COTTON SPINNERS COMPANION

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The writer has often seen difficulties experienced in not having a small vest-pocket book handy for reference on Textile Machinery Calculations.

In this book he has tried to fill this requirement, and at the same time to make the contents as simple and concise as possible, so that any person having charge of the machines can follow him in his explanation when he names the pulleys, gears and rolls. I am,

Yours truly,

I. C. NOBLE.

INDEX.

COTTON.

Cotton is grown in the United States of America, Egypt, China, Corea and South America.

The cotton crop of the United States of America is larger than the whole of the other crops combined.

American varieties are classed in four qualities—good ordinary, low middling, middling and good middling.

South American are classed in three—middling fair, fair, and good fair.

Egyptian, two—fair and good fair.

East Indian, three—fair, good fair, and good.

The names of the commonly used cottons are Sea Island, Egyptian, American. Brazilian, and Indian.

There are several other varieties grown, but not generally used as the ones named.

The Sea Island cotton is grown on islands off the coast of South Carolina and Georgia, namely, St. Helena, Port Royal, Edisto, John and James Islands, St. Simon and Cumberland Islands. It is also grown in the State of Florida from Sea Island seed.

This cotton is the most valuable cotton grown on account of its length of staple, fineness, strength, smoothness, and cleanliness, also for the careful ginning it receives.

The fibre is fine, soft, silky, long, and regular.

The American variety of Sea Island cotton is the best. The Fiji and Tahiti varieties of this cotton are uncertain in their staple.

Lace and thread are made mostly from this cotton.

The length of staple is from 1¼ to 2¼ inches.

Egyptian cotton is next to Sea Island for the making of fine yarns. It is silky, strong, and tough.

The brown Egyptian is generally soft, whilst the white Egyptian is hard and harsh.

Gallini is the best of Egyptian cottons and is grown from Sea Island seed. The staple of Egyptian cottons ranges from 1⅛ to 1½ inches.

American cotton is the staple cotton of the world.

The vast territory covered by the cultivation of this cotton gives us a number of varieties and grades; but we can divide them into four classes: Orleans, Texas, Upland, and Mobile.

Orleans or Gulf cotton is the best of American cottons. It is grown on the banks of the Mississippi river and is known as Benders, Peelers, and Allanseed.

Peelers is a good cotton, regular in strength and staple, and is very soft and pliable. It mixes well with soft Egyptian.

The length of the Gulf cotton staple is from 1 to 1½ inches.

Mobile and Upland cotton is soft and clean, but rather short staple.

Texas cotton is firmer in staple than the Mobile and Upland, but contains more leaf, and is not so bright in appearance. It is a cotton that will make 32s warp or filling.

The staple is about an inch in length.

Brazilian cotton has many varieties, as well as qualities, some being harsh, whilst others are soft.

Peruvian mixes well with wool (the harsh or rough Peruvian), but the softer Peruvian, on account of its color, enables it to mix well with Orleans or Gulf cotton.

Its staple is a little longer than American generally. It is from 1⅛ to 1½.

Indian cotton is generally dirty, some of it being low in character, and containing a large quantity of round and flat fibres, and the fibres are not so uniformly twisted as in American cotton.

The better classes, such as Hingunghat, can be mixed with American.

The length of staple is ⅞ of an inch to 1¼ inches.

China cotton is a short stapled cotton, rather harsh, but very white. It is used in China and Russia.

Cotton is generally planted in April and picked in September or October.

The average yield of lint cotton in India is about 75 lbs. per acre.

American cotton when picked and before being ginned contains two-thirds its weight of seeds. So, if a man takes newly picked cotton to be ginned, and he has 1000 lbs., he receives $1000 \times 2 = 2000$, $2000 \div 3 = 666$ 2-3 lbs. of seed, and the remainder 333 1-3 lbs. cotton fibre.

Name	Length of Staple in inches.	Suitable for Yarns
Sea Island....	1¼ to 2¼	120s up, warp or filling
Edisto	1⅜ to 2¼	120s up, warp or filling
Fiji	1⅜ to 2	Up to 200s, warp or fill.
Tahiti	1⅜ to 2	Up to 200s, warp or fill.
Florida	1¼ to 1⅞	Up to 200s, warp or fill.
Peruvian S. I..	1½	Up to 150s, warp or fill.
Egyptian	1¼ to 1½	
Gallini	1½	Up to 150s, warp or fill.
Abbasi	1¼	50s to 100s, warp or fill.
Brown	1⅜	50s to 130s, warp or fill.
White	1¼	Up to 70s, warp or fill
Brazilian.		
Cera	1 to 1⅜	Up to 50s, warp
Pernambuco...	1 to 1⅜	Up to 50s, warp
Pariba	1 to 1⅜	Up to 50s, warp
Maranham.....	1 to 1⅜	Up to 50s, warp

American.		
Gulf	1⅛ to 1½	50s warp, 100s filling
Uplands	¾ to 1	40s filling
Mobile	1⅛	Up to 50s wp. & 70s fill.
Texas	⅞ to 1⅛	Up to 40s warp or fill.
Peruvian.		
Rgh. Peruvian	1⅜	Up to 70s warp
Sm. Peruvian..	1⅜ to 1½	Up to 70s filling
Indian.		
Hinganghat....	1 to 1⅛	Up to 16s wp. & 28s fill.
Dhollerah......	¾ to 1	Up to 16s wp. & 24s fill.
Comptah	1	Up to 12s wp. & 16s fill.
Oomrawuttee..	1	Up to 16s wp. & 24s fill.
Scinde	¾	Up to 12s
Coconada	⅝	6s
Bengal	⅝	10s
China.		
All kinds......	½ to 1	From 4s to 12s

COTTON GRADING.

There are twenty-six different grades, namely:

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

The Full Grades are Fair, Middling Fair, Good Middling, Middling, Good Ordinary, Ordinary.

The Half Grades are termed "Strict."

The Quarter Grades are termed "Barely," coming between the half grade and the above full grade. The term "Fully" means between the half grade and the next full grade below it.

The qualities to observe in sampling or grading cotton are: Length of Staple.

Regularity of length and diameter of staple. Fineness, Strength, Smoothness, Color, and Cleanliness; also see that the fibre has not been cut when ginning.

The cotton becomes full of sand during wind storms; see that it is as free from sand as possible.

COTTON SAMPLING.

Take 100 lbs. of cotton, shake it well and the sand will drop out; weigh the sand and you then get the percentage of loss through this source.

During heavy rains it becomes stained with the earth. See that it is not stained, especially if you are going to spin filling; but if you are going to size the yarn, you do not require to be so particular, as there can be bought a cotton a little cheaper, of good staple, but stained a little, which can be covered by sizing.

See that there is not too much leaf in the cotton, and that it is not dirty.

Look out for dampness; it always contains a certain amount, absorbed from the atmosphere (about 8%).

On one thing always be very particular. Always deal with reliable cotton brokers.

Look at the brightness of your cotton or "bloom," as it is called.

Bagging and Ties must not exceed 22 lbs. per bale.

The average allowance for loss of weight on any one mark of cotton shall not exceed three pounds per bale, with cotton in sound and dry condition.

Cotton is valued according to its characteristics that best adapt it to the use for which it is intended.

In mixing cottons be careful that you get equal length of staples.

Do not mix a harsh and silky cotton together, except for special purposes. If you wish to imitate wool get rough Peruvian.

Always mix as large mixing as possible, as it keeps the drafts on your machines equal and saves time in the setting and resetting of rolls.

Pay attention to the mixings, and picker room generally, as there lies a part of your foundation for an even yarn.

The shorter stapled Sea Island mix well with Best Egyptian for 80s to 120s yarns.

Peeler and Soft Egyptian also mix well to spin from 60s to 80s yarn.

Gulf, Texas, and Soft Peruvian mix well for yarns of 40s to 60s.

Rough Egyptian and Rough Peruvian incorporate well, and are suitable for spinning yarns from 40s to 50s.

The better class of Indian cotton (Hingunghat) is mixed with the lower classes of American cotton—Georgia or Boweds. Mix also with Oomrawuttee, Broach, and others.

If a mixing of bales—say, 24 bales has to be mixed—divide them as much as possible at the feeder.

Say we have 8.X.Y.Z., 8.G.H.I. and 8.A.B.C. Spread one X.Y.Z. on a large floor space. On the top of this throw one G.H.I. Over the top of these spread one A.B.C. and keep repeating this until the 24 bales are finished.

The mixings given here are only a few of the many different mixings made in our mills.

Rule for Calculating Strength of Cylinders and Boilers.

The tenacity of the metal of which a boiler is constructed is about 60,000 lbs., or six-sevenths of that of good wrought iron, a bar one inch square being the standard.

As the cylinder which constitutes the boiler is not whole, or in one piece welded together, but is composed of a number of plates riveted together, the plates being cut away for the holes, it is necessary to diminish the number, which expresses the strength; therefore let the tenacity be put at 30,000 lbs.

This boiler is 7 feet 6 inches diameter. Thickness of plates ⅜ of an inch.

Multiply the numerator of the thickness by the tenacity of the metal, and multiply the denominator by half the diameter of the cylinder in inches, then divide the numerator by the denominator and the answer will be the strength, or bursting pressure.

Example. The denominator of ⅜:

Dia. 7 ft. 6 in.÷2=45 ins.
45×8=360
30000 tenacity of metal.
3 numerator of ⅜ plate.

360)90000(250 bursting pressure.
720

1800
1800

Then we get 250 lbs. bursting pressure. This is if the iron is good and all things in proportion.

INCRUSTATION OF BOILERS.

1. Potatoes, one-fiftieth of weight of water prevents adherence of scale.
2. Twelve parts salt, 2½ caustic soda, ⅛ extract of oak bark, ½ of potash.
3. Pieces of oak-wood suspended in boilers, and renewed monthly prevents deposit.
4. Two ounces of muriate of ammonia in a boiler twice a week prevents incrustation and decomposes scale.
5. Molasses fed into a boiler prevents incrustation.
6. Carbonate of soda.
7. Chloride of tin.
8. Spent tanners bark.
9. Frequent blowing off.
10. Mahogany or oak sawdust in limited quantities.

The tannic acid attacks the iron, so this should be used with caution.

BOILERS.

Fuel—Average Evaporative Power.

One pound of coke evaporates 9 lbs. of water.

One pound of coal evaporates 9 lbs. of water.

One pound of oak (dry) evaporates 4½ lbs. of water.

One pound of slack evaporates 4 lbs. of water.

(Feed water supplied at 212° for above.)

Coal loses about one-third in coking (of its weight), but increases in bulk one-tenth.

Horse power in engines is calculated as the power which would raise 33,000 lbs. a foot high in a minute, or 90 lbs. at the rate of four miles an hour.

Always keep the cylinder hot and dry. Look to the mode of fitting the steam-pipes.

A nominal horse power of an engine, as was mentioned before, is to move 33,000 lbs. one foot high per minute, or say 150 lbs. raised 220 feet per minute, which means the same thing, for if we multiply 150 by 220 it equals 33,000.

For one horse power, multiply 220 by 22 circular inches. This gives 4840. Then multiply by the pressure 7 lbs. We get 33,880, and divide by 33,000 lbs., and the result is one horse power.

Example:

```
        220
         22
      -----
        440
       440
      -----
       4840
          7
      -----
33000)33880(1 horse power.
      33000
      -----
        880
```

Desaguliers figures that a horse walks 2½ miles an hour against a resistance of 200 lbs; this is at the rate of 220 feet per minute. A horse power is therefore equal to a force that will raise 44,000 lbs. one foot per minute when working eight hours per day.

Mr. Watts found that a horse treading

a mill path at the rate of 2½ miles an hour raised 150 lbs. by a cord hanging over a pulley, which is equivalent to raising 33,000 lbs. one foot high a minute. His steam engines were calculated to work at 44,000 lbs. per horse power, but he allowed 33,000 lbs. in his calculations, considering the difference due to friction.

How Horse Power is Calculated.

1760 yards one mile, a horse walking 2½ miles per hour against a force of 150 lbs. working 8 hours per day.

Work this out, and we find it is equal to raising 33,000 lbs. one foot per minute.

Example:

```
                    1760  yds. in a mile.
                     2.5  miles per hr.
                  ------
                    8800
                   3520
                  ------
                   44000
                       3  ft. in a yard.
                  ------
                  132000
                     150  lb. resistance.
                 -------
                 6600000
                132000
                --------
Mins. in hour=60)1980000.0(33000=1 h. p.
                 180
                 ---
                  180
                  180
                  ---
```

Horse Power of an Engine.

Multiply area of piston in square inches by mean effective pressure of the steam on the piston per square inch, and multiply these by velocity of piston per minute, and divide by 33,000.

Example:

```
                           45 dia. of piston.
                           45
                      ---------
                          225
                         180
                      ---------
                         2025 sq. in. in piston.
                          360 speed of piston.
                      ---------
                       121500
                       6075
                      ---------
                       729000
                           20 avg. pres. piston.
                      ---------
Divide by 33000)14580000(441 h. power.
                132000
                ---------
                 138000
                 132000
                ---------
                  60000
                  33000
                ---------
```

How to Find a Pipe to Supply a 36-Inch Cylinder.

Multiply the diameter of cylinder by .96; this will give area, from which you find diameter.

Example:

```
                               36
                              .96
                            -------
                              216
                             324
                            -------
Decimal area .7854)345600(44 sq. inches.
                   31416
                   -------
                    31440
                    31416
                   -------
```

Find square-root of 44.

```
6)44(6.63 Answer.
  36
  ---
126)800(6
     756
     ---
1323)4400(3
     3969
     ----
```

6.63 inch pipe required.

BELTING.

To Find Speed of Belt Per Minute.

Rule:—Multiply circumference of the pulley on which belt is running by the revolutions of the shaft.

Suppose your pulley is 24 inches or 2 feet, and revolutions of shafting are 200 per minute. Proceed as follows:

$2 \times 3.1416 \times 200 = 1356$ feet per minute.

To Find Horse Power a Single Belt Will Carry from One Pulley to Another.

Rule:—Multiply the width of the belt reduced to inches by 45 and by the feet the belt travels per minute, and divide the quotient by 33,000.

Suppose a single belt travels 1356 feet per minute and the belt is 1 foot and 4 inches wide (equal to 16 inches).

Example:

$$\frac{16\times45\times1356=976320}{33000 \quad = 33000}$$

976320 divided by 33000=29.58 horse power

To Find the Horse Power of a Double Belt.

Rule:—Proceed exactly as you did in finding single belt, only multiply by 75 instead of 45.

Example:

$$\frac{16\times75\times1356=1627200}{33000 \quad = \quad 33000}$$

1627200÷33000=49.3.

To Find a Single Belt Required to Give a Certain Horse Power.

Suppose you require 30 horse power and the belt will run 2000 feet per minute.

Rule:—Multiply the 30 horse power required by 33,000. Take this for the dividend. Then multiply the number of feet the belt travels per minute, 2000 by 45.

Example: $$\frac{30\times33000=990000}{2000\times45 = 90000}$$

990000 divided by 90000=11 inch single belt required.

To Find Double Belt Required to Give a Certain Horse Power.

Rule:—Proceed exactly as when finding single belt, but use 75 instead of 45.

Example:

$$\frac{30 \times 33000 = 990000}{2000 \times 75 = 150000}$$

990000÷150000=6.6 inch double belt required.

In testing the horse power required to run the shafting alone, and then to run the whole load of the mill, I would say that a fair percentage is 25 per cent., or say a mill requires a hundred horse power to run the shafting and belts alone, it should not require more than 400 horse power to drive the whole mill load. If it does, look to your belts; a tight belt makes hot bearings, requires more power to drive, and runs the machine no quicker. A large quantity of coal can be saved by having the belts at a right tension.

Tight belts ruin the bearings, cost more to run, and do not increase production.

RECIPES FOR MACHINE SHOP.

1. Mixture for welding steel is: One salammoniac and ten parts borax. Pound these together and fuse until clear; pour out, and when cool reduce to a powder.

2. Tempering Turning Tools.

When the nature of the steel is unknown, it is a good plan to heat the tool and try with a file at the different shades of color, and when the file is felt to bite the least bit, quench the tool.

This should be done by daylight, as pale straw color is difficult to see in artificial light.

3. Tempering Steel Springs.

Wet the spring (hardened) with olive oil, turn it gently round on the fire till it catches a light. If it is a very particular job, take a pan and boil in oil.

4. Hardening Tools.

Heat the tool to a blood-red heat and plunge it into common oil, and it will be all right for turning purposes.

5. Solder for Brass.

One-half lead and half tin, with a little resin. This solder will adhere to iron, but first rub the iron on a piece of tin.

6. Solder for Lead.

Melt one part of block tin, and when fusing add two parts of lead. Use resin with this solder.

7. For Brazing Iron.

Good brass and a little borax.

8. Uniting Metals.

For uniting wrought and cast iron, or steel. Take 20 parts (by weight) of wrought iron fillings, 10 of salammoniac, and 5 of balsam of copaiba, melt together and beat until dry and hard. This will join metals and fill in holes, cracks, or other defects, in iron or steel plates.

9. Welding Cast Steel.

One ounce powdered glass, one ounce salammoniac, and 16 parts borax. For mild steel, borax may be used alone.

10. Cement.

A strong glue is made by adding powdered chalk to common glue when melted, and a glue to resist warmth may be made by boiling one pound of common glue in two quarts of skimmed milk.

11. A Good Wheel-Grease.

Twenty-five lbs. of tallow, 25 lbs. of tar, 15 lbs. of soda, and 3½ gallons of water. Boil water and soda, then add tallow and tar.

12. Black Varnish.

One pint of vitriol and two gallons of gas tar. Apply after effervescence has nearly finished.

13. Lubricating Mixture.

Sixteen ounces of good lard, 2 ounces of bee's wax, 8 ounces of flour of sulphur, 4 ounces of black lead, 16 ounces of white soap.

14. To Keep Shafting Cool.

Mix white lead and oil to the consistency of cream.

15. Dubbing.

Two lbs. of black resin, 1 lb. of tallow, and 1 gallon of train oil.

16. Lacquering Brass.

Boil the brass in a solution of potash and soda, after which dip them in aquafortis, 3 parts water. Wash them in 2 waters and rub in sawdust. Place on a gas stove; when warm brush them, then apply lacquer. Put the work on the stove with brown paper over it.

17. Case Hardening.

Place horn, hoof, bone dust, or shreds of leather, together with the article to be case hardened, in an iron box, heat to blood red, then dip article in cold water.

Some engineers add white wine vinegar and salt.

18. Case Hardening With Prussiate of Potash.

Polish the article, then heat to a bright red; rub the surface over with prussiate of potash, and when a dull red, dip in water.

19. Case Hardening Mixtures.

Two of prussiate of potash to one of salammoniac mixed.

Or 2 of salammoniac, 2 of bone dust and 1 of prussiate of potash.

20. Cold Soldering Without Fire.

Bismuth ¼ ounce, quicksilver ¼ ounce,

block tin filings 1 ounce. Spirits of salt 1 ounce. Mixed together.

21. Cold Brazing Without Fire or Lamp.

Floric acid ½ ounce, oxymuriatic acid ½ ounce, mix in lead bottle, put a chalk mark at each side you want to braze.

This mixture will keep about six months in a lead bottle.

ARITHMETIC.

Before dealing with the drafts and twists in the machines, a few examples in arithmetic will help us.

The signs used in calculation are:—

+ meaning, add.

= means equal to.

— signifies subtraction.

× means multiplied by.

÷ meaning divided by.

√ signifies that the square root of the number to which it is prefixed is required.

∛ signifies that the cube root is required.

′ means feet.

″ meaning inches.

Examples:

If we write $20+4=24$, we mean 20 add 4 equals 24.

Then $20-4=16$ is 20 subtract 4 equals 16.

$20\times4=80$. This meaning 20 multiplied by 4 equals 80.

$20\div4=5$ signifies 20 divided by 4 equals 5.

$\sqrt{16}=4$ meaning square of 16 equals 4.

$\sqrt[3]{27}=3$ signifies that cube root is required 27 equals 3.

Multiply 3 by 3 equals 9, which is square. Multiply 9 again by 3 and you have cube 9×3=27.

7'-6" means 7 feet 6 inches.

CANCELLATION.

If this is used when taking pulleys or gears as driver or driven and cancelled it makes what would be a very long sum short.

If an 18 inch pulley was driving a 9 inch pulley, and on the same shaft with the 9 inch pulley was a 10 inch pulley, driving a 5 inch pulley, now we should place them thus:

$$\frac{18 \times 10}{9 \times 5}$$

18×10 meaning 18 multiplied by 10.

9×5 and 9 multiplied by 5.

(Note the drivers are on the top or above the line, and the driven under.)

Then we get

$$\frac{18 \times 10 = 180}{9 \times 5 = 45} \qquad 180 \div 45 = 4$$

by multiplying 18 and 10 we get 180, and the 9 by 5 we get 45. Then divide the 180 by 45 and we find 4 revolutions. Thus meaning that if we turned the 18 inch pulley round once, the 5 inch pulley would revolve 4 times, if there was no slippage. But this is not calculation.

What I was leading up to was this:

If we were to cancel these figures it would make a very short sum, thus:

$$\frac{\overset{2}{\cancel{18}} \times \overset{2}{\cancel{10}}}{\cancel{9} \times \cancel{5}} = 4 \text{ Ans.}$$

As you cancel one number in another draw a line through them. The 9 goes twice into 18, and the 5 goes twice into 10, so that you have only a 2 over the 18, and a 2 over the 10, and when multiplying these you have:—

Twice 2 are 4, which is the answer.

Never cancel one number in the bottom line figures with another number in the bottom line. Always find a number in the top line that will cancel with one in the top line, and vice-versa.

Example:

$$\frac{\overset{7}{\cancel{70}} \times \overset{3}{\cancel{45}} \times \overset{6}{\cancel{84}} \times \overset{1}{\cancel{96}}}{\cancel{10} \times \cancel{15} \times \cancel{14} \times \cancel{9}}$$

Now 10 will go into 70 seven times.
15 will go into 45 three times.
14 will go into 84 six times.
8 will go into 96 twelve times.

Multiply the 7, the 3, the 6, and the 12 and the answer is $7 \times 3 \times 6 \times 12 = 1512$ Ans.

Another example:

$$\frac{\overset{\overset{1}{2}}{\cancel{36}} \times \overset{\overset{1}{2}}{\cancel{12}} \times \cancel{7}}{\underset{\underset{1}{\cancel{2}}}{\cancel{6}} \times \underset{\underset{1}{\cancel{2}}}{\cancel{14}} \times \cancel{18}} = \frac{1}{1} = 1 \text{ Ans.}$$

The 18 goes into the 36 twice. The 7 into 14 twice. The 6 into 12 twice. Then the two twos above the line and the two twos below the line cancel, thus leaving 1 for a divisor and 1 for a dividend.

One in one is one, so one is the answer.

If you did not use cancellation here, you would have to multiply the 36, 12 and 7 together, and then multiply the 6, 14 and 18 together, and divide one by the other.

Never cancel a decimal and whole number.

PROPORTION.

Is the equality of two ratios.

: :: : signifies proportion, as 2 : 4 :: 8 : 16.

This meaning, as twice two are four, twice eight are sixteen. It can be written 2 is to 4 as 8 is to 16.

When you see that your answer must be larger, multiply the two larger numbers together and divide by the smallest number, but if the answer is to be smaller, multiply the largest and smallest number together and divide by the intermediate number.

For example:

20 cards produce 3000 lbs. per day, what weight will 50 produce? We know 50 cards will produce more than 30 similar cards, so our answer will be greater. Then multiply the two larger numbers together and divide by the smallest.

$50 \times 3000 = 15000$ and
$15000 \div 20 = 7500$ lbs. Answer.

PERCENTAGE.

This is very useful in mill business.

The term per means by, or on the, and centum means a hundred. So Percentage means on the hundred.

Thus 6 per cent. means 6 of every hundred. Instead of writing per cent., the symbol is used %, or it may be placed by a fraction, as 6/100, or as a decimal, thus, .06.

Example:

A man has 60 ring frames, but they are only 20 per cent. of what he will have when the mill is fully furnished. How many will he have?

Per cent. 20)60 percentage running.

```
          ——
           3
          100
          ———
          300
          ———
```

Divide the percentage of the frames running by the rate per cent., multiply by a hundred.

60 is the percentage of frames running and 20 per cent. of the whole number.

When we say he has 20% of the whole running, we mean 20 of every 100, so he has 300, or 3 times 20=60, which proves the 300 to be correct.

Instead of multiplying by the 100, add two ciphers.

60÷20=3 add 2 ciphers 300

When the principle and the rate per cent. are given, it is simple to find the interest.

A man borrows $500 at 7 per cent. per annum. What must he pay yearly? $500 \times 7 = 3500$ and $3500 \div 100 = 35$ dollars yearly.

The better plan is to cross off the two last ciphers instead of dividing by the 100. Thus:—$500 \times 7 = 35$.

A bale of cotton weighs 500 lbs., and after it has gone through the card-room processes, the roving made from it weighs 400 lbs. What percentage went to waste?

$500 - 400 = 100$ lbs. waste
$100 \times 100 = 10{,}000$ and $10{,}000 \div 500 = 20\%$.

So we see that 20 per cent. went to waste.

FRACTIONS.

A Common Fraction is one in which the unit is divided into any number of equal parts.

The Denominator is the number of equal parts into which the unit is divided.

The Numerator tells us how many equal parts are taken.

When we write 2/3, ask how many thirds? Why two, so it tells us how many of the figure under the line are taken.

Take ¾ for instance:—the 4 shows how many parts the unit is divided into, and we are taking 3, when we say ¾.

An improper fraction is when the numerator, or the figures above the line are greater than the denominator or the figures below the line, 7/5, 9/4, 6/5. These are all improper fractions.

To reduce units or mixed numbers to improper fractions.

How many thirds are there in 7 2/3?

Multiply the 7 by the 3 and add the 2. $7\times 3=21+2=23/3$. To prove this divide the 23 by 3 and we get 7 with 2 over, which are thirds.

To reduce improper fractions to mixed numbers.

How many units are there in 28/4?

Divide the 28 by 4, which equals 7 units.

Addition of Fractions.

How many eights are there in ½ and ¾?

½ is equal to 4/8, and ¾ is equal to 6/8.

4/8 and 6/8 added equals 10/8, which is an improper fraction, $10/8\div 8/8=1\ 2/8$, and the 2/8 when cancelled equals a 1/4, so our answer is 1 1/4.

Add 4/7 and 3/4 and 11/14.

Rule:—Reduce the fractions to a common denominator, add the numerators, and let the denominator or figures under the line remain as they are.

Example: $$\frac{4}{7}+\frac{3}{4}+\frac{11}{14}$$

You take the 4/7 and multiply both these figures by the denominators, or figures under the line, of the other two fractions, this meaning by the 4 and the 14.

Do the same with the ¾, multiply the 3 and the 4 by the other two denominators, the 7 and the 14. Now take the 11/14 and multiply these by 7 and 4, the denominators of 4/7 and 3/4.

Take the denominators of the 4/7 and 3/4 and 11/14. Multiply these, the 7, the 4 and the 14, which equals 392, and this is the least common denominator.

$$\frac{4\times 4\times 14=224}{7\times 4\times 14=392}$$

$$\frac{3\times 7\times 14=294}{4\times 7\times 14=392}$$

$$\frac{11\times 7\times 4=308}{14\times 7\times 4=392}$$

Now they all have a common denominator, or, in other words, the three figures under the line are the same, and it now becomes a simple addition sum, by adding the numerators, which are 224 and 294 and the 308, but we keep the denominator just the same.

224+294+308=826 or 826/392.

826/392 is an improper fraction, so we must divide 826 by 392.

```
392)826(2 42/392
    784
    ---
     42
```

The answer being 2 42/392, but the 42/392 can be cancelled by dividing the enumerator and denominator by 14: we get 3/28, making the answer 2 3/28.

Subtraction of Fractions.

Subtract 15/28 from 31/35.

Now to do this we must have the fractions similar, so they must be reduced to a common denominator, or, in other words, the figures under the lines must be the same.

To do this multiply the first fraction 15/28 by the denominator of the other fraction.

$$\frac{15 \times 35 = 525}{28 \times 35 = 980}$$

Follow this by multiplying the two numbers of the other fraction. Those are the 31 and 35 by the denominator of the first fraction; this is 28.

$$\frac{31}{35} \times \frac{28}{28} = \frac{858}{980} - \frac{525}{980} = \frac{\overset{7}{\cancel{343}}}{\underset{20}{\cancel{980}}} = \frac{7}{20}$$

Now both denominators are similar, and it becomes a simple subtraction sum.

Subtract 525 from 868=343.

Let the denominator remain as it was, then we have 343/980, and finding 49 will divide into the numerator and denominator, thus bringing our answer

$$\frac{\cancel{342}}{\cancel{980}} = \frac{7}{20}$$

Multiplication of Fractions.

Multiply 11/12 by 9.

Multiply the 11 by 9, which equals 99. Let the denominator remain as it was and we get 99/12, which is an improper fraction, so divide the 99 by 12, which gives us 8 3/12, or, when cancelled, for the 3 will divide into 12 four times, we get the answer 8¼.

Multiply 35/54 by 36/49.

$$\frac{\overset{5}{\cancel{35}}}{\underset{3}{\cancel{54}}} \times \frac{\overset{2}{\cancel{36}}}{\underset{7}{\cancel{49}}} = \frac{10}{21} \text{ Answer.}$$

By cancelling the 35 and 49, or, in other words, dividing each by 7, we get 5 and 7 instead of 35 and 49, and by dividing 36 and 54 by 18 we get 2 and 3. Multiply the 5 by the 2, we have 10 above the line; then multiply the 7 and 3, which equals 21, and our answer is 10/21.

Division of Fractions.

Divide 96/115 by 6.

Divide the numerator 96 by 6 and the denominator remains the same.

96÷6=16. 16/115. Answer.

Divide 32/49 by 4/7.

Multiply the dividend by the divisor inverted.

Or, in other words, place the 7 where the 4 is, and 4 where the 7 is, and multiply.

$$\frac{\overset{8}{\cancel{32}} \times \cancel{7}}{\underset{7}{\cancel{49}} \times \cancel{4}} = \frac{8}{7} = 1\frac{1}{7} \quad \text{Answer.}$$

4 goes into 32 eight times.
7 goes into 49 seven times.

We get 8/7, which is an improper fraction; divide the 8 by the 7 and we get 1 1/7 for our answer.

FRACTIONS (Complex).

These are fractions that have their numerators or denominators, or both, fractional.

Example:

$$\frac{\frac{15}{19}}{\frac{45}{76}} \qquad \frac{\cancel{15} \times \overset{4}{\cancel{76}}}{\cancel{19} \times \underset{3}{\cancel{45}}} = \frac{4}{3} = 1\frac{1}{3}$$

Rule:—Invert the denominator and divide by the numerator.

This is similar to dividing one fraction by another.

DECIMALS.

A Decimal Fraction is a number of tenths, hundredths, thousandths, etc.

A Decimal Fraction is shown by placing a dot, or a point, before the numerator, and not expressing the denominator.

If we were to write 1.5 in decimal fractions, we would express it in fractions as 1 5/10, or, when the 5/10 are cancelled, it is 1½. That is expressing a decimal fraction in tenths. When it is written 1.05 it means hundredths, as 1 5/100, and so on, as in thousandths 1.005=1 5/1000.

The symbol of a decimal is termed decimal point.

$$.25 = \frac{\overset{1}{\cancel{25}}}{\underset{4}{\cancel{100}}} = \frac{1}{4}$$

To Reduce a Common Fraction to a Decimal.

Reduce ¾ to a decimal.

Add ciphers to the numerator 3 and divide by the denominator.

3.00÷4=.75 Answer.

It is exactly like saying $1—75 cents, meaning one whole dollar and 75 hundredths of another dollar, or ¾.

In adding decimals write the numbers so that the decimal points come under each other: as, 24.33+146.33+63.175.

White thus:

```
 24.33
146.33
 63.175
-------
233.835 Answer.
```

This written as a fraction, 233 835/1000.

Subtraction of decimals is similar to addition in keeping the points under each other.

Subtract 123.25 from 212.758.

```
212.758
123.250
-------
 89.508
```

Multiplication of Decimals.

Suppose we multiply with the last two figures decimals, and the last two figures in the multiplicand decimals, then there are 4 decimals in the answer or product.

Example:

```
   4.25
   2.25
  -----
  21.25
  85.0
8.50
------
9.5625 Answer.
```

or a little over 9½.

Division of Decimals.

Is exactly similar to simple division, only the place for the points.

Example: Divide 20.7888 by 4.26.

```
4.26)20.7888(4.88 Answer.
     17.04
     -----
      3.748
      3.408
      -----
        3408
        3408
        ----
```

Rule:—Deduct the two decimals in the divisor from the four decimals in the dividend. This leaves two, so we have two in our answer.

SQUARE ROOT.

In finding the square root of 92, multiply a number by itself and the one that will come under 92, but nearest to it. You could not say 10 times 10 because that would be higher than 92, but you could say 9 times 9, so you know the square root of 92 is between 9 and 10, or 9 and a fraction.

Example: Extract square root of 92.

```
    9)92(9.591 Answer
      81
      --
 185)1100(5
      925
     ----
1909)17500(9
      17181
      -----
 19181)31900(1
        19181
        -----
```

In taking 92 for the number, you say 9 times 9 are 81. Commence by dividing 92 by 9, which gives 9 and 11 remaining; to the 11 add two ciphers, which will make the 11 into 1100. Then multiply the 9 which is in the answer by 2, which will make it 18. This you put to divide in the 1100, but you must put another figure after the 18, and this figure must be the number of times 18 and the figure placed after it will divide into 1100.

A good plan is to put a cipher after the 18, which makes it 180, divided into 1100 would go 5 times. Then you place the 5 after the 18 instead of the cipher, making it 185 divided into 1100, which is 5 times with 175 remaining. You again place two ciphers after the 175, making it 17500.

The answer as far as you have gone is 9.5; multiply this by 2 and get your next divisor, 95 multiplied by 2 equals 190. But you must place another figure after this before dividing the 17500 by it. Do as you did before, place a cipher after the 190, making it 1900; now see how many times it will divide into 17500, and you find 1900 will divide 9 times with a remainder of 319. You repeat what you did to get the 5 and the 9. That is, you add two ciphers to the 319, making it 31900.

Multiply the answer again by 2. That is $9.59 \times 2 = 1918$; add a cipher, making 19180; now see how many this will divide into 31900. You find it divides 1 time, so take away the cipher from 19180 and make it 19181; divide this into 31900 and you get 1.

This is quite far enough to take it; in fact, for ordinary purposes, 2 decimals are far enough to go, but you see by our answer we have gone as far as 3 decimals, the answer being 9.591, which is the square root of 92.

What is the square root of 10?

```
3)10(3.16
  9
 ----
61)100(1
    61
   -----
626)3900(6
    3756
    ----
```

NUMBER WITH SQUARE ROOTS GIVEN.

No.	Square Root	No.	Square Root	No.	Square Root
.0625	.25	12	3.464	47	6.855
.125	.353	13	3.605	48	6.928
.25	.5	14	3.741	49	7.0
.375	.61	15	3.872	50	7.071
.5	.71	16	4.0	51	7.141
.625	.79	17	4.123	52	7.211
.75	.866	18	4.242	53	7.28
.875	.935	19	4.358	54	7.348
1.	1.0	20	4.472	55	7.416
1.125	1.061	21	4.582	56	7.483
1.25	1.119	22	4.69	57	7.549
1 375	1.172	23	4.795	58	7.615
1.5	1.23	24	4.898	59	7.681
1.625	1.273	25	5.0	60	7.745
1.75	1.33	26	5.099	61	7.81
1.875	1.37	27	5.196	62	7.874
2	1.414	28	5.291	63	7.937
2.25	1.5	29	5.385	64	8.
2.5	1.58	30	5.477	65	8.062
2.75	1.65	31	5.567	66	8.124
3	1.732	32	5.656	67	8.185
3.25	1.8	33	5.744	68	8.246
3.5	1.87	34	5.830	69	8.309
3.75	1.93	35	5.916	70	8.366
4	2.0	36	6.0	71	8.426
4.25	2.06	37	6.082	72	8.485
4.5	2.12	38	6.164	73	8.544
4.75	2.18	39	6.245	74	8.602
5	2.236	40	6.324	75	8.66
6	2.449	41	6.403	76	8.717
7	2.645	42	6.48	77	8.774
8	2.828	43	6 557	78	8.831
9	3.0	44	6.633	79	8.888
10	3.162	45	6.708	80	8.944
11	3.316	46	6.782	81	9

No.	Square Root	No.	Square Rool	No.	Square Root
82	9.055	122	11.045	162	12.727
83	9.11	123	11.09	163	12.767
84	9.165	124	11 135	164	12.806
85	9.219	125	11.18	165	12.845
86	9.273	126	11.224	166	12.884
87	9.327	127	11.269	167	12.922
88	9.38	128	11.313	168	12.961
89	9.433	129	11.357	169	13
90	9.486	130	11.401	170	13.038
91	9.539	131	11.445	171	13.076
92	9.591	132	11 489	172	13.114
93	9.643	133	11.532	173	13.152
94	9.695	134	11.575	174	13.19
95	9.746	135	11.618	175	13.228
96	9.797	136	11.661	176	13.266
97	9.848	137	11.704	177	13.304
98	9.899	138	11.747	178	13.341
99	9.949	139	11.789	179	13.379
100	10.0	140	11.832	180	13.416
101	10.049	141	11.874	181	13.453
102	10.099	142	11.916	182	13.49
103	10.148	143	11.958	183	13.527
104	10.198	144	12	184	13.564
105	10.246	145	12.041	185	13.601
106	10.295	146	12.083	186	13.638
107	10.344	147	12.124	187	13.674
108	10 392	148	12.165	188	13.711
109	10.44	149	12.206	189	13.747
110	10.488	150	12.247	190	13.784
111	10.535	151	12.288	191	13.82
112	10.583	152	12.328	192	13.856
113	10.63	153	12.369	193	13.892
114	10.677	154	12.409	194	13.928
115	10.723	155	12.449	195	13.964
116	10.77	156	12.49	196	14
117	10.816	157	12.529	197	14.035
118	10.862	158	12.569	198	14.071
119	10.908	159	12.609	199	14.106
120	10.954	160	12.649	200	14.142
121	11	161	12.688		

Troy Weight.

24 Grains=1 Pennyweight.
20 Pennyweights=1 Ounce.
16 Ounces=1 Pound.

Avoirdupois Weight.

16 Drachms=1 Ounce.
16 Ounces=1 Pound.
28 Pounds=1 Quarter.
4 Quarters=1 Hundredweight.
20 Hundredweight=1 Ton.

HOPPER BALE BREAKER.

This machine is made in the United States by Messrs. Howard and Bullough, of Pawtucket, Rhode Island.

Its work is to break the cakes of cotton, which are pulled from the newly opened bales, without damage to the fibres.

It mixes waste with cotton evenly. It is a great improvement to opening or breaking the cotton by hand, and saves a great amount of labor, as one of these machines will open a full sized bale of American cotton in from 6 to 10 minutes, or about 175,000 lbs. per week.

AUTOMATIC FEEDER.

The Automatic Feeder feeds the cotton evenly to the opener.

The cotton is fed into the hopper and carried by a spiked lattice or apron to the Stripping Comb. The Stripping Comb knocks back the surplus cotton taken up by the vertical spiked lattice, so in case a heavier feed is required, the stripping roll is set further away from the lifting-apron, and if a lighter feed is required it is set nearer, or the lifting apron may be made to run slower or quicker to feed heavy or light.

The feed to the opener is controlled by a wood condensing roll.

See that there is no slippage of the apron, and keep the machine clean, removing the sand, seeds, and dirt regularly.

OPENER.

Its duties are to open and clean the cotton and take out foreign matter.

Some makes cut or chop the cotton and cause trouble.

The revolutions of an 18 inch rigid beater are about 1450 per minute; and a porcupine beater 550 R. P. M.

The distance of the beater blades to the feed roll for working medium American cotton is 5/16 of an inch.

The beater blades should be sharp, but not sharp enough to cut the cotton.

They should give the cotton a sharp, solid blow to knock out the dirt.

If the beater knocks out the cotton in bunches there is not sufficient weight on the feed roll.

If the laps vary much in weight the evener and feed roll are not working correctly.

The production of one of these machines is anywhere from a 1000 to 7000 lbs. per day.

BREAKER LAPPER.

The two machines mentioned before are generally connected to this machine in various ways.

The Feeder and Opener are placed in another room and connected by conducting trunks, or they can be directly connected to the Breaker Lapper.

For stock 1⅛ to 1½ inch, a good speed for porcupine beater is 550 R. P. M. The rigid beater 1300 R. P. M. and the fan 1100 R. P. M., but these vary greatly according to the cleanliness of the cotton.

Pay great attention to the setting of the bars.

Set bars about ½ inch and note results. If you make too much waste close them, and if the dirt is coming along with the cotton open them.

When working Sea Island spread the bars and run the rigid beater about 1100 R. P. M. But much depends on whether you are short of laps in card-room.

The same applies to this machine in reference to the beater and feed rolls, as mentioned in the opener.

A good speed for the fan with the other speeds given is 1100 R. P. M. But this depends largely on how they are dealing with the cotton in blowing it on the screens or cages. A good plan is to place a triangular piece of wood the whole length of the screens and near to where the screens meet, and divide the air current. This stops the cotton from being blown at the junction of the screens and prevents thick and thin places in the lap; it also, to a great extent, does away with splitting or licking laps.

See that the fan blows the cotton evenly on the screens or the lap will not be parallel from end to end.

FINISHER LAPPER.

This machine is designed to double the laps from the breaker lapper, and in this way get a more even lap.

The beaters and fans have been dealt with on the Breaker Lapper and Opener.

The Pin Beater has not been mentioned. It is a beater with pins set in the blades, and for long staple cotton it works splendidly.

For Sea Island a pin beater would do well at 1100 R. P. M. and the fans 1300.

Always be well equipped for fires in the picker room.

Keep the room and machines clean.

The laps should be cylindrical, solid throughout, and have perfect salvages.

Calculations on Lappers.

To find speed of beater:—

Speed of line shaft 230 R. P. M. Pulley on line shaft 36 inches, which drives a 20 inch pulley on counter shaft, and another pulley on counter shaft 28 inches drives the pulley on the end of the beater shaft, which is 8 inches.

Rule:—Multiply the driving pulleys and the revolutions of the line shaft together, namely, 230, 36, and 28.

Then multiply the driven pulleys together, which are the 20 and the 8, and divide the drivers by the driven, then you have the revolutions of the beater per minute.

$$\frac{230\times36\times28=231840}{20\times8\ =\ 160}$$

231840÷160=1449 R. P. M. of beater.

The fan is driven from the beater shaft; so for example take a pulley on the beater shaft 6 inches, driving a pulley on the fan shaft 8 inches diameter. What would be the speed of the fan?

Rule:—The beater revolves 1449 R. P. M. Multiply this by 6 and divide the product by 8.

$$\frac{1449 \times 6 = 8694}{8 = 8}$$

8694÷8=1086 R. P. M. of fan.

To find percentage of waste:—Multiply weight of droppings by 100 and divide by weight of production and droppings added.

To find the Hank Lap:—

We must remember that 840 yards make one hank and 7000 grains 1 lb. So if 840 yards of lap, sliver, or yarn weigh 7000 grains, or 1 lb., then the counts must be 1s. or one hank to the pound. If 840 yards weigh 1000 grains, then the sliver or yarn would be 7s. because we would require 7 times 840 yards to make 7000 grains or 1 lb.

Find the Hank of a 12 ounce lap.

Divide 7000 grains by 840. This gives 8.33, which means each yard weighs 8.33 grains. Now find how many grains there are in 12 ounces. There are 7000 grains in 1 lb. and there are 16 ounces in 1 lb. By dividing 7000 by 16 we get to know how many grains in an ounce; 7000 divided by 16 equals 437½ grs. in an ounce. Then multiply 12 by 437½ and we get

5250 grs. in 12 oz. Now divide the grains per yard (8.33) by 5250 and you have the Hank Lap.

$8.33 \div 5250 = .00158$ hank of lap.

CARDING.

Settings.

Set Doffer, Licker-in, and Flats as near to the Cylinder as possible without touching.

Feed Plate to Licker-in 12/1000 of an inch.

Cylinder screen to Cylinder 20/1000 of an inch.

Licker-in knives to Licker-in 12/1000 of an inch.

Back knife to Cylinder 15/1000 of an inch.

Front knife plate to Cylinder (lower edge) 15/1000 of an inch.

The above settings are for a medium heavy production.

When carding light, set all setting parts as near as possible without touching.

Draft between Lap Roll to Calender Roll:—

Multiply Lap Roll gear (59) by Feed Roll gear (154) and side shaft Bevel gear (32) and Doffer gear (180) and diameter of Calender roll 4 inches.

Then multiply the following gears together: Lap Roll driving gear (21). Draft bevel gear (20). Side shaft gear (26). Calender gear (28), and Diameter of Lap Roll 6 inches.

$$\frac{59 \times \overset{22}{\cancel{154}} \times \overset{\overset{8}{\cancel{16}}}{\cancel{32}} \times \overset{\overset{3}{\cancel{9}}}{\cancel{180}} \times \cancel{4}}{\underset{7}{\cancel{21}} \times \cancel{20} \times \underset{13}{\cancel{26}} \times \underset{7}{\cancel{28}} \times \underset{3}{\cancel{6}}} = \frac{10384}{91}$$

10384÷91=113 draft.

To find constant for draft:

Use the same gears as when finding the total draft, but leave out the draft gear (20).

$$\frac{59 \times \overset{22}{\cancel{154}} \times \overset{16}{\cancel{32}} \times \overset{\overset{10}{\cancel{30}}}{\cancel{180}} \times \cancel{4}}{\underset{7}{\cancel{21}} \times \underset{13}{\cancel{26}} \times \underset{7}{\cancel{28}} \times \cancel{6}} = \frac{207680}{91}$$

207680÷91=2282 constant.

To get draft gear, divide the constant by the draft required. Say, for example, we want a gear to put in 113 of draft.

2282 (constant) divided by 113 (draft) equals 20. Then a 20 draft gear would give 113 draft.

Length of Clothing required to cover cylinder and doffer.

Diameter of cylinder 50 inches, and width of carding surface 40 inches, would require 268 feet of clothing, 2 inches wide.

A cylinder 50 inches diameter, and 45 inches wide, would require 297 feet of clothing 2 inches wide.

A doffer 24 inches diameter, and 40 inches wide, requires 172 feet of 1½ inch clothing.

A doffer 27 inches diameter, and 40 inches wide, requires 194 feet of clothing 1½ inches wide.

A doffer 27 inches diameter, and 45 inches wide, requires 218 feet of 1½ inch clothing.

SLIVER LAP MACHINE.

This machine converts the sliver from the card into a lap to be put on the ribbon lap machine or on the comber direct.

There are usually 14 to 20 slivers taken in behind to form the lap.

A small draft of about 1.5 is generally put in here.

RIBBON LAP MACHINE.

This machine dispenses with the first drawing frame. It doubles the laps (generally six) from the sliver lap machine, and makes an evener lap for the comber.

The draft is governed by the number of laps being doubled; it generally runs from 4 to 6 of draft.

Spread the rolls according to the weight of laps behind, say from ⅛ to ⅜ of an inch wider than the staple of cotton being worked.

COMBER.

This machine takes out the short fibres, neps, and leaf by the needles in the half-lap combing the front ends of the fibres, whilst they are held by the nippers, and the top comb combing the rear ends by having the fibres drawn through it by the fluted segment and the detaching rolls.

This process makes a lot of waste, generally from 16 to 22%, but it makes a stronger, evener, and cleaner yarn, with a better lustre, as it combs the fibres parallel.

A single comber gives from 80 to 95 nips a minute.

A good plan when starting a new machine is to commence slowly, then gradually increase in speed until you find the quality of the work deteriorating; then stop right there. This applies to all machines.

Roller Varnish Receipt.

1 lb. Gelatine Glue.
12 oz. Burnt Senna.
2 quarts of Acetic Acid.
4 oz. of Red Lead.
1 oz. of Origanum.

Comber Setting.

Feeds at	5 index
Nipper knife touches cushion plate	9 to 9½ index
Leather detaching roll touches segment	6¾ index
Leather detaching roll leaves segment	9¼ to 9¾ index
Delivery roll delivers.	6¼ to 6½ index
Top comb working	5 index
Cushion plate to need es on halt-lap	18 to 21 gauge
Stop screw to nipper stand	¼ step gauge
Cushion to detaching roll	1¼ finger gauge
Feed roll to detaching roll	1 13/16 finger gauge
Top comb to segment.	18 to 21 gauge
Angle of top comb	28 to 32

These settings vary according to length of staple, but for a 250 gr. lap. Egyptian the above settings are good.

Draught from Lap Roll to Calender delivery roll:—

Multiply the following driving gear together:—Lap roll gear 47. Bevel gear 55. Diagonal shaft gear 22. Feed Roll gear 38. Notch or star gear 5. Cylinder shaft gear 25. Front cross shaft gear 50. Gear 45. Front Roller gear (on opposite end of shaft) 20, and diameter of calender roll 2¾", which we will call 11, as there are 11 quarters in 2¾".

Then multiply the following gears together:—Gear between Lap gears 37. Gear on diagonal shaft 20. Feed Roll gear 22. Change gear 16. Feed Peg 1. Front cross shaft gear 25. Gear on stud 45. Roller gear 42. Calender shaft gear 43. Diameter of lap roll 2¾", or 11 quarters.

Then we get the following:—

$$\frac{47\times55\times22\times38\times5\times25\times50\times45\times20\times11}{37\times20\times22\times16\times1\times25\times45\times42\times43\times11} = 22.97 \text{ draft.}$$

or almost a draft of 23 we get by multiplying the gears above the line, then multiplying the gears below the line, and dividing the product of the top line by the product of the bottom line.

An easy way to get the draft is to mark a yard of the lap behind, putting a mark on the back of the comber. Set the first mark on the lap even with the mark on the machine, then break the sliver at the coiler.

Start the comber, and when the yard of lap has gone to the stationary mark on the comber, again break the sliver at the coiler, and measure it. If there are 27 yards delivered for 1 yard fed at the back, then we have a draft of 27.

To find amount of waste, break the sliver at the coiler and clean all the waste from behind the machine, run the comber a short time, break the sliver again and weigh the sliver that has come through also the waste made during this short time.

Suppose the sliver weighs 60 penny-weights and the waste weighs 10 penny-weights.

Multiply the weight of waste by 100 and divide by weight of sliver and waste added.

```
60   100
10    10
---------
70)1000
---------
    14.28 percentage of waste.
```

There is a weighing-machine made which gives the percentage of waste made, on a quadrant.

DRAWING FRAME.

As the name implies, this machine makes the slivers more uniform and the fibres more parallel by drawing them, 6 to 8 slivers from the card or comber being fed behind, and drafted so as to come out in front of the frame about the weight of one sliver fed behind.

Suppose there are 6 slivers fed behind, each weighing 60 grains, and there is a draft of 6 in the rollers. The one sliver in front of the frame will remain a 60 grain sliver.

Constant for Draft between Back Front Rolls.

Multiply Back Roll gear 70 by Crown gear 100, and by diameter of Front Roll 11 for a dividend.

Then multiply Front Roller gear 25 by diameter of Back Roll 9 for a divisor.

$$\frac{70\times100\times11=77000}{25\times9\quad=225}$$

77000÷225=342 Constant.

Divide Constant by draft. and this will give Draft Change gear.

342 Constant divided by 6 Draft=57.

57 Draft gear to give 6 of a Draft.

Draft from Back Roll to Bottom Calender Roll.

Multiply Calender Roll Compound gear 32, by Crown gear 100, by Back Roll gear 40, and by diameter of Calender Roll 16, for a dividend.

Then multiply gear on Calender Roll 24, by Compound gear 45, by Draft gear 30, and by diameter of Back Roll 11, for a divisor.

$$\frac{32\times100\times40\times16=5120}{24\times45\times30\times11=891}$$

5120÷891=5.74 Draft.

The above figures were cancelled.

Note that the figures 16 and 11 are used for the Calender Roll and Back Roll.

The Calender Roll is 2 inches diameter and the Back Fluted Roll 1⅜ inches.

These rolls are reduced to eighths of an inch. There are 16 eighths into 2 inches, and there are 11 eighths into 1⅜ inches.

This rule is also used in the Draft from Back to Front Roll. Back Roll is 1⅛ and the Front Roll 1⅜, so we use the figures 9 and 11.

Roller Varnish Receipt.

¼ lb. of Gelatine Glue.
¼ lb. of Pulverized Glue.
1 quart of Acetic Acid.
1 tablespoonful of Origanum Oil.
1 teaspoonful of Brown Sugar.

FLY FRAMES.

Slubbing, Intermediate, Roving and Jack Frames.

These machines are built somewhat similar, excepting the slubber, which has no creel, it being the first machine after the Drawing Frame. The cans of sliver are placed behind the slubber and wound on a bobbin, whilst an actual twist is put in here for the first time, so at this machine the spinning really commences. Before, the Picker, Card and Comber have cleared the cotton of impurities and taken out short fibres. The Drawing Frame has made the slivers uniform or even, and now we want to diminish the slivers, and make the fibres still more parallel by drafting as fine as required, and as even as possible to prepare them for the Mule or Ring Frame. For the purpose of making the roving even, it is doubled at the Intermediate, Roving, and Jack Frames.

Jack Frames are only used where fine counts are spun, as the bobbins required must be small and light, to draw off easily at the Mule or Ring Frame, without breaking the roving. The Jack Frame also makes the drafts smaller in the other Frames. For without this Frame it would be quite a task to make a 25 Hank Roving from an ordinary sliver, without having excessive drafts in the Slubber, Intermediate, and Roving Frames, and this would make roller-laps by the drafts being too high, and consequently waste.

The bobbins are run by the cone drums, which act exactly as the quadrant does to the spindle on the Mule.

As the Bobbin becomes larger in diameter, and the rolls are delivering the same amount of roving, the Bobbins must run slower to wind on the roving delivered. To do this the Cone-belt is moving a little at every change of the rail, just as the quadrant chain on the mule is shortening until the cop reaches the body or thickness.

This, of course, is a Frame with a bobbin lead, or, in other words, when the speed of the bobbin is in excess of the flyer, but when it is a Flyer Lead, the speed of the flyer is in excess of the bobbin, and so winds the roving on the bobbin.

Then after doffing the bobbins run slowly and gradually increase in speed until the time for doffing.

Constant for turns per inch, on Slubbing Frame:—

Multiply Front Roll gear 120, by Top Cone gear 35, by Driving Shaft gear 44 and by Spindle bevel gear on shaft 50 for a dividend.

Then multiply gear on Cone Drum shaft 64, by gear on the end of Spindle shaft 44, by gear on the bottom of Spindle 25, and Circumference of Front Roll 1¼ inches or equal to 3.92.

$$\frac{120 \times 35 \times 44 \times 50 = 525}{64 \times 44 \times 25 \times 3.92 = 15.68}$$

(The above figures have been cancelled before being multiplied.)

$525 \div 15.68 = 33$ Constant.

Divide Constant by turns per inch required, and it will give you Twist gear.

Suppose you want to put in .777 turns per inch. Divide the Constant 33 by .777. (All the sevens being decimals we must add three ciphers to the 33.) (See Decimals.)

$33.000 \div .777 = 42$ Twist Gear.

Constant for Draft in Slubbing Frame:

Multiply Back Roll gear 60, by Crown gear 90, and by diameter of Front Roll. 1¼ inches (or 10 eighths) for a dividend. Then multiply Front Roller gear 24, by diameter of Back Roll 1 inch (or 8 eighths).

$$\frac{60 \times 90 \times 10 = 54000}{24 \times 8 \quad = 192}$$

$54000 \div 192 = 281$ Constant.

Constant divided by draft gives Draft gear.
281 (Constant) divided by 5 (Draft)=56 Draft gear.

To find Lay or Lifter Gear.

Suppose a 6 hank-roving requires a 14 lay gear, what lay gear will a 4 hank roving require?

Rule:—Square 14 by multiplying 14 by 14, then multiply the product by 6 and divide by 4, and get the square root of the quotient.

Example:

```
         14
         14
        ----
         56
        14
        ----
        196
          6
        ----
      4)1176
        ----
   √1) 294(17 lay gear required.
        1
        ----
   27) 194
       189
        ----
```

Another way to find Lay Gear, which is far simplier than the rule before given:—

Multiply the 14 by the 6 hank roving and divide by the 4 hank roving, add the 14 to the answer and divide by 2. This gives lay gear.

Example:

```
     14
      6
    ----
  4)84
    ----
    21
    14
    ----
  2)35
    ----
    17.5 lay gear.
```

17 Lay or Lifter Gear required.

To find change for Twist Gear:—

Suppose you are making a 6 hank roving with a 30 twist gear on. What twist gear would you require to make a 4 hank roving?

Rule:—Square the 30 twist gear. (This means multiply 30 by 30.)

Then multiply by the hank roving you are making 6, and divide by the hank roving you are going to make 4, and the square root of the answer is the twist gear required.

```
Example:          30 twist gear
                  30
                 ----
                 900
                   6 hank you're making
                 ----
Hank to make   4)5400
                 ----
            √36)1350(36.7 twist gear reqd
                1296
                -----
             727)5400(7
                 5089
                 ----
```

36.7 or almost 37 Twist Gear required.

Another and easier rule.

Multiply the 30 by 6 hank roving and divide by 4. Then add the 30 to your answer and divide by 2. This will give you Twist Gear required for a 4 hank roving, if a 6 hank roving requires a 30 Twist Gear.

Example: 30 twist gear
6 hank you're making

Hank to make 4)180

45
30 twist gear added

2) 75

37 twist gear required.

To find Tension or Rack Gear:—

Suppose you are making a 6 hank roving with a 30 tension gear. What tension gear would a 4 hank roving require?

Rule:—Multiply the tension gear on, by the square root of the hank roving being made, and divide by the square root of the hank roving you are going to make.

Example: Square Root of 6 is 2.4.
30 tension gear
2.4 square root of 6

120
60

Square root of 4=2)720

36 tension gear reqd.

All the calculations given in regard to the Slubber apply exactly the same to the Intermediate, Roving and Jack Frames.

To find Turns per inch required:—

American and Low Egyptian.

Slubber, Square Root of H. R. multiplied by 1.16.
Intermediate, Square Root of H. R. multiplied by 1.16.
Rover, Square Root of H. R. multiplied by 1.25.
Jacks, Square Root of H. R. multiplied by 1.

Good Egyptian and Sea Island.

Slubber, Square Root of H. R. multiplied by .7.
Intermediate, Square Root of H. R. multiplied by .78.
Rover, Square Root of H. R. multiplied by 1.1.
Jacks, Square Root of H. R. multiplied by .95.

These twists are changed according to the quality of the cotton and the condition of the weather.

To find the Draft Change Gear to put in a draft of 5.5 with the following gears:—

Front Roll Gear 30 teeth.
Crown Gear 100 teeth.
Back Roll Gear 60 teeth.
Diameter of Back Roll 1⅛ inches.
Diameter of Front Roll 1¼ inches.

Multiply Front Roll Gear 30, by diameter of Back Roll 1⅛ inches or 9 eigths, and by Draft required 5.5. Take these for a divisor.

Then multiply Crown Gear 100 by Back Roll Gear 60 and diameter of Front Roll 1¼ inches, or 10 eights.

Take these for your dividend.

Example:

$$\frac{100\times 60\times 10=60000}{30\times 5.5\times 9=1485}$$

60000÷1485=40 Draft Gear.

We are making a 8 hank roving with a 30 draft gear. What Draft Change Gear is required to make a 6 hank roving?

Rule:—Multiply Change pinion on, (30) by hank roving being made (8) and divide by hank roving (6) we are going to make.

```
   30
    8
  ———
 6)240
  ———
   40 draft change gear required.
```

To find turns per inch on Intermediate:—

Multiply gear on driving shaft 52, by Spindle shaft bevel gear 57, and by Top cone gear 55, and by Front Roll Gear 140. These gears taken for a dividend.

Then multiply End Spindle Shaft gear 50, by Spindle gear 25, and by Twist gear 52, and by gear at the opposite end of cone 78, and by diameter of Front Roll 1¼ inches or 3.927. These gears use for a divisor.

$$\frac{52\times57\times55\times140 \qquad =1463}{50\times25\times52\times\ 78\times3.927=1276.275}$$

(The above numbers were cancelled before multiplied.)

1463÷1276.275=1.14 Turns per inch.

To get a constant for Twist Gear:—

Rule:—Proceed exactly as in the example given to find turns per inch, but leave out the Twist Gear 52.

Example:

$$\frac{52\times57\times55\times\ 140=22822800}{50\times25\times78\times3.927=382882.500}$$

22822800÷382882.5=59 Constant.

59 Constant divided by 1.14 Turns per inch equals 52 Twist Gear.

These Twists and Drafts apply also to Rover and Jack Frames.

WRAPPING OR SIZING SLIVERS, ROVINGS, AND YARNS.

In finding the Hank of Slivers weigh a yard of Sliver, and suppose it weighs 58 grains, divide this in 8.33.

8.33÷58=.14 Hank Sliver.

The reason for dividing one yard on sliver in 8.33 is because there are 8.33 grs. to one yard of 1s.; to get this divide 7000 grains by 840 yards.

7000÷840=8.33 grs. per yard.

Wrapping or Sizing Roving.

Wrap 12 yards of Roving, and divide weight in grains in a hundred.

Suppose 12 yards weigh 50 grains.

100÷50=2 Hank Roving.

The reason we divide the weight of 12 yards into 100 is because 12 are 1/70 part of 840 yards, or 1 Hank, and 100 is 1/70 part of 7000 grs., or 1 lb.

Wrapping or Sizing Yarn.

Wrap or Reel 120 yards and divide the weight in grains into 1000.

Suppose 120 yards or 1 Lea weighs 50 grains.

1000 divided by 50=20s Yarn or Counts.

The reason for dividing the weight of 120 yards into 1000 grains is that 120 yds. are 1/7 of 840 yds. and 1000 grs. are 1/7 of 7000 grs., or 1 lb.

SETTING ROLLS.

It is very difficult to give a fast rule for the Setting of Rolls, as the Front Roll running slowly, or at an excessive speed, also the feed being heavy or light, govern the settings to a great extent.

Drawing Frame Rolls.

For Combed stock set Front and 2nd Roll 1/16 of an inch further apart from centre to centre than the length of the staple of the cotton being worked. And from centre of 2nd Roll to centre of 3d Roll set ⅛ of an inch further apart than length of staple. And from centre of 3d Roll to centre of Back Roll set 3/16 of an inch further than length of staple.

Drawing Frame.

Suppose, for example, you are working combed stock 1⅜ inch staple.

Distance from centre to centre of Front and 2nd Roll 1 7/16 of an inch. From centre to centre of 2nd and 3d Roll 1 1/2 inches. From centre of 3d Roll to centre of Back Roll, set 1 9/16 of an inch.

For Carded work you may set the rolls ⅛ of an inch, Front and 2nd ¼ of an inch, 2nd and 3d and ⅜ of an inch 3d and Back Rolls, further apart than length of staple.

Note result after setting rolls, and if the sliver comes through not properly drawn, or in tufts, spread the rolls a little more.

SLUBBER ROLLS.

Set from centre of Front Roll, to centre of 2nd or middle roll, 1/16 of an inch wider than the staple you are working, and from centre of middle roll, to centre of Back Roll ⅛ of an inch longer than staple.

INTERMEDIATE ROLLS.

Set these similar to Slubber Rolls.

ROVER AND JACK FRAMES.

Set Front and Middle Roll a little further apart than length of staple, from centre to centre, and from centre of middle roll to centre of Back Roll ⅛ of an inch.

Set Front and Middle Roll from centre to centre slightly wider than staple.

Always take in consideration, when setting rolls, whether the feed is heavy or light. For a heavy feed, set rolls further apart, for a light feed set nearer.

Watch your drafts when setting rolls. If a small draft, set your rolls further apart, and, if a large draft, set rolls nearer.

Look to your Roving when setting rolls. If it is hard twisted, set the rolls further apart. If the roving is soft, set near.

With Self-weighted rolls on Fly Frames, set Back and Middle Rolls a little further apart.

Never have Top Leather Roll the same diameter as the fluted roll, for if they are, the leather will become fluted.

Keep the leathers on the rolls in good condition.

Loose Boss Front Rolls are best.

Varnish for Drawing Frame Rolls.

1½ lbs. Fish Glue.
½ lb. of Gum Arabic.
¼ lb. Powdered Alum.
2 lbs. Acetic Acid.
4 lbs. Water.

Add together, dissolve over slow fire, and when cold, it is ready for use.

Circumference of Rolls.

1 inch diameter, circumference is 3.1416.

1 1/16 inch diameter, circumference is 3.3379.

1 1/8 inch diameter, circumference is 3.53.

1 3/16 inch diameter, circumference is 3.73.

1 1/4 inch diameter, circumference is 3.92.

Good Drafts for Mules spinning American Cotton range from 7 to 10, but these are often exceeded. In spinning good Sea Island Cotton, 14 of a draft is common.

Suppose you were going to spin 50s. yarn from a 10 hank roving double. The 10 H. R. being double, would be twice as heavy, so it would equal a 5 H. R., and you require what is termed 10 of a draft, or, in other words, draw the 5 H. R. ten times finer. You see this by saying 10 times 5 are 50.

To find Draft Gear, to give a draft of 10.

We will suppose you have a Back Roll gear on 54. Multiply this by Crown Gear 120, and by diameter of Front Roll 1 inch. Take these for a dividend.

Then multiply Front Roll gear, which we will suppose to be 18, by the Draft required 10, and by diameter of Back Roll 1 inch. Take these for a divisor.

Example:

B.R.G. C.G. D. of F.R.

$$\frac{54 \times 120 \times 1 = 6480}{10 \times 18 \times 1 = 180}$$

Draft. F.R.G. D. of B. R.

6480÷180=36 draft gear required.

If the Front Roll diameter is 1 1/16 of an inch, and the Back Roll 1 inch, reduce them to sixteenths. There are 16 sixteenths in one inch, so there must be 17 in 1 1/16 inch.

Place your terms thus:

$$\frac{54 \times 120 \times 17 = 110160}{10 \times 18 \times 16 = 2880}$$

$110160 \div 2880 = 38$ draft gear required.

If the diameter of the Front Roll is 1⅛ inch, reduce to eights. There are 9 eights in 1⅛ and 8 eights in 1 inch.

$$\frac{54 \times 120 \times 9 = 58320}{10 \times 18 \times 8 = 1440}$$

$58320 \div 1440 = 40$ draft gear required.

To find Constant for Draft.

Rule:—Proceed exactly as when finding Draft Gear, but leave out the draft.

Example:

$$\frac{54 \times 120 \times 1 = 6480}{18 \times 1 \quad = 18}$$

$6480 \div 18 = 360$ Constant.

The Constant divided by the Draft required will give you Draft Gear.

360 (Constant) divided by 10 (Draft required)=36 Draft Gear.

Suppose you require 9 of a draft.

360 divided by 9 equals 40 Draft Gear.

If you take the rule given before, the Counts would come a little lower than 50s. The reason for this is that 1/15 is generally taken up with the twist, which would make the numbers of the yarn heavier.

You must also watch the drag or gain in the carriage, for this is equal to putting in more draft. For if the Rolls only deliver 62 inches and the Stretch of the Mule is 64 inches, you are drawing the yarn finer.

A good rule to find the Numbers of the Yarn, from the hank roving, is the following:—

We will suppose the Roving in the Creel is 8 hank doubled. This would equal 4 hank, and you are going to put in 9 of a draft, and the Front Roll delivers 62 inches, and the length of stretch is 64 inches. Now find the Counts or Numbers of the Yarn.

Rule:—Multiply the H. R. 4, by the Draft 9, and the length of stretch 64 inches, and divide the product by the length delivered by the Front Roll 62 inches. Then deduct 1/15 from your answer for twist and you will have the Counts or Numbers of the Yarn.

Example:

```
                      4 H. R.
                      9 draft
                     ---
                     36
                     64 L. of stretch
                    ----
                    144
                   216
                   ----
L..D. by F. R. 62)2304(37.16
                   186
                   ----
                    444
                    434
                    ----
                     100
                      62
                     ----
                      380
                      372
                      ----
```

```
Taken up by twist 1/15)37.16(2.47
                         30
                         ---
                          7.1
                          6.0
                         ----
                          1.16
                          1.05
                         -----
```

```
37.16
 2.47
-----
34.69 yarn you get. Answer.
```

To find the Draft Gear, from one number of yarn to another, without changing Roving:—

Suppose you have on a 45 Draft Gear, and spinning 40s yarn, and you wish to make 45s yarn out of the same roving.

Rule:—Multiply the 45 Draft Gear you have on, by the numbers you are spinning 40s, and divide the product by the numbers you wish to spin 45s.

```
   45
    40
   ———
45)1800(40  draft gear required for 45s yarn
   180
   ———
```

To find the Twist or Turns per inch required for the Numbers of Yarn you are going to spin:—

Suppose you are going to spin 36s Filling.

Rule:—Multiply the standard used for filling, which is 3.25 or 3¼, by the square root of the numbers you are going to spin.

Example:—Square root of 36 is 6, and 3.25 multiplied by 6 equals 19.50 or 19½ turns per inch for 36s filling.

When spinning warp yarns on mules:—

Multiply square root of Counts by 3.75. This gives turns per inch required.

The 3.25 and 3.75 are often left and standards of the overseer's used, as much depends on the quality of the cotton, and whether a hard or soft twisted yarn is required.

Sometimes a standard of 2 is used for very soft hosiery yarn.

This makes quite a difference to the turns per inch for the same numbers of yarns.

Take for example, you are spinning 16s hosiery yarn and using a standard of 2. You would say the square root of 16 is 4 and multiplied by 2 equals 8 turns per inch required to spin very soft hosiery yarn, and in using the standard 3.25 we get 13 turns per inch for exactly the same numbers of yarn.

To find Constant for Twist, or Turns per inch on Messrs. Hetherington's Rim at Back, or Ordinary Mule:—

Rule:—Multiply Front Roller Box Bevel gear 38, by gear 35, and by gear 58, and diameter of Rim Pulley 18 inches, and diameter of cylinder 6 inches, or 97 sixteenths. Take these for a dividend.

Then multiply the bevel gear 17, by the gear 28, and by diameter of Cylinder Pulley 12 inches, and by the diameter of spindle whirl ¾ of an inch or 13 sixteenths, and circumference of Front Roll 3.1416.

$$\frac{38 \times 35 \times 58 \times 18 \times 97 = 134686440}{17 \times 28 \times 12 \times 13 \times 3.1416 = 233282.6496}$$

$134686440.0000 \div 233282.6496 = 577$ constant.

Note.—Having 4 decimals in the divisor we must add 4 ciphers to the dividend.

```
                  38
                  35
            ─────────────
                 190
                 114
            ─────────────
                1330
                  58
            ─────────────
               10640
               6650
            ─────────────
               77140
                  18
            ─────────────
              617120
              77140
            ─────────────
             1388520
                  97
            ─────────────
             9719640
            12496680
            ─────────────
233282.6496)1346864400000(577 constant.
            11664132480
            ─────────────
             18045115200
             16329785472
            ─────────────
              17153297280
              16329785472
            ─────────────
```

```
     3.1416
         13
 ----------
      94248
     31416
 ----------
     408408
         12
 ----------
    4900896
         28
 ----------
   39207168
   9801792
 ----------
  137225088
         17
 ----------
  960575616
 137225088
 ----------
233282.6496
```

Note.—The writer would refer you to Arithmetic (Cancellation), as this example could be shortened considerably by cancelling the numbers.

The turns per inch required to be put in the yarn, divided into the Constant 577, give you the size of Speed Gear.

Suppose you want 20 Turns per inch.

Example: 577 divided by 20 equals 28 Speed Gear at the end of Rim Shaft.

The gears 38, 17, 35, and 28 are not generally changed, but the gear 58 is a change gear. With a 40 gear instead of a 58, the Constant is 398.

Note.—That 97 is used for diameter of cylinder, and 13 for diameter of whirl.

The reason is that we want to add 1/16 of an inch for thickness of spindle band. To do this reduce the cylinder to sixteenths of an inch. The cylinder being 6 inches diameter, and there are 16 sixteenths in 1 inch. Then multiply 16 by 6 and you get 96; add 1/16 for thickness of band and you get 97.

If there are 16 sixteenths in 1 inch, there must be 12 sixteenths in 3/4 of an inch whirl, and 1/16 added for thickness of band gives 13. This accounts for using the 97 and 13 for diameter of cyilnder and whirl of spindle.

Also note that when the Front Roll is 1 inch diameter, the circumference is 3.1416. This is used in the example. But suppose the Front Roll is 1 1/16 inches diameter, you must use 3.338 instead of 3.1416.

The reason is that the larger the diameter of the Front Roll the more it delivers at each revolution. Consequently you get less turns per inch with a thicker roll than you do with a thinner one when using the same gears. This rule applies to all mules.

Constant for Drag or Gain of Carriages over Front Roll on J. Hetherington's Mule:

Rule:—Multiply length of stretch 64 inches, by Gear on Front Spindle 60, and by small Gear on Drag Gear 25, and by diameter of Scroll on Back Shaft and Band reduced to eights of an inch. This is the dividend.

Then multiply Back Shaft gear 75, by diameter of Front Roll reduced to eights of an inch. Diameter of Front Roll 1 inch, or equal to 8 eights.

Example:

$$\frac{64 \times 60 \times 25 \times 45 = 4320000}{75 \times 8 \quad = \quad 600}$$

432000÷600=7200 constant.

Divide Constant by length of stretch and Drag required and you get Drag or Gain Gear.

Suppose length of stretch is 64 inches and you want a gain or drag of 3 inches. 64″ add 3″ equals 67″.

7200÷67=107 drag gear.

To find Constant for Turns per inch on Messrs. Hetherington's Rim at Side Mule:

Rule:—Multiply Front Roll Gear 90, by the gear 70, and by second change gear 70, by diameter of Rim Pulley 18 inches, and by diameter of cylinder 6 inches, or 97 (see Constant Rim at back). Then multiply the gear 45, by the gear 50, and by the diameter of the Cylinder Pulley 12, and by the diameter of the whirl ¾ of an inch or 13 (see Constant Rim at back), and by circumference of Front Roll 3.1416.

$$\frac{90 \times 70 \times 70 \times 18 \times 97 \ = 142590}{45 \times 50 \times 12 \times 13 \times 3.1416 = 204.2040}$$

(The above numbers were cancelled before being multiplied.)

142590.0000÷204.2040=698 constant.

Constant divided by turns per incl give speed gear.

The above Constant is with a 70 secon change gear on. With a 50 second chang gear, the Constant would be 498.5.

Suppose you want to put 20 turns pe inch in the yarn.

698 (Constant) ÷ 20 = 34 Speed Gear.

To find revolutions of Spindle to on revolution of Rim:

Suppose an 18 inch Rim is driving a 1 inch Cylinder Pulley, and a 6 inch Cylin der is driving a ¾ inch whirl on Spindle

Rule:—Multiply 18 inch Rim by the inch cylinder for a dividend. Then mul tiply the 12 inch Cylinder Pulley by th ¾ inch whirl, for a divisor.

Example:

$$\frac{18 \times 6 = 108}{12 \times .75 = 9.00}$$

108 ÷ 9.00 = 12 revolutions of spindle.

Note that decimal 75 is used for the ¾ whirl. The reason is that .75 is ¾ of 100

You can also place the terms thus:

$$\frac{18 \times 6 \times 4 = 432}{12 \times 3 = 36}$$

432 ÷ 36 = 12 revolutions of spindle to on of rim.

If it is a ⅞ whirl place thus:

$$\frac{18 \times 6 \times 8 = 864}{12 \times 7 = 84}$$

864 ÷ 84 = 10.28 revolutions.

If it is one inch whirl:

$$\frac{18\times 6=108}{12\times 1=\ 12}$$

108÷12= 9 revolutions.

To find Twist Gear when putting Twist in on the Catch or Latch. Commonly called "Head Twist" on Hetherington's Mule:

Suppose you are going to put 30 turns per inch in, and the length of stretch is 57 inches, and 3 inches added if you have roller motion on. This would equal a 60 inch stretch. The diameter of cylinder 6 inches and the spindle whirl ¾ of an inch. Then there is the gear 20, driving the finger gear 68, and an 18 inch Rim, driving a 12 inch cylinder pulley.

Rule:—Multiply length of stretch 60 inches, by the turns per inch 30, and by gear 20 and diameter of cylinder pulley 12 and of whirl ¾ of an inch. Take this for your dividend.

Now multiply the finger gear 68 by the 18 inch rim, and by diameter of cylinder 6 inches.

Example:

$$\frac{60\times 30\times 20\times 12\times 3=1296000}{68\times 18\times 6\times 4\ =\ 29376}$$

1296000÷29376=44 Twist Gear required.

Draft Gear and Drafts are found exactly as explained on the Hetherington Mule.

To find Constant for Speed Gear, on Rim at Back:

Rule:—Multiply diameter of Rim, which we will suppose to be 19 inches, by diameter of cylinder 6 inches, and by Roller Box Gear 48. Take this for a dividend.

Then multiply Cylinder Pulley, which we will suppose to be 11 inches, by spindle whirl ¾ of an inch, and by Rim Pinion 22, and by Bevel Gear 24, which gears with Roller Box Gear, and by circumference of Front Roll 3.1416.

Example:

R. C. B.G.
19 × 97 × 48 = 88464

11 × 13 × 22 × 24 × 3.1416=237203.3664
C.P. S.W. R.P. B.G. F.R.

88464÷237203.3664=.372 constant.

When dividing 88464 by 237203.3664 add 4 ciphers to the 88464, as there are 4 decimals in 237203.3664, and the 3 figures in the Constant are decimals (.372 Constant).

The turns per inch required divided by the Constant will give you Speed Gear.

Note.—As the Constant is 3 decimals add 3 ciphers to your turns per inch before dividing.

Suppose you wanted to put in 30 turns per inch, and the Gears and Pulleys were the same sizes as we have used to find the Constant .372.

Proceed as follows: [turns per inch.

.372)30.000(80 speed gear required for 30
2976

.240

Note.—In these examples there is no allowance for slippage of bands.

Note.—Why the 97 and 13 are used for diameters of cylinder and spindle whirl is fully explained on the Hetherington Mule.

In finding Constant for Speed Gear, you may use 7/22 instead of 3.1416, if the Front Roll is an inch diameter, and you get the same result, as:

$$\frac{\overset{R.}{19} \times \overset{C.}{97} \times \overset{B.G.}{48} \times \overset{F.R.}{7}}{\underset{C.P.}{11} \times \underset{S.W.}{13} \times \underset{R.P.}{22} \times \underset{B.G.}{24} \times \underset{F.R.}{22}} = .372 \text{ Constant.}$$

If the Front Roll is 1 1/16 diameter place the terms as follows:

$$\frac{19 \times 97 \times 48 \times 16 \times 7}{11 \times 13 \times 22 \times 24 \times 17 \times 22}$$

or you can place them as follows, with exactly the same result, using 3.338 instead of 3.1416:

$$\frac{19 \times 97 \times 48}{11 \times 13 \times 22 \times 24 \times 3.338}$$

If the Front Roll is 1⅛ inches place as follows:

$$\frac{19 \times 97 \times 48 \times 8 \times 7}{11 \times 13 \times 22 \times 24 \times 9 \times 22}$$

or

$$\frac{19 \times 97 \times 48}{11 \times 13 \times 22 \times 24 \times 3.53}$$

If your mules are "Rim at Side" the Constant works out the same, the only change being the two gears from the Roller Box; on "Rim at Side" these gears are 60 and 30; on "Rim at Back" they are 48 and 24.

Constant for "Rim at Side" Mule with 1 inch Front Roll.

$$\frac{19 \times 97 \times 60 \times 7}{11 \times 13 \times 22 \times 30 \times 22} = .372 \text{ Constant.}$$

To find Twist Gear.

Asa Lees's mule differs from the Dobson and Barlow's and Hetherington's Mules, as the Worm for the Twist Gear is on the Cylinder Shaft and not on the Rim Shaft. So in finding the Twist Gear we have not to deal with the Rim Pulley or Cylinder Pulley.

Suppose the Cylinder is 6 inches and Spindle Whirl ¾ of an inch, and the two Gears cast together, which generally are 45 and 15.

Now suppose, for example, you are going to spin 100s and put in 30 turns per inch, and you wish to put ⅞ of the twist in as the carriage is coming out, and the other ⅛ whilst the carriage is on the latch or holding out catch, and suppose the length of the stretch is 57 inches, and a roller motion on delivering 3 inches, which makes the length of stretch equal to 60 inches.

Rule:—Multiply the length of stretch with Roller Motion added, 60 inches, by the turns per inch 30, and by diameter of spindle whirl ¾ of an inch and the gear 15, which drives the Twist Gear. Take this for your dividend.

Then multiply the diameter of Cylinder 6 inches by the Worm Gear 45. Take this for divisor.

Example:

$$\frac{60 \times 30 \times 13 \times 15 = 351000}{97 \times 45 \quad = 4365}$$

351000÷4365=80 twist gear required.

Constant for Twist Gear.

Rule:—Proceed exactly as when finding Twist Gear, but leave out the Turns per Inch 30.

Example:

$$\frac{60 \times 13 \times 15 = 11700}{97 \times 45 \ = 4365}$$

11700÷4365=2.68 Constant.

Constant multiplied by turns per inch will give Twist Gear.

2.68×30 turns per inch=80 twist gear.

Note.—There is no allowance for slipping of bands. The overseer must make his own allowance with these calculations.

Now we have got the Twist Gear, we want to put in ⅞ of the 30 turns per inch, until the carriage comes on the latch.

Multiply 30 by 7 and divide by 8 and we have 26.22 turns per inch to put in during outward run of carriage and the other ⅛ when the carriage is on the latch.

Take the Constant .372 and divide the turns per inch 26.22 by it, and you get the Speed Gear.

Example:

```
.372)26.220(70 speed gear.
     26.04
     -----
       .180
```

To change from one Number or Count to another without changing speed gear, but to change Rim.

Suppose you are spinning 50s with an 18 inch Rim Pulley and you want to change to 45s by changing your Rim and keeping on the same Speed Gear.

Rule:—Square the Rim Pulley 18 (that means multiply 18 by 18) and then multiply this by the numbers you wish to spin 45s, and divide by the numbers you are spinning, and the square root of the answer is the Rim required.

Example:

```
      18
      18
    ----
     144
      18
    ----
     324
      45
    ----
    1620
    1296
    ----
50)14580(291
    100
    ----
     458
     450
    ----
      80
      50
    ----
```

Square root of 291 is 17. Rim required for 45s.

Here is another and simpler way to get the Rim:

Multiply the 18 Rim by 45 and divide by 50, add 18 (Rim) and divide by 2.

Example:

```
      18
      45
    ----
      90
     72
    ----
  50)810
    ----
      16
      18
    ----
   2) 34
    ----
      17 rim required
```

To change from one Number to anoth without changing your Rim, but change Speed Gear.

Suppose you are spinning 50s with a Speed Gear, and you wish to spin 4 without changing your Rim.

Rule:—Square the Speed Gear you hav on 55, and multiply by the counts or num bers you wish to spin 45, and divide b the counts you are spinning and ge square root of quotient.

Example :

```
        55
        55
      ----
       275
      275
      ----
      3025
        45
      ----
     15125
     12100
     -----
  50)136125(2722
     100
     -----
      361
      350
     -----
       112
       100
     -----
       125
       100
     -----
```

Square root of 2722 is 52. Speed Gear required for 45s.

Another and easier way to find one Speed Gear from another:

Rule:—Multiply the Gear 55, by the counts 45s, and divide by the counts 50s, add the gear 55, and divide by 2.

Example:

$$
\begin{array}{r}
55 \\
45 \\
\hline
275 \\
220 \\
\hline
50)2475 \\
\hline
49 \\
55 \\
\hline
2)104 \\
\hline
\end{array}
$$

52 speed gear required.

Note.—If the speed gear is a **driver,** instead of being larger for finer numbers it will be smaller.

To find Drag Gear for 64 inch draw.

Rule:—Multiply revolutions of Front Roll per stretch, which we will say for example are 20, by gear on Front Roll 47, and by small gear on Drag Gear 25. Take these for a dividend.

Then multiply turns of Back Shaft per stretch or draw 3.6 by Back Shaft Gear 72.

Example:

$$
\frac{20 \times 47 \times 25 = 23500}{3.6 \times 72 \quad = 259.2}
$$

23500.0÷259.2=90 drag gear.

To Find Shaper Gear.

For 1⅛ inch gauge of spindle, or, in other words, when the spindles are 1⅛ inches apart, and the Shaper screw is Pitch 4. This meaning 4 threads to the inch. Then multiply the numbers you are going to spin by .7.

Suppose you are going to spin 30s.

Example:—30 multiplied by .7= 210; strike off the cipher, as it was decimal 7 you multiplied by. Then we get a 21 Shaper Gear for 30s yarn.

If your spindles in the mule are 1⅜ inches apart, and a Shaper screw, pitch 6, your Shaper Gear will be similar to the numbers you are spinning. Suppose you are spinning 40s, your Shaper Gear will be about 40.

A fast rule cannot be given for the Shaper Wheel, as much depends on the weight on the Counter or under Faller, and the tightness of the winding, also the length of chase. If you have a long chase, the cop will be thinner than with a short chase, although you use the same Shaper Wheel.

Production of Mule.

Suppose a mule contains 900 spindles and it is running 4 stretches or draws a minute. Length of draw is 64 inches and 3 inches added for roller motion equals 67 inches. Find how many hanks per spindle, and the weight turned off in 56 hours, deduct 3 hours for doffing and other stoppages, and the numbers of the yarn being spun is 40s.

Rule:—Reduce the 53 hours to minutes by multiplying the 53 by 60, then multiply this by draws per minute 4, and by length of draw 67. Take this for your dividend.

Then multiply 840 (1 hank) by 36 inches (1 yard).

Example:

$$\frac{53\times60\times4\times67=852240}{840\times36 \quad =30240}$$

852240÷30240=28 hanks per spindle.

Now we will find the weight per week.

Rule:—Multiply the number of spindles 900, by the hanks per spindle 28, and divide by the number of yarn 40s.

Example:

```
      900
       28
     ----
     7200
    1800
     ----
40)25200(630 lbs. per week.
    240
     ----
     120
     120
     ----
        0
```

To find the average Numbers or Counts being spun.

Suppose you have spun 1000 lbs. of 80s, and 1000 lbs. of 70s, and 1500 lbs. of 50s, and 2000 lbs. of 40s, and 2000 lbs. of 36s, and 5000 lbs. of 28s. Now what is your average number or count?

Rule:—Multiply each weight by counts and add them together.

Then add all the weights spun and divide the total into the weights multiplied by counts.

Example:

Weight Spun.				Counts.		
1000	lbs.	multiplied	by	80	equals	80000
1000	lbs.	multiplied	by	70	equals	70000
1500	lbs.	multiplied	by	50	equals	75000
2000	lbs.	multiplied	by	40	equals	80000
2000	lbs.	multiplied	by	36	squals	72000
5000	lbs.	multiplied	by	28	equals	140000
12500						517000

517000÷12500=41s average numbers of yarn.

To find Constant for Speed Gear on **D. & B. Mule.**

We will suppose the Rim Pinion is 19, driving a 48 gear on Compound, and the small gear on Compound 35, driving Speed Gear (which you omit when finding Constant for Speed Gear), and on opposite end of Side Shaft is a Bevel Gear 40, driving another Bevel Gear 40 on Front Roller Catch Box.

The Rim 18 inches diameter, driving a Cylinder Pulley 12 inches, and a 6 inch Cylinder, driving a ¾ inch whirl on spindle, and Front Roll 1 inch diameter.

Rule:—Multiply Bevel Catch Box Gear 40, by gear on Compound 48, and diameter of Rim Pulley 18 inches, and diameter of Cylinder 6 inches. Take these for your dividend.

Then multiply Bevel Gear on Side Shaft 40, by small Gear on Compound 35, and Rim Shaft Pinion 19, and diameter of Cylinder Pulley 12 inches, and diameter of Whirl ¾ of an inch, and Front Roll

1 inch (here you can use 7/22, or 3.1416 for Front Roll).

Example:

$$\frac{40\times48\times18\times\ 6\times\ 4\times\ 7=\ 5805080}{40\times35\times19\times12\times\ 3\times22=21067200}$$

5805080÷21067200=.275 constant.

Note.—The three figures in the Constant are decimals, so when you divide the Turns per Inch by them always have three decimal places.

The Turns per Inch divided by Constant will give you Speed Gear.

Suppose you want to put in 19.3 turns per inch, you must add 2 ciphers after the 19.3, so as to have as many decimals as there are in the Constant.

Example:

```
.275)19.300(70 speed gear required.
     19.25
     -----
       .50
```

If you wish to add 1/16 of an inch for thickness of Spindle bands, place your terms as follows:

$$\frac{40\times48\times18\times97\times\ 7}{40\times35\times19\times12\times13\times22}=\text{Constant.}$$

If a 7/8 whirl and 1 1/16 front roll, place as follows:

$$\frac{40\times48\times18\times\ 6\times\ 8\times16\times\ 7}{40\times35\times19\times12\times\ 7\times17\times22}=\text{Constant.}$$

If a 3/4 whirl and 1 1/8 front roll, place as follows:

$$\frac{40\times48\times18\times\ 6\times\ 4\times\ 8\times\ 7}{40\times35\times19\times12\times\ 3\times\ 9\times22}=\text{Constant.}$$

All these examples will give Constant for Speed Gear.

Note.—If you have not the Speed Gear required, you can overcome the difficulty by changing the 35 gear on the Compound.

To Find Twist Gear.

Suppose the length of stretch is 57 inches, and a Roller Motion delivering 3 inches. This would equal 60 inch draw. You wish to put in 30 turns per inch, and you have an 18 inch Rim driving a 12 inch Cylinder Pulley, and a 6 inch Cylinder driving a ¾ whirl on spindle.

Rule:—Multiply length of draw 60 inches, by Turns per inch 30, and by Cylinder Pulley 12 inches, and diameter of Whirl on Spindle ¾ of an inch. Take this for your dividend.

Then multiply the Rim 18 inches by Cylinder 6 inches. Take this for your divisor.

Example:

$$\frac{60\times 30\times 12\times 3=64800}{18\times 6\times 4 = 432}$$

$64800\div 432=150.$

$150\div 2=75$ twist gear.

Note.—Always divide your answer by 2 on the D. & B. Mule, as it always works out twice the size of Twist Gear required.

The reason you divide by 2 is: The Twist Gear revolves twice each draw, and on the Asa Lees's Mule the Twist Gear only revolves once each draw.

To Find Drag Gear.

Suppose the Front Roll makes 19 revolutions per draw, and the Front Roll Spur Gear is 51, and Drag Gear Pinion is an 18, and Back Shaft Gear 68, and revolutions of Back Shaft 3.5 for a 64 inch draw.

Rule:—Multiply Rev. of Front Roll 19, by Front Roll Spur Gear 51, and by Drag Gear Pinion 18. Take these for your dividend.

Then multiply Back Shaft Gear 68 by Rev. of Back Shaft 3.5. Take this for your divisor.

Example:

$$\frac{19\times51\times18=17442}{68\times3.5\ =238}$$

$17442\div238=73$ drag gear.

Note.—For 60 inch draw use 3.28 instead of 3.5 for Rev. of Back Shaft and for 54 inch stretch use 2.95.

To Find Draft.

Suppose you have a 120 Crown Gear on, and 54 Back Roll Gear, and an 18 Front Roll Gear, and 40 Change Gear. Find the Draft.

Example:

$$\frac{120\times54=6480}{18\times40=\ 720}$$

$6480\div720=9$ of a draft.

Diameter of Rim	10 inch Cylinder Pulley		11 inch Cylinder Pulley	
Inches	6 in.Cyl. ¾whirl	6 in.Cyl. 1 in.whirl	6 in.Cyl. ¾ whirl	6 in.Cyl. 1 in.whir
12	8.95	6.84	8.14	6.22
13	9.70	7.41	8.81	6.73
14	10.44	7.99	9.49	7.26
15	11.19	8.55	10.17	7.77
16	11.93	9.12	10.84	8.29
17	12.68	9.70	11.52	8.81
18	13.43	10.27	12.20	9.33
19	14.19	10.84	12.90	9.85
20	14.92	11.41	13.56	10.37
	12 inch Cylinder Pulley		13 inch Cylinder Pulley	
12	7.46	5.70	6.88	5.26
13	8.14	6.17	7.46	5.70
14	8.70	6.65	8.02	6.14
15	9.32	7.12	8.60	6.57
16	9.94	7.61	9.17	7.01
17	10.56	8.08	9.75	7.46
18	11.19	8.56	10.33	7.90
19	11.82	9.03	10.91	8.32
20	12.43	9.50	11.47	8.77

When finding turns of spindle to one o Rim, there is 1/16 of an inch added fo thickness of spindle band to the Cylinde and Whirl.

The 6 inch Cylinder is reduced to six teenths. This is got by multiplying 1 by 6, which equals 96, and 1/16 added fo thickness of band equals 97.

There are 12 sixteenths in 3/4 of an inch, and 1/16 added equals 13.

There are 16 sixteenths in 1 inch, and 1/16 added equals 17.

Suppose you have on an 18 inch Rim, and a 12 inch Cylinder Pulley, a 6 inch Cylinder, and a ¾ inch Whirl.

Place them as follows:

$$\frac{18\times 97=1746}{12\times 13=156} \qquad 1746\div 156=11.19 \text{ turns.}$$

Suppose the whirl was 1 inch instead of 3/4. Place as follows:

$$\frac{18\times 97=1746}{12\times 17=204}$$

1746÷204=8.56 turns of spindle to one of rim.

NUMBERING YARNS.

For every revolution of Reel handle, the Reel revolves twice and winds on 1½ yards at each revolution of Reel. If the handle has made 40 revolutions, the Reel has made 80 revolutions, and 80 times 1½ yards equals 120 yards or 1 Lea.

Suppose 120 yards of yarn weighs 25 grains. You divide the 25 into 1000 and this gives the Number or Count of the Yarn.

Example: 1000÷25 grs.=40s. yarn.

The reason for dividing 1000 by the weight (in grains) of 120 yards is because 120 yards is equal to 1/7 of 840 yards, or 1 hank, and 1000 equals 1/7 of 7000 grains, or 1 lb.

To Find Draft.

Suppose you have on an 84 Back Roll Gear, and a 40 Change Gear, a 120 Crown Gear, a 30 Front Roll Gear, and the Back Roll is ⅞ of an inch diameter, and the Front Roll 1 inch diameter or 8 eights.

Rule:—Multiply Back Roll Gear 84, by Crown Gear 120, and by diameter of Front Roll 1 inch, or 8 eights. Take this for a dividend.

Then multiply Change Gear 40 by Front Roll Gear 30 and diameter of Back Roll 7 eights.

Example:

$$\frac{84\times120\times8}{40\times\ 30\times7}=9.6 \text{ draft.}$$

To Find Constant for Draft Gear.

Rule:—Proceed exactly as when finding draft, but leave out the Draft Gear.

Example:

$$\frac{84\times120\times8}{30\times7}=384 \text{ constant.}$$

Constant divided by draft required gives Draft Change Gear.

Example: 384 (constant) $\div$ 9.6 draft = 40 change gear.

To Find "Turns per Inch" on the Whitin Spinning Frame.

Rule:—Multiply Front Roll Gear 108, by Stud Gear 74, and by diameter of Cylinder 7 inches. Take these for a dividend.

Then multiply Twist Gear (which we will suppose to be) 40, by Cylinder Gear 36, and diameter of whirl ¾ inch and circumference of Front Roll 3.1416.

Example:

$$\frac{108 \times 74 \times 7}{40 \times 36 \times .75 \times 3.1416} = 16.48 \text{ turns per inch.}$$

Deduct 11% for slippage and thickness of bands.

16.48 less 11%=14.65. Actual turns per inch.

To Find Constant for Twist Gear on Whitin Frame.

Rule:—Proceed as when finding "turns per inch," but omit the Twist Gear.

Example:

$$\frac{108 \times 74 \times 7}{36 \times .75 \times 3.1416} = 659$$

Deduct 11% from 659=586 Constant.

Constant divided by "turns per inch" gives Twist Gear.

Constant 586 divided by 14 turns per inch equals 42 Twist Gear.

To Find Turns Per Inch on the H. and B. Frame.

Rule:—Multiply Front Roll Gear 84, by Jack Gear 72, and diameter of Cylinder 7 inches. Take these for a dividend.

Then multiply Twist Gear (supposed to be) 40, by Cylinder Gear 21, and by diameter of Whirl ⅞ of an inch, and circumference of Front Roll 3.1416.

Example:

$$\frac{84 \times 72 \times 7 \times 8}{40 \times 21 \times 7 \times 3.1416} = 18.33$$

Deduct 15% from 18.33 on H. and B. Frames.

$18.33 \times .85 = 15.58$ actual turns per inch.

Constant for Twist Gear on H. and B Frame.

Rule:—Proceed as when finding turns per inch, but omit Twist Gear.

Example:

$$\frac{84 \times 72 \times 7 \times 8}{21 \times 7 \times 3.1416} = 733$$

Deduct 15% from 733.

$733 \times .85 = 623$ Constant.

Constant divided by turns per inch gives Twist Gear.

(Constant) $623 \div 15.58$ (turns per inch) = 40 T. G.

A fixed rule cannot be given for the weights of travellers, as an inferior grade of cotton, a large draft, and a larger ring, requires a lighter traveller. Whilst good stock, and more twist in the yarn, also the spindles running quicker, requires a heavier traveller, although spinning the same Counts or Numbers.

To Find Average Counts Being Spun.

Rule:—Proceed exactly as when finding average numbers given on the Mule.

Keep the spindle rail and roller beam level, the spindle perfectly upright, or vertical and in the centre of the ring, when the rail is at the highest and lowest point of traverse.

The guide wires should be set exactly over centre of the spindle (with spindle band on).

HORSE POWER REQUIRED.

	I.H.P.	Spindles.
Hopper Bale Breaker.........	2	
Automatic Feeder	1½	
Opener	2	
Picker (Single Beater)........	4	
Picker (Double Beater).......	8	
Flat Card	1	
Sliver Lap Machine...........	½	
Ribbon Lap Machine..........	1	
6 Head Single Nip Comber...	¾	
8 Head Single Nip Comber...	1	
Drawing Frame (12 Deliveries)	1½	
Slubbing Frame	1	45
Intermediate Frame	1	65
Roving Frame	1	85
Jack Frame	1	105
Fine Mule	1	130
Coarse Mule	1	115
Ring Spinning Frame.........	1	75