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FLY FRAMES
RING FRAMES
COTTON MULES
DOUBLING FRAMES

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ANSWERS

TO THE

QUESTIONS AND EXAMPLES

INCLUDED IN THE

EXAMINATION QUESTIONS

Each Key, or set of Answers, has the same section number as the corresponding set of Examination Questions. All references are to the portion of the text that bears the same section number as the Key in which the references occur, unless the title of some other part of the text is mentioned.

To be of the greatest value, the Key should be consulted sparingly, much in the same manner as a pupil would go to a teacher for assistance in solving a problem he is unable to master unaided. The Key should not be referred to except as a last resource, when the student has failed, after using every reasonable effort, to solve the example or answer the question. If used in this way, the Key will be a help and a source of encouragement in studying the various subjects comprising the Course.

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FLY FRAMES

(PART 1)

CONSTRUCTION OF FLY FRAMES

PRINCIPLES OF FLY-FRAME PROCESSES

CLASSIFICATION OF MACHINES

1. Condition of Drawn Sliver. — After the sliver has been formed at the card, it is passed through the drawing frames, where the fibres are straightened, laid parallel to one another, and the sliver is evened throughout its whole length. The structure of the sliver can be perfected by the use of combing machinery previous to its passage through the finisher drawing frame, the process of combing removing much foreign matter, short fibres, and neps. On leaving the finisher drawing frame the sliver is still in too bulky a form and is of such dimensions as to require further attenuation before it is sufficiently fine to be run through the machine that completes the operation of making it into yarn. A sliver of American cotton for a finisher drawing frame weighs about 60 grains per yard, in mills producing up to 36s counts, while a sliver of Egyptian cotton weighs about 45 grains per yard in mills producing yarn of about 50s counts, and about 40 grains per yard for the production of about 80s counts.

2. Machines Used in Attenuation.—The machines that are used further to attenuate the sliver and prepare it for the final

stages of manufacture into a satisfactory yarn are collectively known as **fly frames,** since their characteristic feature is a revolving device called a *flyer.* Fly frames are also variously known as *speed frames, speeders, speeds,* or simply as *frames.* In these frames, in addition to attenuating the sliver by successive stages until the required weight per yard is obtained, opportunity is taken at several frames to multiply the number of doublings. The result of this increase in the number of doublings is an improvement in the evenness imparted to the sliver in the drawing processes.

3. A specific name is given to the fly frame that accomplishes each stage of the attenuation. Three successive stages are ordinarily adopted, the machines for each stage being respectively known as **slubbing frames, intermediate frames,** and **roving frames,** their sequence being in the order given. The sliver resulting from the first stage is called *slubbing,* that produced at the second stage is called *intermediate,* and the final product of the fly-frame processes is known as **roving.** If four successive fly-frame processes are employed, as when yarn is spun of about 100s counts, the last frames are called **jack-frames.** By the use of a fourth fly frame an extra doubling is obtained, and the attenuation is rendered more gradual throughout the whole series of processes ; this last is advantageous because high drafts militate against good work. In spinning mills producing low counts of yarn, it is customary to employ only two fly-frame processes in the treatment of the cotton, the machines being then termed either slubbing frames and intermediates, or else slubbing frames and roving frames.

4. Differences Between Various Fly Frames.—All the machines classified as fly frames are practically identical in principle, construction, and function, differing chiefly from one another in the size of their parts and in the number of spindles contained in each frame. As the sliver is drawn finer at each successive process it is necessary that certain parts of the intermediate frame shall be smaller than similar parts in the slubbing frame, in order to accommodate themselves to the attenuated strand of cotton. The same is also true in regard to the roving frame as

compared with the intermediate. Other differences lie in the gearing and in minor details of the various frames, one noteworthy point of difference being in the manner of feeding. With the slubbing frame, the cans from the finisher drawing frames are placed directly behind the fly frame, and the rollers of that machine draw the slivers from the cans. The slubbing that is produced is wound on **bobbins,** or slender cylinders of wood, and these bobbins are arranged at the back of the intermediate frame in a **creel,** or framework in which the bobbins are free to revolve as they unwind to feed the frame whereon they are mounted. The sliver that is produced at the intermediate frame and at the succeeding frames is likewise wound on bobbins, and as a consequence all of the fly frames that follow the slubbing frame are fed from bobbins set in a creel.

METHODS ADOPTED IN FLY FRAMES

5. Attenuation. — The sliver is attenuated by passing it through a set of drawing rollers on each fly frame, the series of roller drafts thus obtained being arranged so as to obtain a gradual reduction to roving of the required fineness. As an instance of the extent to which attenuation is carried by fly-frame processes, it may be stated that a common weight for the sliver at the finisher drawing frame is 60 grains per yard, and this sliver is converted into roving that weighs from 1 to $2\frac{1}{2}$ grains per yard, corresponding to a reduction in weight in proportions ranging from 24 to 1 to 60 to 1. Since the sliver is doubled as well as drawn out, the attenuation is very great, and it is evident that the process should be gradually carried out in successive machines. A predetermined amount of draft is decided on for each machine, the individual and total drafts varying, of course, according to the class of cotton used, the counts of yarn required, and so on. Commonly, the drafts at the slubbing frame range from 3·3 to 5·5; at the intermediate frame they range from 5 to 6·3; at the roving frame they vary from 5·5 to 8; and where jack-frames are used, the drafts employed range from 6 upwards in those frames.

6. Doubling in Fly Frames.—In passing through the slubbing frame the sliver from the finisher drawing is not doubled, but doubling is resorted to in all succeeding fly frames so as to ensure the production of an even roving by averaging the irregularities of several slivers. At all frames after the slubbing frame, doubling is carried out to the extent of feeding 2 ends to each spindle for incorporation into 1 end, thus assisting to procure uniformity in the final product.

7. Twisting of Sliver.—At each stage a slight twist is imparted to the sliver. It is necessary to twist the strand as it is delivered from the front rollers of each fly frame, since, by its gradual attenuation, the number of fibres in the cross-section of the sliver is correspondingly reduced and the strand becomes weaker; hence, it must be twisted to enable it to hold together during the following process. The twisting is effected by securely holding the strand of cotton at two points, namely, at the nip of the front drawing rollers and at the bobbin on which the material is wound, the sliver passing from one point to the other through the flyer already mentioned, which device, by revolving rapidly, imparts the necessary twist.

8. Winding Sliver on Bobbins. — Twisting of the sliver is followed by winding it on a bobbin, which in this case is a tube with one end flanged, since the reduced strand must be laid in such a form as will allow it to be revolved rapidly round a spindle. The winding is accomplished by having either the surface speed of the bobbin exceed the speed of the flyer or the speed of the flyer exceed the surface speed of the bobbin, the excess speed of one part over the other in either case being sufficient to take up the sliver delivered by the front rollers. The strand is laid on the bobbin in regular layers by the aid of what is known as a *builder motion*, which shapes the bobbin so that it has tapered ends. The first layer of sliver that is wound on the bobbin extends nearly its whole length, but succeeding layers are gradually reduced in length, by reduction of the traverse of the builder motion, thus securing the desired shape of bobbin. The length and diameter of the full bobbins gradually decrease from the slubbing frame to the jack-frame.

CONSTRUCTIONAL FEATURES OF FLY FRAMES

PASSAGE OF COTTON THROUGH MACHINE

9. As the slubbing frame may be considered the simplest form of fly frame, and as it is the first machine in the series, a slubbing frame will be described to illustrate the passage of the cotton

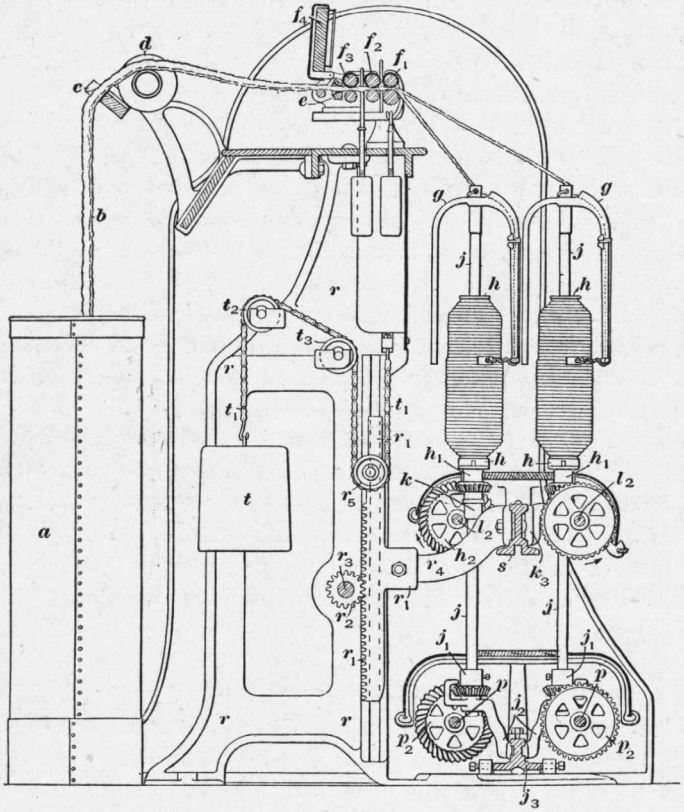

FIG. 2

through a fly frame. A perspective view of a portion of the front of a slubbing frame is shown in Fig. 1, while a cross-section through the essential parts of the machine is given in Fig. 2.

Referring to Fig. 2, the cans *a* that are brought from the finisher drawing frame are placed behind the slubbing frame, and the sliver *b* is drawn out of the cans and through a groove in the guide plate *c* by the assisting roller *d*. From the assisting roller the sliver passes through the traverse guide *e* and then through three pairs of drawing rollers f_3, f_2, f_1 that apply the necessary draft. Above the drawing rollers is shown the clearer f_4.

10. From the front drawing rollers f_1, Fig. 2, the strand of cotton passes to the flyer *g*. It will be noticed that 2 ends of slubbing are shown at the front of the machine, each going to a separate flyer, although for convenience only 1 sliver *b* is shown at the back. Each end shown at the front is produced from a separate sliver fed behind the slubbing frame. In this machine, doubling does not ordinarily take place, each end of sliver being treated individually; as already mentioned, doubling is the general practice in succeeding fly frames. The strand of cotton passes through a hole in the upper end of the hollow leg of the flyer *g* and emerges at the bottom of the tube, where the sliver is wound round an arm that is supported by the flyer. From this arm the slubbing passes to the bobbin *h*, on which it is compactly wound. The flyer is supported and rotated by the spindle *j*, while the bobbin rests on a flange that forms the upper end of the bevel pinion h_1. The bobbin and the flyer are thus driven independently of each other, although they rotate in the same direction. Their rates of speed are different, the surface speed of the bobbin, in this case, slightly exceeding the speed of the flyer and so causing the slubbing to be wound on the bobbin.

GUIDES AND ROLLERS OF SLUBBING FRAME

11. Guides and Assisting Roller.—The guide plate *c*, Fig. 2, through which the sliver is drawn from the can, is simply a long plate with rounded notches cut in it at suitable intervals. Its function is to prevent one sliver from coming in contact with another. The roller *d*, known variously as the *assisting roller*, *carrier roller*, or *tin cylinder*, extends the entire length of the machine. It is driven by means of a sprocket wheel on one end,

the chain receiving its motion from another sprocket wheel on the bottom back drawing roller. The assisting roller serves to assist or carry the sliver out of the can *a*, hence its name, and thus relieves the strand of much of the pull due to the action of the drawing rollers. In some cases the assisting roller is made of wood and has an octagonal section, but is generally of metal and tubular, solid rollers being rarely used. In some cases, beads or rings are formed on the assisting roller at regular intervals, the beads serving to guide the slivers into their proper position relative to the drawing rollers. The traverse guide *e* is actuated by a suitable traverse motion and guides the sliver first to one part of the rollers and then to another, thus preventing the concentration of the wear in one portion of the drawing rollers.

12. Drawing Rollers in Fly Frames.—It is usual, in all fly frames, to have three lines, or pairs, of drawing rollers; four pairs of rollers are occasionally, but very rarely, used. As in drawing frames, the rollers of fly frames and their stands are set level, that is, horizontally. Each bottom line of rollers extends the whole length of the machine and is fluted at intervals. The front bottom rollers in all fly frames should be case-hardened throughout, and some authorities advocate the same treatment for all bottom rollers. The middle and back bottom rollers should be at least case-hardened at the necks. It is also important that the joints should be well made and should not allow the slightest play at the points where one length of roller is joined to the next.

13. Top Rollers.—Top rollers in fly frames are made of iron, covered with flannel and leather in the usual manner. Double-boss rollers are used; in slubbing frames, two ends of sliver pass under each roller, or one end per boss. These rollers are commonly termed *single-end boss rollers*. In intermediate frames it is also the rule to have one end passing under each boss, but in roving frames it is usual to have two ends passing under each boss. Some spinners prefer loose bosses for the front top rollers of all fly frames, while others prefer loose-boss rollers for that position in slubbing frames only, fitting fast-boss rollers to all other frames. Enumerating from front to back, the bottom rollers of

slubbing frames have diameters of $1\frac{1}{4}$, $1\frac{1}{8}$, and $1\frac{1}{4}$ inches, respectively, for American cotton; the corresponding diameters for Egyptian cotton are $1\frac{3}{8}$, $1\frac{1}{8}$, and $1\frac{3}{8}$ inches. The diameters of the top rollers of slubbing frames, taken outside the covering, are usually $1\frac{1}{16}$ inches for American cotton, the corresponding diameters for Egyptian cotton being $1\frac{1}{2}$, $1\frac{1}{4}$, and $1\frac{1}{4}$ inches, respectively, from front to back. The roller stands are bushed with brass for all lines of rollers.

14. Dividing Plates.—What are known as **dividing, or separating, plates** are commonly used on slubbing and intermediate frames, and sometimes on roving frames as well. When they are fitted, if an end should break between the front rollers and the flyer, the dividing plates prevent the cotton delivered by the rollers from being blown about by the air-current set up by the revolving flyers, which might result in the cotton catching on to an unbroken end, producing a fault known as *double*, or *thick*. A dividing plate is usually provided with notches for 4, 6, or 8 slivers, so that a considerable number of plates are required for each fly frame. Two of these plates are shown in Fig. 3, the left-hand plate i showing their position in use and the right-hand plate i_1 their position when not in use. Secured to the roller beam are brackets i_2, which extend diagonally upwards between the rollers and the flyers. In the sides of these brackets are formed channels or grooves for the reception of the plates, which work in the brackets like the window in the door of a railway carriage. When in use, the plates rest on the corner of the roller beam; when they are not required, they are lifted a little, to release them from their resting place on the beam, and are then slid down out of the way, as shown.

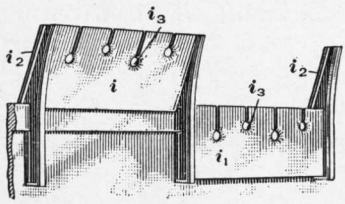

FIG. 3

15. The holes i_3, Fig. 3, through which the slivers run are extended by notches to the edge of the plate, so that the latter may be inserted or removed without breaking the slivers. The edges of the holes are rounded, to avoid damaging the sliver, and

the plates should be polished. Only one end passes through each aperture ; the zigzag arrangement of the holes is adopted to suit the spacing of the spindles. If the quality of the cotton is good, there is less need for dividing plates on slubbing and intermediate frames than there is if the quality of the cotton is inferior, since in the latter case there is more likelihood of broken ends, especially if the speeds and drafts are large. For roving and jack-frames the speed of the front rollers is not so high as in the preceding fly frames, so there is less need of the dividing plates, and some authorities hold that these accessories are only in the way on the later frames.

16. Hank Indicators and Hank Clocks.—Instruments known as **hank indicators** and **hank clocks** are customarily fitted to all fly frames for registering the number of hanks per spindle of slubbing, intermediate, or roving that pass the front rollers. The indicator is usually situated at one end of the fly frame, in close proximity to the front bottom roller, and is driven by

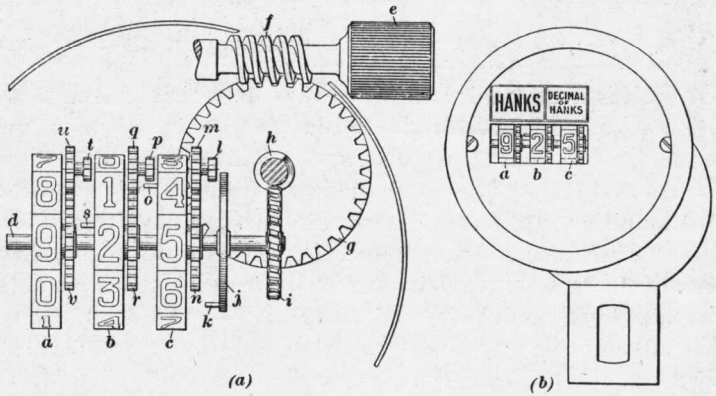

FIG. 4

worm-gearing from that roller. The gearing of a hank indicator and the external appearance of the instrument are shown in Fig. 4 (*a*) and (*b*). The indicator is shown with 3 index discs *a*, *b*, *c*, representing, respectively, the tens, units, and decimals of hanks that pass the rollers. Each disc bears 10 numbers from 1 to 0 on its edge, and is loose on the shaft *d* whereon all are mounted.

The front roller *e* has a diameter of $1\frac{1}{4}$ inches and carries on its shaft a single-threaded worm *f* that gears with a 36-tooth worm-wheel *g*. On the shaft of the worm-wheel *g* is a second single-threaded worm *h*, gearing with a 22-tooth worm-wheel *i* that is fixed on the shaft *d* supporting the index discs. On the shaft is keyed a disc *j* in which is fixed a peg *k* that comes in contact with the cog-wheel *l* at each revolution. The wheel *l* has 4 teeth and is compounded with the 8-tooth wheel *m* that in turn meshes with the wheel *n*, which is in one with the disc *c*. As there are 20 teeth in the wheel *n*, the length of sliver that passes the roller *e* during 1 revolution of the disc *c* is $\frac{3{\cdot}1416 \times 1\frac{1}{4} \times 36 \times 22 \times 4 \times 20}{36 \times 8} = 863{\cdot}94$ yards.

17. A peg *o*, Fig. 4 (*a*), in the side of the disc *c* engages, once every revolution, with the wheel *p* that is compounded with the 8-tooth wheel *q*, and this in turn meshes with the 20-tooth wheel *r* on the units disc *b*. Thus, at each revolution of the disc *c*, the disc *b* is rotated through a distance corresponding to $\frac{1 \times 8}{4 \times 20} = \frac{1}{10}$ revolution, and so a fresh unit number appears through the little window in (*b*), at the completion of each revolution of the decimals disc *c*. In like manner, by means of the peg *s*, Fig. 4 (*a*), and the wheels *t*, *u*, *v*, each revolution of the units disc *b* moves the tens disc *a* through $\frac{1}{10}$ revolution and causes the next number to appear on the tens disc through the little window in (*b*). The gearing is so arranged that the indicator registers an amount that is less by a given percentage than the actual distance travelled by a point on the circumference of the front rollers. This allowance is generally about $2\frac{1}{2}$ per cent., but may be less or more, and serves to compensate for odd spindles not working, and to allow for time lost in piecing broken ends, since the record of the indicator is used as a basis for payment by piecework. A hank clock differs from a hank indicator in form, but works on the same principle. In the clock, the various figures are printed on a dial, and the short hand indicates the number of hanks, while the long hand indicates the fractions of a hank in one-hundredth parts.

18. To determine the allowance for idle spindles, etc., it is necessary to know the length of sliver theoretically delivered by the front rollers while the clock or indicator is registering 100 hanks. This is ascertained by the following rule :

Rule I.—*To find the number of hanks that may be delivered while the indicator records 100 hanks, multiply the circumference of the front roller, in inches, by the product of the numbers of teeth in all the driven wheels, and divide the result by 30,240 times the product of the numbers of teeth in all the driving wheels.*

The constant 30,240 is the product of the number of inches in a yard and the number of yards in a hank. In applying the rule, each worm is taken as a wheel of 1 tooth. To find the allowance for idle spindles and other stoppages, use is made of the following rule :

Rule II.—*To find the allowance, expressed as a percentage of the hanks recorded, subtract 100 from the number of hanks as found by rule I.*

EXAMPLE.—In a hank indicator having gearing similar to that shown in Fig. 4 and fitted to a frame having $1\frac{1}{4}$-inch front rollers, what is the allowance for idle spindles, loss for breakage of ends, etc. ?

SOLUTION.—First find the total number of hanks that could be delivered while the indicator was registering 100 hanks. Applying rule I, the number of hanks is

$$\frac{3{\cdot}1416 \times 1\frac{1}{4} \times 36 \times 22 \times 4 \times 20 \times 4 \times 20 \times 4 \times 20}{30{,}240 \times 1 \times 1 \times 1 \times 8 \times 1 \times 8 \times 1 \times 8} = 102{\cdot}85$$

Then, by rule II, the allowance is $102{\cdot}85 - 100 = 2{\cdot}85$ per cent. Ans.

19. Clearers.—Stationary flat clearers are used for the top rollers in slubbing frames. These clearers are attached to the under side of cast-iron covers, placed as shown at f_4, Fig. 2, the covers being hinged at the back so that they may be raised and the waste removed from the clearer. One clearer box usually serves 4 spindles in a slubbing frame, 6 or 8 spindles in an intermediate frame, and 8 or 10 spindles in a roving frame. The ordinary **V**-shaped bottom clearers are also employed, but generally for slubbing frames only. Stationary clearers are also used for intermediate frames and for roving frames on coarse and medium counts. Revolving roller clearers are generally fitted to roving frames producing fine counts.

FLYERS AND FLY-FRAME SPINDLES

20. Details of Flyer.—A flyer, as used in the various fly frames, is shown in Fig. 5 (*a*) and (*b*), the former being a front view and the latter a side view of the device. The flyer has two downward projecting *legs*, or *arms*, one hollow and one solid, united by a *boss*. The boss g_1 is bored out tapering at g_2 to fit on the spindle, and the solid leg g_3 simply serves to counterbalance the hollow, or tubular, leg g_4. On the hollow leg is supported the presser g_5, which is hooked round the leg at its upper end and is bent at right angles to the flyer at the bottom. The hollow leg tapers toward its lower end, and the presser is shaped at this point to form a circular clamp through which the end of the leg is passed. Two lugs, or projections, g_7, g_8 serve to support the presser by means of its hooked upper end. The inner part of the presser is flattened out to form a palm, or paddle, g_9 that is furnished with a guide eye for the sliver. The horizontal part of the presser is of such length that the guide eye in the palm comes about opposite the centre of the bobbin when the latter is empty.

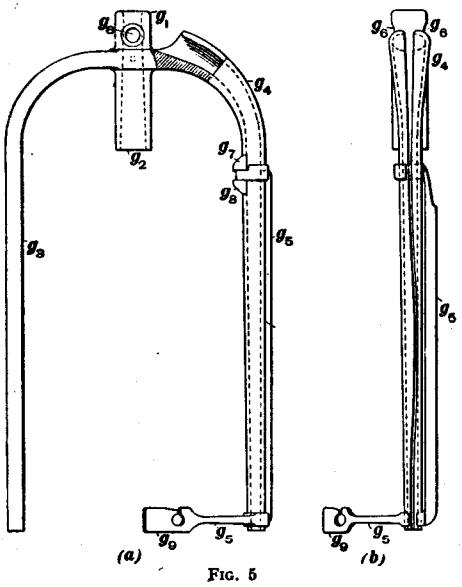

FIG. 5

21. Threading Sliver Through Flyer.—The sliver coming from the front rollers is passed down into the hole at the top of the boss g_1, Fig. 5 (*a*), and comes out through one side or the other by the hole g_6. The sliver is wound partly round the boss, on the side of the solid leg g_3, and is then passed down the hollow leg g_4.