

FIG. 111. Double-can Drawing Box, showing Motor Drive.

set simply comprising two pairs of rollers of different surface speeds, between which the slubbing is drafted.

Fig. 111a is termed the two-spindle drawing box. A number of bobbins from the preceding or two-spindle gill-box, are placed behind this machine in the creel, and the slivers conducted to rollers R R^1 and R^2 , and forward to the front rollers, $F R$ and $F R^1$. Drafting takes place between rollers R^1 and R^2 , and the front rollers $F R$ and $F R^1$. The upper one is covered with leather and large in diameter, gripping the slubbing without injury to the staple of the wool. Over each roller, $F R$, is placed a brush, c , for cleaning functions.

The pressure of $F R$ on $F R^1$ may be regulated by the hand screws, $H S$. The slubbing on leaving the front rollers, passes through a hole, L and N , of a sleeve on the top of the spindle, s , then through the top guide, I , of the flyer, P , round one part of the flyer to the lower guide, I^1 , and on to the bobbin, B . The spindles are driven by belts (not shown) round pulley, P .

It is the difference between the speed of the bobbin and the flyer, revolving round the bobbin and distributing the slubbing on the same, which controls the degree of twist inserted into the slubbing.

The chief difference in *open* and *cone* drawing consists in the method of varying the speed of the bobbin as it gets larger in circumference by coil upon coil of thick thread being wound upon it. In open drawing, the bobbins are loose on the spindle, but the flyer is fixed. Round one part of the flyer, the thread is twisted, and then passed through a guide or twizzle on to the bobbin. The flyer, as it revolves with the spindle, drags the bobbin round; the more resistance the latter offers to the motion of the flyer, the greater its speed. It follows, therefore, that the heavier the bobbin becomes (*i.e.* fuller of yarn), the less is the difference between its speed and that of the flyer; thus the gradual increase in the weight of the bobbin as it fills with yarn, by increasing the *drag* between it and the flyer, causes its speed to accelerate as the slubbing is

wound upon it. By this means, the same length of slubbing is wrapped on the bobbin, whether full or empty. Now it will be observed that on the variation of the *drag* on the slubbing, depends, in open drawing, the speed of

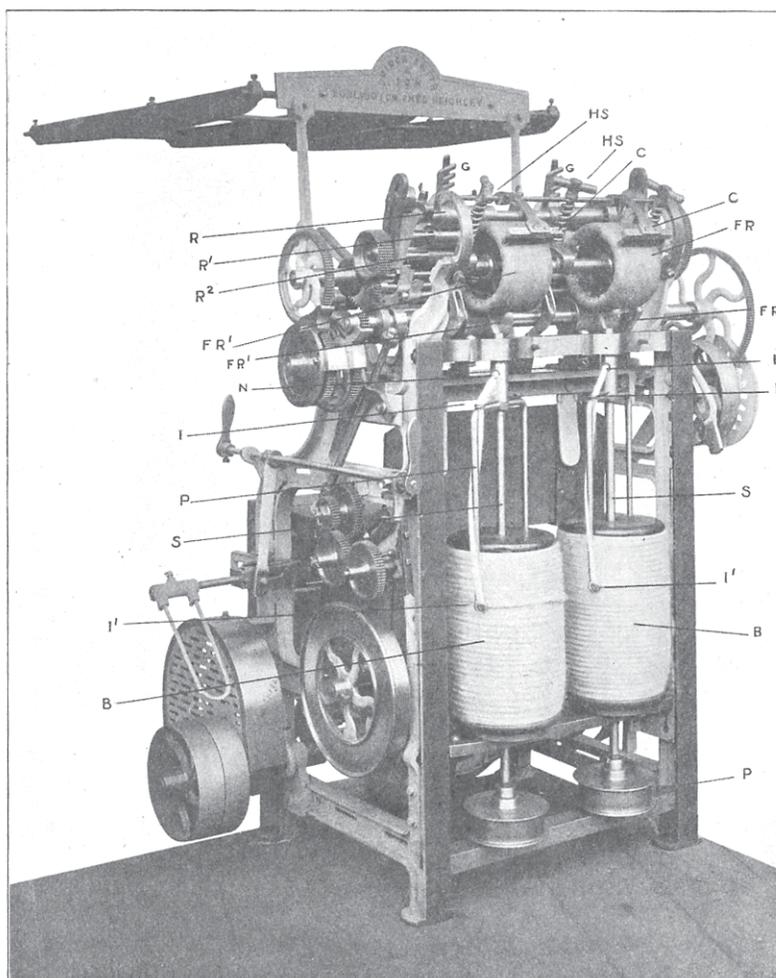


FIG. 111a. Two-spindle Drawing Box.

the bobbins. In *cone* drawing (Fig. 112), the speed of the bobbin is varied by mechanical arrangement, so that the tension on the slubbing is always uniform. The bobbin again runs loose on the spindle, but receives motion from the plate on which it rests, the latter being driven off the

two cones A and A¹. The base of the top cone is opposite the apex of the lower one. By strap, the upper cone A, revolving at a uniform speed, drives the lower cone, A¹. This strap travels from the base to the apex of the top cone during the filling of the bobbin. When the bobbin is empty, there is a 5-inch pulley driving a 2-inch, but when full, a 2-inch driving a 5-inch, so that the speed of the plate on which the bobbin is fixed gradually increases as the latter is filled with slubbing.

In other features the principle of *cone* drawing machinery is similar to *open* drawing. Each box possesses a pair of back and a pair of front rollers—with intermediate carriers—for drafting purposes. The endless leathers, 4, Fig. 112, take the place of rollers FR, Fig. 111*a*, and are under tension screw, s, control. The chief advantage of this system of “drawing” is the absolute uniform distribution of the slubbing and thread, at a like tension throughout the operation, on to the bobbin.

The principle of French drawing, which differs in essentials and also in the schemes of mechanism employed from English drawing, is described later.

82. *Roving*.—This is the last operation through which the slubbing passes before spinning. It may be defined as a combination of drawing and twisting, with an excess of *drawing*, while spinning is a combination of the same processes with an excess of *twisting*. In the roving-box two of the thick slubbings from the preceding machine are combined and reduced in size, but increased in length, as in the drawing machines, the operation being the same with the exception of imparting more twine to the soft thread formed. There is not much resemblance in the arrangement of the fibres resulting from the roving on the English drawing frames, and the condensed sliver from the carder (Specimens 4 and 8, Plates XXIV and XXV): the roving having been twisted may be further attenuated on the spinning frame before additional twine is inserted, whereas the sliver being devoid of twist could not be stretched without breaking.

83. *Worsted Spinning*.—The spinning frame used in worsted yarn manufacture, whether cap, flyer, or ring, differs in principle of construction from the self-actor. It is not required to impart twist in the same manner as in the condensed sliver. As already pointed out, the roving contains a degree of twist, and may correctly be called a spun thread. In the worsted spinning frame, the rollers

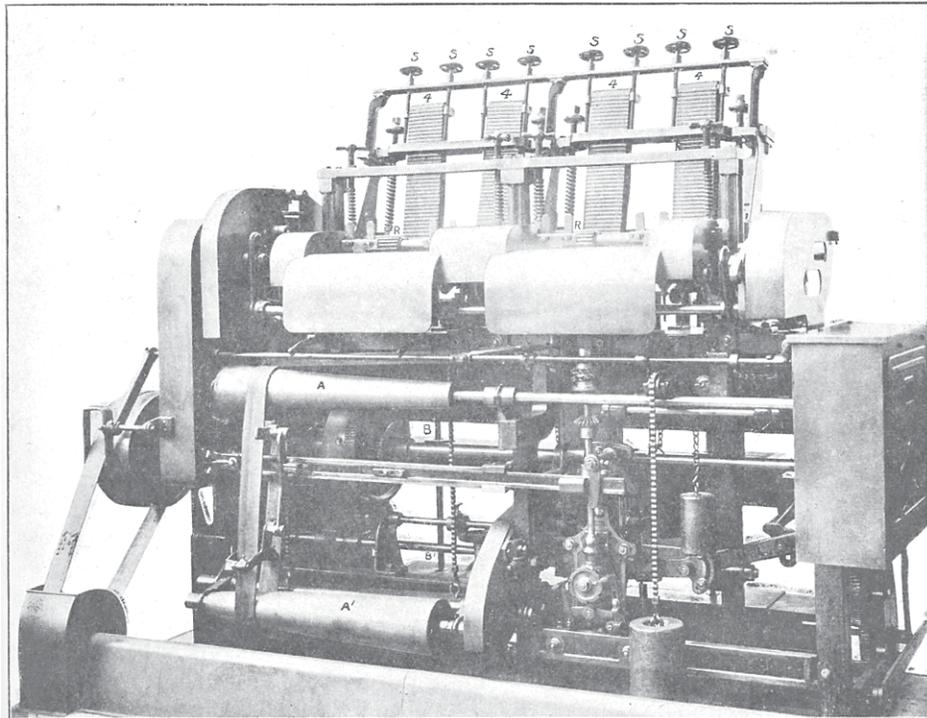


FIG. 112.

are so arranged as to draw out the roving before any twist is inserted.

Worsted spinning frames are of three classes, Flyer, Cap, and Ring. When the roving has been formed on the French principle, it is spun on the self-actor, giving really four methods of spinning worsted yarns. Whether the flyer, cap, or ring principle of twisting the roving and winding the yarn on to the bobbin is adopted, the method of drawing out the roving is the same. Thus, the roving

On this, the "flyer" principle, the bobbin runs loosely on the spindle. The flyer, *F*, Fig. 113, gives motion to the bobbin; and the degree of twist put into the yarn is determined by the relative speeds of the bobbin and the flyer. If, for example, the latter makes sixty turns per minute, and the bobbin fifty, there will be ten wraps of yarn on the bobbin for sixty turns of the flyer, or six turns in each

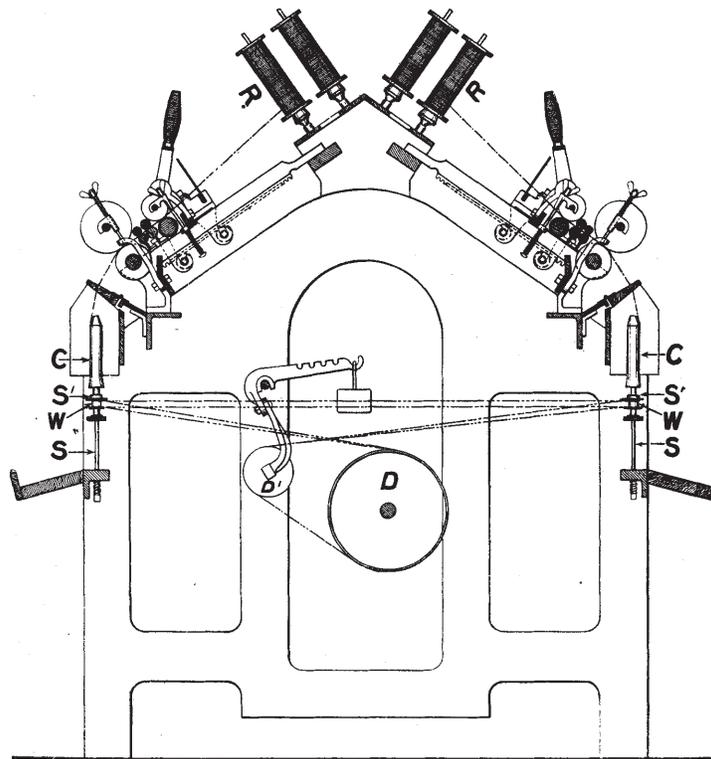


FIG. 114. Cap Spinning Frame.

wrap of yarn on the bobbin. The flyer has three functions: (1) it keeps the thread at a regular tension; (2) it inserts twist into the roving; and (3) winds the yarn on to the bobbin. In Fig. 113 the flyer is driven off a wharfl on the top of the spindle, and on the tension principle; this is the arrangement adopted by Hall & Stell in applying Foster's automatic doffing motion to their frames. Ordinarily, however, the drive is effected off the usual tin cylinder

running the whole length of the frame, a cord passing round this cylinder (one for each spindle) and a wharll on the spindle below the bobbin lifter plate. The bobbin slides up and down on the spindle, being carried by the "lifter." By twisting the thread round the arm, *a*, of the flyer, it is tensioned as it is wound on to the bobbin.

The principle of cap spinning (Figs. 114 and 114*a*)

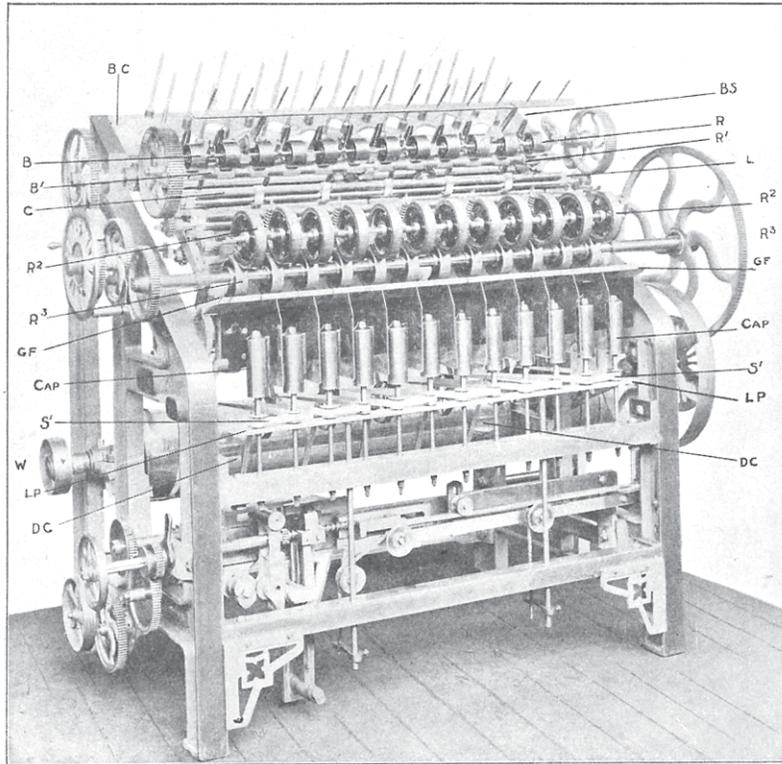


FIG. 114*a*. Prince Smith's Cap Spinning Frame.

is different from that of the flyer. Here the spindle has no rotary motion. A tube or shell, *s*¹, which carries the bobbin, is placed on it. The shell is mounted with a wharll, *w*, and like the spindle in the flyer frame is driven by drum, *DC*. The cap is inoperative. The lower rim of the cap is smooth and polished to cause as little friction as possible on the thread during spinning. By an up-and-down motion being given to the bobbin by the spindle, the yarn

is regularly wound. For fine yarns, cap spinning is better adapted than flyer spinning, as the spindles may be run at a very high speed. But for crossbred and lower qualities

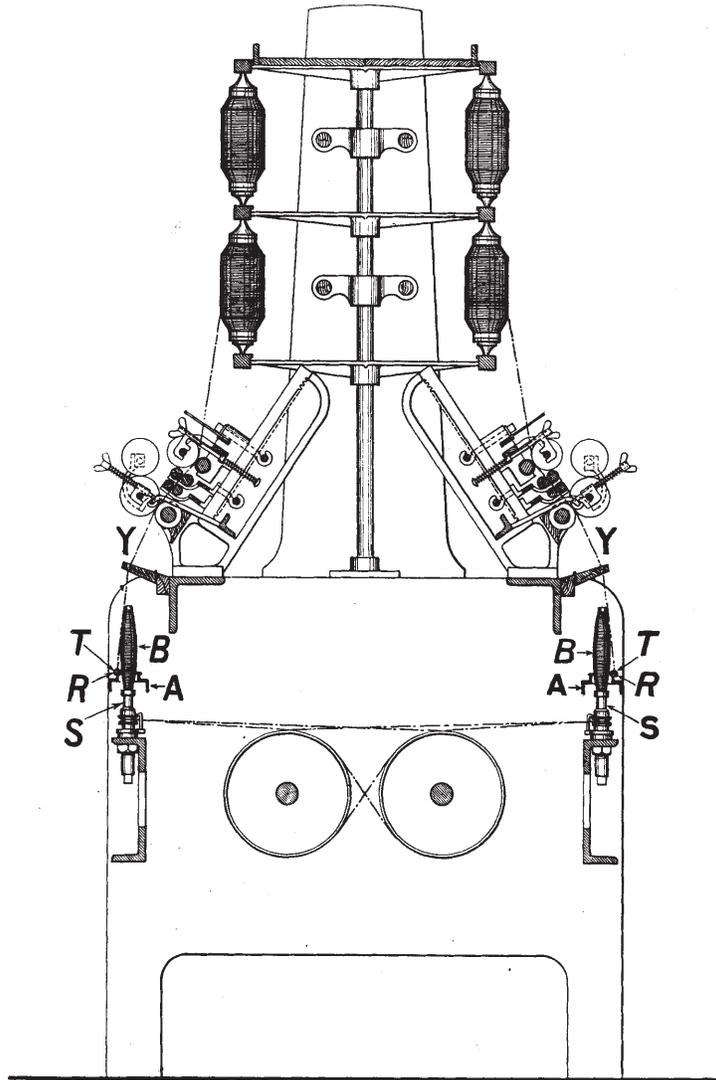


FIG. 115. Ring Spinning Frame.

of yarn, it is not as suitable on account of the friction developed between the rim of the cap and the surface of the yarn.

Fig. 115 is a section of the ring frame; B is the bobbin;

R , the ring; T , the traveller; S , the spindles; and Y the yarn. The bobbin is fastened on to the spindle revolving with it; and rail A rises and lowers during the process of winding the yarn on to the bobbin. Winding and twisting are effected by the bobbin and the traveller. The latter, under which the yarn is passed to the bobbin, revolves on the rim of ring, R . The shape of the bobbin of spun yarn is regulated by the motion of rail, A .

The ring frame in worsted yarn production is chiefly used for doubling purposes.

The worsted self-actor (sectional drawing, Fig. 116, Plate XXXIII) is a similar compound of intermittent motions to the woollen mule, with the exception of a continuous delivery of the slubbing during the spinning and twisting operations.

The routine consists in (1) drafting to the length required by the rollers R and R^1 , which correspond in function to similar rollers in the ordinary types of worsted spinning frames (Figs. 113, 114, and 115); so that the measure of attenuation is fixed by the adjustment of the two pairs of rollers from each other, and also of their relative speeds; (2) of the delivery of the drawn out or drafted sliver by rollers R R^1 , and of twisting during the receding of the carriage; (3) of the stopping of rollers R R^1 , and of the carriage on reaching the end of its traverse; (4) of the change of the speeds of the spindles from twisting to winding-on purposes, and of bringing the counter-faller into position for guiding the threads on to the spindles during winding; and (5) of the inward movement of the carriage, the spindles winding up the yarns. Small rollers 1 and 2 are carriers and R^2 a pressure roller.

The shape of the scroll (Fig. 116*a*) shows that the speed of the carriage is, with the exception of the starting and stopping points, practically uniform throughout the outward or twisting-period traverse.

The mechanism of control of the several motions, including drafting, delivery, twisting, movement of the carriage, and also for regulating the degree of twist, speeds of the

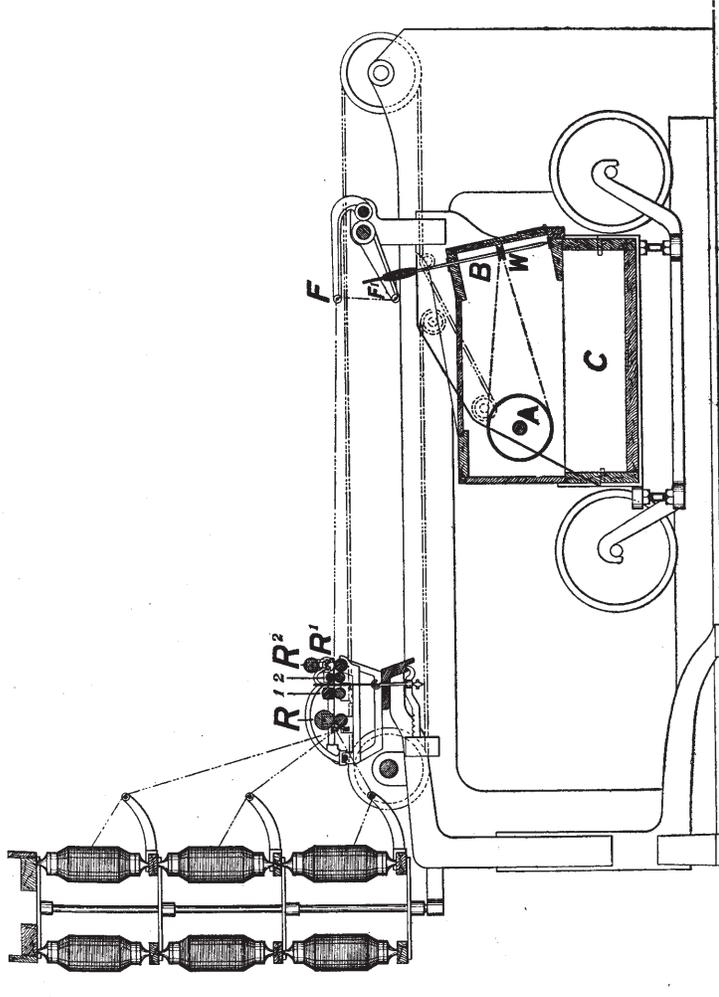


FIG. 116. SECTION OF WORSTED SELF-ACTOR.

spindles, winding-on, and the bobbin shaping, is similar in principle to that employed in the ordinary type of woollen mule described.

84. *Continental System*.—Up to backwashing, the processes of worsted yarn manufacture for fine wools are the same in both the English and Continental systems. Combing may also be done on the Noble machine, but French and German spinners favour the Heilman type, which is specially adapted for the treatment of very short wools and materials. But the results of combing, whether done on the Noble or the Rectilinear, are similar, and do not indicate any distinctive difference in the condition of the material. This begins in the process of drawing, and continues in mixing as performed on the *mélangeur*, and also in spinning on the self-actor. As noted, on the English system, from the first transference of the sliver—after doubling and drafting in the preliminary boxes

—on to bobbins, a degree of twist is introduced. This runs through the whole routine of a set of English drawing, up to and including, roving. On the French system it is

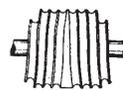


FIG. 116a.

exactly the reverse. At no stage in the sequence of operation is twist applied. The fibres composing the sliver remain perfectly parallel, the only adhesiveness mechanically produced being due to combining a number of slivers together, elongating them to the thickness of one of the group, and submitting them to the rubbing action of a pair of oscillating and rotating leathers.

85. *French or Continental Drawing*.—The entire system is uniform in principle from the first to the final operation. The material is drafted and levelled by the action of three pairs of rollers—back, middle and front, R^1 , R^2 , and R^3 , Fig. 117—having augmenting circumferential speeds from one to the other—and of a “porcupine” roller, P , placed between the middle and the front rollers. This takes the place of the fallers in an English set, and has a speed slightly above the back and the middle, but below that of the delivering rollers. It is made of brass

tubing studded with steel pins increasing in fineness and closeness of setting at each box. By fixing this roller a shade higher than the nip of the front rollers, the latter obtain a satisfactory grip of the wool, drawing it cleanly and effectively through the pins. Attached to each head is a pair of rubbing leathers, having a revolving and oscillating movement which roll or rub the fibres of individual slivers together, and carry them to horizontal bobbins, one for each head. These are made to rotate by fluted rollers, and have also a traverse action so as to give a cross wind of the material.

. Two kinds of winding are practised, namely, the single *mèche* or single sliver bobbin, that is, one sliver on each bobbin—customary at the first frame and the roving frame; and, second, double *mèche*, two slivers are run together on each bobbin, and which is favoured in this country.

The relative position of these parts in the machine are shown in Figs. 117 and 117*a*. The former is the roller stand for a drawing frame, and the latter an end view of the roving frame double *mèche* (*i.e.*, double sliver) cross wound on balls as sketched at B¹. Fig. 117 indicates the complete passage of the slivers from creel to the balling apparatus, namely, through fixed guides, G, between rollers R¹, forward to R², being slightly attenuated in the traverse, over the porcupine P, and to rollers R³, and thence to the rubbers.

The effect of the porcupine pins in straightening the fibres of the wool and removing curliness, is shown in the sectional sketch, Fig. 117*b*. The rubbers have the same action and effect on the slivers as in the condenser of a woollen carding machine, imparting adhesiveness and consistency to the slivers without adding twist. Passing from their control the slivers are conducted through guides to the bobbin B, driven by friction, and to which is given both a transverse and rotary movement.

In the machine following that sketched in Fig. 117*a*, namely, the finishing roving frame, the slivers are wound

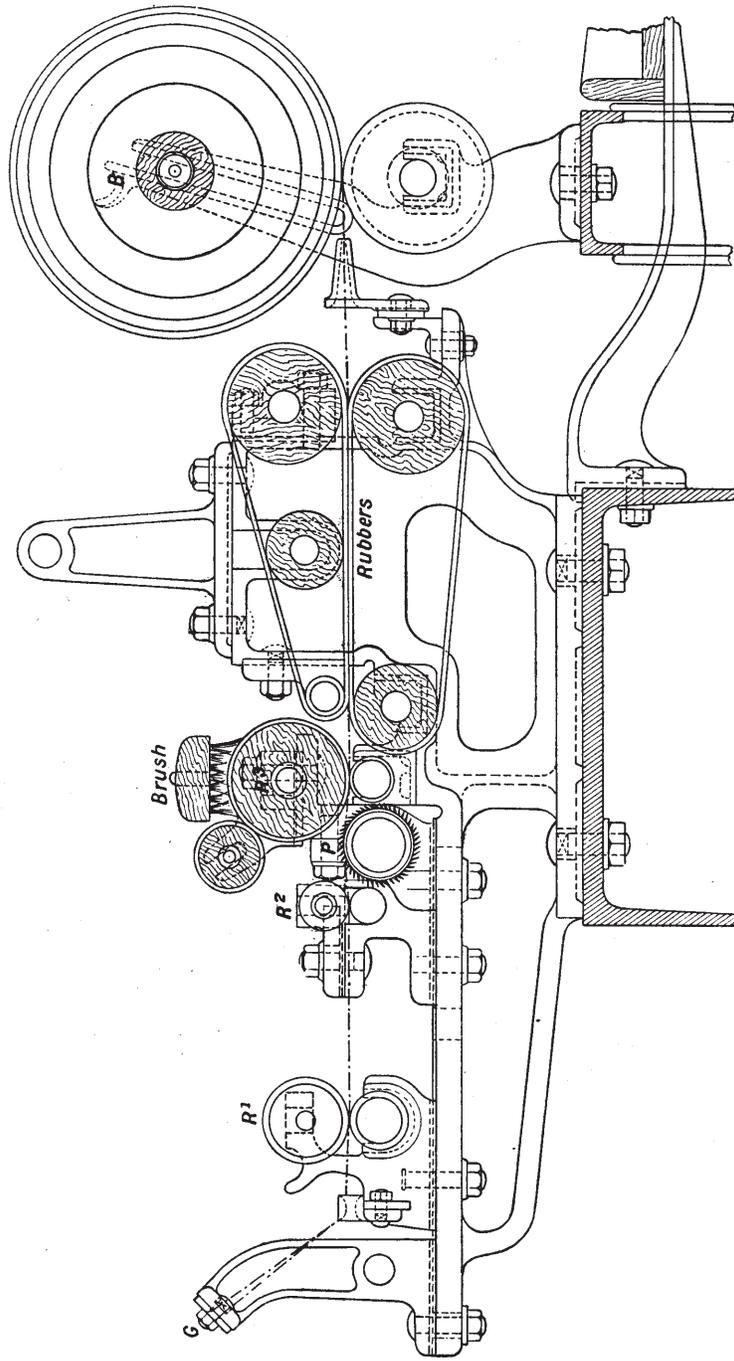


FIG. 117. Drawing Frame, Continental System.

on conical shaped bobbins, in which form they are ready for the self actor.

“ A feature of interest is the arrangement or dividing up of the slivers; two methods are available (a) single *mèche*, or the winding of one sliver per bobbin as is often done at

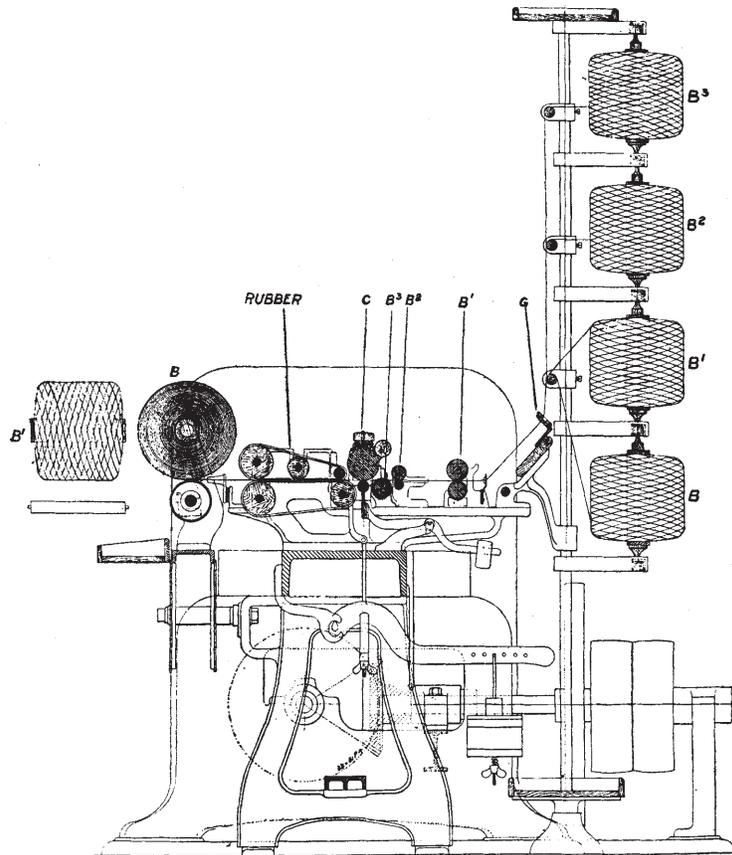


FIG. 117a. French Roving Frame (Double *Mèche*).

the first drawing frame and at the finishing roving frame, and (b) double *mèche*, where two slivers are wound together on each bobbin, a practice in favour in this country for each operation.

“ The system operates as follows: at the first drawing frame the bobbins in the creel are single *mèche*, and the slivers delivered and wound on to the bobbins in front are in single *mèche* form, and as there are twenty-four bobbins

in the creel and six bobbins at the front of the machine, there is a doubling of four ends into one.

“ At the second machine the bobbins in the creel will be also single *mèche*, but the delivery in this case is double *mèche*. Thus with such *mèche*, twenty-four bobbins in the creel and six double *mèche* deliveries at the front of the machine, the doubling is equal to two ends into one.

“ For the third machine twenty-four bobbins may be creeled, having two ends per bobbin, and six deliveries of double slivers are made at the front which provides a doubling of four ends into one.

“ In succeeding operations the bobbins, back and front,

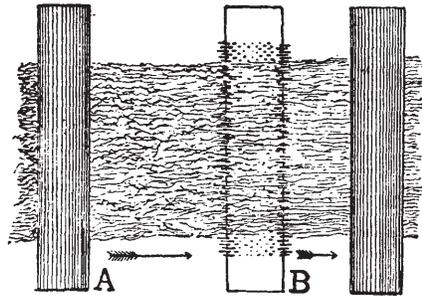


FIG. 117b.

are double *mèche*, and further details would simply give the number of ends doubled into one.”

STAGES IN DRAWING

These comprise the following:

I. Drawing Box. 24-single *mèche* bobbins delivered on to 6 bobbins, or equal to four slivers formed into one.

II. Drawing Box. 24-single *mèche* bobbins delivered on to 6 double-*mèche* bobbins, or two ends formed into one.

III. Drawing Box. 24-double *mèche* bobbins delivered on 6 double-*mèche* bobbins providing a doubling of four ends to one.

For the successive frames the double-*mèche* wind is practised both at the front and back of the machine.

This would be the routine in ordinary lots, in which case mixing for various shades is done in the usual way, the tops being blended on the gill-balling machine, the mixed gilled slivers, wound on bobbins, being run down the drawing. Providing a mixture of wool and cotton has to be made, then after treatment in the preparing gill-boxes, the material is run through the *mélangeur* (Fig. 118), a machine with four heads, each a complete drawing box, Nos. 1 and 4 being for the slivers of wool, and Nos. 2 and 3 for those of cotton. So that each material may be drafted separately, the driving and gearing of the first series are independent of the second series of boxes. The cotton may be either in the combed or uncombed state, but if combed it is in a more suitable condition for mixing with the wool. The slivers having passed through the respective boxes, are delivered to a balling head—one placed over the other, that is, a sliver of wool and a sliver of cotton, alternately, resembling in scheme of arrangement, the “bedding” for Angola blends for woollen carding and spinning.

The construction and working of the *mélangeur* will be understood from the view of the machine in Fig. 118. It consists of four heads or of four sets of drawing, 1 to 4 inclusive, each set delivering a separate sliver which passes over the metal guides, A, B, C, and D, to rollers, R¹, R², R³, and R⁴, which deliver the slivers on the table, T. Here they are collected and delivered as one on the bobbin, B¹.

Taking the materials to be from section No. 1 wool, from No. 2 and 3 cotton, and from No. 4 wool, they would be formed into one sliver on the table, and wound on to the bobbin B¹, prepared for the drawing frame. The slivers of different materials are placed in cans fixed behind the machine, the number necessary to give the required blend being fed to each head, 1, 2, 3, and 4.

86. *Method of Treatment for a Blend of Wool and Cotton (Worsted Yarn)*.—“The following detailed considerations show the preparation and machinery capable of delivering

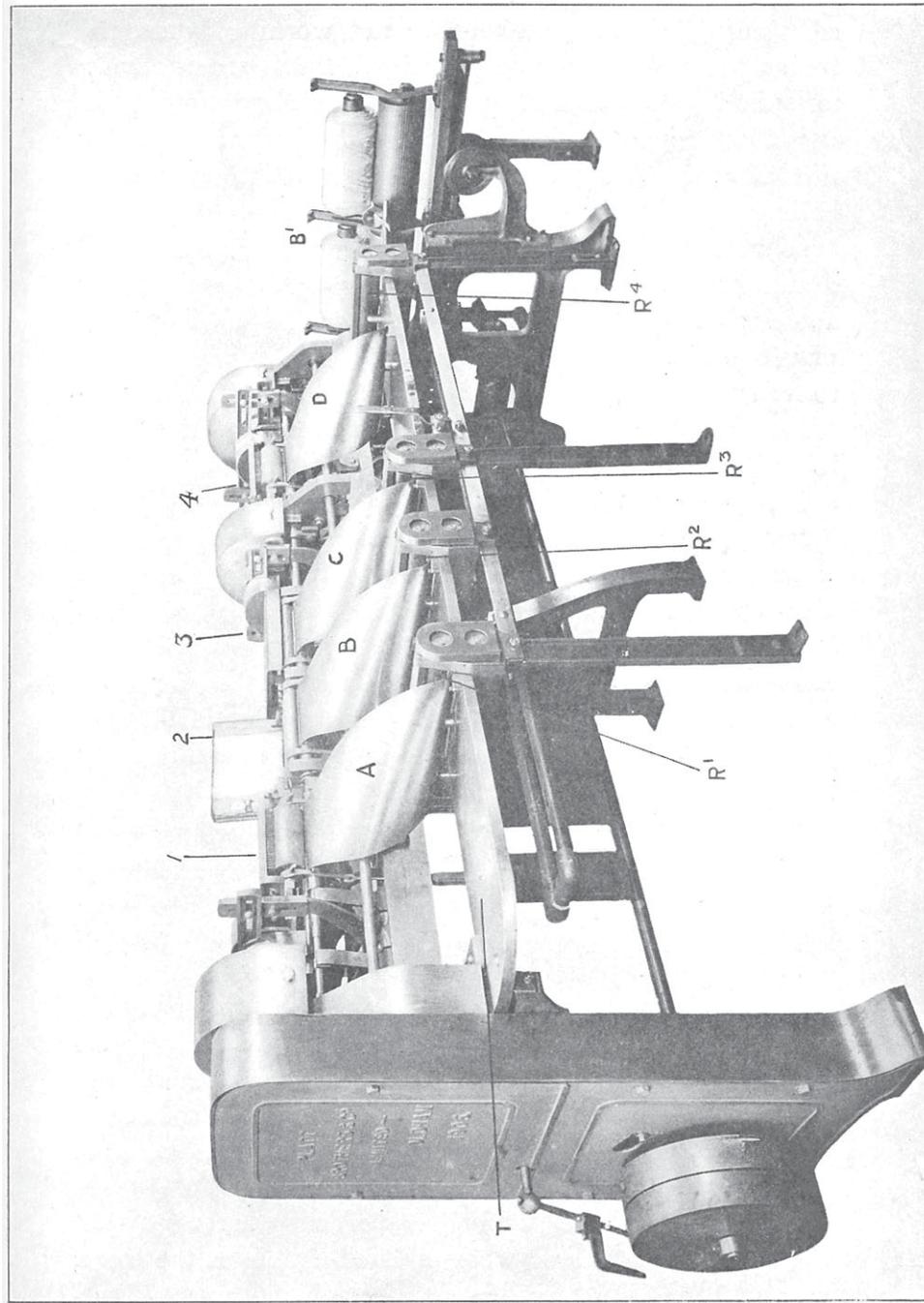


FIG. 118. *Mélangeur* or Mixing Machine.

5,600 lb. of Merino yarn (50 per cent. wool and 50 per cent. cotton) in one week of 50 net working hours, the roving to be 4.39 drams 40 yards, or a 4.16 hank roving for spinning 40's yarn on the worsted self-actor.

“The tops from the second finishing gill-box, requiring further preparation, are passed to a 4-bobbin screw gill balling machine; 8 tops are placed in the creel and the ends are doubled two into one; with tops weighing 273 drams per 40 yards which is equal to .067-hank roving and a draft of 6, the resulting slivers each equal 91 drams per 40 yards, or .2-hank roving which is a suitable weight to feed the *mélangeur* machine where the wool and the cotton are mixed together in a perfectly open condition, that is, neither the slivers of wool or cotton contain any twist.

“The class of machine most suitable has five boxes, three for wool, 1, 3, and 5, and two for cotton, 2 and 4. The driving and gearing of the rollers in the wool boxes is quite independent of those for the cotton boxes so that the drafts, between reasonable limits, can be varied as desired. The cotton will also have received suitable preparation and may be either combed or uncombed, by preference, the former.

“Behind the *mélangeur* are creeled 12 bobbins of wool; 16 cans of combed cotton are also placed in position and the whole so arranged that two ends of wool are doubled together at each roller, with a draft of 5, and 4 ends of cotton together with a draft of 6, and 6 wool slivers and 8 cotton slivers deliver together into each end or bobbin of the machine, which is equal, therefore, to doubling 14 ends into one; and as there are 3 wool boxes, and only 2 cotton boxes, the compound sliver wound on to each of the two bobbins in front is composed of 3 layers of wool and 2 layers of cotton.

“The weights and drafts have been so arranged that the combined layers of wool on each bobbin at the front, weigh 75 grains per yard, and the combined layers of cotton total 74 grains per yard, or a sliver weighing 218.3.

drams per 40 yards, or equal to .084 hank roving on each bobbin.

“Having placed the wool and cotton together in the required proportions and in a manner well suited for effective mixing, the batch may be passed to the French drawing processes, by which means, the preparation for actual spinning, or the roving, is obtained: nine passages or operations are required to complete this work.

“FIRST DRAWING FRAME: Twenty-four bobbins from the *mélangeur* are placed in the creel behind the machine and deliver to 6 bobbins in front of the machine with a draft of 4. There is therefore a doubling of four ends into one, and the weight of the sliver produced will be the same as the slubbing from the *mélangeur*, namely, 217.8 drams, or, in equivalent counts, .084 hank roving.

“SECOND DRAWING FRAME: Twenty-four ends in the creel deliver to six bobbins in front of the machine, but in this case the delivery is double, not single *mèche* as in the first box; in other words two drafted slivers are wound on to each of the bobbins, and each of the twelve slivers in front has received two slivers at the back and been submitted to a draft of 4.5; they therefore weigh 96.8 drams or equal .189 hank roving.

“THIRD DRAWING FRAME: Twenty-four double *mèche* bobbins are creeled at the back and pass material to six bobbins carrying double slivers in front, which is again equivalent to a doubling of four into one and with a draft of 4.2 gives a sliver of 91.9 drams or equal to .198 hank roving. The bobbins for these first three machines are 16" long.

“REDUCING FRAME: As the name implies a considerable reduction in the weight or thickness of the sliver takes place during the operation and further in this and all the subsequent operations of drawing; the bobbins measure 8" in length. Twenty-eight bobbins at the back deliver to fourteen bobbins in front of the machine with a draft of 5. Consequently the sliver is reduced from 91.9 drams to 36.9 drams, or expressed as lengths, or in hanks, from .198 to .496.

“SLUBBING FRAME: Fifty-six reducer bobbins supply twenty-eight bobbins at the slubber and with the doublings two into one and a draft of 4.2 the resulting sliver weighs 17.59 drams or is equal to 1.04 hank roving. Owing to the rapid reduction in thickness during these last two operations, to insure a uniform roving for spinning, the slivers pass through the next two operations without being changed in weight, and benefit considerably by the doubling and drawing they there undergo.

“FIRST INTERMEDIATE FRAME: One hundred and twelve bobbins from the slubbing frame are placed in the creel of this machine and pass material to twenty-eight bobbins in front, four ends being doubled into one with a draft of 4. The sliver thus weighs 17.59 drams, which is equivalent to 1.04 hank roving.

“SECOND INTERMEDIATE FRAME: One hundred and twelve bobbins fill the creel at the back, and the slivers pass to twenty-eight bobbins in front, yielding a doubling of four into one and have a draft of 4. The weight of the sliver still remains 17.59 drams.

“ROVING FRAME: One hundred and twelve bobbins are creeled and furnish material to fifty-six bobbins on this machine. Thus the doubling is equal to two ends into one and this with a draft of 4 causes a reduction in the weight of the sliver by one half, *e.g.*, 8.79 drams or 2.08 hank roving.

“TWO FINISHING ROVING FRAMES: One hundred and twelve bobbins are put up at the back of each of these machines and deliver to fifty-six bobbins in front; thus with a doubling of two and a draft of 4 the required finished weight of roving (4.39 drams = 4.16 hank roving) is obtained.

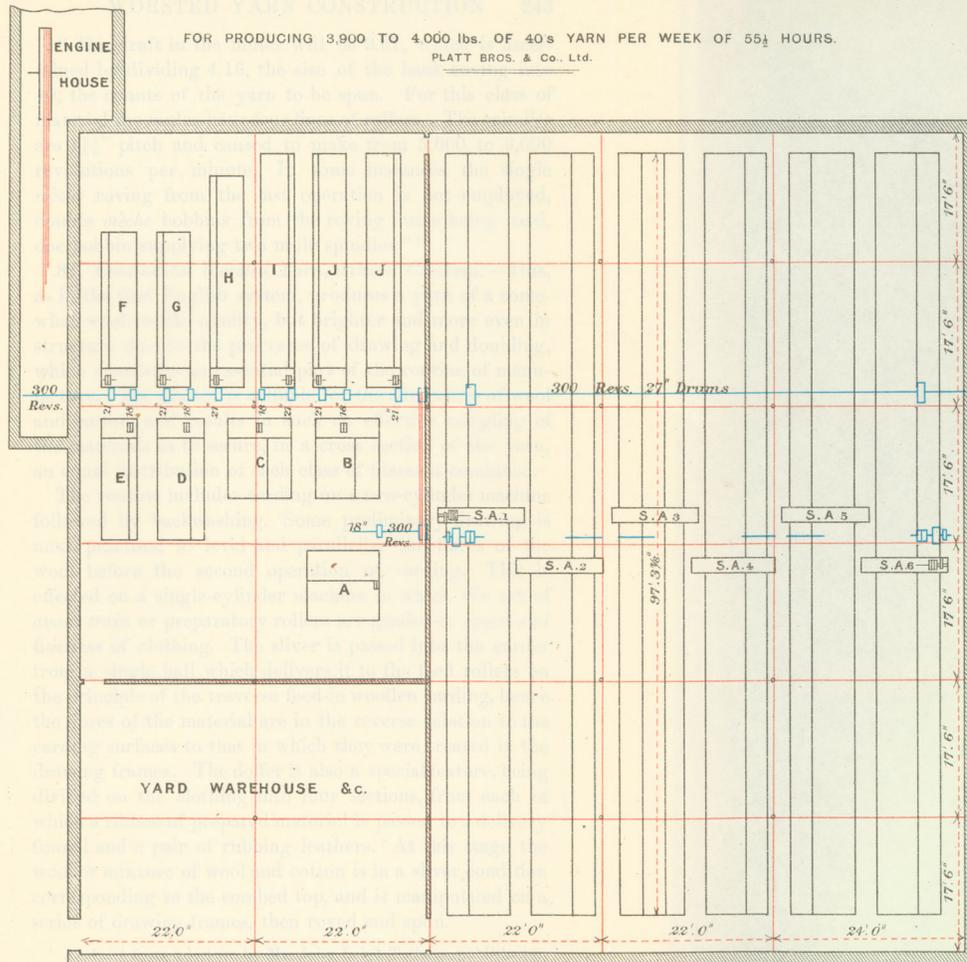
“SELF-ACTING WORSTED SPINNING MACHINE: The finished rovings are now ready for spinning into merino yarn equal to 40's counts, or 40 hanks of 560 yards each per pound; as the production is estimated to be 40 hanks or one pound of yarn per spindle per week, eight mules of 700 spindles each would be required to follow the drawing machinery specified and produce of 5,600 pounds of yarn per week.

PLAN OF A SET OF CONTINENTAL WORSTED DRAWING AND SPINNING MACHINERY

PLATE XXXIV

FOR PRODUCING 3,900 TO 4,000 lbs. OF 40s YARN PER WEEK OF 55½ HOURS.

PLATT BROS. & Co., Ltd.



- A. Screw Gill Balling Machine of 4 heads and 1 delivery
- B. 1st Drawing, 4 boxes, 4 bobbins ... 450 ^{11/16} inch staff
- C. 2nd Drawing, 4 boxes, 4 bobbins ... 450 " staff
- D. 3rd Drawing, 8 boxes, 8 bobbins ... 17½ inch staff
- E. Reducing Frame, 8 boxes, 16 bobbins ... 17½ " staff
- F. Slubbing Frame, 11 boxes, 22 bobbins ... 17½ " staff
- G. 1st Intermediate Frame, 11 boxes 22 bobbins 18½ " staff

- H. 2nd Intermediate Frame, 16 boxes, 32 bobbins 17½ inch staff
 - I. Roving Frame, 18 boxes 36 bobbins... 17½ " staff
 - J. Finishing Roving Frames, 18 boxes, 36 bobbins 17½ " staff
- and
- S.A.¹, S.A.², S.A.³, S.A.⁴, S.A.⁵, S.A.⁶, Head Stocks of self actors Nos. 1 to 6, each of 650 spindles, 1½ inch pitch, and 63 inch stretch with a length over all of 97 feet 3¼ inches.

“The draft in the mules will be 9.61, which is ascertained by dividing 4.16, the size of the hank roving into 40, the counts of the yarn to be spun. For this class of material the mules have four lines of rollers. The spindles are $1\frac{1}{16}$ " pitch and caused to make from 5,000 to 6,000 revolutions per minute. In some instances the single *mèche* roving from the last operation is not employed, double *mèche* bobbins from the roving frame being used, one bobbin supplying two mule spindles.”¹

87. *Continental Worsted Yarn, without Combing*.—This, as in the first English system, produces a yarn of a somewhat woollen-like quality, but brighter and more even in structure due to the processes of drawing and doubling, which constitute an essential part of the routine of manufacture. The system is suitable for the admixture of wool and cotton, and results in such an effective mingling of the materials as to secure, in a cross section of the yarn, an equal distribution of each class of filament combined.

The routine includes carding on a two-cylinder machine followed by backwashing. Some preliminary drawing is next practised to level and parallelize the fibres of the wool before the second operation of carding. This is effected on a single-cylinder machine in which the set of *avant train* or preparatory rollers are graded in speed and fineness of clothing. The sliver is passed into the carder from a single ball which delivers it to the feed rollers on the principle of the traverse feed-in woollen carding, hence the fibres of the material are in the reverse relation to the carding surfaces to that in which they were treated in the drawing frames. The doffer is also a special feature, being divided on the clothing into four sections, from each of which a ribbon of prepared material is passed to a delivery funnel and a pair of rubbing leathers. At this stage the wool or mixture of wool and cotton is in a sliver condition corresponding to the combed top, and is manipulated on a series of drawing frames, then roved and spun.

¹ Abstract from a lecture by Mr. John Leigh Tatham, published in the “Leeds University Textile Journal,” edited by the author.

88. *Costing of Worsted Yarns.*—In calculating the cost of worsted yarns it is usual to proceed as follows:

I. Estimate the cost of the scoured wool.

II. Find the cost of the “top” thus:

(a) Take the net number of pounds of top yielded, and add the cost of “preparing” and “combing” to that of the clean wool.

(b) Deduct from these two items the value of the noil plus the value of the shoddy, and divide the result by the number of pounds of top.

(The number of pounds lost in manufacture represents the amount of “sinkage.”)

III. Ascertain the cost of “drawing,” “spinning,” and “doubling,” thus:

(a) Take the net weight of yarn yielded in pounds, and add the cost of spinning to that of the top.

(b) Subtract the value of the waste laps, clean waste, and sweepings from the above.

(c) Divide total cost of yarn by net weight in pounds.

EXAMPLE.—Find the cost per lb. of 2/36's worsted spun from 18,376 lb. of scoured cross-bred wool at 1s. per lb.

TABLE VIII

COSTING OF WORSTED YARNS

		<i>Cr.</i>			<i>Dr.</i>		
		£	s.	d.	£	s.	d.
I.	18,376 lb. scoured cross-bred wool	1s.			918	16	0
II.	Combing result—						
	13,242 lb. net top received	Combing	1½d.		82	15	3
	1,900 noil	Noil	6d.	47 10 0			
	165 lb. shoddy	Shoddy	2d.	1 7 6	1,001	11	3
	3,069 lb. sinkage						
				48 17 6	48	17	6
					952	13	9

13,242 lb. of top = £952 13s. 9d., or 1s. 5¼d. per lb.

		<i>Cr.</i>			<i>Dr.</i>		
		£	s.	d.	£	s.	d.
III. Result of—							
13,242 lb. of top, drawing, spinning, and doubling to 2/36's warp		Brought down			952	13	9
11,587 lb. net yarn received	Spinning, etc.	3½	d.		168	19	6
735 lb. of laps	Laps	1s. 3d.	45	18 9			
300 of clean waste	Clean waste	9d.	11	5 0	1,121	13	3
68 lb. of sweepings	Sweepings	4d.	1	2 8			
552 lb. of sinkage							
			58	6 5	58	6	5
					1,063	6	10

11,587 lb. of net yarn = £1,063 6s. 10d., or 1s. 10d. per lb.

TABLE IX

PRODUCTIVE POWER OF MACHINERY EMPLOYED IN WORSTED YARN MANUFACTURE

The following data form a general guide as to the productive power of the various machines employed in the production of worsted yarn.

WORSTED CARDING.

Production:

- On fine wool: 200 to 300 lb. per day.
- On coarse wool: 500 to 600 lb. per day.

Controlling Factors:

As for woollens, except that the work must be done with a minimum breakage of fibre.

BACKWASHER

Production:

- Double-Head Machine : 1,000 to 2,000 lb. per day.

Controlling Factors:

- I. Weight of sliver.
- II. Number of ends up.
- III. Number of drying cylinders.
- IV. Sizes of drying cylinders.

PREPARING GILL BOX

Production:

1,000 to 2,000 lb. per day of 10 hours.

Controlling Factors:

- I. Weight of slivers.
- II. Number of ends up.
- III. Speed of back rollers.
- IV. Size of back rollers.

PUNCH, OR WINDING MACHINE

Production:

1,000 to 2,000 lb. per day.

Controlling Factors:

- I. Speed of Spindle.
- II. Character of sliver.

COMBING (NOBLE'S SYSTEM)

Production:

Fine wool: 280 lb. per day.
Coarse wool: 800 lb. per day.

Controlling Factors:

- I. Weight of sliver fed in.
- II. Amount of sliver fed in per revolution.
- III. Speed of circle.
- IV. Tare or proportion of top to noil.

OPEN DRAWING

Production:

Hardly any two sets of drawing machinery exactly agree in composition.

WORSTED YARN CONSTRUCTION 247

A double set, as below, for *Botany* should give 2,400 lb. of 2-dram roving per week.

- Two double-can gill boxes.
- Two spindle-gill boxes.
- One 4-spindle drawing box.
- One 6-spindle weigh box.
- One 6-spindle 1st finisher.
- Two 6-spindle 2nd finisher.
- Four 8-spindle dandy finishers.
- Three 30-spindle reducers.
- Twelve 30-spindle rovers.

A double set for *crossbred*, as below, ought to give 4,000 lb., of 4-5 dram roving, per week,

- Two double-can gill boxes.
- Two 2-spindle gill boxes.
- One 4-spindle drawing box.
- One 6-spindle weighing box.
- One 8-spindle drawing box.
- Two 8-spindle finishers.
- Five 28-spindle rovers.

Controlling Factors:

- I. Materials.
- II. Weight of roving required.
- III. Number of reducing and roving spindles.

SPINNING (CAP FRAMES)

Production:

- Botany 1/60's : 1 lb. to 1½ lb. per spindle per week.
- Crossbred 1/40's : 2 to 3 lb. " " "
- Speed for botany : 6,400 to 7,000 revs. per minute.
- Speed for crossbred : 4,800 to 6,400 revs. per minute.

Controlling Factors:

- I. Material to be spun.
- II. Quality of thread required.

III. Speed at which it will spin.

IV. Turns per inch in the yarn.

V. Speed of the spindles.

Continental System.

The following is an example of the hanks, doublings, and drafts usually practised in producing 40's worsted yarn with approximately a .08 hank sliver delivered at the gill box, and a $4\frac{1}{4}$ hank sliver at the finishing roving frame.

Machines.	Hank Sliver in Creel.	Ends into 1.	Draft.	Hank Sliver delivered.
Gill Balling	—	—	—	.08
1st Drawing . . . . .	.08	2	4.0	.16
2nd Drawing . . . . .	.16	3	4.0	.212
3rd Drawing . . . . .	.212	2	4.0	.424
Reducing . . . . .	.424	2	4.25	.90
Slubbing . . . . .	.90	3	4.25	1.27
1st Intermediate	1.27	4	4.25	1.34
2nd Intermediate	1.34	3	4.25	1.89
Roving	1.89	4	4.25	2.00
Finishing Roving	2.00	2	4.25	4.25
S.A. Mule	4.25	1	9.41	40's.

The drawing machines should produce about 20 to 24 yards per minute, and the self-actor 40 hanks per spindle per week of $55\frac{1}{2}$ hours varying, of course, in turn out with local conditions.

Plate XXXIV (Messrs. Platt Bros.) is a plan of a set of preparing and spinning machinery, showing the methods of grouping the machines and the system of driving. The plant is capable of producing 3,900 lb. of 40's yarn per week. For such a plant a two-storied building would not be suitable. A shed, as sketched, with

one bay of 24 ft. and four bays of 22 ft. each by 105 ft. wide inside, would provide convenient floor space for the laying out of the machinery and also for working, with a yarn warehouse or store-room. For a larger plant say eighteen self actors and preparation either a shed or a three-storey building, with one section for the preparing and three sections for spinning, would be a satisfactory arrangement.

The horse-power required for driving the whole plant exclusive of friction and shafting, for which 25 to 30% should be added, is about 60, which might be generated by steam engine or by electric motor.

English Systems.

Plans (Messrs. Prince, Smith and Son) showing the system of arranging and driving, drawing, spinning and twisting machines for double-set plants for Botany, Crossbred and Long-wools, are given in Plates XXXV, XXXVI, and XXXVII.

Plate XXXV. Plan of a room containing a double set of Botany drawing with the necessary spinning and twisting to follow, and showing the production on 40's counts—per week of 55½ hours—with horse-power required for driving.

Plate XXXVI. Plan of a room containing a double set of crossbred drawing with necessary spinning and twisting.

Machine.	Diam. of Driving Pulleys.	Speed of Driving Pulleys.	Diam. of Drum.	Speed of Shaft.
Gills . .	12	200	16	150
Drawing .	12	200	16	150
Finishers .	12	200	16	150
Rovers . .	14	170	16	150
Spinners .	20	540	36	300
Twisting .	20	540	36	300

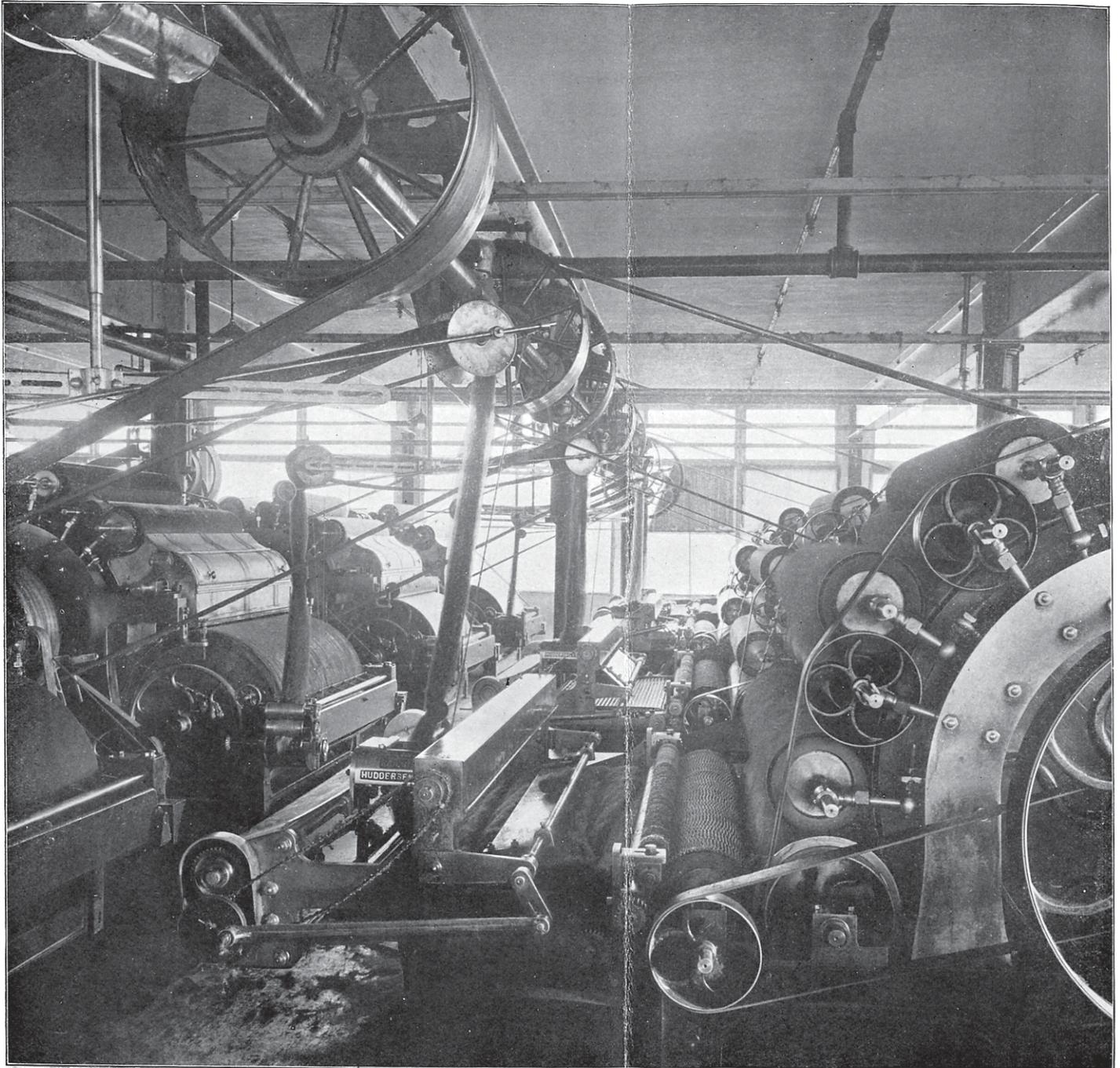
Plate XXXVII. Plan of a room containing a double set of long wool gilling, combing, drawing, and spinning plant.

Production on 24's counts 5,200 lb. per week.

Horse-power required for drawing, 15 ; for spinning and twisting, 110.

Machine.	Diam. of Driving Pulleys.	Speed of Driving Pulleys.	Diam. of Drum.	Speed of Shaft.
Gills . .	12	200	16	150
Drawing .	12	200	16	150
Finishing .	12	200	16	150
Roving . .	14	170	16	150
Spinning .	20	340	18	300
Twisting .	20	450	30	300

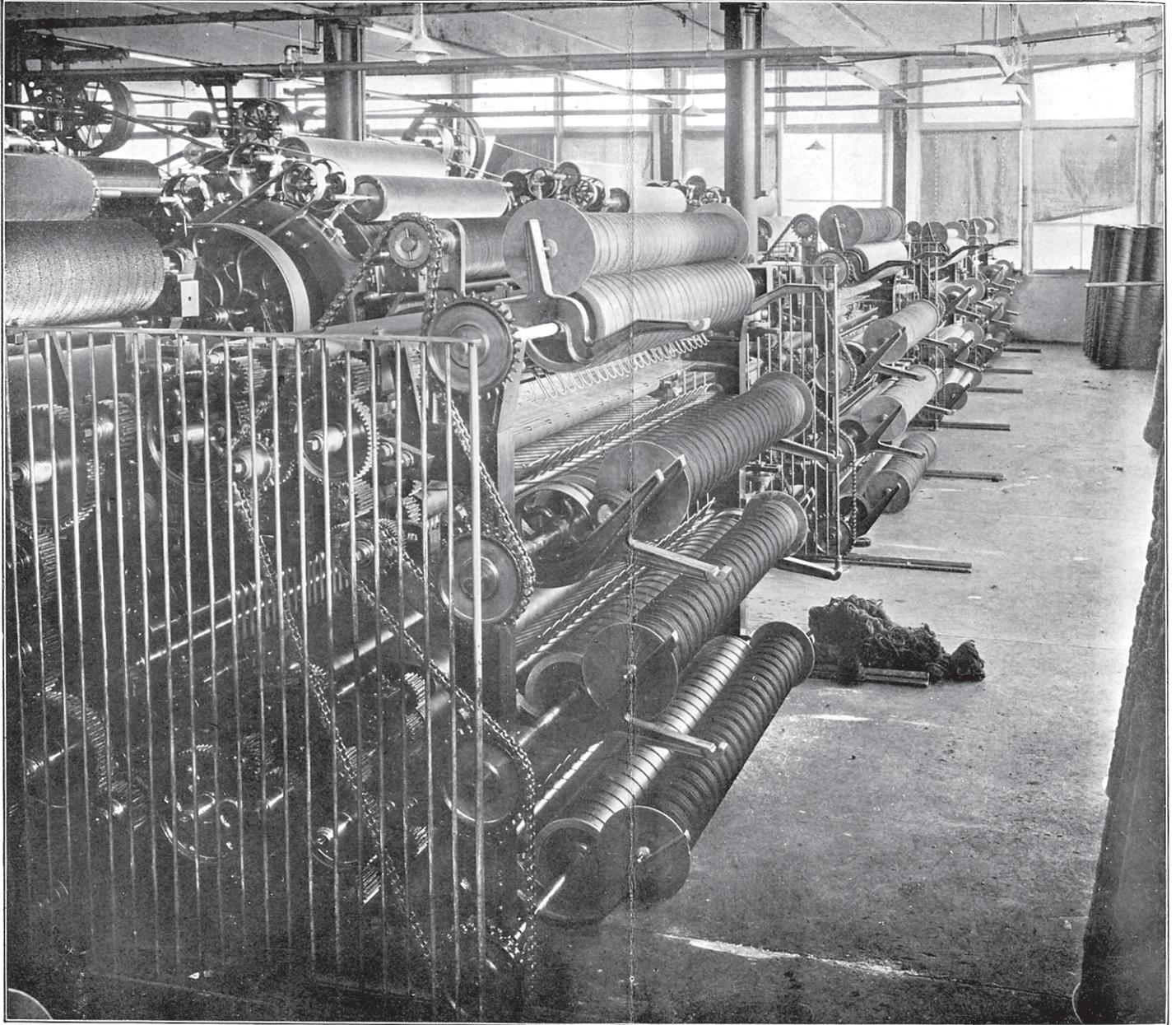
PLATE XX (1)



[The Convoyn Woollen Co., Ltd., Convoyn, Co. Donegal.]

FACTORY VIEW OF CARDING MACHINERY. SCOTCH-FEED DELIVERY AND CONVEYING MECHANISM.

PLATE XX (2)



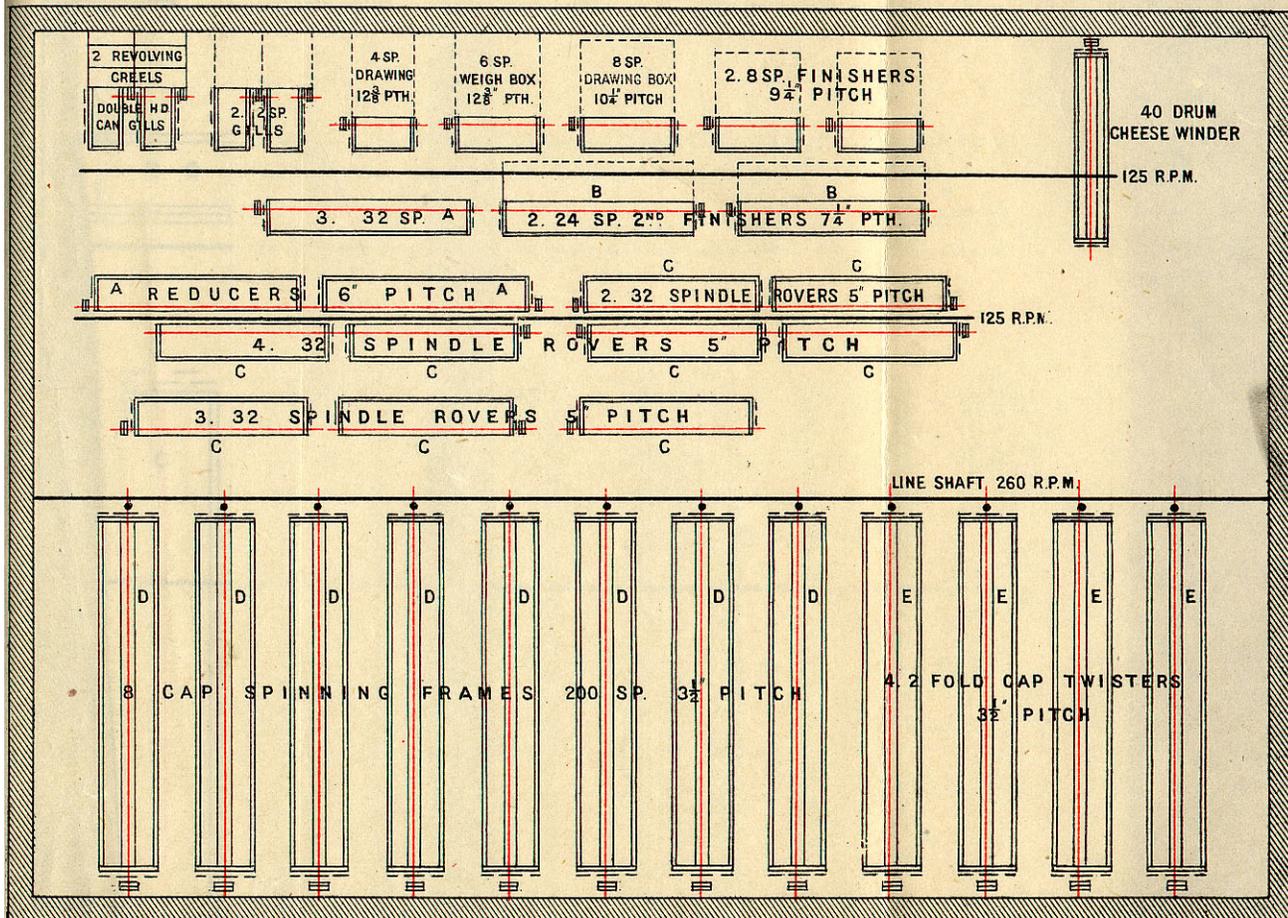
[The Convooy Woollen Co., Ltd., Convooy, Co. Donegal.]

FACTORY VIEW OF CARDING AND CONDENSING MACHINERY—CONDENSER SECTIONS.

PLAN OF A ROOM CONTAINING A DOUBLE SET OF BOTANY DRAWING
WITH NECESSARY SPINNING AND TWISTING

Spinning production on 36's = 3,800 lbs. per week of 55 hours.
 " " 40's = 3,460 lbs. " "
 " " 44's = 3,050 lbs. " "

PRINCE SMITH & SON.



PARTICULARS OF PLANT.

- A. Three 32-spindle Reducers, 6" Pitch
- B. Two 24-spindle 2nd Finishers, 7 1/4" Pitch
- C. Nine 32-spindle Rovers, 5" Pitch
- D. Eight Cap Spinning Frames (200 Spindles), 3 1/2" Pitch
- E. Four 2-fold Cap Twisters, 3 1/2" Pitch

H.P. required for Driving a Double Set of Botany Drawing—16.
 H.P. required for Spinning and Twisting—110.

