)

Brown Egyptain is a long stapled cotton of good quality, having a comparatively large percentage of short fibres. As its name implies, it is of a brown color, which is caused by the presence of a natural substance known as "endochrome," which turns brown on exposure to the action of the sun after the bursting of the pods. It is of a soft silky nature, and ranks next to Sea Islands in quality. Counts, from 80's to 140's. Price from 6½d. to 8d. per pound. (13 to 16 cents American.)

Hingunghat.—An East Indian cotton of a white color. For a cotton of this class it is fairly regular and rather soft, therefore most suitable for weft; will spin up to 36's weft. Price from 4½d. to 5¾d. per pound. (9 to 11½ cts. American.)

Note.—Cotton values have depreciated very materially since the preceeding answer was written.

Q. 4.—The bale-opener is a new machine recently introduced Describe it and say in what respect its use is advantageous.

A.—The bale opener is a machine used to prepare cotton for mixing, and for the opener or Hopper feeder. Under the old system of cotton mixing the cotton is taken from the bale, pulled by hand, and thrown on to the mixing. This operation is often negligently performed by the "mixers," and the result is that the cotton is quite often thrown upon the mixing in hard lumps, and when these are passed through the opener they cause bars to be broken, and the cotton is not opened nor the dirt extracted to the same extent as would be the case if the cotton were pulled or broken in a proper manner. These causes have led to the construction of the machine known as the "bale opener" or "bale breaker," which is designed and adapted to perform this important work efficiently. The following is a description of the machine, as generally constructed. The machine has a feeding lattice, 6 feet long, from centre to centre of the lattice blocks; this lattice delivers the cotton to the first pair of rollers, which are named the collecting rollers, revolving at about 4.9 revolutions per minute. From these rollers the cotton is passed through three pairs of breaker rollers successively, a well proportioned draft being provided between each pair, thus obtaining all the features of hand pulling, and also ensuring the cotton from each bale being equally and well pulled. The approximate respective velocities of the rollers are:—

1st	pair or	Collecting Rollers		4.9	rev.	per min.
2nd	"	1st Breaker	"	10.4	"	"
3rd	"	2nd "	"	47	"	"
4th	"	3rd "(delivery)"		229	"	"

The cotton is taken from the bales in layers and laid upon the creeper feed lattice of the "breaker," and by the action of the collecting and breaker rollers it is delivered in good condition for spreading on the opener lattice. In addition to the cotton being pulled, all hard substances are removed, passing down between the rollers to the floor. This machine is admirably adapted for long stapled cottons.

Another machine of this type is made which is more specially designed and adapted for manipulating pressed East Indian Low-grade American and similar cottons. It has only two pairs of breaker rollers, eight inches in diameter, the second pair of which deliver the cotton to a cylinder 18 inches in diameter. This machine also runs at a somewhat greater speed than the former.

Q. 5.—Which is better, small mixings of cotton or large? Give the reasons for your opinion, and briefly describe how you would proceed to mix, say 20 bales of Low Middling Orleans and 10 bales of Dhollerah.

A.—Large mixings of cotton will produce better results than small ones.

The advantages to be derived from a large mixing as compared with a small one are numerous, and of an important character to the cotton spinner. The mixing should be as large as circumstances—such as size of mixing room, capital at disposal, or state of cotton markets—render advisable. A mixing of such magnitude as to last a month is to be desired in preference to one that will only last a week or a few days, since every new mixing will cause some appreciable difference in either color, strength, or cleanliness of the yarn, or perhaps in all of these points. Another point not to be overlooked is that the cotton having been subjected to enormous pressure in baleing, it is clotted into hard lumps, and being somewhat loosened in the process of mixing, and left for some time,—in the case of a large mixing—it expands further, and thus renders the work of the opener less difficult than it would otherwise be.

If any superfluous moisture be present it will evaporate, and thus leave the cotton in a more suitable condition for manipulation in subsequent operations.

In mixing the 20 bales Low Middling Orleans and 10 bales Dhollerah given in the question, the mode of procedure calculated to produce the best results would be to make two mixings, one of Orleans and one of Dhollerah; open say the first 20 bales Orleans, and from the first bale form a layer by shaking its contents loose upon the floor—if hand mixed—so as to cover the area allotted to this mixing. Other layers should then be formed, one from each bale, and superimposed in regular order. After having mixed the 10 bales Dhollerah in a similar manner, each mixing should be passed through the opener separately by taking vertical sections of same. In this manner the different grades of cotton frequently found in individual bales, or in different bales of the same lot, will be thoroughly blended.

The laps formed from each of these mixings should then be "doubled" in the creel of the intermediate scutcher in the ratio two of Orleans to one of Dhollerah.

Q. 6.—From what cottons would you spin a medium quality of the following yarns:—16/24's, 32/36's, 40's, 60's, 80's, all twist or warp yarns?

A.—The cottons from which the above counts would be spun are dependent upon the purposes for which the yarn is required; if it is to be introduced into goods required to take a large percentage of size, a harsh, intractable cotton, producing a soft, oozy, loosely constructed yarn, would be selected; but if the yarn is required for goods which are only to be sized sufficiently to enable them to stand the strain and abrasion of weaving operations, *i. e.*, light goods, then a fine, silky cotton, producing a strong, compact and firm yarn, would recommend itself.

The following are some of the cottons adapted for a medium quality of the twist yarns enumerated in the question, due regard being paid to the above mentioned conditions:—

16/24's may be spun from Dharwar, Dhollerah, or Oomerawuttee, either mixed together or alone.

32/36's.—The better grades of the above cottons may be mixed with the strong, low classes of Americans, as Texas or Georgia.

40's.—The middling varieties of Orleans, Texas, &c., alone, or mixed with some such South American cotton as soft Peruvian, would form a good mixing for these counts.

60's—The higher grades of American, with some of the S. A. cottons, as Maranham, Ceara, Santos, Pernams, &c., would be suitable.

80's.—A mixing composed of good, fair brown Egyptian and Peeler (American), would produce good results for these counts.

Q. 7.—What number of turns per inch, medium twist would be proper for 16's, 24's, 32's, 40's, 60's "twist," and 24's, 36's, 40's 50's, 60's wefts? Give the rule by which you find these results.

A.—The proper turns per inch for a medium quality of the following counts are:—

Twist Yarns.			Weft Yarns.		
Counts.		*Turns.*	*Counts.*		*Turns.*
16's	=	15.00	24's	=	15.92
24's	=	18.37	36's	=	19.50
32's	=	21.21	40's	=	20.55
40's	=	23.71	50's	=	22.96
60's	=	29.04	60's	=	25.17

The turns per inch given in this answer are for mule spun yarns.

The rule by which these results are obtained is as follows:

Multiply the square root of the counts by 3.25 for medium weft, and by 3.75 for medium twist yarns, and the quotient will be the turns per inch required.

EXAMPLE:—Say we require the turns for 36's weft.

Then $\sqrt{36} = 6$.

$\therefore$ By rule $6 \times 3.25 = 19.50$ turns per inch required.

Again, say we require the turns for 16's twist.

Then, as before,

$$\sqrt{16} = 4.$$

$$\therefore\ 4 \times 3.75 = 15.00 = \text{turns required.}$$

For extra twist yarns the general rule is to multiply the square root of the counts by 4 for twist, and by 3.50 for weft yarns.

Q. 8.—What are "neps" in cotton, and how and in what machines are they most liable to be made?

A.—Neps are small white specks, sometimes found in cotton, and we may define a nep as a small tangled mass of cotton fibres, so interwined and entangled that it is impossible to disentangle them in the process of cotton spinning, and it is also very difficult to extricate them from the properly opened fibres. There are three machines used in the preparation of cotton, which are mainly responsible for the production of this objectionable feature, namely, the Saw Gin—a machine whose function it is to separate the cotton from the seed on which it grows, and to which it adheres very tenaciously,—The Opening and scutching machinery, and the Carding Engine. The Saw Gin is a machine largely used in America, and neps are found in a larger proportion in this class of cotton than in any other. If the saws in this machine are improperly set, if the machine is fed too thickly, or the cleaning brush does not clear off all the cotton from the saws at each revolution, "Neps" will be the result. If in the construction or management the openers or scutchers are not made to pass on every particle of cotton struck off from the feed rollers at each revolution of the beater, but allows some of the cotton to be carried round the beater and past the feed rollers and grate bars a second time, this objectionable feature would be found in the resultant laps.

There are many things in the Carding Engine which will cause Neps to be produced, the four principals, of which are:—

1st.—Overloading the Wire.
2nd.—Want of Stripping.
3rd.—Want of Grinding.
4th.—Want of Setting.

1st.—If the card is overloaded, *i. e.*, if we have very heavy carding, we should probably find the web to be neppy.

2nd.—If the stripping through any cause has been neglected, we should have the same result.

3d.—If the wire be dull through some part of the carding surfaces being in contact, we should find the same defect, which would be remedied by grinding the wire sharp.

4th.—If the card has been working for some time and the setting been neglected, we should find "neppy" carding as the result.

Q. 9.—In what respect has the revolving flat card proved itself superior to the roller card; and what is the difference in appearance between yarn produced from the roller card and the revolving flat card?

A.—The superiority of the revolving flat over the roller and clearer card is manifest in the more approximate parallel arrangement of the fibres as seen in the web as it leaves this machine than in that from the roller card; it is also much more gentle in its treatment of the cotton, and does not injure the fibre, nor break up the seeds, motes, etc., so much as the roller card does, but allows them to get embedded in the wires and spaces between the flats until they come up to be stripped off by the comb; whereas in the roller card some of the bearded seeds and motes that have passed the dirt rollers are delivered by the cylinder to the first roller, and then taken from that and delivered to the cylinder again, when they are again carried forward to the first roller, or, if they escape being caught again by the first roller, they are passed on to the second, and are again taken from the roller by the clearer and given to the cylinder, and so on, this process being repeated by each roller in succession, from the first to the last, which causes them to break up, pass on, and ultimately to be incorporated with the yarn.

The former machine also extracts more immature, weak, and unripe fibre, which, if it entered into the structure of the yarn, would greatly diminish its strength and deteriorate its quality. It also produces a more level, clear, and strong sliver than the latter. Another point to which the revolving flat owes its superiority over the roller card lies in the fact that in the former machine the flats are continuously bringing clean wire to work at the position where it is most required, and where the work to be performed is the heaviest, *i. e.*, at the back of the cylinder. From these facts we should expect to find the difference in appearance between yarn produced from the roller card and that produced from the revolving flat to be more level, clean, strong, and more compactly formed silky-looking thread from the flat card than from the roller card; the yarn from the latter card would appear oozy and soft, and would contain a comparatively greater quantity of foreign matter, bearded motes, etc., which spoil its appearance and depreciate its value.

Q. 10.—How is cotton injured if passed through too many heads of drawing, and what is the effect upon the yarn?

A.—Cotton, when passed through too many heads of drawing, or, as it is technically termed, "overdrawn," has its natural configuration destroyed and the fibres are strained, whereby the yarn is weakened, owing to the reduction in the number of the convolution of the fibres allowing them to slide over each other, when subjected to strain, much more readily than would be the case if the fibres composing the thread were in their normal condition. It is also rendered inelastic, unlevel, or cloudy in appearance, and its quality is generally deteriorated. When it has been passed through too many heads of drawing there is also, as a result of this evil, a considerable financial loss, owing to the power, supervision, labor expended, waste made, etc., being in excess of that which is absolutely necessary to produce a good yarn.

Q. 11.—How is the slubbing, roving, and yarn injured when the top rollers are badly covered, or the coverings channelled by wear; and when the flutings of the bottom rollers are worn?

A.—The effects produced by defective top or bottom rollers such as referred to in the question are the same upon the slubbing and roving as well as the yarn, therefore if we consider the effects produced upon the latter, we shall include the two former. There are several points in the preparation and covering of top leather rollers which require careful attention, and which, if neglected, will have an injurious effect upon the yarn. If the piecings either of the leathers or cloths are badly made, they will cut the thread at every revolution of the roller, causing a weak, irregular yarn, and making much waste. The ends of the rollers should be finished off smooth, as, if left rough, breakages, and consequently uneven yarn, is the result. If the leathers or the cloths on both bosses of the rollers (if fast-bossed rollers) are not of the same thickness, they will cause one boss of the roller to have a greater diameter than the other, and since their motion is acquired entirely by contact with the bottom roller, there will be an amount of abrasion in one of the bosses which will give the yarn a raw, cloudy appearance as it leaves the front roller, and cause cut, soft, and consequently weak yarn to be produced. If the top rollers were in good condition when covered, but have become channelled by wear, they are unable to grip the fibres of the thread properly, when by the movement of the traverse they come into the depression, and are thus prevented from drawing them in a regular and even manner, and as a result they produce, as in the previous case, a soft uneven, and weak thread. Now, as mentioned previously, the motion of the top rollers is derived solely from the contact with the bottom ones, and if the flutings of the latter are worn, they have not the same hold on the leathers as when the flutings are good; therefore there is a greater liability in these rollers to slip, which liability is still further increased if they require oiling or are dirty, and the same results will be produced as in the previous cases. Hence we find that whether all or any one of these defects be present, the result is a soft, irregular, and weak or cut yarn.

Note.—The economy and importance of using the best qualities of roll skins and cloth cannot be too strongly emphasized.

Q. 12.—What advantage, if any, is obtained by spinning yarns from a double roving? Are there any disadvantages attending the process? If so, state them.

A.—The principal advantage obtained by spinning yarn from a double roving is, that it conduces to the equalization of the thread by introducing twice the number of doublings that would be obtained from a single roving, and we thus obtain a more level and uniform thread from this mode of procedure; but when we consider that all drawing after the parallelism of the fibres is completed—which we may reasonably suppose it to be when it gets to the roving—is injurious, and weakens the thread; so in spinning yarn from double roving there is the disadvantage of having twice the amount of draft required for single roving, and this must have some tendency to weaken the yarn. Again, in using a double roving, if from any cause one of the ends of roving should break, or if the bobbin runs off unnoticed by the attendant, then a quantity of "single" will pass on into the yarn, which is a very objectionable feature in subsequent processes. This cannot take place in yarns spun from single roving. The cost of production is also appreciably increased by the use of double roving.

Q. 13.—Describe the main points of difference between the doubling ring frame and the "twining jenny," and say which produces the best and greatest quantity of work.

A.—The machines named in this question are modifications of the ring spinning frame and the mule respectively, and the principal point of difference between them is that while the former machine is continuous the latter is intermittent in its action. In the first-named machine the creel is stationary, and the yarn is passed from the delivery rollers to a traveller revolving round a ring fixed in a lifting rail. This traveller gives the requisite drag to the yarn, and the cop or bobbin is formed by the upward and downward traverse of the lifter rail. In the "twining jenny" the spindles are fixed in a stationary "bank," while the creel is movable, and during the operation of twisting the yarns the creel retires from the spindles, and when it has arrived at the end of its outward traverse or stretch the operation of "backing off" is performed, and then it returns to its former position at the spindle bank. During its return or inward traverse the yarn is wound on the spindles or tubes by means of a copping arrangement somewhat similar in principle to that found in the mule, the faller guiding the yarn so as to form a cop, and the "counter faller" supplying the necessary drag. This class of machine is used for either dry or wet doubling. Occasionally the converse arrangement of spindles and creels to the foregoing is found, the creel being fixed and the spindles movable as in the mule spinning frame; but this is seldom the case except the "jenny" has been previously used for spinning purposes. The ring doubling frame is the most productive, and also produces the best work, except for very fine counts, when the "twining jenny" is preferred owing to its being more gentle in its treatment of the yarn. Wet doubling is generally performed on the former machine.

Q. 14.—On what terms is cotton usually bought in Liverpool, and yarn sold in Manchester?

A.—The terms on which cotton is usually bought in Liverpool are: Ten days credit, less $1\frac{1}{2}$ per cent. discount. If the payment is delayed beyond the ten days allowed five per cent. interest is charged on the amount of the account, and conversely, if the account is paid before the expiration of ten days 5 per cent. interest is allowed.

It is also specified that falsely packed, damaged, or unmerchantable cotton will be allowed for at the value of the sound cotton at the date of return, if such return be made and the claim sent in within ten days and three months from the date of invoice.

The terms on which yarn is sold in Manchester are: 14 day's credit, less $2\frac{1}{2}$ per cent. discount. These terms apply to the home trade. For the terms of foreign trade see answer to question 17 honors. Carriage or freight on yarns is generally paid by the buyer, except it is sent to Manchester, in which case it is delivered carriage or freight prepaid.

HONORS GRADE.

QUESTION 1.—Name the chief cotton markets of the world in which the raw material is sold to the trade; and say what sections of the trade are supplied by each.

ANSWER.—These are:—Liverpool, which supplies all sections of the home trade. A considerable number of bales are also sold in this market for exportation.

Bremen:—One of the three free towns in Germany, in the kingdom of Prussia, supplies the trade of that country, which consists chiefly of medium (American) counts. About one-fifth of the total consumption of cotton is spun into low numbers from East India cotton.

Havre:—On the Seine in France, is the source from which the spinners of that country are supplied. The major portion of the trade is engaged in spinning low numbers (Surats), but a considerable quantity of medium counts are also spun.

Amsterdam:—Supplies Holland, whose trade is somewhat similar to that of France.

These constitute the principal European markets. The American section of the trade is supplied in New York and some of the various markets in or about the cotton growing states, as New Orleans, Charleston, etc.

The East Indian trade obtains its raw material chiefly in Bombay. The mills remote from this market are supplied from the markets in their more immediate vicinity.

Q. 2.—How and through what agency is cotton bought in Liverpool? Describe the function of the buying and the selling broker, and their respective duties.

A.—Cotton is bought in Liverpool by spinners or their representatives, who invariably employ "brokers" to act as their agents. These brokers generally act exclusively either as "buying brokers" or as "selling brokers," and their function is to serve as a connection between the importer and the spinner or purchaser. A buying broker is one who buys the cotton for the spinner.

A selling broker is one who sells the cotton to the buying broker acting on behalf of the spinner.

The duties of the buying broker are, to attend to the interests of the firm for whom he is acting; to keep them informed as to the state of the market, its fluctuations and current prices; to submit to the purchaser samples of the various cottons in the market, and the prices of the same; and to attend to the due delivery, marking, and weighing of the bales, and to see that they are up to sample. He also receives payment for the cotton from the purchaser, and transmits it to the selling broker, who in turn pays it to the importer. All claims for falsely packed or unmerchantable cotton must be forwarded to the buying broker.

The duties of the selling broker are to act in a similar manner for the individual or firm who place their cotton with him to sell, and to dispose of the same on the most advantageous terms.

Cotton brokers are remunerated at the rate of one-half per cent. "brokerage" or commission on the amount of each transaction; in the case of the buying broker the brokerage is paid by the purchaser, and the selling broker is paid by the importer of the cotton.

Q. 3.—Some persons combine in themselves the duties of both buying and selling brokers; is it prudent from a spinner's point of view to deal with such?

A.—It is certainly not prudent for a spinner to deal with such persons as those mentioned in the question, for it will be to the advantage of these "double brokers" to sell the cottons of those persons for whom they are acting as selling brokers to the spinners for whom they are buying, and to get the best price for them, and they will thus obtain brokerage from both parties for one transaction. Persons who combine in themselves the duties of both buying and selling brokers are the exception and not the rule, and the bulk of the selling is done by one class of brokers, and the bulk of the buying by another class. This is an arrangement which is calculated to be to the advantage of all the parties concerned, since it secures to the seller an agent who will act just as if he were selling his own cotton, and the buyer is insured a servant whose interests will be identical with his own as much as if the broker himself were the owner of a mill, and was purchasing the cotton for himself.

Q. 4.—What are the various terms on which cotton is bought and sold in Liverpool; and what do the letters c. i. f. indicate?

A.—The first part of the answer to question 14, Ord., and question 5, Hon., are a sufficient answer to that part of this question which requires the terms on which cotton is bought and sold in Liverpool.

The letters c. i. f. indicate "costs," "insurance," and "freight."

Q. 5.—What are "spot," "arrivals," and "future" cottons; and what are the conditions governing a transaction in them?

A.—"Spot," "arrivals," and "futures," are three terms which may be said to designate the position of cottons tendered for sale in the Liverpool market.

The meaning of the term "spot," or spot cottons, is obvious. It is applied to cotton actually at Liverpool, i. e., the seller may be said to be tendering goods actually in his possession.

The conditions governing transactions in them are ten days' credit, less $1\frac{1}{2}$ per cent. discount. If paid before or after the ten days 5 per cent. interest is allowed or charged.

The term "arrivals" is applied to cotton in transit, either at sea or shipped on vessels before departure. The purchase of this class of cotton is similar to obtaining goods on order. The conditions for "arrivals" are identical with those of spot cottons, except that the seller can demand payment before delivery if he thinks proper to do so. Also the cotton must be taken direct from the ship's side to the mill, or if warehoused it is at the expense of the buyer.

"Futures" are cottons bought for delivery in certain forward months. They are bought on a basis, of say 6d. (12 cents American) per pound for Middling American. For example, say a spinner buys in March a certain quantity of cotton, on the above basis, to be delivered in September, he will then have to pay or receive, on the weekly settlement day, the difference in the market value of the month purchased. This is done weekly until the day of delivery, which may be at any time during the month in which it is contracted to be delivered; it is then at the buyer's option whether he will have the actual Middling American or receive or pay the difference in value. If the seller cannot deliver the cotton if demanded, he must pay the difference in value, and in addition a fine fixed by the Liverpool Cotton Association. The other conditions are similar to those of "spot" cotton.

If a spinner buys what are called "distant futures," he may be contracting for cotton which is not yet even planted or sown; which, in fact, only exists upon paper. A person who buys "futures" is sometimes termed a "bull," while the seller of the futures is termed a "bear."

Q. 6.—Describe a cotton fibre by sketch or words; give your opinion as to how its convolutions are formed, what functions the fibres serve in the natural propagation of the plant, and how the convolute structure of the fibre becomes useful in making yarn?

A.—For a description of the cotton fibre, and also for an explanation of the manner in which its convolute structure becomes useful in making yarn, reference must be made to the answer to question 1 Ord. Grade; and the only two points in this question which require further notice are, first, that which refers to the manner in which the convolutions of the fibres are formed, and second, the functions of the fibre in the natural propagation of the plant.

Then, firstly, as to the formation of its convolutions:

When the seed has reached maturity the secretion of the vital fluid is arrested, and the supply to the fibre is therefore stopped; and that fluid or "sap" which is contained in the tube of the fibre is absorbed by the seed, and a vacuum is thus formed commencing at the outer free extremity of the fibre. Following the retreat of the fluid is the collapse of the tube owing to the pressure of the atmosphere; and, as a consequence of this, the fibre is twisted on its own axis at its apex. This process proceeding simultaneously in the majority of the fibres contained in the pod produces such a distortion of their primary arrangement as to burst the capsule, and the process of twisting is then rapidly completed under the favorable influence of the direct action of the sun's rays.

Secondly, with regard to the functions of the fibre in the natural propagation of the plant. They are as follows:

1st. They serve as a protection to the seeds. 2nd. When the seed is in a proper condition for germination it is liberated from the parent plant, and the fibres attached to it serve as a parachute, presenting a light surface to the action of the winds, by which means it is distributed to situations favorable to its growth and more perfect development.

Q. 7.—What is the difference in origin, character, and value between "good fair brown" and "good fair white" Egyptian cottons; and for what yarns are they respectively best adapted?

A.—"Good fair" brown Egyptian cotton is an indigenous variety belonging to the species *Gossypium Herbaceum*; it may be described as a long-stapled cotton of good quality. As its name implies, it is of a brown shade, which is due to the presence of "endochrome," as explained in answer to question 3 Ord. G. It is of a fine silky nature, and is the most regular cotton grown in the diameter of its fibres. Another noticeable feature of this cotton is that in it there is found a more considerable quantity of short, imperfectly developed fibres than in any other variety.

White Egyptian is grown from the exotic varieties *G. Hirsutum* and *G. Peruvianum.* It is a fairly regular cotton, rather harsh, white in color, and most suitable for weft.

The price of this grade of brown Egyptian may be taken at about 7⅛d. per pound, and the same grade of white Egyptian is valued at about 6½d. per pound, so that the difference in their values is about 8.77 per cent.

Number or Counts:—Brown, 80's. to 140's.
" " " :—White up to 80's.

Q. 8.—Is it always good to mix cottons in one "stack" or mixing; or is it sometimes better to blend each variety separately, and afterwards mix in the lap machine? If sometimes one, and sometimes the other, state the conditions which make either the one or the other preferable.

A.—It is not advisable in all cases to mix cottons in one "stack" or mixing, but it is sometimes better to blend each variety separately, and afterwards mix in the scutcher. In order to determine when either of these methods will be best, it will be of advantage to inquire into the objects sought to be attained in the mixing process, and also why this process is necessary. Cotton which has been grown upon the same plant is always found to be in different stages of maturity, and it is a matter of impossibility to so assort the fibres that all those of one degree of maturity and structure may be relegated to one lot, and this being the case in the individual plant it is much more so in cotton which has been grown upon different plants, and owing to the fact that cotton grown upon different plantations is often packed in the same bale without sufficient regard to classification, this difference in quality is increased to such an extent that it is highly desirable to mix all cottons even of the same class in a "stack," in order to secure their proper assimilation. Again, in some instances it is necessary to blend cottons having very different characteristics to produce a special class of yarn; or it may be that the current prices of the different classes of cotton, suitable for making any counts of yarn, make it desirable to lay down a mixing of two or three varieties having somewhat different features, and since the primary object of mixing is to so blend the cottons as to ensure the production of a good yarn, uniform in color and structure, the method of mixing in one "stack" would be resorted to when all the mixing is of one class of cotton; or if two varieties are to be incorporated, and they are in such a proportion as to make it impossible to mix them in the lap machine, they would be blended in one mixing.

Mixing in the scutcher or picker:—

If two or three classes of cotton are to be used, possessing different properties of color or length of staple, and they are in some such ratio as 2:2, 3:1, 2:1, or 2:1:1, the method of mixing in the lap machine would recommend itself, each variety having been previously blended separately. Another case in which mixing in the lap machine would be adopted is when we have two lots of cotton, one dirty and the other clean. If these lots are blended in one mixing the impurities of the dirtier cotton will be scattered through the whole bulk of both lots, whereas if each lot is passed through the opener separately, a large portion of the impurities are extracted previous to mixing, and the result is that more of the impurities are removed in the aggregate than there would be if they were mixed in a single "stack" or mixing.

Q. 9.—What would be the consequence of mixing cottons of irregular length of staple in each of the successive stages of opening, lap forming, carding, drawing, slubbing, roving, and spinning; and what would be the character of the yarn produced?

A.—This question can be dealt with more readily without too frequent repetition if taken in the four sections into which it appears naturally divisable, viz.:—

(1) Opening and Lap Forming.
(2) Carding.
(3) Drawing.
(4) Slubbing, Roving, and Spinning.

Opening and Lap Forming.—The results which would arise from the use of the mixing assumed in the question, in the machines of the opening and scutching department are, the fibres would either be broken or else passed on insufficiently opened, owing to the impossibility of setting the feed rollers at the proper distance from the beater for both long and short staples, at the same time. The long fibres would be broken if the rollers were set for the short staple, and the second result would be found if the rollers were set for the long staple. Another evil result generally found when a mixing of this class is used, is that the shorter fibres, being of a less specific gravity, they are carried forward by the exhaust current or fan draft more rapidly than the longer ones, they thus form a thin sheet on the top dust cage which in the succeeding process of carding causes the laps to "lick," or "split," as it is variously termed; and as a result irregularities will be found in the sliver produced by the card, and the amount of waste made will be much increased. The speeds of the beaters and the angles of the grate bars also require to be modified for long or short stapled cottons, and this cannot be done when they are both being passed through the same machine at the same time.

Carding.—In the carding stage the difficulty of setting the feed rollers again arises, more waste is made, and a weaker sliver is produced. The shorter fibres also make the card to require more frequent strippings, and if this is not attended to, the wire becomes rapidly overloaded. This will cause much of the longer-stapled cotton to be formed into "neps," which are a most objectionable feature. See question 8, Ord. G.

Drawing.—In the drawing frame the setting of the drawing rollers at the proper working distances is the principal difficulty encountered, for since we cannot set them for both classes of staple, if we set them for the long fibre some of the shorter ones will fall out and cause a large amount of waste, and if we set them for the shorter staple the longer fibres will be broken, and an abnormal quantity of top or flat waste will be made. In this case the only plan to be adopted is to set the rollers in an intermediate position, and even then the result will be a weak and cloudy sliver, when compared with one that has been produced from a regular mixing.

Slubbing, Roving, and Spinning.—The results obtained from this mixing, as seen in the slubbing, roving, and spinning machines, may be taken together, as they are generally analogous.

The difficulty of setting the drawing rollers, as explained previously, is encountered in these machines, and the same undesirable results are found in the work produced.

Further, during the operation of twisting, the longer fibres yet remaining unbroken are formed into the centre or core of the thread, and the shorter fibres are loosely twisted round these, not being properly incorporated into the thread, and contributing little if anything to its strength. This defect, when present in the yarn, is termed "crackers."

From these facts we should infer that the yarn produced from such a mixing would be weak, oozy, or loosely compacted and irregular, and of a generally inferior character.

Q. 10.—Is the mechanical mixing of cotton to be preferred to hand mixing, or the reverse? State the grounds of your opinion.

A.—Mechanical mixing is generally preferred to hand mixing, owing mainly to its being more economical. The mechanical method is also an improvement on hand mixing, since it dispenses to a certain extent with the "manual" factor in the problem, which is always a variable one, as the "mixers" do not constantly pay that attention to their duties which they ought to do; but sometimes instead of putting the bales down in regular layers, they will throw down the cotton indiscriminately, and consequently it is not mixed or blended in a proper manner. In mechanical mixing, the cotton being deposited from above, it devolves upon the attendant to level it over the area allotted to the mixing, and it is thus ensured that the work shall be performed in a more regular and systematic way than in hand mixing.

Q. 11.—Describe the functions of the opener, the scutcher, and the finisher lap machines; the derangements to which they are liable, and the manner in which the cotton passing through is injured by the occurrence of these derangements.

A.—As is well known, cotton is received so matted together—due to the compression to which it has been subjected—as to render it necessary that the first operation it undergoes should have for its object the loosening and disentanglement of the mass so that it may be in such a condition as to readily submit to manipulation in subsequent operations. To bring about this result is the primary function of the opener. (The hopper feeder has been generally adopted since the publication of the first edition of this work.)

Its secondary function is to extract the heavier impurities, such as sand and other earthy matter. If the dust trunks and porcupine are attached to the machine, any superfluous moisture which may be present is in part evaporated. In the majority of cases the opener has a lap forming attachment, when the formation of a lap may be considered as one of its functions. (The application of this attachment is now almost universal.) The functions of the scutcher or intermediate lap machine are, to further open the cotton and to extract the impurities passed with it through the opener; a considerable quantity of the impurities of a vegetable origin, such as seeds, leaf, and motes are taken out in this machine, and the amount of sand yet contained is diminished, as previously observed, openers have generally a lap attachment, therefore the scutcher is the first stage in the process where "doubling" is adopted, three or four laps from the opener being run together in the creel of this machine. The old method was for the opener to deposit the cotton on to the floor whence it was taken and fed by hand to the scutcher, a given weight being as far as possible spread equally upon a certain marked space of the feed lattice, so that in either case, equalization is to be considered as one of the functions of the scutcher. The functions of the finisher lap machine are:—

1st.—To further perfect the cleanliness of the cotton.

2nd.—To further open the fleece and bring it in a condition most suitable for the action of the Carding Engine.

3rd.—To further equalize the sheet; and it may here be stated that as this is the last stage in which the pneumatic principle is made use of, the lap as it leaves this machine should be even in the sheet, and level throughout, having well-made selvedges, and of an approximately uniform weight, since any defect in these points will only be diminished, and never entirely eradicated in the following processes. In considering the derangements to which these machines are liable, it will be well to consider the various items in their construction, which it is important to observe in order to produce satisfactory results. Then the derangements and misarrangements to which these machines are subject are numerous, and those which may be attributed to faulty constructions are:—

(*a*) Feed rollers having too small a diameter.
(*b*) Insufficiently weighted feed rollers.
(*c*) Disadvantageous configuration of the nose of the pedals, or cotton holders.
(*d*) Doors and cases of the machine not air-tight.
(*e*) Ends of dust cages not let into the framework of the machine.

We will now consider these points in detail.

(*a*) If the feed rollers are too slender, they will spring or give way in the middle, and the cotton will be drawn through in lumps, and these will be passed on insufficiently opened and cleaned, and will probably retard the properly opened cotton in its passage to the dust cages, and thus cause irregularities in the lap.

(*b*) If the feed rollers be insufficiently weighted, we should have the cotton dealt with in the same way as in the preceding case, owing to the rollers not having sufficient grip or hold on the cotton, and similar defects will be found in the lap.

(*c*) If the "piano" feed regulator or evener is attached to the scutcher or lap machine the nose of the pedals should be rounded off so as to throw the "bite" of the feed roller further from the beater. If this is not done the fibre will be injured by having its convolute structure destroyed or materially impaired, and the fibres to some extent broken. This point should be specially observed when the long-stapled varieties of cotton are to be used; though the better plan, when this class of cotton is to be used, is to have an additional pair of feed rollers so arranged that the beater shall strike the cotton from the pair of rollers, and behind these are placed the levers or cotton holders with the single feed roller, for regulating purposes.

(*d*) If the framework and doors of the machines are not made air-tight, so that the current induced by the fan may be collected from the proper source, the result will be an irregular lap.

(*e*) If so much of the ends of the dust cages as is covered by the hoops for staying or holding them together be not recessed or let in the framework, so that the current may act upon the whole breadth of the sheet, the selvedges of the lap will be thin and jagged, and unnecessary side waste will be made at the carding engine.

The derangements to which they are liable, and the manner in which cotton is injured by their occurrence are as follows:—

If the feed rollers are set too near the beater, there is a tendency to break the fibres and impair their natural configuration, whereby the yarn is weakened.

If the blades or knives of the beaters are allowed to become so far worn that they do not at each stroke clear off all the cotton presented to their action by the feed rollers, but allows some portion of it to hang down toward the top bar, this portion will receive a second or third stroke from the beater before it is liberated, and the same injurious effects will follow as in the case of the feed rollers set too near the beater. Running the beater too quickly or having the beater bars set too near the circle described by the beater blades will affect the cotton in a similar manner.

If any obstruction is allowed to accumulate either in the dust flues or air passages, or if the perforations of the dust cages become closed from any cause, the draught or current will be affected, as also will be the regularity of the lap

If the removal of the impurities from the dirt or leaf chambers is neglected, and they become full, the impurities contained in the cotton will be passed on to the lap; the same result will follow if the current induced by the fan is too strong, and if this is too weak, a quantity of good fibre will be expelled with the "droppings" and leaf. The former derangement must be avoided, since it would deteriorate the quality and appearance of the yarn, and the latter evil should be carefully guarded against, as it would entail a considerable loss.

If the "piano" feed regulator is attached to any of the machines, care should be taken to keep it in good order and sufficiently sensitive, and if this appliance is driven by a belt or band, it should be kept at a proper tension, and in a good flexible condition; this must also be seen to in the belt connecting the two cones; if any of the "bowls" between the pendant bars are worn, they must be renewed, as if any of these defects be present, an irregular lap will be made.

(With a badly constructed or unmechanical evener, level and even running laps cannot be made.)

If the lap rollers are weighted too heavily, or if the air current is so directed as to be too much upon the bottom dust cage, we should very probably have the laps "licking" or "splitting" when unrolled in the succeeding process.

Another matter which in conjunction with the above applies to all the machines in the "scutching" department is, to see that all belts are sufficiently tight, and in proper condition, so that they may perform their work without any slipping, for if this is not attended to they will become too slack, and the various speeds of the machines will not hold their proper ratio to each other, and unsatisfactory results will follow.

Reference should be made to Ans., Ques. 8, Ord. Grade, in considering this question.

Q. 12.—Which principle of carding—roller or flat—is best for making, say first, a loosely compacted or "oozy" yarn that will take size well; and second, a dense, silky-looking thread that will make a good printing cloth?

A.—From the perusal of the answer to question 9, Ord. Grade, it will be evident that the roller principle of carding is best adapted for producing a loosely compacted oozy yarn that will take size well, and for the productionof a dense, silky-looking thread, suitable for "Printers," or lightly sized goods, cards constructed on the revolving flat principle are the best.

Q. 13.—What system of spinning, flyer throstle, ring frame, or mule, is best for producing the yarns described in the previous question, and for the same purposes?

A.—There is no system of spinning which can produce so loosely compacted and oozy a yarn as the mule.

The reasons that this machine can produce a better yarn of this description than either the ring frame or the flyer throstle are: It is capable of spinning yarns with a less number of turns per inch, owing to the drag necessary in the process of winding on not being applied until the yarn is brought up to its full strength, by having received its full number of turns. Its drag—*i. e.*, force exerted upon the yarn by the counter or under "faller," is also so adjustable that the winding process can be accomplished with much less strain on the yarn than in either of the other machines mentioned. As this class of yarn is obviously not so strong as the dense, silky-looking thread, the above considerations, together with the fact that the centrifugal force generated during the process of twisting, causes a considerable quantity of fibres to project from the surface, thus making the thread more hairy, place this machine in the foremost position for the production of this class of work.

The flyer throstle will produce the most dense and silky thread.

Its superiority in this respect over the ring-frame and mule being chiefly attributable to the action of the flyer-leg on the thread during its passage to the bobbin, it having a smoothing and consolidating tendency, thus causing the maximum number of fibres to be incorporated into the thread, and a more sericeous or silky yarn is the result.

Although this machine is capable of producing a smoother thread than the ring-frame, economical considerations have led to the adoption of the latter frame for this class of work, since it produces a thread which is better in this respect than the mule, thus placing it in an intermediate position to these two machines. The considerations which have principally led to the extensive use of the ring-frame, to the comparative exclusion of the flyer throstle, are its greater productiveness and diminished cost of working.

Q. 14.—What hank roving should be used to get the best results in the following counts of yarns, each in low, medium, and good qualities:—*Twists* 16/24, 32/36, 40's, and 60's; *wefts* 30's, 40's, 50's, 60's, 70's, 80's.

(In questions 14 and 15 the student is desired to answer to those counts with which he is most familiar.)

A.—Suitable hank roving (single) for the various counts given in the question are:—

TWISTS:

COUNTS.	16's	24's	32's	36's	40's	60's
Hank Roving...........	2.11	2.99	3.78	4.13	4.56	6.38

WEFTS:

COUNTS.	30's	40's	50's	60's	70's	80's
Hank Roving...........	3.59	4.75	5.45	6.27	7.20	8.06

These rovings will produce good results for a medium quality of yarn, and for a low quality we should go from about one quarter to one half hank coarser, and for a good quality about the same proportion finer in the hank of the roving.

Q. 15.—What should be the weight of lap used, and the draughts in the card, the drawing frame, the slubber, the intermediate, the roving and the spinning frame or mule, to give the best practical results from the material used in producing the yarns named in the previous question?

A.—This question is a very comprehensive one, and the answer is given without showing the method by which it has been obtained, as to do so would require such a multitude of figures as would probably make it less lucid and, perhaps, somewhat confusing.

DRAUGHTS, ETC., FOR TWISTS.—On reference to the subjoined table it will be noticed that in setting out the draughts for 16's the intermediate frame is omitted, as it is generally considered to be unnecessary for these numbers. Three heads of drawing are used with six ends up into one, at each head. In the 24's the intermediate frame is introduced, since it is not deemed advisable to spin above 20's without it; in the drawing frames the same number of heads are used and doublings made as in 16's.

In 32's, 36's, and 40's there are eight ends "doubled" at the first head, and six at the second and third heads of drawing. In 60's there are eight ends up at each of the three heads. Single rovings are used for all the counts, both twist and weft.

It will also be observed that the weight of the lap is given in ounces and fractions of an ounce per yard, and also in grains per yard. The hank of the lap is also given. For a good quality of 60's twist the combing machine might be introduced with beneficial results.

Counts.	16's	24's	32's	36's	40's	60's
*Weight of Lap in ozs..	13.70	13.60	12.69	11.90	11.53	10.53
* " " grains	5992	5950	5553	5206	5048	4508
Hank of Lap..........	.00129	.0014	.0015	.0016	.00165	.00185
Draught in Card.......	90.00	100	100	100	100	100
" " 1st Drawing	6.00	6.00	8.00	8.00	8.00	8.00
" " 2nd "	6.00	6.00	6.00	6.00	6.00	8.00
" " 3rd "	6.00	6.00	6.00	6.00	6.00	8.00
" " Slubbing...	5.27	3.41	3.79	3.88	3.90	4.19
" " Inter.......	....	4.58	4.71	4.84	4.87	5.23
" " Roving.....	6.13	5.35	5.65	5.81	5.84	6.28
" " Spinning...	7.90	8.02	8.48	8.72	8.77	9.42

* Weight per yard is given.

Draughts, etc., for Wefts.—In examining the table for wefts it must be understood that in 30's there are six ends "doubled" at each of the three heads of drawing. In 40's and 50's eight ends are put up at the first head and six at the second and third heads. 70's and 80's have eight ends "doubled" at each of the three heads.

Counts.	30's	40's	50's	60's	70's	80's
Weight of Lap in ozs...	12.45	11.90	11.20	13.00	11.07	9.31
" " grains	5446	5206	4900	5689	4843	4074
Hank of Lap..........	.0015	.0016	.0017	.00164	.0017	.0018
Draught in Card........	100	100	100	110	110	110
" " 1st Drawing	6.00	8.00	8.00	8.00	8.00	8.00
" " 2nd "	6.00	6.00	6.00	8.00	8.00	8.00
" " 3rd "	6.00	6.00	6.00	8.00	8.00	8.00
" " Slubbing....	3.61	3.92	4.09	4.25	4.45	4.43
" " Inter........	4.46	4.90	5.10	5.31	5.40	5.51
" " Roving.	5.57	5.88	6.12	6.38	6.48	6.62
" " Spinning....	8.36	8.83	9.18	9.56	9.72	9.92

These tables give the requisite draughts for a medium quality of the yarns to which they are subjoined, and for a good quality we should work a fraction finer throughout, while for a low quality we should keep a fraction coarser all through.

(The methods by which these draughts have been obtained and divided are given in the appendix.)

Q. 16.—Some years ago it was the common practice in the slubbing, intermediate, and roving frames for the flyer to lead the bobbin; it was found, however, that the flyer started in advance of the bobbin, and by so doing made a thin place in the slub or rove. In order to remedy this, the arrangement was altered, and the bobbin made to lead, in the belief that the flyer would still start first, and only cause a little slack, which would soon be taken up and do no harm. Was this belief correct? Explain the reason why the flyer started in advance, and especially say if the alteration has proved to be a remedy; and if not, why not?

A.—In the answer to this question the three sections into which it is divided are not dealt with in the same order in which they are given, since it is thought it may lead to a better conception of the subject if they are taken in the following order:—

1st.—"Explain the reason why the flyer started in advance of the bobbin."

2nd.—"Was the belief correct that in bobbin-leading frames the flyer would start first and only cause a little slack which would soon be taken up and do no harm?"

3rd.—"Especially say if the alteration has proved a remedy."

Taking these sections in this order, we must first inquire why the flyer starts in advance of the bobbin; and the reason is, that since the motion to the bobbins is transmitted through a greater number of wheels than the motion communicated to the spindles, and consequently to the flyers—the actual number of wheels in each train being bobbins nine, flyers five—therefore it follows that the flyers must start before the bobbins, owing to the sum of the "backlash" in the nine wheels driving the bobbins being greater than that of the five wheels driving the flyers. It may be said that owing to the flyer starting first and having, as it were, to lap the rove round the bobbin—because the bobbin has the least velocity—and their velocities at the instant of starting not being in the required ratio the rove will be stretched in frames which have the flyer leading. And here it may be permitted respectfully to differ from several recent works on cotton spinning, the authors of which seem, in the opinion of the present writer, to be somewhat under a misconception as to the cause of the flyer starting in advance of the bobbin, since in the works referred to the non-positive factor in the motion of the bobbins or the slipping of the strap or belt driving the bottom cone drum is given as the cause.

It will be both interesting and instructive to examine this question in detail. Consider for a moment what happens when a frame is doffed. The bottom cone drum is raised, which causes the "sun" wheel to stop, and no winding takes place. The following calculation will show that winding cannot take place when the bottom cone is stopped.

A 42 on frame shaft drives a 42 on spindle shaft, a 55 on spindle shaft drives a 22 on spindles. Revolutions of frame shaft, 517. This gives $\frac{517 \times 42 \times 55}{42 \times 22} = 1{,}297.5$ as the number of revolutions of the spindles per minute.

Now, when the sun wheel is stationary after the stopping of the bottom cone, it ceases to be a factor in the motion of the bobbins, and the only motion they possess is that acquired direct from the frame shaft, which has a constant velocity, and under these conditions we may find the revolutions of the bobbins as follows:—Revolutions of frame shaft, as before, 517. A 56 on boss of loose bevel drives through two carriers in the swing; a 56 on bobbin shaft and a 55 on bobbin shaft drives a 22 washer or bobbin wheel. Then the revolutions of the bobbins from these particulars are $\frac{517 \times 56 \times 55}{56 \times 22} = 1{,}297.5$.

These are the revolutions of the bobbins per minute, without the agency of the differential motion.

From the above it is evident that under these circumstances, the bobbins and the spindles both have the same number of revolutions per minute.

Now suppose, at the time of "doffing" the bobbin is 4 ins. in diameter, its circumferential velocity will be $\frac{1297.5 \times 4 \times 22}{7}$ $= 4{,}077.85$ inches per minute.

Now, the foot of the presser being by centrepetal force in juxtaposition with the periphery of the bobbin, it will, in one revolution describe a circle having a radius equal to the radius of the circle described by the periphery of the bobbin. Therefore the radii of the circles described by each being equal, and the number of revolutions of each being equal, the circumferential velocity or the space described by each per minute will be the same, therefore no winding can take place.

As a corollary to the above, we should say that the slipping of the cone belt on starting the frame would tend to ease the rove rather than stretch it, whether we have the bobbin or the flyer leading. So that the reason previously given is the only cause of the stretching of the rove.

In considering the second section of the question we must remember that when the flyer is leading, the winding is accomplished by the velocity of the flyer being greater than that of the bobbin, and this difference will be better understood by an example being given.

Say the front roller delivers 500 inches of rove per minute, then taking the circumferential velocity of the bobbin, at any time, at 4,500 ins. per minute, then the flyer must pass through a space of 4,500+500=5,000 ins. per minute, and as explained previously, the flyer starting in advance of the bobbin, it must cause the rove to be stretched.

In frames which have the bobbin leading, the converse arrangement to the above is adopted, the bobbin having as it were to take the rove from the flyer, therefore its circumferential velocity must be the same as that of the flyer, plus the velocity of the front roller. This being the case, it follows that in bobbin leading frames the flyer starting in advance will cause a little slack, which will be taken up when the full velocity has been attained.

With regard to the question, "whether the alteration has proved a remedy."

It has certainly remedied the stretching of the rove, and has also eliminated another minor evil, *i. e.*, when an end broke the bobbin unroved itself, making waste, and this does not occur when the bobbin leads. But considering all the points pro and con, the frames which have the bobbin leading are admittedly the best.

Q. 17.—What are yarn agents, and what are the duties they ought properly to perform for spinners? State the terms on which yarns are usually sold to the home trade, and to the shipping or export trade.

A.—Yarn agents are persons who buy or sell yarn.

They are either deputed by the manufacturer to buy yarns for him, or they are engaged by the spinner to sell his yarns. They may be described as persons who negotiate transactions between seller and buyer. If engaged by the spinner the duties they ought properly to perform for him are: To sell the yarn to the best advantage to persons of whose solvency they are sure, and to collect accounts for transactions conducted by them. There are two kinds of yarn agents, termed respectively guaranteeing and non-guaranteeing. The guaranteeing agents do not inform the seller who is the purchaser of the yarn, but they are held responsible by him for the payment, and they guarantee payment in case the buyer becomes insolvent, for which they are allowed ½ per cent. They receive in addition 1 per cent. commission.

The non-guaranteeing agents inform the spinner who is the purchaser of the yarn, but they are not responsible for payment. They are allowed 1 per cent. commission on the amount of the invoice.

For the terms on which yarns are sold to the home trade refer to question 14, Ord.

The terms on which yarns are usually sold to the shipping or export trade are: 2½ per cent. discount, if payment is made within 14 days of date of invoice; the merchant is allowed 95 days interest, at 5 per cent., on the amount of same.

APPENDIX.

COTTON SPINNING.

CONE DRUMS IN SLUBBING INTERMEDIATE; AND ROVING FRAMES.

Cone drums in spindle and fly frames are introduced to regulate the winding of the rove upon the bobbins, which must be accomplished without its being elongated or stretched in the slightest degree, *i. e.*, if 500 inches of rove are delivered by the front roller per minute, there must be exactly the same length deposited on the bobbin per minute; and as the diameter of the bobbin is increased at each upward or downward change of the traverse, by twice the diameter of one ply of rove, the velocity of the bobbin must be accelerated or retarded; accelerated if the flyer leads the bobbin, and retarded if the bobbin leads the flyer; this acceleration or retardation, as the case may be, is obtained through the medium of the cone drums, and must have a constant ratio. To obtain this differentiation in a constant ratio the cone drums must be rotary surfaces of the same parabolic curve, the top or driving cone being concave, and the bottom or driven cone convex. They must be constructed in such a manner that in moving the belt towards the opposite end of the top cone, the number of revolutions of the bottom cone must decrease in the same proportion as the length the belt has been moved. Thus:—Suppose the number of revolutions of the bottom cone decrease by 8 on moving the belt one inch; then on moving the belt, say

10 inches, the revolutions of the bottom cone should be decreased by 80. This could not take place if the cones were rotary surfaces of a straight line, *i. e.*, of a straight taper. We must now proceed to demonstrate these theorems. First we may say in dealing with these questions, that the distance of the axis of the two cones from each other must be the same at all points, or in other words, they must be exactly parallel, and that the sum of the two circles described by the centre line of the belt must be equal at any position of the belt. These points must be observed or the belt will not always be at the same tension. Further, the belt must always be parallel to the position it occupied at the end of the drums. Also, in calculating the different speeds, we must assume that the same number of revolutions would be produced as if the cones were replaced by two drums of the same diameters as those circles round which the centre line of the belt is moving. Suppose the diameter of the thick ends of the cones to be 6 inches, and the diameter of the smaller ends 3 inches, and that its length be 30 inches. Then, if the driving cone makes 150 revolutions per minute, the number of revolutions of the driven cone when the belt is on the smallest diameter, and consequently on the largest diameter of the driving cone will be $\frac{150 \times 6}{3} = 300$. Now the diameters of the drums at the centre will be $4\frac{1}{2}$ inches each. If we suppose in the first instance the cones are a straight bevel, and the number of revolutions of each will be 150 per minute. Now let us suppose the driving cone to be produced to its apex, we can find the length of this supplementary cone by the following simple application of the proportion rule:—As the length of the supplementary cone is to the total length of the drum, so is the diameter of the smaller end of the drum to the diameter of its larger end or base.

If we designate the length of the supplementary cone by x (being the unknown quantity) we can obtain its corresponding numerical value as follows:—

$$x : (30 + x) :: 3 : 6$$
$$\therefore 6x = 90 + 3x$$
$$\therefore 6x - 3x = 90$$
$$\therefore 3x = 90$$
$$\therefore x = \frac{90}{3} = 30$$

Therefore the length of the side of the supplementary cone is 30 inches.

By a process very similar to the above we can obtain the diameters of the drums at any point. Suppose we move the belt 1 inch toward the smaller end of the driving cone; the diameter of the circle described by the centre line of the belt would then be

$$30 : (30 + 29) :: 3 : x$$
$$\therefore \frac{3 \times 59}{30} = 5.9 \text{ inches.}$$

And since the sum of the diameters of the two cones must be nine inches, the corresponding diameter of the driven cone must be $9 - 5.9 = 3.1$ inches and the number of revolutions it makes per minute will be $\frac{150 \times 5.9}{3.1} = 285.49$.

As before we may obtain the number of revolutions of the driven cone and its diameter and also the diameter of the driving cone for each inch the belt is moved, which are obtained and tabulated under, for six positions of the belt.

Distance of centre of belt from apex of cone.	Diameter of top or driving cone.	Diameter of bottom or driven cone.	No. of revolutions of the driven cone per minute.	Decrease of number of revolutions of driven cone.
60	6	3	300	
59	5.9	3.1	285.49	14.51
58	5.8	3.2	271.87	13.62
57	5.7	3.3	259.09	12.78
56	5.6	3.4	247.06	12.03
55	5.5	3.5	235.71	11.35

If we examine the above table we shall find that the decrease in the number of revolutions of the driven cone diminishes each time the belt is moved toward the smaller end of the driving cone, and thus it is not proportional to the lateral traverse of the belt. We have seen thus far that the differentiation will not be proportional to the lateral traverse of the belt, if the cones are of a straight bevel. And as in the spindle and fly frames it is absolutely necessary that the difference in the velocity of the driven cone be in exact proportion to the lateral traverse of the belt. We must now endeavor to find that shape of the conical surfaces which will produce this:—

REQUIRED VELOCITY.

For example:—Suppose we require our driven cone to decrease from 300 to 75 revolutions per minute, and to have a decrease of 7½ revolutions for each inch the belt is moved. Then the length of the axes of our cones must be $\frac{300-75}{7\frac{1}{2}} = 30$ inches. Take the largest diameter of the driving cone at 6 inches. Then the corresponding smallest diameter of the driven cone must be $\frac{6 \times 150}{300} = 3$ inches.

The dimensions we have now obtained are as before:— Length of axis, 30 inches; largest diameter of driving cone, 6 inches; corresponding least diameter of driven cone, 3 inches. Therefore, also, the sum of the diameters of the two cones is again 9 inches.

Considering, in the first instance, the driven cone, we must now take a line 30 inches long to represent the axis of the cone and divide it into 30 equal parts, each being one inch long, and through each of these points draw a straight line at right angles to the axis; and on the first of these lines at the smaller end of the cone set off 1½ inches on each side of the axis, which will represent the smaller diameter of the driven cone = 3 inches.

The length to be measured along the next vertical line may be found thus:—If we denominate the diameter of the driving cone by d and the corresponding diameter of the driven cone by e since the number of revolutions of the cone e must now be $300 - 7.5 = 292.5$. We know that $150 \times d = 292.5 \times e$. $\therefore d = \frac{292.5}{150} e = 1.95\, e$. And we also know that the $d + e$ must equal nine inches. Therefore $d = 9 - e$. If we now take these two values of e and place them equal to each other, by an easy application of simple equations we have

$$1.95\, e = 9 - e$$

$$\therefore e + 1.95\, e = 9$$

$$\text{also } e\,(1 + 1.95) = 9$$

$$\therefore 2.95\, e = 9$$

$$\therefore e = \frac{9}{2.95} = 3.05 \text{ inches.}$$

This 3.05 is the length to be measured on the second perpendicular, and if we set off one-half of this length on each side of the axis we shall have two other points in the curves of the driven cone.

By calculations, analogous to the above, we have

$$e_2 = 3.104$$

$$e_3 = 3.16 \text{ etc.}$$

If we proceed in this way and connect all the points thus obtained, we shall have a curve by whose rotation the required form of cone will be described.

If we now subtract these values of e, e_1, e_2, e_3, etc., from 9 inches, and proceed as in the previous case we shall obtain a curve similar to the last, with the exception that it will be concave, while the previous one is convex. These concave curves are those by whose rotations the surface of the driving cone will be described. On examination these cones will be found to be parabola.

Note.—A parabola is a plane section of a right conical surface, which is at all points equidistant from a fixed point and a fixed straight line, termed respectively the focus and the directrex.

We have thus shown that cones of a straight bevel will not answer our purpose, and have found the method by which the required conical surfaces can be obtained.

RULES AND EXAMPLES.

To find the total length of yarn produced by a mill per week in hanks, the weights spun of the various counts being known.

Rule:—Multiply the weights produced of the various counts by their numbers, and the sum of these results will be the total length.

Example:—A mill produces 2,500 lbs. 30s, 3,000 lbs. 36's, 5,000 lbs. 40's, 8,000 lbs. 50's, and 2,000 lbs. 60's, what will be the total length?

2,500 × 30 =	75,000 =	length of	30's	produced.
3,000 × 36 =	108,000 =	"	36's	"
5,000 × 40 =	200,000 =	"	40's	"
8,000 × 50 =	400,000 =	"	50's	"
2,000 × 60 =	120,000 =	"	60's	"

The sum of these = 903,000 = Total length in hanks.

To find the average counts spun.

Rule :—Divide the length in hanks spun per week by the total weight produced in pounds, and the quotient will be the average counts.

Example :—Take the particulars of the previous example, and find the average counts?

Then

$$\frac{\text{Total length} = 903{,}000}{\text{Total weight} = 20{,}500} = 44.05 \text{ average counts.}$$

To find the production in ounces per spindle per week.

Rule :—Multiply the weight in pounds spun per week by 16, and this will give the ounces per week, which divided by the number of spindles contained in the mill will give the ounces per spindle.

Example :—Taking the particulars as before, and the mill as containing 30,000 spindles, find the ounces per spindle per week.

Then

$$\frac{20{,}500 \times 16}{30{,}000} = 10.93 \text{ ozs. per spindle.}$$

To find the number of hanks per spindle produced per week.

Rule :—Divide the length in hanks produced by the number of spindles, and the quotient will be the hanks per spindle.

Example:—Production 903,000 hanks, number of spindles 30,000; find the hanks per spindle.

Then

$$\frac{903,000}{30,000} = 30.10 \text{ hanks per spindle.}$$

To find the number of hours continual running that would be required for a pair of mules to produce any number of hanks per spindle of any counts.

Rule:—Multiply the turns per inch of the counts spun by the product of 840×36, this will give the turns in one hank. Then the product of the turns per hank, and the number of hanks given, divided by the number of revolutions of the spindles per hour, will give the number of hours required.

Example.—A pair of mules produces 28 hanks per spindle of 36s weft. Find the number of hours required to produce this number of hanks, assuming that the "wheels" were continuous spinning machines, and no stoppage to take place.

Turns per inch 36's W = 19.5.

Turns in 1 hank of 36's = 19.5 × 36 × 840.

Revolution of spindles = 7,500 per minute.

Then

$$\frac{19.5\times36\times840\times28}{7500\times60} = 36.42 \text{ hours required.}$$

To find the approximate number of spindles with preparation, that one indicated horse power will drive.

Rule:—Take 100 spindles per horse power for 60s, add 1 spindle for each 2 hanks finer, and deduct 1 spindle for each 2 hanks coarser, in the numbers to be spun.

Example:—How many indicated horse power will be required to drive a mill spinning 50's, and containing 60,000 spindles?

$60-50=10 \therefore \frac{10}{2}=5=$ No. of spindles to be deducted.

$$\therefore \frac{60{,}000}{100-5} = 632 \text{ nearly} = \text{horse power required.}$$

The above will form a good basis to work upon, since it is obtained from the number of spindles and indications, of many mills actually at work.

To find the cost per pound of cotton at the carding engine head.

This will be best shown by an example. 200 lbs. of cotton are passed through the opener and scutchers, and on the finished laps being weighed, it is found to have lost 11 lbs. 5 ozs. Then the loss per cent. in this process is found as under:—

$$\frac{11.3125 \times 100}{200} = 5.65 \text{ per cent.}$$

A lap from this cotton, weighing 25 lbs. 11 ozs., is passed through the carding engine, and when re-weighed, it is found to have lost 1 lb. 9 ozs.

Then, as before, the loss per cent. is

$$\frac{1.5625 \times 100}{25.6875} = 6.08 \text{ per cent.}$$

Then the total loss is

$$\begin{array}{r} 5.65 \\ 6.08 \\ \hline 11.73 \end{array} \text{ per cent.}$$

Now, suppose this lot of cotton cost $5\frac{17}{32}$d. per lb., its cost at the engine head may be found thus:—$100 \times 5\frac{17}{32} = 553\frac{1}{8}$ pence = amount paid for 100 pounds. But this 100 lbs. when passed through the scutching and carding, only gives 100—11.73 = 88.27 lbs.

Therefore,

$$\frac{553.125}{88.27} = 6.30 \text{ pence per lb. cost at engine head.}$$

English pence × 2 = American cents.

To find the total draught in slubbing, intermediate roving, and mule or spinning frame inclusive.

Rule:—Multiply the counts being spun by the number of doublings in these machines, and divide this product by the hank of the sliver put up behind the slubbing frame, and the quotient will be the total draught required.

Example:—Find the total draught when the hank sliver is .16 and the counts 40's, two ends up at intermediate, and two at roving frame, and single roving in the mule.

Then

$$\frac{40 \times 2 \times 2}{.16} = 1{,}000 \text{ total draught required.}$$

To divide the above total draught into any desired proportion between the slubbing, intermediate, roving frames, and the mule or ring frame, as the case may be.

Rule I.—First, it must be decided in what proportion the total draught shall be divided; and, for example, we will suppose that it is desired to divide it in the proportion of 9, 6, 5, 4 for the mule, roving, intermediate, and slubbing *respectively. Then multiply these supposed draughts together, and extract the biquadrate or fourth root of the product.*

Then extract the biquadrate root of the total draught required to be divided, and by multiplying this root by the supposed draught or proportion of each machine, and dividing the product by the biquadrate root of the product of the supposed draughts or ratios, we shall obtain the draughts for each machine.

Example:—40's weft is spun from a sliver of .16 hank to the pound, put up behind the slubbing frame. There are two doublings at the intermediate, and two at the roving frame. The total draught being 1,000, divide this draught between the slubbing, intermediate, and roving frame and the mule in the ratio 9, 6, 5, 4 respectively?

Biquadrate root, 1,000 = 5.62
" " of product of $9 \times 6 \times 5 \times 4 = 1080$
$= 5.73$

Then

$$\frac{5.62 \times 9}{5.73} = 8.83$$ draught in mule.

And

$$\frac{5.62 \times 6}{5.73} = 5.88$$ " " roving.

Also

$$\frac{5.62 \times 5}{5.73} = 4.90$$ " " intermediate.

Also

$$\frac{5.62 \times 4}{5.73} = 3.92$$ " " slubbing.

Rule II.—In cases where there are only three draughts—as in low numbers where the intermediate frame is not required—we should use the cube root in both instances in place of the biquadrate root used in Rule I.

Example:—Assuming that 20's twist is spun from a .125 hank sliver, what will be the total draught from slubber to spinning frame when the intermediate frame is omitted, and how must this draught be divided?

Suppose the draught is divided in the ratio 9 : 6 : 5 for spinning, roving and slubbing respectively.

Then

$$\frac{3 \times 20}{.125} = 320 \text{ total draught.}$$

And

$$\sqrt[3]{320} = 6.8399$$

Again, product of

$$9 \times 6 \times 5 = 270 \text{ and } \sqrt[3]{270} = 6.4634$$

Then, as before,

$$\frac{6.8399 \times 9}{6.4633} = 9.51 = \text{draught in spinning frame.}$$

And

$$\frac{6.8399 \times 6}{6.4633} = 6.35 = \text{" roving "}$$

Also

$$\frac{6.8399 \times 5}{6.4633} = 5.26 = \text{" slubbing "}$$

Note.—The fourth root of a number is obtained as follows: Extract the square root of the number, and the square root of the number obtained is the biquadrate or fourth root required.

Example:—Find the biquadrate root of 1,000.

$\sqrt{1,000} = 31.62$ and $\sqrt{31.62} = 5.62$ — answer.

An approximate method of dividing the total draught in drawing frames having four lines of drawing rollers.

Rule:—For the middle draught take the cube root of the total draught, and the square root of this middle draught will give an approximate back draught. The quotient of the product of these two numbers divided into the total draught will give a suitable number for the front draught.

Example:—If the total draught in a drawing frame is 8, find the back, middle, and front draughts by the above rule.

Then

$$\sqrt[3]{8} = 2 = \text{middle draught.}$$

And

$$\sqrt{2} = 1.40 = \text{back draught}$$

Therefore

$$\frac{8}{2 \times 1.40} = 2.86 = \text{front draught}$$

"DIVIDENDS" OR "CONSTANT NUMBERS."

These numbers are exceedingly useful to overseers and managers generally.

They are especially of great practical utility in those mills which spin a large range of numbers, thus necessitating frequent changes both in the spinning and carding departments, since they bring out results very briefly, which to obtain by an ordinary rule would involve the employment of a considerable number of figures.

The term "dividend" is here used in the sense in which it is applied to the loom. It is a number, which divided by the result we require, will give as an answer the change wheel or "pinion" to produce that result; and conversely, if it is required to find the draught, turns per inch, etc., of a frame, then the constant number for the draught, or for the turns, divided by the change wheel or pinion working, will give as a quotient the required result.

To find the dividend or constant number for obtaining the draught in slubbing, intermediate, and roving frames.

Rule:—Multiply all the driving wheels—except the change pinion—and the diameter of the back roller for a divisor, and all the driven wheels and the diameter of the front roller, for a dividend; and the quotient will be the constant number required.

Example:—What will be the constant number for draught in a frame of the following particulars:—

Wheel on the front roller, 20 teeth.
Wheel on the back roller, 48 teeth.
Crown wheel, 80 teeth.
Diameter of back roller, $1\frac{1}{4}$ inches.
Diameter of front roller, $1\frac{1}{4}$ inches.

Then the driver is 20 on front roller, and the driven are 80 and 48.

Then by rule

$$\frac{80 \times 48 \times 1\frac{1}{4}}{20 \times 1\frac{1}{4}} = 192 = \text{dividend required.}$$

Now, say we require a draught of 4 in this frame, we must divide this 192 by 4, and the quotient will be the change pinion to produce the draught.

Therefore,

$$\frac{192}{4} = 48 = \text{pinion required.}$$

Again, suppose that there is a 50 change pinion working on this frame, then to find the draught we adopt the converse method to the above, and divide 192 by the pinion.

That is,

$$\frac{192}{50} = 3{,}84 = \text{draught of frame.}$$

The above rule is equally applicable to the various spinning frames and to drawing frames.

To find the constant number for obtaining the number of revolutions of the spindles to one revolution of the front roller.

Rule:—Divide the product of all the driving wheels from the front roller to the spindles by the product of all the driven wheels—except the twist wheel—and the quotient will be the dividend or constant number required.

Example:—What will be the dividend for obtaining the turns of the spindles to one of the front roller, in a frame having the following particulars:—

112's	wheel on	front roller, geared with a
64's	"	end of top cone drum shaft; a
54's	"	top cone drum shaft, geared with
28's	"	twist wheel;
64's	"	twist wheel stud, geared with a
48's	"	Jack or frame shaft;
42's	"	end of Jack shaft drives a
42's	"	end of spindle shaft;
55's	"	spindle shaft drives a
22's	"	spindles.

Then

$$\frac{112 \times 54 \times 64 \times 42 \times 55}{64 \times \quad 48 \times 42 \times 22} = 315 = \text{constant number required.}$$

Therefore the turns of the spindles to one of the roller are

$$\frac{315}{28} = 11.25$$

If we required the spindles to make 10.5 revolution to one revolution of the front roller,

Then

$$\frac{315}{10.5} = 30 = \text{twist wheel required.}$$

The above are the particulars of a frame driven by an upright, or vertical shaft—a most convenient method when pressed for space—instead of being driven from the frame end. This method of driving renders the introduction of a twist wheel stud necessary.

For a frame driven in the ordinary way, from the frame end, the constant number would be found as under:—

Take the particulars of the previous example, but substitute for the 64's carrier, and the 28's twist wheels, a 21's twist wheel on the end of the frame shaft, then the constant number would be

$$\frac{112 \times 54 \times 42 \times 55}{64 \quad \times 42 \times 22} = 236.25$$

To find the constant number or dividend, for obtaining the turns per inch in slubbing, intermediate, and roving frames.

Rule:—Divide the constant number for obtaining the turns of the spindles, to one of the roller, by the circumference of the roller, and the quotient will be the constant number required.

This number divided by the number of teeth in the twist wheel will give as quotient the number of turns per inch being put in the rove; and if it be divided by the turns per inch it is desired to put in, the result will be, the number of teeth in the twist wheel necessary for obtaining this number of turns.

Example:—If the constant number for obtaining the turns of the spindles to one of the front roller be 315, find the constant number for obtaining the turns per inch, the diameter of the front roller being $1\frac{1}{4}$ inches.

First—Find the circumference of the roller from the given diameter, by multiplying the diameter by $3\frac{1}{7}$, thus:—

$$1\tfrac{1}{4} \times 3\tfrac{1}{7} = \tfrac{5}{4} \times \tfrac{22}{7} = \tfrac{110}{28} = 3.929 \text{ nearly.}$$

Then

$$\frac{315}{3.929} = 80.17 \text{ constant number required.}$$

Then if this frame has on a 28's twist wheel, the turns per inch it is putting into the rove will be:—

$$\frac{80.17}{28} = 2.86$$

Again, suppose it is required to put in 3.08 turns per inch,

Then

$$\frac{80.17}{3.08} = 26 = \text{twist wheel required.}$$

MISCELLANEOUS DATA, ETC.

The number of operatives per thousand spindles in such mills as are organized to spin all their yarns, differs materially in mills making approximately the same class of goods. For comparative purposes the subjoined table may be of value:—

TABLE A.

Mill.	No. of Spindles.	Average Counts.	Goods Made.		No. of Operatives per M. Spls.	Wages per M. Spindles per week.
			Style.	Width.		
A	18,356	30.65	Twill and Plain.	33" to 45"	9.90	61.10
B	28,403	32.01	Plain.	40"	10.75	60.72
C	41,136	35.22	Sateens & Fancies.	28" to 42"	10.12	61.43
D	27,810	29.72	Plain.	38" to 92"	11.96	67.80
E	101,312	29.73	Plain and Drills.	38" to 44"	12.01	70.70
F	25,316	51.12	Cambric.	40"	10.01	58.21
G	4,211	32.19	Plain.	40"	13.21	68.18
H	18,325	21.16	Plain.	32" to 40"	16.11	53.29

An examination of these figures will show some interesting contrasts.

WASTE AND COTTON TESTING.

The waste question is one which has been given much thought, and it is also a matter of paramount importance in successful mill management. In Table B are given the pounds of cotton consumed and waste made per spindle per annum by the mills shown in Table A.

Similar letters indicate the same mills in both tables.

TABLE B.

Mill.	Pounds of Cotton consumed.	Pounds of Waste made.
A	59.09	8.02
B	55.85	7.50
C	51.17	6.22
D	63.04	8.72
E	66.02	8.81
F	36.57	4.14
G	......	....
H	99.72	9.12

A system of keeping accurate and comprehensive records of the detail of waste production, will amply repay any time and expenditure necessary to its complete carrying out, and will frequently bring to light unsuspected losses that might be stopped by more careful supervision. The periodic testing of each lot of cotton through the pickers and cards, carefully made and recorded in a book kept for that purpose, will at times prove that an apparently cheap purchase is really an expensive one, from the fact that the cheapest lot at first cost contained an unusual proportion of unripe or imperfectly developed fibre, or that an abnormal amount of seed, leaf or other foreign matter was present. When combed yarns are to be produced it is also advisable to pass a sample through the comber (without altering the settings of the machine) this will give an approximately correct indication of the percentage of short staple in the sample.

Many mills make a rough test for moisture by exposing one or two hundred pounds spread loosely on the floor of the card room for twenty-four hours, and after re-weighing and again exposing the sample to a normal temperature for the same length of time the material is again weighed and any moisture artificially introduced may thus be discovered. The second exposure under normal conditions allows the cotton to re-absorb its "*water of hydration*," which is partially evaporated during the time it is exposed to the heated atmosphere in the mill.

(See page 52).

ORGANIZATION, LABOR COST, ETC., OF AN ENGLISH YARN MILL.

Number of mule spindles,	69,300
" " frame "	5,120
Total,	74,420

	Doublings.	Draft.	Weight.	Speed.	No. of Delys or Spindles.
Bale Breaker..........	0	8.37	....	......	1
Breaker P............	0	....	14 oz.	445	3
Finisher P............	4 and 3	....	10½ oz.	951	3
Cards..................	0	111 to 129.5	30 and 36	8½ to 12	99
Derby Doublers.......	16	2	240 & 288	331	9
Ribbon Lappers.......	6	6.16 and 6.54	240 and 288	240	9
Combers	8	30.47	49 & 55	84	53
Drawing 1st...........	5 and 6	4.86 to 6.73	......	241 and 292	60
Drawing 2nd..........	6	5.89 to 6.73	......	"	60
Drawing 3rd..........	6	6.4 to 6.92	32.5 to 43.7	"	60
Slubbing.......	0	5.55 and 5.81	1.07 HK 1.20 " 1.38 "	380	840
Intermediate..........	2	5.40 to 5.74	2.92 " 3.47 " 3.87 "	650	2720
Roving................	2	6.27 5.95 6.9	9 " 10 " 14 "	1132	8528

Note:—One bale breaker will open 20 bales per day. Waste taken out at combers, 16% and 18%. Four grades of cotton are used.

Total labor cost carding dept., 9 hank carded, $\frac{95}{100}$c. per lb.
" " " " " 10 " " $\frac{99}{100}$c. " "

MULES 1050, SPINDLES 64″, STRETCH ROLLER MOTION 4″, SPINNING DOUBLING WEFT.

Counts.	Rov of Spindles.	Turns per in.	Gain inches.	Production weekly in pounds.	Weekly per Spindle	Stretches.	in Seconds	Distance rolls. Front to Middle.	Distance rolls. Middle to Back.
36 B. S.	7757	17.26	2.97	1540	.73	4	59	$1\frac{5}{32}$	$1\frac{1}{2}$
40 " "	"	18.23	"	1320	.63	4	60	"	"
45 " "	"	19.20	"	1160	.55	3	50	"	"
50 " "	"	20.40	3.80	1000	.48	3	53	"	"
58 " "	"	22.24	"	820	.39	3	55	"	"
45 C. S.	"	19.20	2.97	1160	.55	3	50	"	"
50 " "	"	20.42	3.80	1000	.48	3	53	"	"
20 D. S.	5171	11.36	2.97	2500	1.19	4	61	"	"
24 " "	6205	12.54	"	2400	1.14	4	58	"	"
28 " "	6722	12.91	"	1950	.93	4	57	"	"
30 " "	"	13.54	"	1820	.86	4	58	"	"
36 " "	7759	15.07	"	1650	.78	4	58	"	"
40 " "	"	16.04	"	1320	.63	4	60	"	"
54 " "	"	20.90	3.80	920	.44	3	53	"	"
58 " "	"	22.36	"	820	.39	3	55	"	"
66 " "	"	24.06	5.43	700	.33	3	$57\frac{1}{2}$	"	"
48 F. S.	"	19.93	3.80	1050	.50	..	....	$1\frac{7}{32}$	"
76 " "	"	25.76	6.46	550	.26	3	$62\frac{1}{2}$	"	"

The productions given above are for a week of $56\frac{1}{2}$ hours.

EXAMINATIONS IN COTTON SPINNING.

In May, 1889, a new departure was made in the examinations, conducted by the City and Guilds of London, in cotton manufacture.

Previous to that time the examination in this subject embraced both the spinning and weaving divisions of the trade, but in this year it was divided into two sections, and two papers were set, one in Cotton Spinning and another in Cotton Weaving.

This being the case, a new syllabus was issued, and that for the spinning examination is included in this work for the information of those who are preparing for this examination.

The syllabus is retained in this edition for the information of the large and increasing number of those who recognize the important influence technical education must necessarily have in the future progress of the American textile industries.

SYLLABUS.

19b. COTTON MANUFACTURE.

SECTION 1.—COTTON SPINNING.

The examination will include questions founded on such subjects as the following:—

1.—The geographical position of the world's cotton fields, and suitable regions to which it may be introduced.

2.—Cotton cultivation, and the various causes of damage to the fibre during growing and picking seasons, with the date of planting and picking in all cotton growing countries.

3.—The mode of preparing the raw material, cotton gins, ginning, packing, etc. Means and methods of adulteration.

4.—Commercial handling of the raw material up to the spinning mill.

5.—The nature and properties of the various kinds of raw material:—Sea Islands, Queensland, Fiji, Egyptian, New Orleans, Uplands, Boweds, Dhollerah, Hingunghaut, Surat, Brazilian, etc.

6.—The selection and advisability, or otherwise, of mixing various cottons, with a view to the full utilization of every kind.

7.—The development of and the principles involved in the construction of the several machines used in cotton spinning.

8.—Cleaning cotton by opening, scutching, carding, and combing machines.

9.—Process of attaining a parallel arrangement of fibres by carding, and the attenuation of the sliver, through drawing, slubbing, intermediate, and finishing roving frames.

10.—Spinning operations upon the throstle, mule, and ring frame.

11.—The doubling of single yarns for lace, hosiery, sewing thread, and kindred purposes.

12.—Warping and bundling for home trade and export, with the accompanying process of winding and reeling.

13.—Packing and commercial dealing with yarns in process of distribution.

In the Honors examination more difficult questions in the above subjects will be set than in the Ordinary Grade.

VARIETIES OF COTTON AND THEIR CHARACTERISTICS.

Cottons that are of commercial importance may be divided into five (5) classes or varieties, viz.:—

Sea Island, Egyptian, Brazilian, American, Indian.

There are several other varieties of minor importance, such as West Indian, African, etc. Asiatic cotton, while grown to some extent, is almost wholly consumed by the cotton mills of Russia.

SEA ISLAND COTTON is the finest cotton grown, having long, finely diametered, soft, sericeous fibres. It is generally used for yarns from 120's and upwards, except in the spool cotton trade, where its use is general for numbers as low as 70's. The lower grades are also used extensively to mix in with Egyptian cottons.

EGYPTIAN COTTON ranks next to Sea Island in value. It is strong, tenacious, and generally silky. There are several grades grown. The Gallini variety was grown from Sea Island seed, but is now almost extinct. Brown Egyptian cotton is strong and pliable, while the White Egyptian variety possesses about the same general characteristics but is slightly harsher. These cottons will mix well with the finer grades of American cotton, such as "Peeler" and "Allen seed." The Gallini variety was spun into numbers as fine as 150's, Brown Egyptian being used for yarns up to 130's, while the White Egyptian is seldom used for numbers finer than 70's. This class of cotton contains a greater percentage of short fibre than any other variety.

BRAZILIAN COTTON.—There are a number of varieties of cotton which the term "Brazilian" covers; some are harsh and wiry, while others are of a softer nature, possessing many of the general characteristics of the American cottons. The particular varieties are:—"Santos" cotton, which is grown from American seed *(Gossypium Hirsutum)* and partakes more of the nature of American cotton than any other Brazilian variety.

The Rough Peruvian variety is of a good appearance and is largely used to mix with wool for the production of certain classes of woolen goods. It is extremely well adapted for this purpose. In the cotton trade it is also used most generally in the production of warp yarns.

Smooth Peruvian is of about the same staple, appearance and regularity as the Rough variety, but is much softer and more pliable. By many manufacturers it is largely used to mix with American cottons when an extra good grade of yarns is required.

Used alone Rough and Smooth Peruvians will spin up to 70's. The "Santos" and other varieties of the cottons of Brazil are seldom used for numbers finer than 60's.

AMERICAN COTTON.—This is the staple cotton of the world. There are necessarily a large number of varieties, owing to the wide extent of territory and the different climatic conditions under which it is grown, New Orleans, Texas, Mobile and Uplands being important types. The better grades of the Orleans and Texas are frequently spun into numbers as high as 50's. Mobile does not usually give very satisfactory results for yarns over 40's, while "Uplands" may be spun from 50's downward, according to the grade. This class of cotton (American) possesses many valuable characteristics. Its affinity for dye-stuffs, its clean, clear color, silky nature, and general character being the most prominent.

Its strength and value is, however, very frequently reduced by careless handling in the gin; the saw-gin being a machine that must be intelligently operated and never crowded. It is frequently found that when cotton is allowed to air for a considerable period and becomes thoroughly dried before being ginned, its value per pound to the spinner is materially increased.

INDIAN COTTON.—This is the lowest grade of commercial cottons. It has the shortest fibre with the largest diameter, and while the strength of the individual fibres is greater than that of any other cotton; on account of their large diameter and short length, it is only suitable for low numbers. It is also very dirty, and the lower grades, such as "Oomrawuttee," are not used alone except for the very lowest numbers. The higher grades of this variety, such as "Hinghunghat," may be spun into 30's. This class is also suitable for mixing with American cottons, when somewhat higher numbers can be spun.

OTHER VARIETIES.—There are several other varieties that are only grown to a very limited extent, such as African cotton, Smyrna cotton, West Indian cotton, etc. Most of these are fairly clean, but quite irregular. The numbers into which they are mostly spun will range from about 30's to 50's.

HEAT AND MOISTURE IN RELATION TO THE COTTON FIBRE.

The cotton fibre is most complex and peculiar in its mechanical structure and chemical composition. A brief description of the general formation of the fibre has already been given, and it now remains to determine to what extent this structure influences its "spinning" properties, under different atmospheric conditions as to heat and moisture. If the temperature of any room in which the material is being manipulated is allowed to become too low and the air dry, these conditions cause the fibre to become harsh, dry and brittle, from the fact that the waxy covering of each fibre congeals and therefore offers a materially increased resistance to the various processes of twisting and drawing to which it is being subjected. There is also an appreciable amount of electricity generated by the fibres themselves in the drawing processes, when they are in the condition described, and this together with the increased electricity developed by the slipping friction of the belts, etc., causes an abnormal increase in the amount of waste made, decreases the production, and yarns produced under such an atmospheric and hygrometical condition are oozy, weak, uneven, and have a large percentage of protruding fibres, which are rubbed off in the succeeding processes, and the general quality is very much reduced.

These considerations have led to the adoption of many methods to minimize these evils, beginning with the old-fashioned watering can. This method, while troublesome and exceedingly crude, was a natural one, since to whatever degree the relative humidity of the room might have been increased, it was arrived at by nature's own method of natural evaporation. Subsequently the practice of blowing live steam into the room came into very general use, this being followed by the different modifications of the "spray" type of humidifyers. And these, while a decided improvement on the previous methods, are unscientific and faulty in principle. As is well known, rain while it washes the air, adds but little to the amount of moisture held in suspension. The only method by which uniform and altogether satisfactory results can be obtained is one whose fundamental principle is *natural evaporation*, the introduction of finely divided water into a room being, at the best, but a makeshift method.

The production, strength and general quality of the goods produced will be increased to a remarkable extent by the installation of a humidifying apparatus, built on correct principles, if intelligent attention be given to its operation, for the reason, that each fibre will be brought into the most suitable condition for proper manipulation, and free electricity is virtually eliminated.

Textile fibres once charged with electricity are most difficult to discharge, they being charged with electricity of the same kind producing the mutual repulsion, so evident in any mill on a dry day, where no means of producing artificial humidity are at hand. It is an absolute impossibilty to produce good yarns under such conditions.

A few words may now be said on the subject of the "conditioning of yarns." This is a matter, the importance of which is but little understood by the majority of manufacturers, but as competition increases and margins become narrower it will be taken up and carefully studied, in order to first discover its absolutely beneficial effects upon the yarn, and then the easiest and best method of getting the requisite percentage of conditioning will be carefully considered. A careful test of the breaking strength of yarns taken direct from the spindle and compared with a similar test after these yarns have been allowed to regain that amount of the "water hydration" they have evaporated during their treatment in the mill, will, on the average, show a difference of 10 per cent. in favor of the latter test.

The curl or liability to kink would be effectually and permanently taken out, the yarn would weave better and knit better and with less breakage and less waste, and its flexibility would be materially increased.

Less fluff or fly, and loss of yarn in the knitting or spooling process, and the fabric produced, whether knitted or woven, would be brighter in appearance, and also have a much better "feel" or "cover."

The old-fashioned steam chest, for steaming the filling, to lay the twist, and obviate the trouble caused by yarn curling in the weaving, is used to-day to a very considerable extent, with all its glaring disadvantages, the most prominent of these being soft and weak yarn, stained cops or bobbins, unequal treatment, the outer layers being dampened to the point of saturation, while the center layers are but slightly affected, if at all; further, if the yarn is placed in boxes the cops or bobbins composing the upper layers will be treated abnormally, while those toward the center and bottom of the box will be found to be almost as dry as they were before being subjected to treatment.

The boxes or baskets in which the yarn is placed in the steam chamber are quickly rendered useless, and are a serious item of expense.

The injurious effect of steaming yarns is especially noticeable when they have been spun from Egyptian cotton, the brown coloring matter or "endochrome" of the fibres is almost always so acted upon as to produce a series of distinct streaks of color, from this effect and others, it is quite evident that steaming does very seriously affect the strength of the threads for the reason that it most certainly softens, and to a certain extent dissolves and damages the filaments.

Whenever a method is brought out whereby every particle of yarn can be permeated, without the aid of steam, sprinkling with water, chemicals, or other deleterious substances, and this uniform permeation accomplished quickly, so as to avoid the carrying of a very large stock of yarn, and the purchase of a very large number of boxes or baskets, its use will become general.

GLOSSARY.

Brokerage.—Commission.

Doubling.—Twisting.

Doubler.—Twister.

Droppings.—The heavier impurities thrown out by the pickers.

Dollerah.
Dharwar.
Hingunghat. —Grades of East Indian cotton.

Licking.—Splitting of laps during unrolling.

Motes.—Particles of broken cotton seed with short fibres attached.

Oomerawutte.—A type of East Indian cotton.

Opener.—First picking machine.

Pinion.—Change gear.

Printers.—Print cloths.

Rollers.—Rolls.

Roller Card.—A carding engine formerly much favored in the Lancashire mills.

Scutcher.—The name by which a picking or lap machine is known in England.

Spindle and Fly Frames.—Speeders or roving frames.

Strap.—Belt.

Sun-Wheel.—The "plate" or largest wheel in the "differential," or as it is sometimes termed, the "sun and planet motion" in speeders.

Surats.—Another name for low grade East Indian cottons.

Twist.—A Lancashire term for warp yarn, sometimes abbreviated T, as 60's T, for 60's warp yarn.

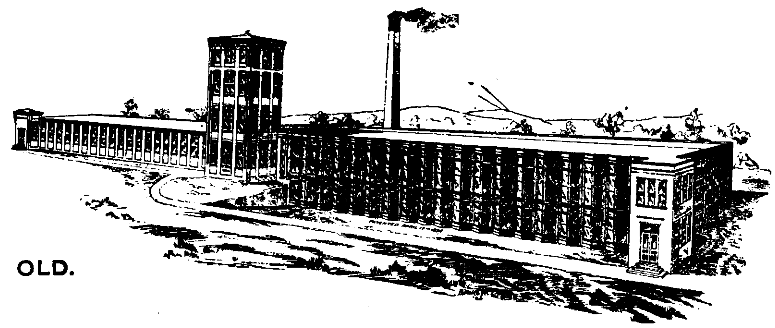
Weft.—Filling, abbrv. W, as 32's W.

Wheels.—A factory term sometimes applied to a pair of cotton mules.

Wheel.—Gear.

C. A. M. PRARAY. [redacted]

C. A. M. PRARAY & Co.



OLD. THOS. M. HOLT MILL. NEW.

MILL ARCHITECTS AND ENGINEERS.

PLANS AND SPECIFICATIONS FURNISHED FOR THE

CONSTRUCTION AND EQUIPMENT

OF

Cotton, Woolen Worsted and Silk Mills,

BLEACHING and DYEING WORKS,

Water and Electrical Powers.

THE PRARAY IMPROVED CONSTRUCTION FOR TEXTILE MILLS

CAN BE APPLIED TO ANTIQUATED BUILDINGS, INCREASING THE LIGHT . . . . 33 Per Cent.

☞ The illustration shown above gives a view of the Thos. M. Holt Mill, constructed on two systems: at the right of the central tower, the "*PRARAY*" Construction is shown, while on the left, a view of the old method.

PLANS Made by us meets all requirements of the Mutual Insurance Companies.

SOUTHERN AGENTS FOR TEXTILE MACHINERY.

CORRESPONDENCE SOLICITED.

MAIN OFFICE, PROVIDENCE, R. I., BANIGAN BUILDING.

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GREAT ADVANTAGES RESULT

——FROM——

The PRARAY Improved System of Construction.

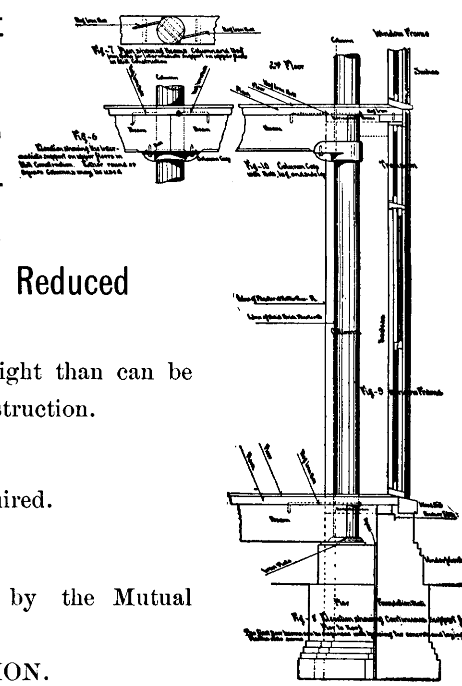
PATENTED APRIL 17, 1894.

Floors are Supported Independent of Walls.

Less Massive Brick Work required.

Lighter and Stronger in Construction, at a Less Cost of Erection.

A Less Fire Risk, consequently a Reduced Insurance.



SECTION THROUGH WALL AND WINDOW.

THIRTY-THREE PER CENT. more light than can be obtained by any other system of construction.

33 PER CENT. less bricks in the walls.

10 PER CENT. less height of wall required.

10 PER CENT. less space to heat.

MEETS ALL POINTS REQUIRED by the Mutual Insurance Companies.

IS A SLOW BURNING CONSTRUCTION.

PRESENT EXAMPLES ERECTED ON THIS SYSTEM:

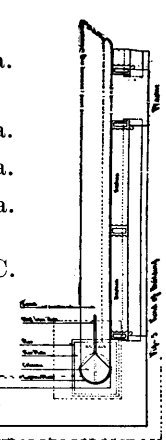
THE DIXIE COTTON MILLS, ... La Grange, Ga.
Cost less per spindle for building than any mill built in the South.

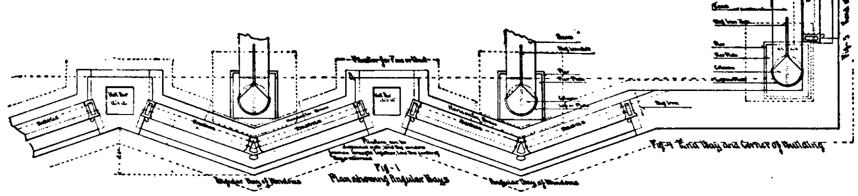
SELMA COTTON MILLS, ... Selma, Ala.

AFRO COTTON MILLS, ... Anniston, Ga.

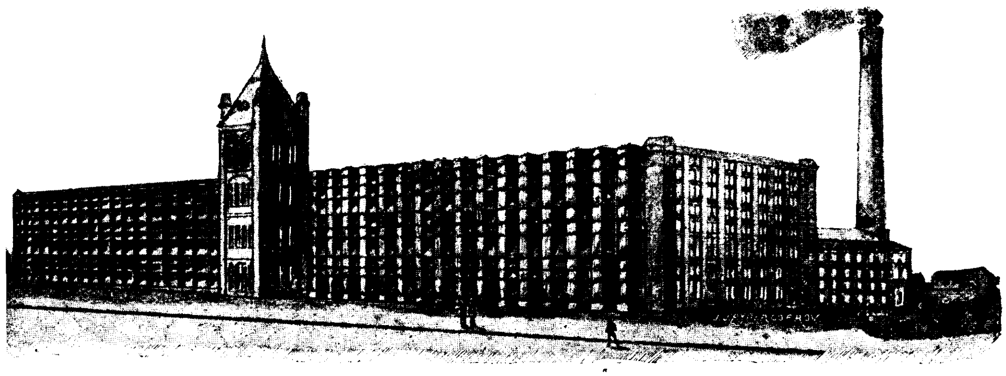
GEORGIA WESTERN COTTON MILL, . . . Douglasville, Ga.

THE THOMAS M. HOLT, } Thomas M. Holt Mfg. Co.,
THE —— CORA —— } Haw River, N. C.





PLANS OF WALLS, ETC.
Patented by C. A. M. Praray, April 17, 1894.



CORA COTTON MILL.

WE PRINT below letters from Messrs, B. S. Robertson, Treasurer of the Thomas M. Holt Mfg. Co., and of Samuel Hale, Vice-President of the Dixie, and General Manager of the Georgia Western Cotton Mills:

THE THOS. M. HOLT MANUFACTURING CO.

HAW RIVER, N. C., April 4, 1898.

MESSRS. CHAS. A. M. PRARAY & Co., Providence, R. I.

Gentlemen :—Yours of the 2nd to hand. We should say that the lamps are lighted in the old part of our mill 3 or 4 times as long during the day in the old part as they are in the new part. Of course, having weaving in the old part, and carding and spinning in the new part accounts for some of this, but even allowing for this, there is still a great difference in the matter of light in the new construction. We only wish we had the same construction in the part that contains the looms, since the light would be *infinitely* better.

We are fixing to put some looms in the Cora Mill this Summer, and we think the weave room there will be *eminently satisfactory*.

Yours truly,

(Signed) B. S. ROBERTSON, Treasurer.

OFFICE OF THE GEORGIA WESTERN COTTON MILLS.

DOUGLASVILLE, GA., April 19, 1898.

MESSRS. CHAS. A. M. PRARAY & Co., Providence, R. I.

Gentlemen :—Your favor of the 16th duly received. In reply I beg to say that I have built two Cotton Mills in the South, *using your "PRARAY" Patent Construction.*

The Dixie Mills at La Grange, Ga., and the *Georgia Western Cotton Mills of Douglasville, Ga.* now under construction, and nearly completed, and I am pleased to say that I am more than pleased with the plans and construction, and prefer them to any that I have seen for this class of buildings.

The Mills can be built cheaper with these plans, than with the ordinary mill construction, and are *lighter* and much better *adapted for the business in every way*, being *especially fitted to the Southern Climate.*

It will give me great pleasure to give any of your friends or clients any further details, if they will come to me at Douglasville, Ga., or write.

Very truly yours,

(Signed) SAMUEL HALE, General Manager Georgia Western Cotton Mills.

WE NAME YOU A FEW MILLS located in the Northern and Southern States of which Mr. Praray was the Architect and Constructing Engineer:

THE NORTHERN MILLS ARE:

The N. H. Slater, Webster, Mass.; Whitman Mills, New Bedford; The Corr Mills, Taunton, Mass.; Two additions to the Whittin Bros., Mill at Whittensville, Northbridge, Mass.; The River Spinning Mills, Woonsocket, R. I.; The Vesta Knitting Mills, Providence, R. I.; The Kenyon Mills, at Shannock, R. I.

THE SOUTHERN MILLS ARE:

Two Mills for the Clifton Mfg. Co., Clifton, S. C.; Two Mills for the Anderson Cotton Mills, Anderson, S. C.; The Piedmont Mills, Piedmont, S. C.; The Pelham Mills, Pelham, S. C.; The Eronee Mills, Eronee, S. C,; The Raleigh Mills, Raleigh, N. C.; Tallasee Fall Mills, Tallasee Falls, Ala.; Aiken Mills, Bath, S. C.; Stonewall Mills, Stonewall, Miss.; The South Side Mills, Salem, S. C.; Caraleigh Mills, Raleigh, N. C., and many other smaller mills.

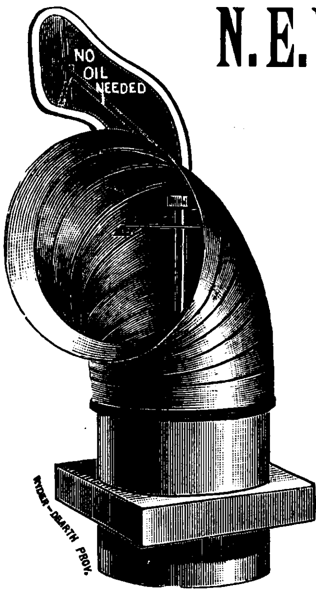
WATER POWERS

TWO FOR THE CLIFTON MILLS, CLIFTON, S. C.
ONE FOR THE TALLASSEE FALLS MFG. CO., TALLASSEE, GA.
ONE FOR THE PELHAM MILLS, PELHAM, S. C.
ONE FOR THE FRIES ELECTRIC AND POWER CO., SALEM, N. C.
TWO FOR THE CANADIEN COLORED COTTON MILL CO., CANADA.

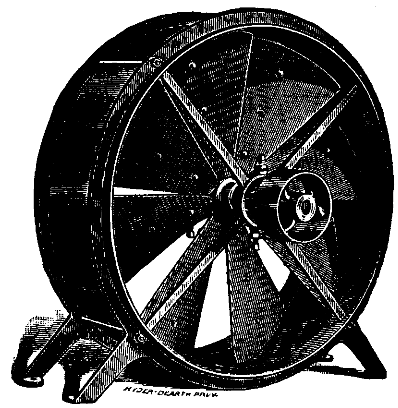
N.E. VENTILATING & HEATING CO.

PROVIDENCE, R. I.

The best for mill use. Discharges more air than any other portable Ventilator on the market. Is perfectly balanced, has ball bearings, never gets out of order.



RICHARDSON'S
REVOLVING VENTILATOR.



RICHARDSON'S EXHAUST FANS

For removing steam from Dye Houses and Slashers; also for drying Cotton, Wool, Cloth, Yarn, etc., and for ventilating over-heated work rooms.

MANUFACTURERS OF

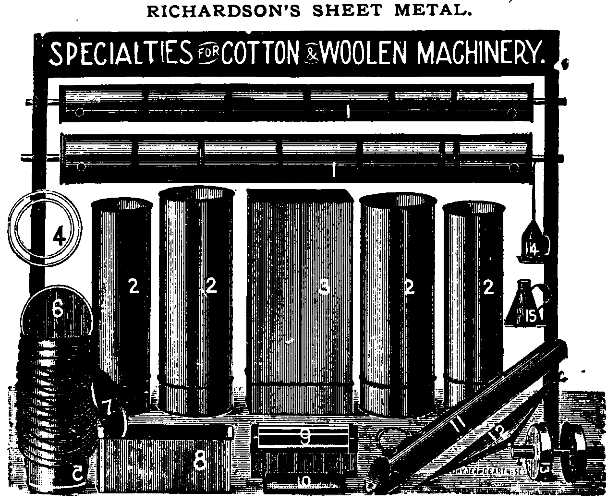
RICHARDSON'S BLOWER SYSTEM FOR MILL VENTILATION.

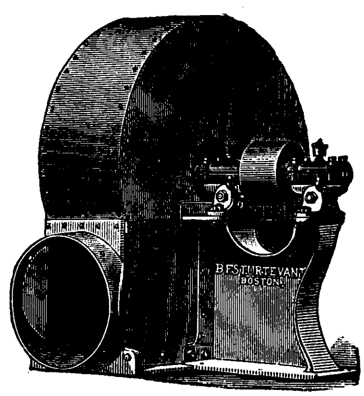
Supplies Pure Air. Makes any desirable Humidity.

Lowers the Temperature. Increases Production.

Gives Health and Energy to Employes. Can be adapted to any Mill.

RICHARDSON'S SHEET METAL.





SPECIAL BLOWERS

For conveying Wool, Cotton, Rags, Shavings, Dust, etc.

Office and Works, . . . 926, 928 & 930 Manton Avenue.

WALRUS MANUFACTURING CO.

TRADE MARK.
1897

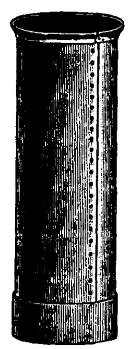
C·H·WHALL & Co

SELLING AGENTS,
620 ATLANTIC AVE.
BOSTON, MASS.

FACTORY AT WEST MEDFORD, MASS.

MANUFACTURERS OF

FIBRE ROVING CANS AND BOXES



For Cotton and Woolen Mills, Cordage Works, &c.

We would call particular attention to our

PATENT KICKING BAND, which is practically **SEAMLESS,**

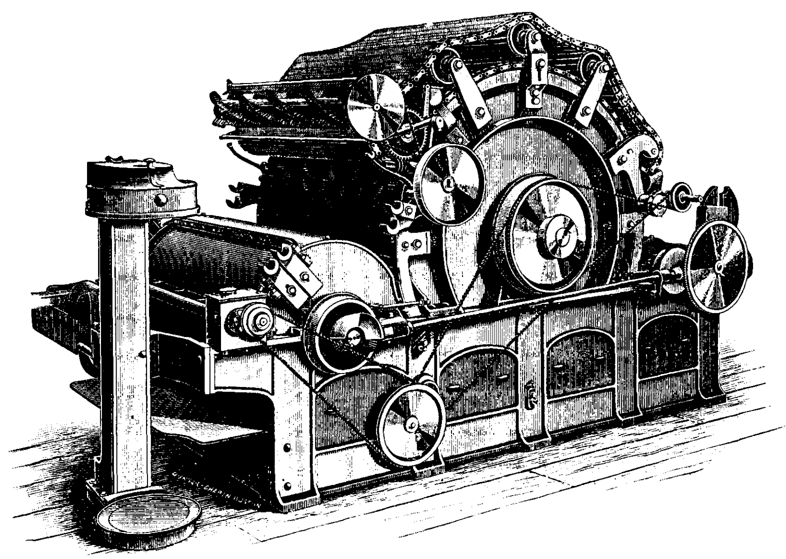
increasing the strength and general appearance of the can.

MASON MACHINE WORKS,

TAUNTON, MASS.

BUILDERS OF

COTTON MILL MACHINERY



REVOLVING FLAT CARDS,

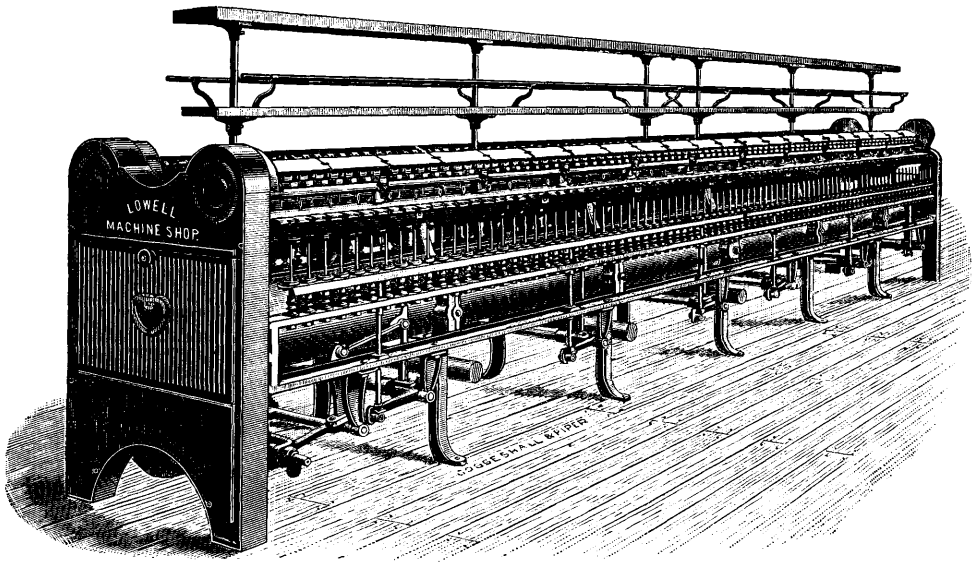
RAILWAY HEADS, DRAWING FRAMES,

COMBERS, SPINNING FRAMES,

MULES AND LOOMS.

ALSO THE .. MASON-NORTHROP LOOM.

The Lowell Ring Frame.



All parts are made on special tools to standard sizes and are interchangeable.

The greatest care is taken to have the frames constructed so as to obtain the greatest production with the highest speed.

All spindles are run in their bearings before being sent out.

Fluted Rolls are ground to accuracy as to their roundness and diameter, a very important characteristic for high speed.

We supply the best Separator in the market and provide all our frames with traveller clearers, lifting thread board device, cut gearing, improved roving traverse motion, heavy tin drums that don't break down, and all other parts that go with a first-class machine.

Lowell Machine Shop,

LOWELL, MASS.

General Fire Extinguisher Co.

MANUFACTURERS, JOBBERS AND DEALERS

PIPE, FITTINGS, VALVES, HYDRANTS

AND ALL KINDS OF

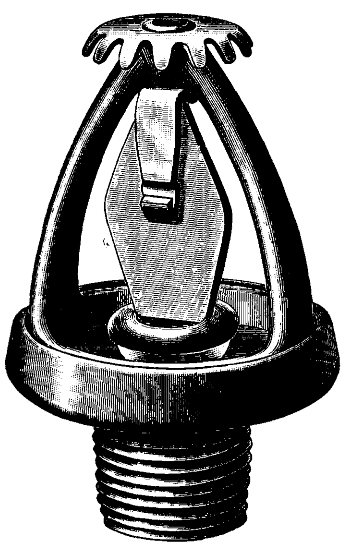
STEAM, GAS AND WATER SUPPLIES

AND SPECIALTIES.

FACTORIES AND WAREHOUSES EQUIPPED WITH THE

Grinnell Automatic Sprinkler

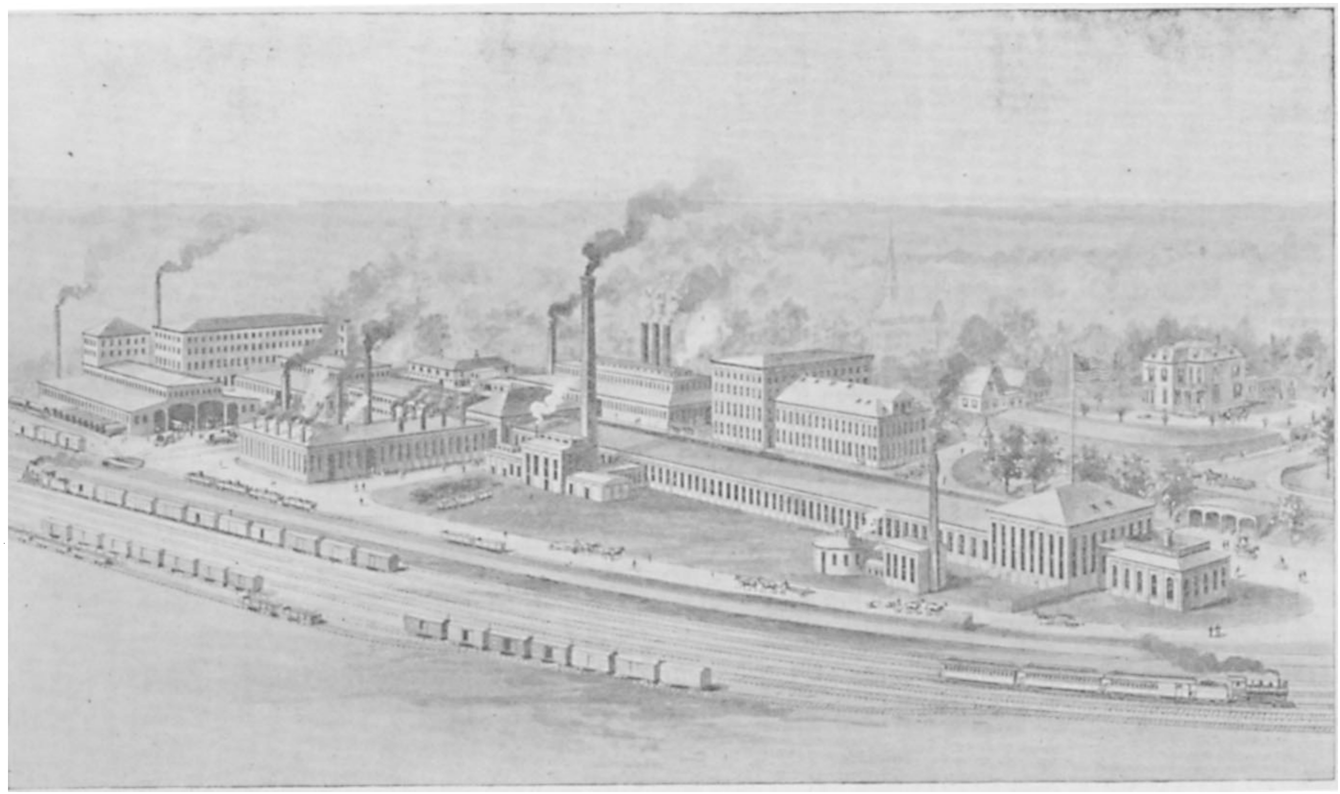
BOTH WET PIPE AND DRY PIPE SYSTEMS.



IN THOUSANDS OF ACTUAL FIRES IN ALL PARTS OF THE WORLD THE GRINNELL SYSTEM OF AUTOMATIC SPRINKLERS HAS CONFINED THE DAMAGE TO A LIMITED AREA AND MINIMUM AMOUNT. THESE REMARKABLE RESULTS HAVE BEEN SECURED WITH A LARGE PECUNIARY GAIN TO *THE INSURANCE COMPANIES* AND WITH A REDUCTION IN THE COST OF INSURANCE OF *25* TO *50* PER CENT.

Information and Proposals furnished at the several Department Agencies, and at the

Executive Offices, Providence, R. I.



Works of the Corliss Steam Engine Company, Providence, R. I.

THOROUGH INSPECTIONS

AND

INSURANCE

Against Loss or Damage to Property and

Loss of Life and Injury to Persons

CAUSED BY

STEAM BOILER EXPLOSIONS.

J. M. ALLEN, President; J. B. PIERCE, Secretary and Treasurer;

WM. B. FRANKLIN, Vice-President; L. B. BRAINARD, Assistant Treasurer;

F. B. ALLEN, Second Vice-President; L. F. MIDDLEBROOK, Assistant Secretary.

D. RUSSELL BROWN, President. H. MARTIN BROWN, Secretary. CHARLES H. CHILD, Treasurer.

BROWN BROTHERS COMPANY,

MANUFACTURERS OF

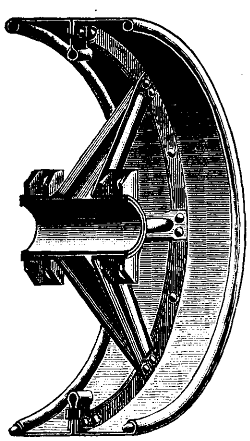
LEATHER BELTING, BELT HOOKS, SHAW'S U. S. STANDARD RING TRAVELERS, LOOM FORKS, FACTORY WIRE GOODS, BOBBINS, SHUTTLES, LOOM PICKERS, HEDDLES, ETC.

GENERAL . . .
MILL . . . . . .
FURNISHERS.

NEW MILLS EQUIPPED THROUGHOUT.

The All-Wrought Steel Split Pulley

AS ILLUSTRATED HEREWITH,



Is made exclusively of a "mild" sheet steel, accurately rolled to standard gauges, no castings or forgings entering into its make-up.

It has Strength and Rigidity that renders the All-Steel Pulley practically indestructible.

Its weight two-thirds less than that of the ordinary cast-iron pulley, and less than that of most wooden ones.

A Pulley that to this unique lightness and strength is true running, perfectly balanced, and safe under highest speeds.

The All-Steel Pulley is rendered interchangeable by the use of steel bushings, and will fit shafts of different diameters.

Brown Brothers Company,

PROVIDENCE, R. I.