The Project Method of Teaching

SILK THROWING

PART 6

PREPARED UNDER THE SUPERVISION OF

C. J. BRICKETT

DIRECTOR, SCHOOL OF TEXTILES

By

CARL A. LUFT

GRADUATE PHILADELPHIA TEXTILE SCHOOL

5002 F—FIRST EDITION

INSTRUCTION PAPER

With Examination Questions

PREPARED ESPECIALLY FOR
INTERNATIONAL CORRESPONDENCE SCHOOLS

Published by
INTERNATIONAL TEXTBOOK COMPANY
SCRANTON, PA.
1925

ADVICE TO THE STUDENT

You learn only by thinking. Therefore, read your lesson slowly enough to think about what you read and try not to think of anything else. You cannot learn about a subject while thinking about other things. Think of the meaning of every word and every group of words. Sometimes you may need to read the text slowly several times in order to understand it and to remember the thought in it. This is what is meant by study.

Begin with the first line on page 1 and study every part of the lesson in its regular order. Do not skip anything. If you come to a part that you cannot understand after careful study, mark it in some way and come back to it after you have studied parts beyond it. If it still seems puzzling, write to us about it on one of our Information Blanks and tell us just what you do not understand.

Pay attention to words or groups of words printed in **black-face type.** They are important. Be sure that you know what they mean and that you understand what is said about them well enough to explain them to others.

Rules are printed in *italics;* they, too, are important; you should learn to repeat them without looking at the book. With rules are usually given *Examples for Practice.* Work all of these examples according to the rules, but do not send us your work if you are able to get the right answers. If you cannot get the correct answer to an example, send us all of your work on it so that we can find your mistakes. Use one of our Information Blanks.

After you have finished studying part of a lesson, review that part; that is, study it again. Then go on with the next part. When you have finished studying an Instruction Paper, review all of it. Then answer the Examination Questions at the end of the Paper. It is not well to look at these questions until you have finished studying and reviewing the whole Paper.

Answer the Examination Questions in the same order as they are given and number your answers to agree with the question numbers. Do not write the questions. If you cannot answer a question, write us about it on an Information Blank before you send in any of your answers.

Remember that we are interested in your progress and that we will give you by correspondence all the special instruction on your Course that you may need to complete it. Remember, too, that you will get more good from your Course if you learn all that you can without asking for help.

 INTERNATIONAL CORRESPONDENCE SCHOOLS

SILK THROWING
(PART 6)

DOUBLING AND SPINNING—(Continued)

SPINNERS—(Continued)

INSERTION OF TWIST

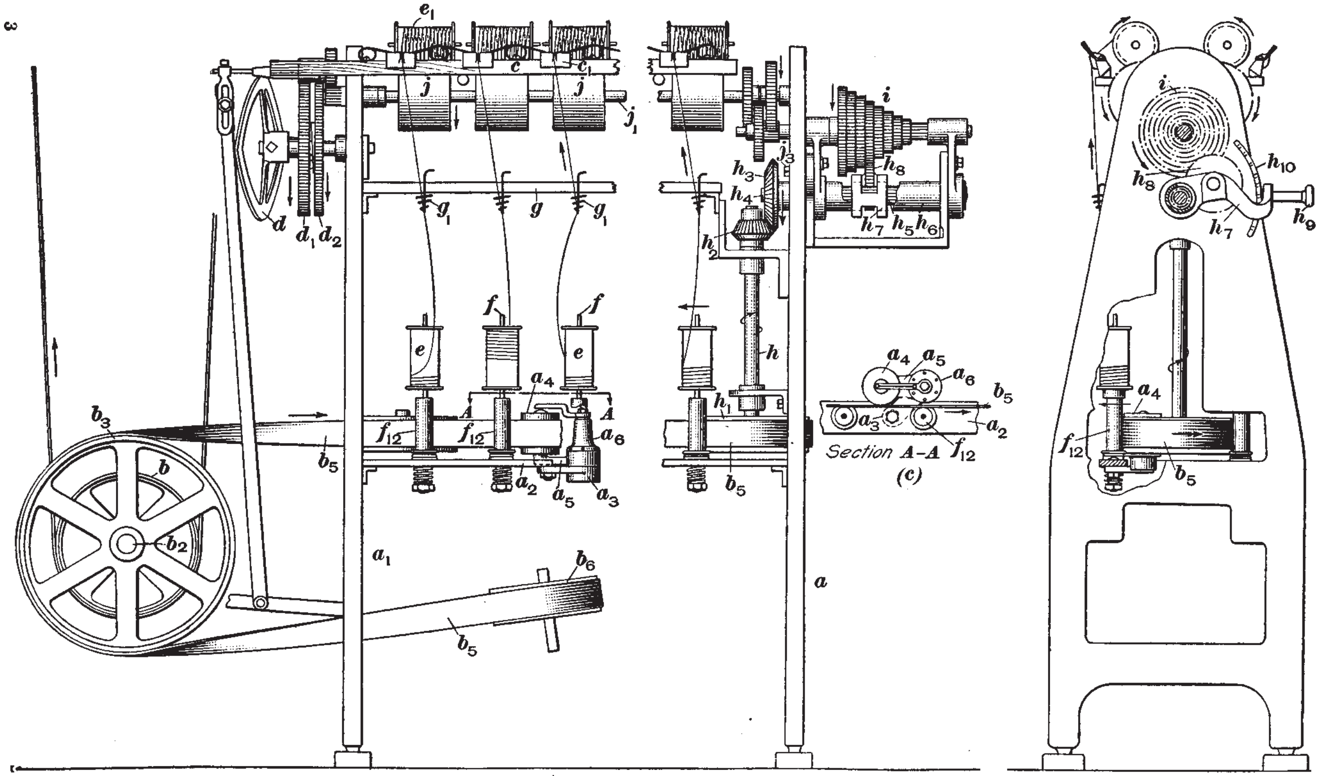
1. Turns of Twist per Inch.—The object of the spindle is to support the bobbin and at the same time allow it to be revolved at the proper speed. The speed of the spindle and bobbin depends on the velocity of the spindle belt and the diameter of the spindle whorl. While the spindle is revolving, the thread is gradually drawn from the whirling bobbin and wound on the take-up bobbin. Thus, should the bobbin on the spindle revolve at 10 revolutions per minute, and the take-up roll turn at the proper speed to take up 1 inch of thread, 10 turns of twist will be inserted, since the thread is twirled on its axis ten times while 1 inch of thread is taken up. Should the spindle speed be increased to 10,000 revolutions per minute, it will require a much shorter time to insert 10 turns of twist in the thread; in fact, 1,000 inches of thread could be taken up per minute and 10 turns of twist would be inserted in every inch. A thread with these specifications would be known as having 10 turns of twist per inch, which is frequently written 10 T. T.

2. Should the speed of the spindle be slackened during the period of twisting, the twist per inch would be immediately reduced. For example, if the spindle speed is reduced to 6,000 revolutions per minute, while the speed of the take-up roll causes the bobbin to take up 1,000 inches of thread, the result will be that 6 turns of twist are inserted in every inch of thread. If, on the other hand, the speed of the take-up roll is reduced so that only 500 inches of thread are taken up, while the spindle speed remains the same, the time required for the thread to travel from the whirling bobbin to the take-up bobbin will be greater; hence, it will be possible for the spindle to revolve a greater number of times before a definite length of thread is taken up with the result that 20 turns of twist will be inserted in every inch of the thread.

3. Changing Twist.—From the examples given it may be seen that a direct relation exists between the spindle speed and the speed of the thread as it is taken up. Since it is only necessary to alter either the speed of the spindles or the speed of the thread take-up in order to change the number of turns of twist per inch in the thread, the easier and more practical method is chosen, namely, to change the speed of take-up of the thread. This is done by altering the speed of the take-up rolls, which naturally changes the thread speed of the yarn being processed. Hence, all spinners and twisters maintain a constant spindle speed, while suitable twist change mechanisms are provided to allow quick changing from one take-up roll speed to another.

When reference is made to the speed of the take-up rolls in terms of inches per minute, it also indicates the speed of the take-up bobbin in inches per minute; that is, it represents the number of inches of thread wound on the bobbin while revolving at that speed for a period of one minute. This speed is also referred to as the *surface speed,* since it is the speed of the surface of the bobbin, and it remains unchanged even though the rotative speed of the bobbin varies.

4. Twist Change Gears.—The spindles are driven by the rotation of the spindle belt, which also transmits the power to the take-up rolls. In the transmission of power to the take-up rolls a point is selected where the twist change gears



(a) (b) (c)

Fig. 1

may be most advantageously located. Thus, the driving is secured through gearing that may be arranged in various combinations to allow the take-up rolls to be driven at a different speed from the spindles. The twist change gears also allow the ratio of the speed of the spindles and of the take-up rolls to be altered, thus changing the twist that is being inserted in the thread. The arrangement of twist change gears on the spinner being described is radically different from the twist change gears of spinners to be described later. In the first place, the change gears are located in what is known as the *quick-change gear-box,* of which the series of gears shown at *i,* Fig. 1 (*a*) and (*b*), are the most important. By means of this arrangement of gears, the twist per inch may be easily and quickly changed.

5. In Fig. 1 (*a*), it will be seen that the spindle belt b_5 drives the vertical shaft h when passing around the pulley h_1 attached to the lower end of the shaft h. This shaft is supported in the position shown by two sets of ball bearings, one set being located near the pulley h_1 while the second set is in proximity to the small bevel gear h_2 fastened to the upper end of the vertical shaft. By locating the bearings in the positions shown, an unobstructed space is created between the under side of the pulley h_1 and the frame of the machine. This space is of sufficient height to allow the removal of the old spindle belt, or the application of a new belt in an endless condition. In other words, a construction of this design eliminates the necessity of cementing the splice after the belt has been placed on the machine; hence, extra belts that are already spliced and cemented may be kept in reserve to replace belts that may break or prove otherwise useless.

6. The small bevel gear h_2, Fig. 1 (*a*), at the upper end of the vertical shaft h, may also be seen in Fig. 2, which is a perspective view of the entire gear-change mechanism. As shown, the gear h_2 meshes with a larger bevel gear h_3 attached to the shaft h_4 of the long-faced gear h_5 that extends the entire length of the gear housing. The shaft h_4 and the gear h_5 are integral, being made from a solid piece of steel. Surrounding the long-faced gear is a sleeve h_6 that acts as a bearing for the sliding hanger h_7 that holds the intermediate gear h_8.

To prevent the gear h_5 from coming in contact with the inside of the sleeve h_6, the latter is constructed with a diameter sufficiently large to allow the gear to rotate freely within it. The gear h_5 may be easily seen in this illustration, since part of the sleeve has been broken away. One side of the sleeve, however, is partly open, exposing the gear h_5 and allowing the intermediate gear h_8 to mesh with it. The intermediate gear is supported by the sliding hanger h_7, and the latter is so constructed as to allow the hanger to be shifted into any position in order that the intermediate gear will mesh with the

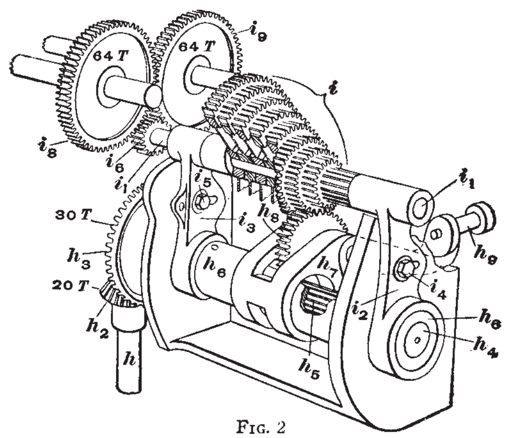


Fig. 2

gear h_5 and a predetermined gear of the i series. To retain the sliding hanger and the intermediate gear in the correct position relative to the gears of the i series and the long-faced spur gear, the sliding hanger is provided with a pin arrangement whereby its location may be readily changed, and the gear firmly locked when in running position. This is accomplished by a spring pin device illustrated in Figs. 1 (b) and 2. The pin h_9 is held in the handle, which also contains a spring that presses the pin toward the long-faced gear. When it protrudes from the handle, the pin engages with a hole in the quadrant h_{10}, Fig. 1 (b), the position of which determines the twist per inch that is inserted in the thread.

7. Directly above the shaft h_4, Fig. 2, is the shaft i_1 that holds the gears of the i series, which consists of nine gears firmly pinned together and keyed to the shaft. The number of teeth in the gears of the series increase by steps of 8 teeth; that is, the first, or smallest, gear is designed with 16 teeth, the second gear contains 24 teeth, the third contains 32 teeth, and so on to the ninth gear, which has 80 teeth. The shaft i_1, which carries the gears, rotates in the bearings of the arms i_2 and i_3, which are supported on the sleeve h_6. The bearings for the shaft i_1 are cast integral with the arms i_2 and i_3, which are adjusted or alined when set up and are held in the proper alinement by screws i_4 and i_5 that enter the tapped holes in the gear-box housing. A small spur gear i_6, attached to one end of the shaft i_1, meshes with either of the large gears i_8 or i_9 according to the direction of twist that is being placed in the thread.

8. When it is desired to change the turns per inch being inserted in the thread, it is necessary to provide a different gear combination in order that the ratio between the spindle speed and the speed of the take-up bobbins will be altered. This is accomplished by shifting the sliding hanger so that the intermediate gear will mesh with the long-faced gear and a different gear of the i series, Fig. 2. Thus, if the intermediate gear meshes with a small gear of the series, and it is desired to have it mesh with a larger gear, it is necessary first to draw the spring pin outwards until it is disengaged from the hole in the quadrant. Then, with the pin held out, the sliding hanger is moved downwards and at the same time shifted to the right. When the intermediate gear engages with the desired gear, the pin is allowed to engage with the correct hole in the quadrant and thus retain the hanger and gear in the proper position. The holes in the quadrant are designated as No. 1, No. 2, etc., to No. 9, inclusive, which is done in order to simplify the proper placing of the sliding hanger when adjusting it according to a twist chart. Hole No. 1 is located at the upper left-hand end of the quadrant while hole No. 9 is located at the lower right-hand end.

9. After the pin has been placed in the proper hole to obtain the desired twist, it may be securely locked to prevent operators from tampering with the twist. In order to bring this about, a small arm is attached to the spring pin, which, when in position, coincides with an extension that projects from the sliding hanger. Each of the parts referred to has a small hole, and so they may be coupled together by a padlock. Sometimes, only a bolt is inserted in the holes and a nut is placed on it and firmly drawn into place. This is sufficient to hold the hanger in position, since disturbances to this part are usually accidental and a padlock would be unnecessary.

It may be added that the gears of the *i* series, Fig. 2, are adequately protected by a cover constructed in two parts. One part of the cover is fixed and extends over the gears on that side of the gear-box from which the sliding hanger protrudes, the cover being shaped so as to form the quadrant. The opposite side of the gear-box is protected by a hinged cover that may be lifted when it is desired to examine and oil the gears, the sleeve, or other parts requiring lubrication. Both covers are removed in the illustrations in order that the gear assembly may be seen more easily.

10. Twist Chart.—Reference has been made to the various gear combinations that are employed to produce threads with different numbers of turns of twist per inch. Hence, when changing from one twist to another, it will be necessary to calculate the proper size gears that must be combined to give the desired twist. To simplify the matter, however, all manufacturers supply a *twist chart,* or *feed gear table,* with the machines they manufacture. By referring to this table, the proper gears to give the desired twist may be found without making any calculations. Table I is a twist chart suitable for the spinner being described.

As has been explained, the various gear combinations in the gear-box are obtained by moving the sliding hanger in the proper direction and inserting the spring pin in the correct hole in the quadrant. However, due to the construction of this type of twister, it is impossible to obtain the extremes in twist without a slight alteration to several gears that are not located within the gear-box. Because of this fact it is necessary to divide the wide range of twists into three parts, and, for convenience, to designate the gearing necessary so that the range of twists from each gear will be easily recognized. For this reason the gears for the twists are arranged under the headings of tram gears, organ (organzine) gears, and crêpe gears.

11. As shown in Table I, when the tram gear combination is employed, a twist range of from 1 to 5 turns per inch is

TABLE I

TWIST CHART FOR SPINNER

Number of Hole for Spring Pin	Tram Gears	Organ Gears	Crêpe Gears
	Turns of Twist per Inch		
1	1	4	12
2	1½	6	18
3	2	8	24
4	2½	10	30
5	3	12	36
6	3½	14	42
7	4	16	48
8	4½	18	54
9	5	20	60

obtainable, the number of turns of twist increasing by half turns. Thus, should it be desired to obtain 3½ turns of twist it would only be necessary to place the spring pin in hole No. 6, which would give the desired number of turns of twist. The organ gearing is employed when it is desired to secure twists of from 4 to 20 turns per inch. In this case the twist increases by 2 turns per inch as the sliding hanger is moved from one position to the next. Should the spring pin be placed in hole

No. 6 when the organ gear combination is in mesh, 14 turns of twist per inch would result. In order to obtain twists of more than 20 turns, a third gear combination called the crêpe gearing is employed. With this combination, twists of from 12 to 60 turns per inch may be obtained, while the twist increases by 6 turns for each consecutive change in the position of the sliding hanger. Twists greater than 60 turns may be

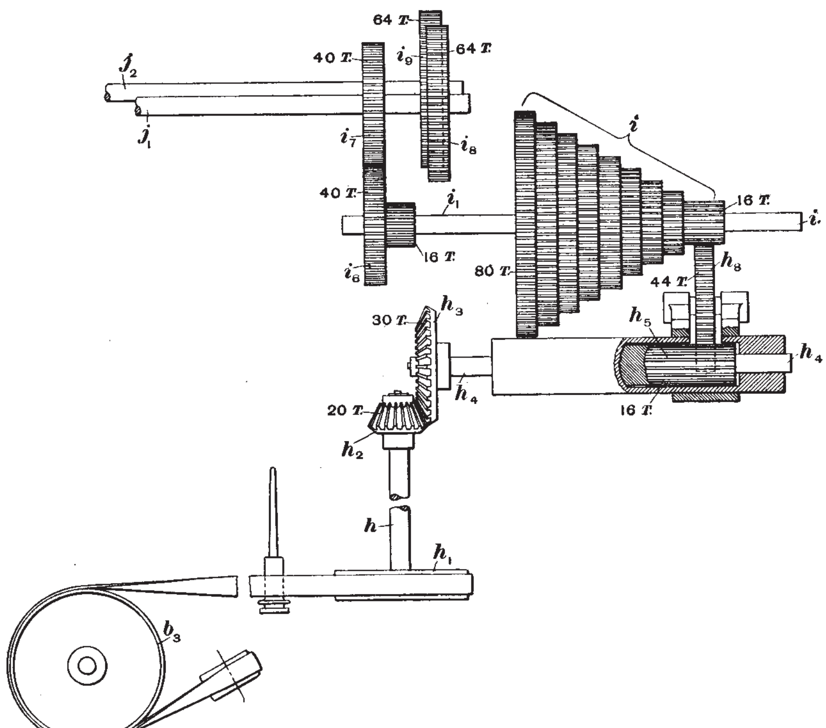


Fig. 3

obtained by gear changes that will be described later. It should be remembered, in connection with the terms tram, organ, and crêpe gearing, that any class or kind of yarn with a number of turns of twist within the limits of twist that can be produced, say, by organ gears, may be made while these gears are in place. The terms are employed merely to distinguish the gear combinations and do not strictly designate their use.

12. When tram gearing is used, the twister is geared as shown diagrammatically in Fig. 3. In this illustration, the take-up shafts j_1 and j_2 are shown, one slightly above the other, in order to be clearer. A compound gear i_6 having 40 teeth in the large gear and 16 teeth in the small gear, is held in place on the shaft i_1 by a setscrew, and is in mesh with the 40-tooth gear i_7 on the take-up shaft j_1. At the end of the take-up shaft j_1, a 64-tooth gear i_8 meshes with a similar 64-tooth gear i_9 on the opposite take-up shaft, thus driving both take-up shafts at the same speed. If it is now required to change to the organ gears, it is only necessary to loosen the set-screw holding the compound gear i_6 and to slide it along the shaft i_1 toward the gears of the *i* series until the 16-tooth gear of the compound gear meshes with the 64-tooth gear attached to a take-up shaft. When this combination has been completed, the take-up rolls revolve at just one-quarter of the speed at which they revolved in the previous case, when the tram gearing was employed.

13. Since the speed of the take-up rolls decreases when the twist per inch increases, a considerable reduction in their speed will be necessary in order to obtain the twists for the hard-twisted crêpes. The high twist is obtained by the introduction of another compound gear in the train of gears, which effectively increases the twist per inch. The crêpe gearing is illustrated in Fig. 4. The setscrew holding the compound gear i_6 is loosened and the gear is moved along the shaft i_1 for a very short distance. Another compound gear i_{10} having 60 and 20 teeth is placed on a stud so that the 20-tooth gear of the compound meshes with one of the 64-tooth gears i_8 and i_9 on the take-up shafts according to the direction of the twist. The compound gear i_6 is then moved along the shaft i_1 toward the gears of the *i* series until the 16-tooth gear of this compound meshes with the 60-tooth gear of the compound on the stud. In the illustration, the positions of the gears and shafts have been altered slightly in order that the introduction of the compound i_{10} may be more clearly seen. This gear combination reduces the speed of the rolls so that they revolve only one-twelfth as fast as when the tram gearing is employed; that is, twelve times as much twist is inserted in 1 inch of thread when the crêpe gearing is used as when the tram gearing is in place.

14. While a twist of 60 turns is considered a hard twist, at times it may be necessary to insert a higher number of turns. To accomplish this it is necessary to change several gears on other parts of the frame. Thus, by increasing the size of the bevel gear h_3, Fig. 3, which will cause the shaft i_1 and also all following gears to run at reduced speeds, twists of from 72 to 80 turns and higher may be inserted. Should

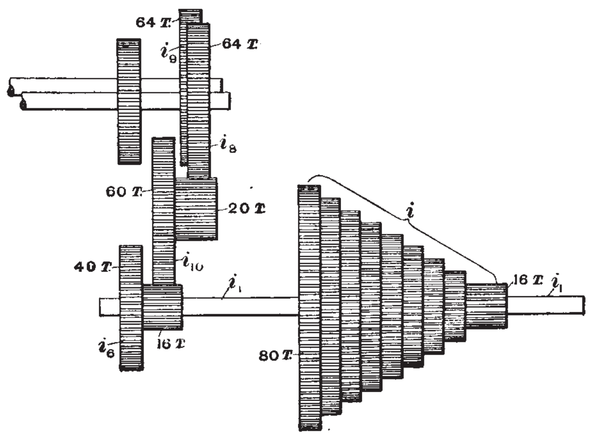


Fig. 4

it be desired to obtain twists with an odd number of turns when the organ gearing is in place, it will only be necessary to substitute a 17-tooth or 19-tooth gear for the 16-tooth gear i_6 and twists having 5, 7, 9, etc. turns will be obtained.

15. Reversing Twist.—As referred to from time to time, threads are twisted in one of two directions, namely, to the left or to the right. In fact, some threads, like organzine, are twisted in both directions, that is, to the left and then to the right. For this reason all spinners and twisters are so constructed that by changing several parts a machine that was employed for left twist may be changed to insert a right twist or vice versa. It is evident that to change the direction of twist from left to right, the first requisite is to change the direction of rotation of the spindles. This naturally changes the direction of twist that is being inserted in the thread; for, instead of turning in a clockwise direction, the spindles then revolve in a counter-clockwise direction, thus inserting a right twist in the thread.

There are two methods of changing the direction of rotation of the spindles on the spinner being described. One method is to change the drive belt that transmits power from the line shaft to the driving pulley of the spinner from an open belt to a crossed belt. When this is done, it is necessary to insert a small length of belting, for a crossed belt is always longer than an open belt on the same pulleys.

16. Another method of changing the direction of rotation of the spindles is the following: The spring that exerts a constant pull on the spindle-belt idler, thus keeping the belt at an unvarying tension, is removed so that the belt becomes loose, and the spindle belt is slipped from the spindle-belt pulleys. The bearings that hold the crosshead shaft in the brackets attached to the floor and the end stands are next removed. The entire crosshead shaft and pulley assembly is lifted from the brackets and turned around so that the spindle belt that adjoined the bracket located at the right side of the machine, is now at the left. After properly fastening the bearings, the spindle belt is placed on the pulleys and the tension spring is again adjusted. It is evident that the spindles will revolve in an opposite direction, since applying power to the opposite pulley will cause the belt to run in a reverse direction. When the direction of twist is changed in this manner, it is not necessary to lengthen the belt; for if an open belt is employed, it need not be cut or unfastened, as it may be run as an open belt for either right or left twist.

17. After the direction of rotation of the spindles has been reversed, it will be seen, by following the transmission of power, that the vertical shaft will revolve in an opposite direction, and consequently the gears, take-up rolls, and bobbins that are driven by it will also revolve incorrectly to take up the thread. To overcome this, all spinners are equipped with some means of causing the take-up rolls to revolve correctly. This operation is accomplished in the following manner on this spinner: The entire gear-box is supported on the sleeve h_6, Fig. 2, which passes through the end stand of the spinner. When the direction of rotation of the take-up rolls is to be changed, the entire gear-box is shifted so that the small gear i_6 in mesh with a 64-tooth spur gear on the right-hand take-up shaft will engage with the gear on the left-hand take-up shaft, thus effecting the desired change. In moving from one side to the other, the entire gear-box swings in an arc with the shaft h_4 as a center, which is also the center for the sleeve h_6. By this construction, the bevel gears h_2 and h_3 will always be in proper mesh, since the shaft h_4 supports the gear h_3. After the gear-box has been swung into the proper position, so that the gears mesh properly, it is held firmly in place against the end stand by two capscrews. In Fig. 1 (*a*), only one capscrew j_3 is seen, but another screw is located directly back of the screw j_3.

CALCULATIONS

18. Speed Calculations.—In connection with spinning and twisting frames, there are numerous calculations that must be understood. Examples of all the necessary calculations are given in this Section; but rules relating to the calculation of speeds are omitted, as they have been given previously in connection with mechanical calculations.

EXAMPLE 1.—Find the speed of the crosshead shaft if a line shaft carrying a 16-inch pulley and making 415 revolutions per minute drives an 8-inch pulley on the crosshead shaft.

SOLUTION.—The speed of the crosshead shaft is

$$\frac{415\times16}{8}=830 \text{ r. p. m. Ans.}$$

EXAMPLE 2.—With the spinner geared as in Fig. 3, and the crosshead shaft making 830 revolutions per minute, what is the speed of the take-up shaft j_1 if the pulley b_3 is 12 inches in diameter and the pulley h_1 is 8 inches in diameter?

SOLUTION.—The speed of the take-up shaft is

$$\frac{830\times12\times20\times16\times40}{8\times30\times16\times40}=830 \text{ r. p. m.} \quad \text{Ans.}$$

EXAMPLE 3.—If the 12-inch spindle belt pulley makes 830 revolutions per minute and the spindle whorl is 1 inch in diameter, what is the speed of the spindle?

SOLUTION.—The speed of the spindle is

$$\frac{830\times12}{1}=9{,}960 \text{ r. p. m.} \quad \text{Ans.}$$

19. Although the spindle speed may be determined by calculation, it may also be found by using a standard speed indicator, several types of which are on the market. When a speed indicator is used for testing spindle speeds, it is fitted with an attachment that enables the motion of the spindle to be transmitted to the indicator. With this device no calculations are necessary, for the number of revolutions is read from the dial of the instrument after a period of 1 minute has elapsed, and, of course, the result is expressed as revolutions per minute. When the speed indicator is used, at least six spindles should be tested in various parts of the frame, and the average of the six results should be taken as the actual speed. Great care should be exercised, when testing, to note that the spindle whorl is in proper contact with the belt; for, should the spindle slip, the wrong speed will be recorded.

20. Twist Calculations.—In all twist calculations, to be accurate, the amount of slippage between the take-up roll and the bobbin, and also between the spindle and spindle belt, would have to be known. Since this is variable and also very small, it can be disregarded. Hence, for all practical purposes it is considered sufficiently accurate to divide the length of thread taken up by the bobbin into the calculated speed of the spindle, making no allowance for slippage, and accepting the result as representing the actual turns per inch that may be expected to be obtained.

It is evident that, to determine theoretically the length of thread taken up by the bobbin, it is necessary to include the pulley on the vertical shaft in the calculations. For this reason it may be well to note that two types of this particular make of spinner are constructed, each having several parts of different sizes of which a knowledge is very essential in solving twist calculations. The spinners are known as type A and type B. The type A spinner is constructed with rigid spindles and has swinging idlers to keep the spindle belt in continuous contact with the spindles. The spindle belt, traversing the length of the machine, passes around the pulley h_1, Fig. 3, attached to the vertical shaft h, this pulley measuring $6\frac{5}{8}$ inches in diameter. Mounted on the upper end of the vertical shaft is a 20-tooth bevel gear h_2 that in turn meshes with a 36-tooth bevel gear h_3 on the shaft h_4. The type B spinner, on the other hand, is equipped with swinging spindles and stationary idlers. Besides this difference in construction, the pulley h_1 on the vertical shaft is larger, measuring 8 inches in diameter, while the gear h_2 on the upper end of the vertical shaft contains 20 teeth and meshes with the bevel gear h_3, which has 30 teeth. In all the following examples the gearing for the type B spinner will be considered; hence, it should be remembered that the pulley on the vertical shaft h measures 8 inches in diameter and that a 20-tooth gear located at the upper end of the vertical shaft meshes with a 30-tooth gear attached to the shaft h_4.

21. The take-up rolls are of the same size on both types of spinners and are slightly more than $3\frac{13}{16}$ inches in diameter; hence, for all practical purposes, the circumference of the roll may be taken as 12 inches.

When finding the twist per inch from a machine where it is necessary to count the number of teeth in the various gears and measure the diameters of the rolls, pulleys, and spindle whorls, it is very important that measurements be made with the greatest degree of accuracy. If this is not done, differences in the twist per inch are likely to occur. The results may be checked by counting the actual number of turns that are inserted in a thread being twisted. The number of turns of twist per inch is found by the following rule:

Rule.—*To find the twist per inch being placed in the thread, when figuring from the gears, consider the gear on the end of* *the take-up shaft as a driver. Multiply together all the driving gears and the diameter of the pulley on the vertical shaft and divide the product by the product of all the driven gears, the diameter of the whorl, and the circumference of the take-up roll.*

EXAMPLE.—What is the number of turns of twist per inch being inserted in a thread being twisted on a frame geared as illustrated in Fig. 3, if the circumference of the take-up rolls is 12 inches, the pulley h_1 on the vertical shaft is 8 inches in diameter, and the diameter of the whorl is 1 inch?

SOLUTION.—Apply the foregoing rule. Then, the number of turns of twist per inch is $\frac{40\times16\times30\times8}{40\times16\times20\times1\times12}=1$. Ans.

22. The number of inches of thread taken up by the take-up rolls may be found by the following rule:

Rule.—*To find the number of inches of thread taken up per minute by the take-up rolls, multiply together the diameter of the spindle belt driving pulley, all the driving gears, the circumference of the take-up roll, and the revolutions per minute of the spindle belt pulley, and divide the product by the product of all the driven gears and the diameter of the pulley on the vertical shaft.*

EXAMPLE.—Find the inches of thread taken up per minute by the take-up roll if the 12-inch spindle belt pulley makes 830 revolutions per minute and the circumference of the take-up roll is 12 inches.

SOLUTION.—Apply the foregoing rule. Then, the take-up is

$$\frac{12\times20\times16\times40\times12\times830}{30\times16\times40\times8}=9{,}960 \text{ in. per min. Ans.}$$

The number of inches of thread taken up by the take-up rolls may also be found by multiplying the number of revolutions per minute of the take-up shaft by the circumference of the take-up roll, in inches.

23. In case the speed of the spindles and the number of inches of thread taken up by the take-up roll are known, the number of turns of twist per inch may be found by the following rule:

Rule.—*To find the number of turns of twist per inch, divide the speed of the spindles in revolutions per minute, with-*

out allowance for slippage, by the number of inches of thread taken up per minute by the take-up roll.

EXAMPLE.—How many turns of twist per inch are inserted in a thread if the spindle makes 9,960 revolutions per minute, while the take-up shaft makes 830 revolutions per minute and carries a take-up roll 12 inches in circumference?

SOLUTION.—The number of inches per minute taken up by the take-up roll is $830 \times 12 = 9,960$ in. Apply the rule, and the number of turns of twist per inch is $\frac{9,960}{9,960} = 1$. Ans.

24. The methods of determining the spindle speed by calculation from the speed of the crosshead shaft and by means of a speed indicator have been described. Another method, based on the speed of the take-up rolls in relation to the spindle speed may now be illustrated. It is evident that the speed of the spindles and the speed of the take-up rolls are always considered when changing twists. Thus, should it be desired to change from 6 turns per inch to 3 turns per inch, it will be necessary to insert a twist change gear in the train to cause the take-up rolls to revolve just twice as fast, causing one-half the amount of twist to be inserted in the thread. This fact is the basis of the following rule:

Rule.—*To find the spindle speed from the speed of the take-up roll, multiply together the circumference of the take-up roll, the revolutions per minute of the take-up roll, and the number of turns of twist per inch that are being inserted by the machine.*

EXAMPLE.—A twister is geared to insert 4 turns of twist per inch in the thread, while the take-up shaft, supporting take-up rolls having a 12-inch circumference, is known to make $207\frac{1}{2}$ turns per minute. Find the spindle speed.

SOLUTION.—Apply the rule. Then, the spindle speed is

$$12 \times 207\tfrac{1}{2} \times 4 = 9,960 \text{ r. p. m. Ans.}$$

25. If the constant for twist is to be found from the gears, the gear on the end of the take-up shaft is assumed to be a driver and the twist gear is taken as a 1-tooth gear, and the following rule is used:

Rule.—*To find the constant for twist from the gears, multiply together all the driving gears and the diameter of the pulley attached to the vertical shaft and divide the product by the product of all the driven gears, the diameter of the whorl, and the circumference of the take-up roll.*

Example.—What is the constant for twist with the spinning frame geared as in Fig. 3, if the circumference of the take-up roll is 12 inches, the pulley attached to the vertical shaft is 8 inches in diameter, and the diameter of the whorl is 1 inch?

Solution.—Apply the rule. The constant for twist is

$$\frac{40\times1\times30\times8}{40\times16\times20\times1\times12}=.0625. \text{ Ans.}$$

26. As previously described, the gear combination illustrated in Fig. 3 may be termed the tram gearing. Thus the constant that is obtained by solving this gear combination may be designated the tram gear constant. Hence, should it be desired to find a gear to give a certain twist within the tram twist range, this constant may be employed. In a like manner a constant may be found for the organ gear combination, and also for the crêpe gear combination, it being only necessary to substitute the proper gears, arrange the train in the correct manner, and then solve as shown. When the organ gears are employed, the gear i_6 is merely loosened, taken out of mesh with the 40-tooth gear i_7 on the take-up shaft, and moved toward the right until the 16-tooth gear of the compound is meshing correctly with the 64-tooth gear on the take-up shaft. The crêpe gearing, of course, requires the introduction of an extra compound in the train illustrated in Fig. 4. This does not affect the method of calculation in any way, it being performed exactly as for the previous constants.

Example.—Find the constant for twist with the organzine gearing properly arranged on the twister, and the remaining gears and pulleys as illustrated in Fig. 3.

Solution.—Apply the foregoing rule. The constant for twist with organzine gears is $\frac{64\times1\times30\times8}{16\times16\times20\times1\times12}=.25$. Ans.

Example.—If the compound gear is added to the train of gears, to produce the crêpe gearing illustrated in Fig. 4, what is the twist constant provided the remaining gears are unchanged?

SOLUTION.—Apply the foregoing rule. Then, the constant is

$$\frac{64\times60\times1\times30\times8}{20\times16\times16\times20\times1\times12}=.75.\quad \text{Ans.}$$

27. If the constant for twist and the number of teeth in the twist gear are known, the twist per inch may be found by the following rule:

Rule.—*To find the twist per inch, multiply the constant for twist by the number of teeth in the twist gear.*

EXAMPLE.—What is the number of turns of twist per inch being inserted in a yarn if the constant for twist is .0625 and the twist gear contains 16 teeth?

SOLUTION.—Apply the rule. Then, the twist per inch is

$$.0625\times16=1 \text{ turn.}\quad \text{Ans.}$$

The result obtained in the solution of the preceding example is correct only when the tram gearing is employed. If the organ gearing or the crêpe gearing is used, then the constant for twist must correspond to the particular gearing used.

28. If the constant for twist is known, the size of twist gear required to give a desired number of turns of twist per inch may be found by the following rule:

Rule.—*To find the number of teeth in the twist gear, divide the twist per inch by the constant for twist.*

EXAMPLE.—If the constant for twist for a train of gears is .25 (in this case the organ gear constant), what size of twist gear is required to give 16 turns of twist per inch in the thread?

SOLUTION.—According to the rule, the number of teeth in the twist gear must be

$$16\div.25=64.\quad \text{Ans.}$$

29. After making a calculation to determine the twist per inch from the gearing, the twist gears are set accordingly; of course, it is absolutely necessary that the intermediate h_8, Fig. 3, be placed in mesh with the gear of the i series that was employed in the calculation while meshing with the gear h_5. It is evident that this is very important; for, should the intermediate be placed in any position other than the one employed in the calculation, the twist inserted in the thread will be incorrect. As an aid in setting the gears, Table II is given. From it the proper hole in the quadrant may be found after the twist gear is known. Suppose, for example, that the twister is geared with the organ gear combination and the twist constant is found to be .25. It is also known that 14 turns of twist are required in the thread. Solving this according to the rule of Art. **28,** a 56-tooth gear will be found necessary to give the required twist. The problem then is to determine the proper hole with which to engage the spring pin so as to cause the intermediate gear to mesh with the 56-tooth twist change gear. By referring to Table II it will be seen that a 56-tooth gear requires the spring pin to engage with hole No. 6 of the quadrant in order to obtain the desired 14 turns of twist.

30. Calculation of Production.—The production of a spinner or twister may be found by calculating either from

TABLE II

SPRING-PIN HOLES FOR DIFFERENT TWIST GEARS

Number of Teeth in each Gear	Numbers of Teeth in Gears of Series								
	16	24	32	40	48	56	64	72	80
Number of Hole	1	2	3	4	5	6	7	8	9

the take-up rolls or from the spindles. The more accurate method, however, is the calculation from the take-up rolls since there is less slippage between the bobbins and the take-up rolls, than between the spindles and the spindle belt. Also, the speed of the take-up roll is more uniform since it is driven through gearing while the bobbin is driven by frictional contact. With a suitable roll covering on the take-up rolls, the slippage at this point may be disregarded more or less.

Rule.—*To find the pounds per spindle-hour, from the take-up roll, divide the product of the circumference of the take-up roll, the number of revolutions per minute of the roll, and the number of minutes in an hour, by the product of the number of inches in 1 yard and the number of yards in 1 pound of the yarn.*

EXAMPLE.—How many pounds are produced per spindle-hour on a twister having take-up rolls 12 inches in circumference, revolving at 167 revolutions per minute, twisting a 3-thread tram composed of 13/15-denier singles?

SOLUTION.—The yardage per pound of ply threads may be found by dividing 4,464,528, the number of yards in 1 pound of a 1-denier silk, by the product of the average denier size and the number of ply; thus, $\frac{4,464,528}{14\times 3}=106,298$ yd. per lb.

Now apply the rule just given, and the production per spindle-hour is found to be $\frac{12\times 167\times 60}{36\times 106,298}=.0314$ lb. Ans.

31. The number of pounds produced per spindle-hour, may be calculated from the spindles by using the following rule:

Rule.—*To find the pounds per spindle-hour, from the spindles, divide the product of the revolutions per minute of the spindle and the number of minutes in an hour by the product of the number of turns per inch, the number of inches in a yard, and the number of yards per pound.*

EXAMPLE.—Determine the number of pounds per spindle-hour if the spindles revolve at 7,000 revolutions per minute while the take-up rolls turn at the proper speed to take-up threads of 13/15-denier silk to produce a tram thread having $3\frac{1}{2}$ turns of twist per inch.

SOLUTION.—Apply the rule, and the production per spindle-hour is found to be $\frac{7,000\times 60}{3\frac{1}{2}\times 36\times 106,298}=.0314$ lb., nearly. Ans.

32. The term *pounds per spindle-hour* indicates the number of pounds of silk twisted by one spindle during a period of 1 hour. Thus, should it be known that the frame is equipped with 108 spindles, multiplying the pounds per spindle-hour by the number of spindles per frame would give the pounds produced per hour on that frame. Again, should it be desired to find the daily, or weekly production, it would be necessary to include the number of hours per day or the number of hours per week in the calculation. Thus, if the frame has 108 spindles and operates 9 hours each day, the daily production, without any stoppage allowances, would be $108\times 9\times .0314=30.52$ lb. In other words, should a 108-

spindle spinner run continuously for the length of time and at the spindle speed indicated, approximately 30 pounds of silk would be twisted according to the calculation. Thus, the result would indicate that the spinner is returning 100-per-cent. production.

33. The condition just mentioned is seldom found in a mill, for many things affect the silk while it is being processed, so that frequent stoppages are necessary, thus lowering the percentage of production. For instance, the operative's skill is of primary importance and must be considered; for, should an inexperienced operative be employed, the broken ends will not be tied up as quickly, and all ends will not be kept running as efficiently as when an experienced operative tends to the machine. Then, again, the quality of the silk must be considered, for it is evident that a silk of excellent quality will run better than silk of a poor quality; also, the production will be increased and the percentage of waste will be decreased. In addition to this, the atmosphere of the mill may be very dry, so that the silk becomes charged with static electricity, causing broken ends to fly in the path of running ends, breaking the latter and consequently increasing the amount of stoppage. Besides this, the actual condition of the machine itself may cause unnecessary stoppages. For instance, should the take-up rolls be out of true and revolve with a somewhat wobbly motion, the bobbin might bind, or climb the roll and be thrown from the machine. Besides the stoppage of the machine for these causes, a certain allowance must be made for the time required to doff the bobbins; that is, full take-up bobbins must be removed and replaced with empty take-up bobbins, while those becoming empty on the spindles must be changed. Cleaning and oiling of machines should also be taken into consideration, for even though the time required for these duties may be short, it tends to lower the production.

34. Because of the foregoing difficulties, which of course vary in different mills, a definite percentage of stoppage cannot be specified which would suitably meet all conditions. Thus, silks of good quality that are thrown into organzine, for instance, may run with little trouble and produce only $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of waste during the first and second spinning operations; whereas, when throwing other lots of silk of poor quality into organzine on the same machine, and even with the same operators, it is possible that the wastage will increase, totaling at times, from $\frac{3}{4}$ to $1\frac{1}{4}$ per cent. Since the amount of stoppage is proportional to the amount of waste, the variation in the actual stoppages of machines is quite apparent. For this reason the percentages of stoppage are not given and these may be found in the mill in the following manner:

The theoretical or 100-per-cent. production should be determined by calculation for a definite period, as 9 hours, for example. With the gearing unchanged, the spinner should be operated for 9 hours and at the end of that period all the silk that has been twisted, plus the waste that has been made, should be weighed. The percentage of difference is then found between the theoretical production, which is 100 per cent., and the actual production, which is the amount weighed; the result then, will be the percentage of stoppage. Besides this method, the percentage of stoppage may be found by observation. At regular intervals during the day, the department head or foreman should count the number of spindles that are stopped, tabulating these results for a sufficient length of time so that a fair average will be obtained of the ratio between the spindles that are on the machine and those that are not in operation. From these results the percentage of stoppage may then be calculated.

35. In a preceding article, the production of a 108-spindle spinner operating 9 hours was found to be 30.52 pounds. This, of course, was a theoretical amount and no deductions were made for stoppage. While various percentages are commonly found, it is customary to allow 10 per cent. for average work. This is a fair value and may be employed in production calculations.

EXAMPLE.—The theoretical production of a 108-spindle spinner in 9 hours is 30.52 pounds. What is the actual production, if 10 per cent. is deducted for stoppages?

Solution.—As the actual production is 10 per cent. less than the theoretical production, it must be 100—10=90 per cent., or .90 times the theoretical production. Therefore, the actual production is

$$.90 \times 30.52 = 27.468 \text{ lb. Ans.}$$

36. It may be desirable to find the number of spindles required to throw 1 pound of silk in 1 hour, in which case the following rule may be used:

Rule.—*To find the number of spindles required to throw 1 pound of silk per hour, divide 1 by the number of pounds per spindle-hour of that silk.*

Example.—Find the number of spindles necessary to produce 1 pound of silk per hour if the spinner produces .0314 pound per spindle-hour.

Solution.—Apply the rule, and the number of spindles is found to be

$$1 \div .0314 = 31.8$$

Therefore, 32 spindles are required. Ans.

37. After the number of spindles required to produce 1 pound of silk yarn in 1 hour has been calculated, that value may be employed in the calculation of the approximate number of spindles necessary to throw a given number of pounds of silk in a definite number of hours. Thus, should it be desired to throw a certain number of pounds of silk in a certain number of hours, the question that would immediately arise would be in connection with the number of spindles that should be placed in operation when throwing this particular thread.

Rule.—*To find the number of spindles necessary to produce a given weight of thrown silk in a given number of hours, divide the product of the number of spindles required to produce one pound per hour and the number of pounds to be thrown in a given period by the number of given hours, and divide this result by .90 to allow 10 per cent. for stoppage.*

Example.—Find the number of spindles necessary to throw 600 pounds of 13/15-denier silk into 3-thread $3\frac{1}{2}$-turn twist tram in 55 hours.

Solution.—According to the solution of the example of Art. **36**, the number of spindles required to produce 1 lb. per spindle-hour is 32. Then, apply the rule, and $\frac{32 \times 600}{55} = 349$, very nearly. Ans.

However, this result must be divided by .90 to allow 10 per cent. for stoppage; so, the total number of spindles required is

$$349 \div .90 = 388 \text{ spindles, nearly. Ans.}$$

It may be seen from this result that dividing by .90 makes an allowance of 10 per cent. for the time that the spindles do not produce. For, suppose that, of the 388 spindles, an average of 10 per cent. are not producing. In that case, the number of non-producing spindles is $.10 \times 388 = 38.8$, or say 39 spindles. The number in operation is then $388 - 39 = 349$, which is the number required to produce the yarn in 55 hours, if no stoppage is considered.

GENERAL INFORMATION

38. Sizes of Machines.—Spinning and twisting frames are built in various lengths according to the available floor space and the number of spindles desired; also, as mills are built of different shapes, it is often desired to place machines in quite narrow parts, thus necessitating short machines. To supply the demands of various throwsters, machines are regularly built in sizes ranging from 72 spindles to 112 spindles, which may be called standard sizes. Should it be desired to employ a machine with a greater number of spindles, its length would be in proportion to the increased number of spindles, and a machine of this type could readily be made to order. A variation exists in the length of first- and second-time machines, which is to be expected, since the spacing of the spindles on these machines is different. This may be readily seen by comparing two 108-spindle machines. The length of a first-time machine is about 18 feet 8 inches, whereas the length of a second-time frame with an equal number of spindles is just 22 feet. The width of both styles of frame is the same, measuring 14 inches, while the height is slightly over 4 feet.

The lengths of double-deck spinners and twisters are approximately the same as those of the corresponding single-deck machines; hence, the 108-spindle single-deck first-time spinner has the same length as the 216-spindle double-deck first-time twister. Similarly, the second-time double-deck twister has the same length and width as the single-deck twister; its height, needless to say, is greater.

39. The machines should be arranged in the mill in the most advantageous manner. For this reason, the distance between machines may be different in various mills according to the number of machines to be located in a given space. When sufficient floor area is available, the spinners or twisters should be spaced about 24 inches apart, leaving an aisle sufficiently large to allow the operative to work comfortably and efficiently. Sometimes, the spacing is as small as 18 inches, but this is somewhat dangerous; for there is a possibility that the clothing of the operative may catch on the spindle belt, or come in contact with the ends that are running, thus breaking them down.

40. Power Required.—The horsepower required to operate a silk spinner or twister depends, to a large extent, on the type of bearings and spindles with which the frame is equipped, and also on the operating speed, or spindle speed. It is known from actual tests that spinners equipped with ball bearings on the crosshead shaft and the vertical shaft run with greater ease and consume less power than when ordinary bearings are employed. Ball-bearing spindles, while not used to a great extent, also aid in reducing the power required.

When the frame is operating at a low speed the power required will be much less than when operating at a high speed. For instance, about $1\frac{1}{8}$ horsepower is required for 124 spindles operating at 8,000 revolutions per minute. However, with the same frame operating at 12,000 revolutions per minute, the power required will have advanced to 3 horsepower, thus showing that an increase in speed results in more than proportional increase of power. In calculating the required horsepower, therefore, the following figures may be employed as a basis: When driving the spinners from a line shaft, 2 horsepower will be sufficient for 100 spindles running at practically all spindle speeds. Should individual motors be employed, a 2-horsepower motor will serve for speeds up to 10,000 revolutions per minute, but above this it is better practice to employ a larger motor. A double-deck machine equipped with twice as many spindles requires about twice as much power; hence, a suitable motor for such a machine would be of approximately 5 horse-power, which is sufficient for all conditions and speeds for this type of spinner.

41. Speed of Spinner.—The speed of the spinner or twister is generally designated by the spindle speed, in revolutions per minute. The speed, of course, is varied, but the best results are obtained if the spindles revolve within certain limits of speed. When operated below what could be called a normal speed, the production will naturally be low; whereas, should the other extreme of speed be approached, many parts of the machine are subjected to rapid wear, which would necessitate numerous renewals. Besides, the threads being processed may break with greater frequency. It is evident that a first-time machine operating on first-time work may be run at a higher speed than a second-time machine on twisting, since the absence of flyers allows this increased speed. First-time machines are usually run at from 9,000 to 12,500 revolutions per minute, which is considered a normal operating speed for a spinner. Sometimes, when it is desired to secure a large production, the spindle speed is increased to 16,000 revolutions per minute, but this excessive speed is detrimental to the life of the machine.

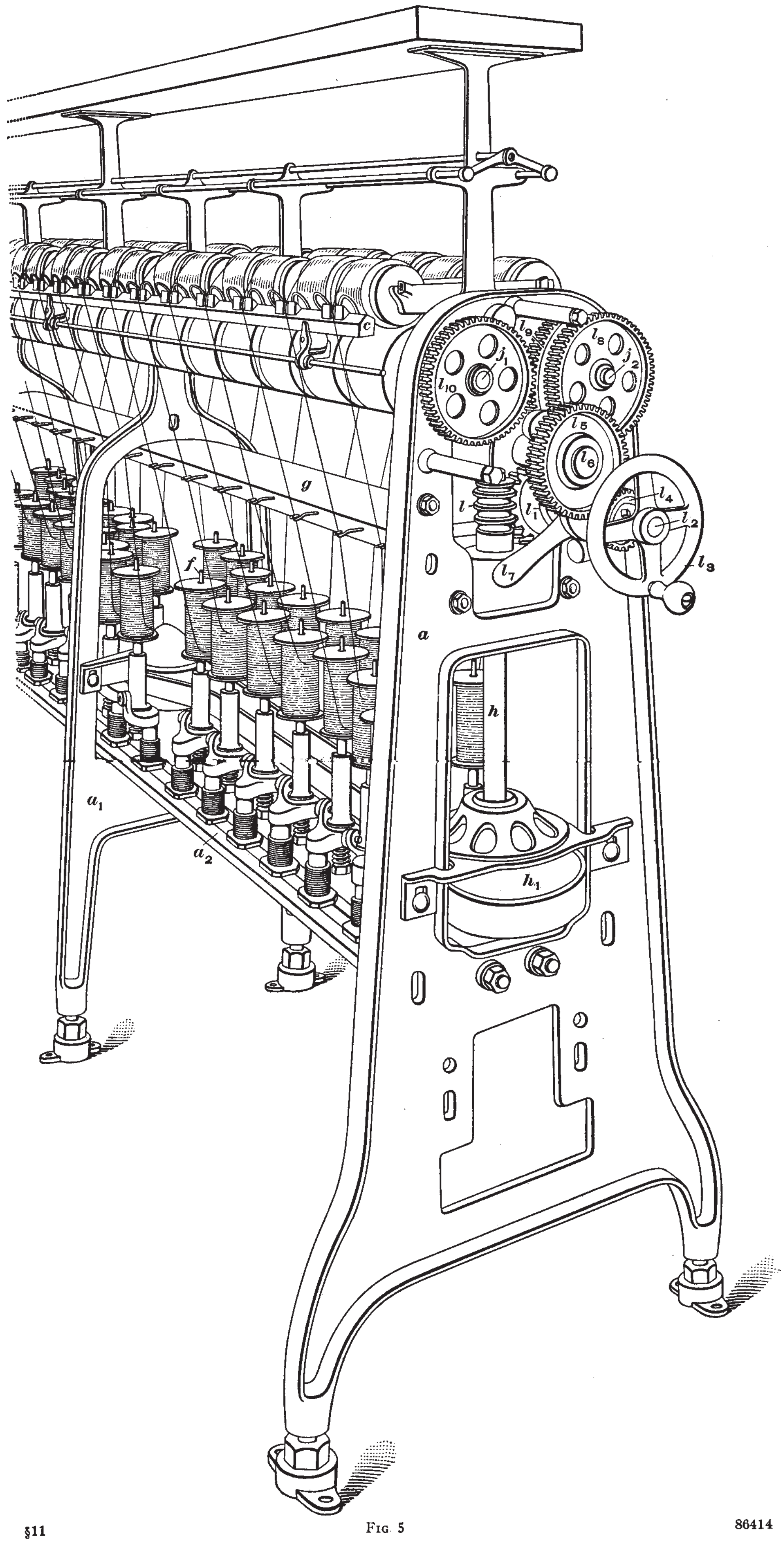
When considering the speeds of the second-time spinner, it should be remembered that it will be necessary to run the machine at a slower speed, since flyers are employed. The average speed of second-time spinners ranges between 6,000 and 7,000 revolutions per minute; nevertheless, some machines are speeded up so that the spindles make 9,000 revolutions per minute. This, however, is not always conducive to good work and consequently the product of second-time machines running at such a speed should be carefully examined.

OTHER TYPES OF SPINNERS

42. Frame.—In addition to the spinner that has just been described, several other types are manufactured, which are employed to a considerable extent in the silk-throwing industry. One type of spinner similar in many respects to the frame just described is illustrated in Figs. 5 and 6 (*a*) and (*b*). Fig. 5 is a perspective view of the change-gear end of the frame, while Fig. 6 (*a*) and (*b*) illustrates a side and an end view.

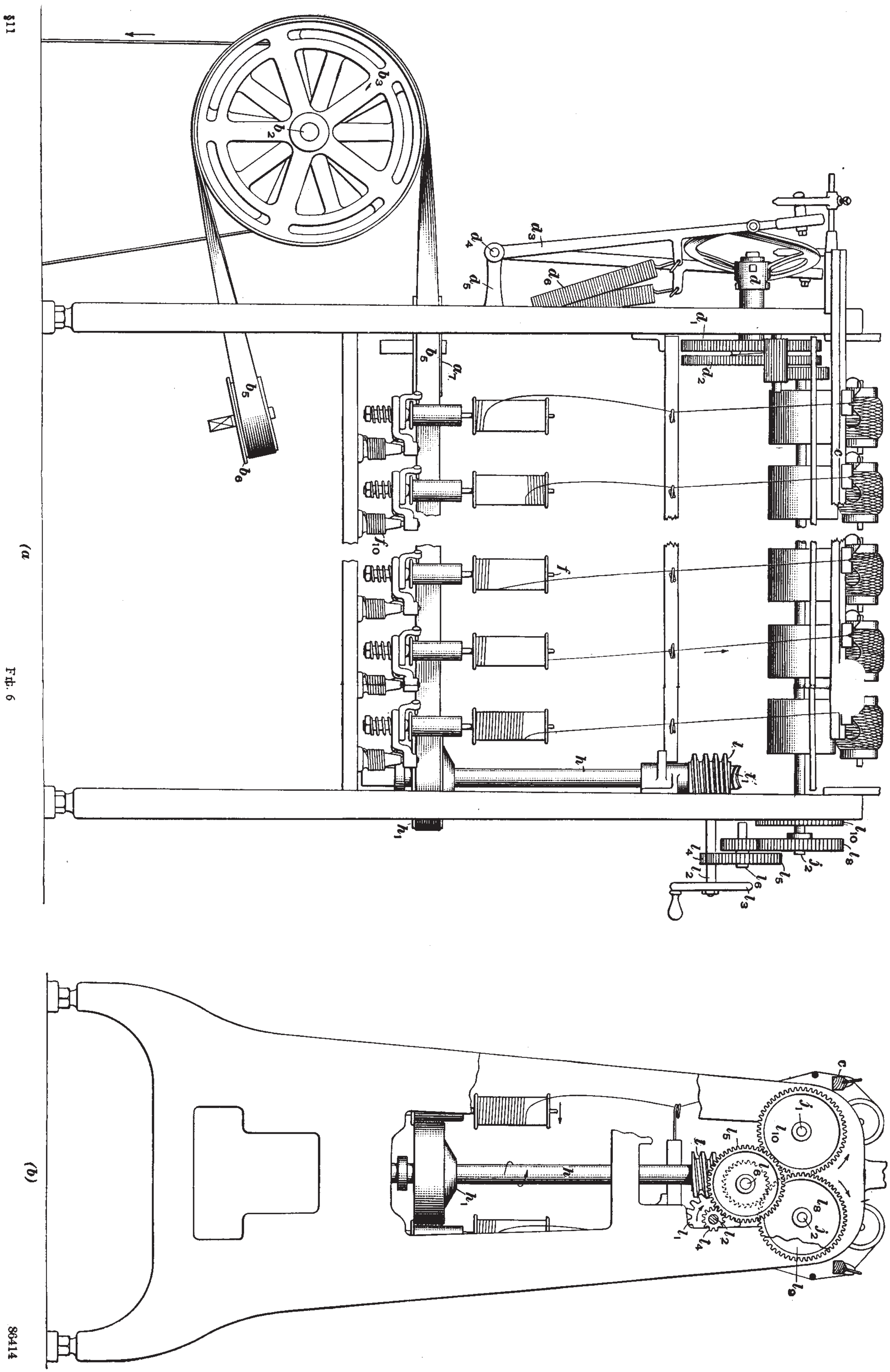
The spinner in Fig. 5 has two end stands *a*, of which only one is shown, and middle stands a_1 that support the spindle rails a_2, the traverse bars *c*, the guide rail *g*, and the take-up shafts j_1 and j_2.

43. Drive.—The driving mechanism, located at one end of the machine, Fig. 6 (*a*), consists of the tight and loose drive pulleys, and the tight and loose spindle-belt pulleys supported on the crosshead shaft b_2. The tight drive pulley and the tight spindle-belt pulley b_3 are cast integral, and due to the location of the latter, the tight drive pulley and remaining pulleys cannot be seen distinctly. The tight drive pulley receives its motion from the line shaft, which is located under the floor in this case, and imparts motion through the tight spindle-belt pulley and the spindle belt b_5 to other parts of the machine. The spindle belt, of course, drives the spindles on the frame and in returning from the foot-end, it drives the vertical shaft *h* by its contact with the pulley h_1, which is attached to the lower end of the shaft. Leaving the loose spindle-belt pulley, the belt passes under the frame and around the movable idler b_6, which is always maintained at a constant tension either by a heavy extension spring, or by a weight. It will be seen that the frame is equipped with swing spindles *f* that are very similar to those employed on the preceding machine. The coil spring f_{10} maintains a constant pull on the swing gate and holds the whorl in continuous contact with the spindle belt. In order to prevent the spindle belt from sagging, stationary idlers a_7 are distributed along the frame to keep the belt in a better running position.



§11 FIG. 5 86414

Rotated 90° to fit on page.



Rotated 90° to fit on page.

44. Traverse Motion.—A slightly different arrangement is employed to give the back-and-forth motion to the traverse bar *c*, Fig. 6 (*a*). As illustrated, the customary cam *d* is employed which receives its variable motion from the two gears d_1 and d_2 located on the inside of the frame and driven from the take-up shaft. The motion from the cam is transmitted to the traverse levers d_3 which are designed slightly different from previously illustrated levers. They are a great deal shorter than the ordinary traverse levers and pivot on a short shaft d_4 supported in brackets d_5, which are fastened to the end stand. At a point slightly above the center of each traverse lever, a small arm, which is a part of the traverse-lever casting, has one end of a strong extension spring d_6 attached to it, while the opposite end of the spring is fastened to the end stand. It will be noted that the springs d_6 are nearly upright or vertical; for this reason the name *vertical-spring traverse motion* is sometimes applied to this type of traverse motion.

45. Gearing of Take-Up Rolls.—While the principles of transmitting the power from the spindle belt to the take-up rolls on the type of spinner shown in Fig. 6 are practically the same as on the spinner previously described, the arrangement of the change gears and the method of changing the combinations of gears to alter the twists are somewhat different. On this machine, the alteration of the speed of the take-up rolls, and consequently the twist that is inserted in the thread, is accomplished by substituting gears with the correct numbers of teeth, the proper gears being found with the aid of a twist chart. The vertical shaft *h* is driven by the spindle belt, which passes around the pulley h_1 fastened to the lower end of the shaft. A worm *l* attached to the upper end of the vertical shaft meshes with the worm-gear l_1 mounted on the worm-gear shaft l_2. The worm-gear shaft extends through the end stand and carries at its opposite end the hand wheel l_3. Also located on the worm-gear shaft, at a point about half way between the hand wheel and the end stand, is a small spur gear l_4 that meshes with the larger gear of the compound l_5. The latter rotates on the adjustable stud l_6 which, as illustrated in Fig. 5, is fitted with a short handle l_7. The extension of the stud that carries the intermediate is designed to facilitate the operation of meshing the intermediate gear after it has been placed on the stud. Thus, after the gear is in position on the stud, the gear may be raised or lowered by means of the extension, or handle, until it is in proper mesh with the two gears between which it transmits power.

46. The compound gear l_5, Figs. 5 and 6, is located on the stud l_6 in such a position that the smaller gear of the compound meshes with a large gear l_8 fastened by a setscrew to the end of the take-up shaft j_2. On the take-up shaft between the gear l_8 and the end stand is a 54-tooth gear l_9. This gear cannot be seen in Fig. 6 (*a*), but may be seen in Figs. 5 and 6 (*b*), since a part of the gear l_8 directly in front of the gear l_9 has been broken away in the latter illustration. The gear l_9 meshes with a gear l_{10} of the same size located on the opposite take-up shaft; hence, both shafts will revolve at the same speed.

47. Hand Take-Up Mechanism.—The hand take-up mechanism with which the spinner being described is equipped is located between the source of power and the take-up rolls. Its object is to permit the speed of rotation of the take-up rolls to be increased slightly during the period of time between the shipping of the driving belt to the loose pulley and the actual stopping of the frame. The reason for this procedure is to cause the take-up of the thread to be increased and prevent the formation of kinks or snarls in the thread.

As illustrated in detail, in Fig. 7, the worm-gear l_1 is mounted loosely on the worm-gear shaft l_2, which is adequately supported in bearings on both sides of the end stand. Located at one side of the worm-gear and setscrewed to the worm-gear shaft, is the removable ratchet arm l_{11}. This is constructed with a spring pin l_{12} that protrudes somewhat from the arm. Furthermore, a spring located inside the arm constantly presses the pin toward the gear l_1; consequently, it engages with one of the three teeth l_{13} on the side of the gear. These teeth are so constructed that all parts are equally distant from the center of the gear, thus causing the spring pin to be in contact with some part of a tooth at all times. Moreover, they gradually increase in height and are cut away sharply at their high ends. Thus, as the worm l on the vertical shaft *h* causes the worm-gear l_1 to revolve, a tooth strikes the spring pin and carries the arm l_{11} and the worm-gear shaft l_2 around with it, causing the remaining gears and also the take-up rolls of the machine to revolve.

48. The direction of slant of the teeth l_{13}, Fig. 7, is such that the worm-gear shaft may be rotated more rapidly than the worm-gear is revolving by turning the hand wheel l_3 in the

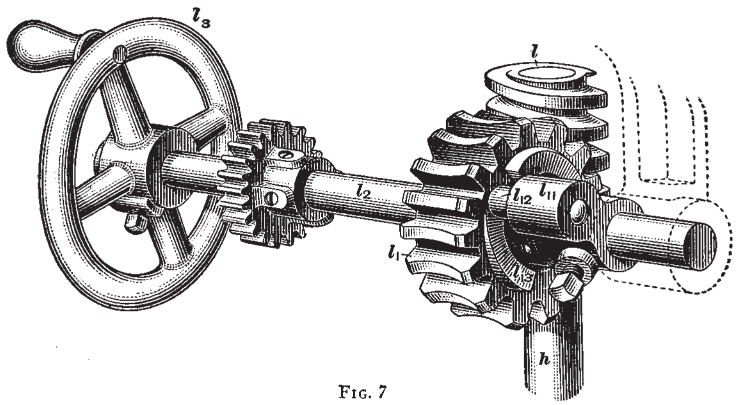


Fig. 7

proper direction. In this case the spring pin will gradually be depressed as it passes from the low to the high spot of the tooth and after leaving the high spot it repeats the motions on the following teeth.

In operation, the hand take-up mechanism functions in the following manner: During the period from the shipping of the drive belt and the actual stopping of the machine, the thread often becomes slack and forms into small snarls, especially when high twists are made. For this reason the hand take-up is provided, which is brought into operation as the machine stops. As the spindle speed decreases, the operator grasps the knob attached to the hand wheel and follows the latter at the same speed at which it is rotating. Then, when the frame is almost at rest, the operator turns the hand wheel so that it revolves only slightly faster than the worm-gear. This, of course, keeps the thread taut and prevents the formation of snarls. The operator should exercise considerable care and not turn the hand wheel too fast, as this would cause the thread to be taken up too rapidly and result in a slackly twisted thread.

49. Twist Gears.—Of the various gears that are employed on the spinner illustrated in Fig. 6 (*a*) and (*b*), the gears l_8 and l_4 are the twist change gears. Thus, when changing from one twist to another it will be found that the gear l_8 is changed most frequently. In accordance with the twists that are inserted in the thread, the gear l_4 is also changed to a certain extent, but not as frequently as the gear l_8, provided that the twist change is for only a few turns. In these changes, gears of various sizes are employed, which accounts for the construction of the previously described movable arm that supports the intermediate gear, since the latter must be adjusted to numerous positions.

50. Twist Chart.—In order to find the proper gears to produce a desired twist, it will be necessary to refer either to a twist chart or to determine the change gears by calculation. On a twist chart, the proper sizes of gears and gear combinations for twists from 1 to 70 turns, inclusive, may be found immediately; but to simplify the chart these twists may be divided into three groups that may be called tram, organ, and crêpe twists. The twist that will be inserted in the thread is governed by the speed of the take-up rolls in relation to the speed of the spindle; hence, it is important to note the diameter of the spindle whorl with which the spinner is equipped, before attempting to calculate the twist. It is known that the spindle regularly found on the spinner being described has a whorl $\frac{13}{16}$ inch in diameter; therefore, all the calculations in the compilation of the twist chart are performed on this basis.

51. When determining the gears to be employed to give the tram twists, which range from 1 to 5 turns, inclusive, it will be necessary to make use of the following information besides that given in Table III: For twists ranging from 1 to 1½ turns of twist, it will be necessary to place spiral even gears

TABLE III

CHANGE GEARS FOR TRAM TWIST

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
1	41	25	3½	40	52
1½	52	21	4	42	48
2	23	52	4½	47	48
2½	28	52	5	52	48
3	34	52			

on the vertical shaft *h*, Fig. 6 (*a*) and (*b*), and also on the worm-gear shaft l_2, while a single intermediate should be located on the stud l_6. The proper size of gear l_8 on the take-

TABLE IV

CHANGE GEARS FOR ORGAN TWIST

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
6	34	52	16	47	27
7	40	52	17	50	27
8	45	52	18	53	27
9	39	40	19	41	20
10	44	40	20	44	20
11	48	40	21	46	20
12	52	40	22	48	20
13	38	27	23	50	20
14	41	27	24	52	20
15	44	27			

up shaft and the gear l_4 on the worm-gear shaft may be found from the table. With these gears in position, the vertical shaft and the worm-gear shaft will revolve at the same speed, which is necessary because of the high speed at which the take-up bobbin must revolve in order to take up the thread so that a few turns of twist will be inserted in the thread. When inserting from 2 to 5 turns of twist, inclusive, certain substitutions must again be made, which are not shown in Table III. In this case, a single worm is placed on the upper end of the vertical shaft to mesh with a 15-tooth worm-gear on the shaft l_4. A compound gear that has 48 and 24 teeth should

TABLE V

CHANGE GEARS FOR CRÊPE TWIST

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
25	45	33	36	47	24
26	47	33	37	48	24
27	49	33	38	50	24
28	50	33	39	51	24
29	52	33	40	53	24
30	54	33	45	47	19
31	47	28	50	52	19
32	49	28	55	53	26
33	51	28	60	53	24
34	52	28	65	53	22
35	53	28	70	53	20

then be placed on the stud l_6, so placed that the 48-tooth gear will mesh with the gear l_8 on the take-up shaft.

When inserting from 6 to 24 turns of twist, inclusive, which may be called the organzine twists, Table IV should be consulted. Besides the gears found in the table, a 15-tooth worm-gear should be placed on the worm-gear shaft, as before, while a single intermediate should be substituted for the compound gear that was on the stud l_6.

52. Table V illustrates the gears to be employed when inserting the crêpe twists in the thread, ranging from 25 to 70 turns. When inserting from 25 to 50 turns of twist, inclusive, a single worm is placed on the vertical shaft to mesh with a 15-tooth worm-gear located on the worm-gear shaft. A compound gear that has 24 and 48 teeth is placed on the stud l_6 in such a manner that the 24-tooth gear of the compound meshes with the gear l_8 on the take-up shaft. When inserting 55 to 70 turns, inclusive, as in previous cases, a 15-tooth worm-gear is employed. A compound gear that has 16 and 48 teeth is substituted for the 24- and 48-tooth compound gear. This compound is placed on the stud l_6 so that the 16-tooth gear of the compound will mesh with the gear l_8 on the take-up shaft.

53. Reversing Twist.—The reversing of the twist on the machine being described is accomplished by the substitution of certain gears. The usual method of procedure is to reverse the direction of rotation of the spindles by changing the drive belt from a crossed belt to an open belt or vice versa. Then, in order to cause the take-up rolls to revolve in the proper direction it will be necessary to remove the worm and worm-gear and substitute similar gears, but with the teeth cut in the opposite direction, so that the gears following the worm and worm-gears, and consequently the take-up rolls, will revolve in the correct direction.

54. The removal of the worm is usually accomplished by loosening the bearings that support the vertical shaft and shifting the latter to such a position that the worm may be easily removed. The proper worm is then placed on the shaft. Next, the worm-gear, located on the worm-gear shaft, is removed from the latter and a worm-gear that will mesh with the worm is placed on the shaft. The gear will have the ratchet teeth slanting in a direction opposite to that in which they were previously slanting, which is necessary in order that the gear will carry the hand take-up around with it. With the gears on the shafts, the bearings supporting the shafts are again tightened, whereupon the gears are given the final adjustment. In connection with this subject it may be added that in order to simplify the operation of changing worms, a split worm is manufactured that may be removed in halves from the shaft. This eliminates the necessity of shifting the shaft in order to remove the worms.

It should be remembered, when reversing the direction of twist, that the number of turns of twist being placed in the thread will not be affected. For example, if 60 turns of right twist are being inserted in the thread, changing the worm and worm-gear to insert a left twist will cause 60 turns of left twist to be inserted in the thread.

55. Twist Calculations.—The following are examples of the methods of calculating the twist that will be inserted in a thread when the gears are in a given condition.

EXAMPLE 1.—Find the twist that is being inserted in a thread with the gears on the spinning frame in Fig. 6 having the following numbers of teeth: Gear l_8 on the take-up shaft has 52 teeth and meshes with a single intermediate having 36 teeth; the intermediate in turn meshes with a 21-tooth gear l_4 on the worm-gear shaft. Spiral even gears are employed on the worm-gear and vertical shafts. The diameter of the pulley h_1 on the vertical shaft h is $5\frac{3}{4}$ inches; the diameter of the whorl is $\frac{13}{16}$ inch, and the circumference of the take-up roll is $11\frac{3}{4}$ inches.

SOLUTION.—The twist being inserted is

$$\frac{52 \times 1 \times 5\frac{3}{4}}{21 \times 1 \times \frac{13}{16} \times 11\frac{3}{4}} = 1.491, \text{ or, say, 1.5 turns per in. Ans.}$$

EXAMPLE 2.—What is the twist per inch that is being inserted in a thread with the spinner, Fig. 6, geared in the following manner: Gear l_8 on the take-up shaft has 34 teeth, meshing with a single intermediate having 36 teeth; this meshes with a 52-tooth gear l_4 on the worm-gear shaft, while the spiral even gears are replaced by a 15-tooth worm-gear on the worm-gear shaft and a single worm on the vertical shaft. The diameter of the pulley h_1 on the vertical shaft h is $5\frac{3}{4}$ inches; the diameter of the spindle whorl is $\frac{13}{16}$ inch, and the circumference of the take-up roll is $11\frac{3}{4}$ inches.

SOLUTION.—The twist being inserted is

$$\frac{34 \times 15 \times 5\frac{3}{4}}{52 \times 1 \times \frac{13}{16} \times 11\frac{3}{4}} = 5.907, \text{ or practically 6 turns per in. Ans.}$$

EXAMPLE 3.—Find the twist per inch being inserted in the thread with gears arranged as illustrated in Fig. 6 but having the following numbers of teeth: Gear l_8 on the take-up shaft has 53 teeth, meshing with the smaller, or 16-tooth, gear of the compound, while the larger gear of this compound having 48 teeth meshes with a 26-tooth gear l_4 on the worm-gear shaft. A 15-tooth worm-gear at the end of this shaft meshes with a single worm on the shaft h_1. The diameter of the pulley h_1 on the vertical shaft is $5\frac{3}{4}$ inches, the diameter of the spindle whorl is $\frac{13}{16}$ inch, and the circumference of the take-up rolls is $11\frac{3}{4}$ inches.

SOLUTION.—The twist being inserted is

$$\frac{53\times48\times15\times5\frac{3}{4}}{16\times26\times1\times\frac{13}{16}\times11\frac{3}{4}}=55.248, \text{ or } 55 \text{ turns per in. Ans.}$$

56. Since rules for calculating the twist constant have been given previously, it will be unnecessary to repeat them here. However, it may be explained that slight differences will be found in the calculation of the constants to be employed when determining the twist gears for this type of spinner. This is evident, for two change gears are located in the train of gears and consequently two constants must be found. Hence, when substituting the theoretical one-tooth change gear for the change gear in the train it may either be a driving or a driven gear which determines whether it will be known as a *constant factor* or a *constant dividend*. A constant factor may be defined as a number that, when divided into the desired twist per inch, will give the number of teeth in the change gear to give the desired twist, or, when multiplied by the size of the change gear used, will give the resulting turns of twist per inch. A constant dividend is a number that, when divided by the number of teeth in the change gear used, will give the twist obtained by using that train of gears, or, by dividing by the twist desired, will give the size of gear required.

EXAMPLE.—Find the twist constant of the train of gears illustrated in Fig. 6 considering the 23-tooth gear l_8 on the take-up shaft as the change gear which in turn meshes with the 48-tooth gear of the compound gear. The smaller gear of the compound, which in this case has 24 teeth, meshes with a 52-tooth gear on the worm-gear shaft. A 15-tooth worm-gear at the opposite end of the shaft meshes with a single worm on the vertical shaft. The diameter of the pulley on the vertical shaft is $5\frac{3}{4}$ inches, the spindle whorl is $\frac{13}{16}$ inch, and the circumference of the take-up roll is $11\frac{3}{4}$ inches.

SOLUTION.—The twist constant, which in this case is a constant factor, is

$$\frac{1\times24\times15\times5\frac{3}{4}}{48\times52\times1\times\frac{13}{16}\times11\frac{3}{4}}=.0868. \text{ Ans.}$$

57. It will be noted, by referring to Tables III, IV, and V, that the gear l_4 on the worm-gear shaft and the gear l_8

on the take-up shaft are both changed when changing the twist per inch. However, while the gear on the take-up shaft is changed for every twist change, the gear on the worm-gear shaft is sometimes changed in groups; hence, the gear l_8 may be considered the change gear in the calculations. Therefore, when determining the constant, the theoretical 1-tooth gear should be substituted for the gear on the take-up shaft and the result found when the calculation is completed will be a constant factor, since the change gear is a driving gear. The constant that is found may be employed only for those twists employing the same size of gear l_4. In other words, it will be necessary to obtain four constants in Table III, four constants in Table IV, and so on, since the gear l_4, located on the worm-gear shaft, is changed four times in the respective tables. That is, taking Table IV as an example, one twist constant will be sufficient for finding the twist change gear l_8 when the twist ranges within 6, 7, and 8 turns per inch. Should the twist to be found be within 9, 10, 11, or 12 turns per inch, it will be necessary to obtain a new twist constant, since the gear l_4 on the worm-gear shaft has been changed, which alters the value of the train of gears.

58. If the constant is known, the number of teeth in the change gear required to give a desired number of turns of twist per inch may be found by the following rule:

Rule.—*To find the size of change gear to give a certain number of turns of twist per inch, divide the required twist by the twist constant.*

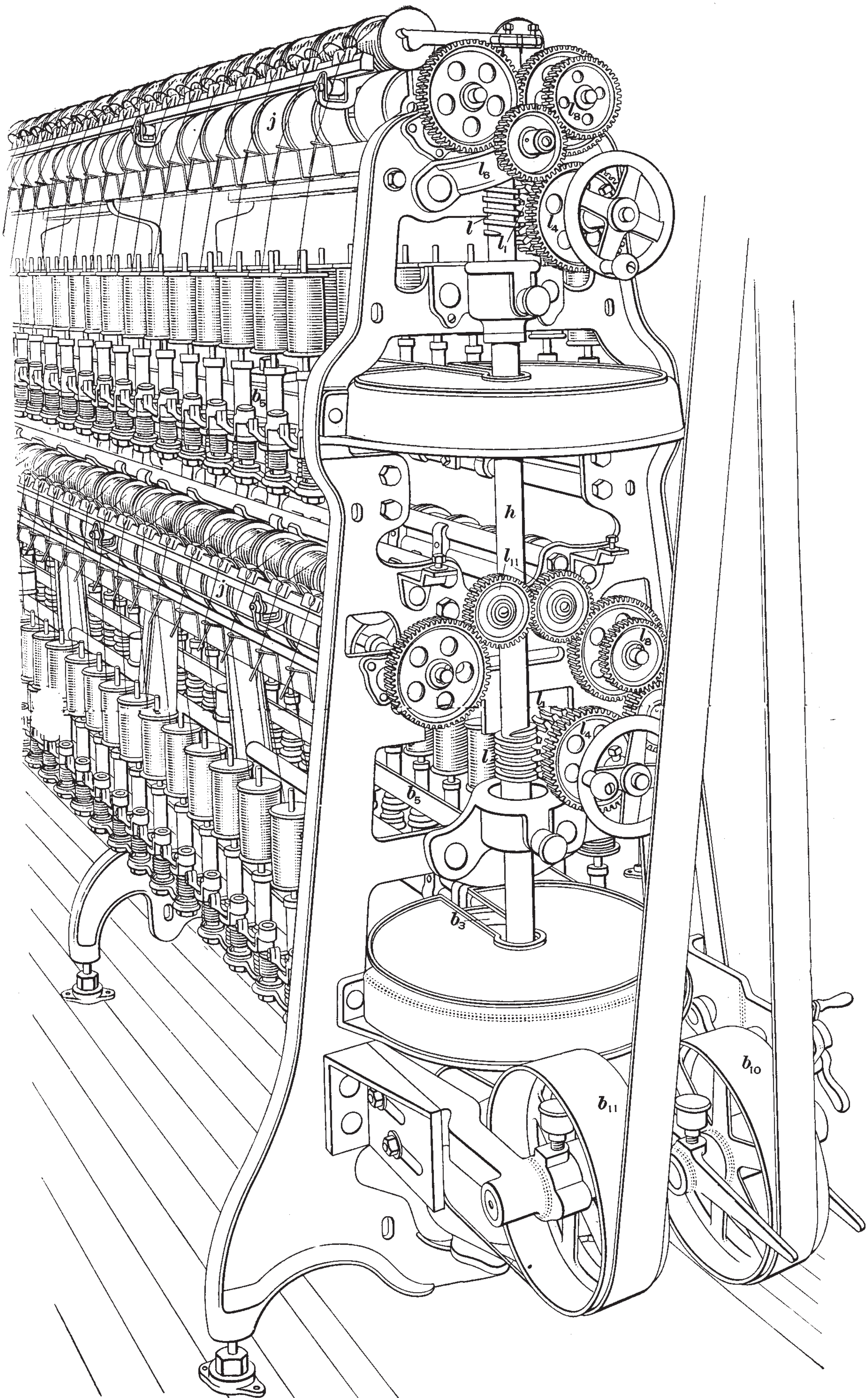
EXAMPLE.—Find the size of change gear necessary to insert 2 turns per inch in the thread, if the constant factor is .0868.

SOLUTION.—Apply the rule, and the required change gear is found to contain

$$2 \div .0868 = 23.041, \text{ or say 23 teeth. Ans.}$$

DOUBLE-DECK SPINNERS

59. Advantages and Disadvantages.—Another type of spinner that is employed to a large extent in the silk-throwing industry is the double-deck spinner illustrated in Fig. 8. It is



§11

Fig. 8

86414

Rotated 90° to fit on page.

constructed in practically the same manner as the spinner previously described, employing similar methods of changing the twist gears, mounting of spindles, and so on. The slight differences that exist will be explained. The double-deck spinner may be compared with the double-deck winder in regard to the general principles of construction. Both machines possess certain advantages over the single-deck type, and as is to be expected, these are offset somewhat by several disadvantages. Among the important advantages of the double-deck spinner may be considered the economy in floor space that is effected when a machine of this type is employed. Thus, where a 100-spindle single-deck frame is used, a 200-spindle double-deck machine may be substituted in its place and occupy practically the same amount of floor space as the former machine.

60. A saving in drive belting will also be effected by using double-deck frames. Thus, in a mill equipped with double-deck frames, only one-half the number of machines will be required to supply the necessary number of spindles in comparison to single-deck frames. Therefore, with half the number of required frames in operation, fewer drive belts will be necessary, provided, of course, that the machines are equipped with belt drive. If, on the other hand, the frames are driven by individual electric motors, it will be necessary to have only one-half the number of motors; however, the motors must be larger, since the increased number of spindles per machine requires a corresponding amount of power.

61. One of the greatest disadvantages of the double-deck type of spinner is the location of the take-up bobbins of the lower and upper decks. The take-up bobbins of the lower deck, as illustrated in Fig. 8, are shown as somewhat lower than on the ordinary single-deck machine, whereas, the take-up bobbins of the upper deck are quite high. The placement of the bobbins in this manner causes the operatives to work under a strain. When removing take-up bobbins from the upper deck it will be necessary for a short operative to stretch, whereas, when replacing bobbins on the lower deck it will be necessary for the operative to bend over. Because of these disadvantages, it is sometimes difficult to obtain operatives to run double-deck machines. Hence, when laying out a mill or planning for new equipment, these points should be taken into consideration.

Frequently, as operatives tie up ends on the upper-deck, pieces of waste silk, such as bobbin waste and waste made in tying knots, is allowed to fall. It naturally drops and sometimes is caught by a running end of the lower deck. In taking up the thread, the waste is twisted with the running end, forming a slug-like defect in the thrown yarn.

62. Furthermore, the losses that occur when a double-deck spinner is stopped are greater than when a single-deck machine is stopped, for the single-deck machine has fewer spindles than the double-deck spinners. Stoppages that are caused by broken spindle belts, necessary repairs to the machine, etc., therefore, have a slight tendency to decrease the production of thrown yarn.

Overseers, or foremen, are also prevented from observing the movements of the employes when double-deck machines are used, because of the height of the machines. Employes frequently take advantage of this and congregate behind the machines, thus neglecting their work. With single-deck spinners, overseers can easily observe the employes and determine whether or not they are attending to their work.

63. Drive.—A perspective view of the drive end of a double-deck spinner is illustrated in Fig. 8. The machine is driven from an overhead line shaft by means of a belt, of which only a part may be seen in the illustration. The drive belt passes downwards and around the idler b_{10}, and thence, according to the position of the latter, encircles either the tight or the loose pulley of the machine. The latter pulleys are mounted near the lower end of the vertical shaft h, being hidden from view in this illustration. On leaving either of the pulleys on the vertical shaft, the drive belt passes around the idler b_{11} and returns to the pulley on the line shaft.

64. The construction and method of mounting the idlers and pulleys of the drive are illustrated in detail in Fig. 9, which is a side elevation. The tight and loose pulleys b and b_1 are mounted on the vertical shaft h, and the loose pulley b_1 receives the belt. In passing to either of the pulleys b or b_1, the drive belt passes over the idler b_{10}, which is referred to as the *receiving idler*, since it receives the drive belt prior to guiding it on the pulleys. Leaving one of the latter pulleys, the drive belt returns to the line shaft over the idler b_{11}. The receiving idler b_{10} rotates on a pin b_{12} that is

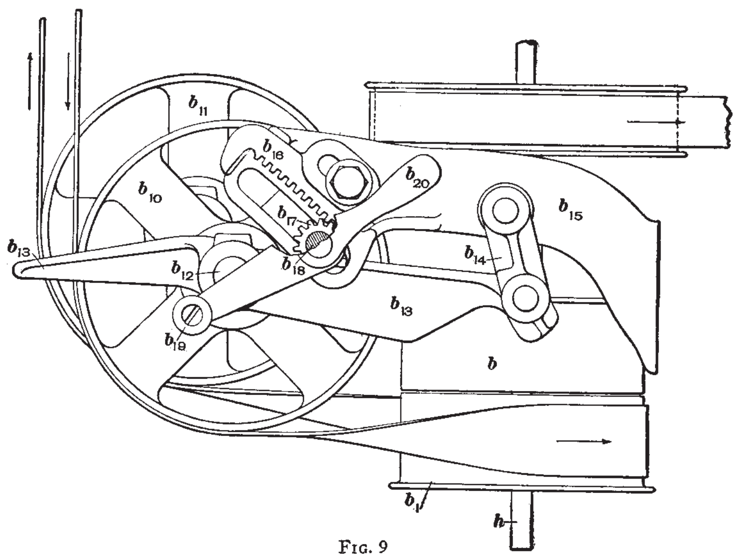


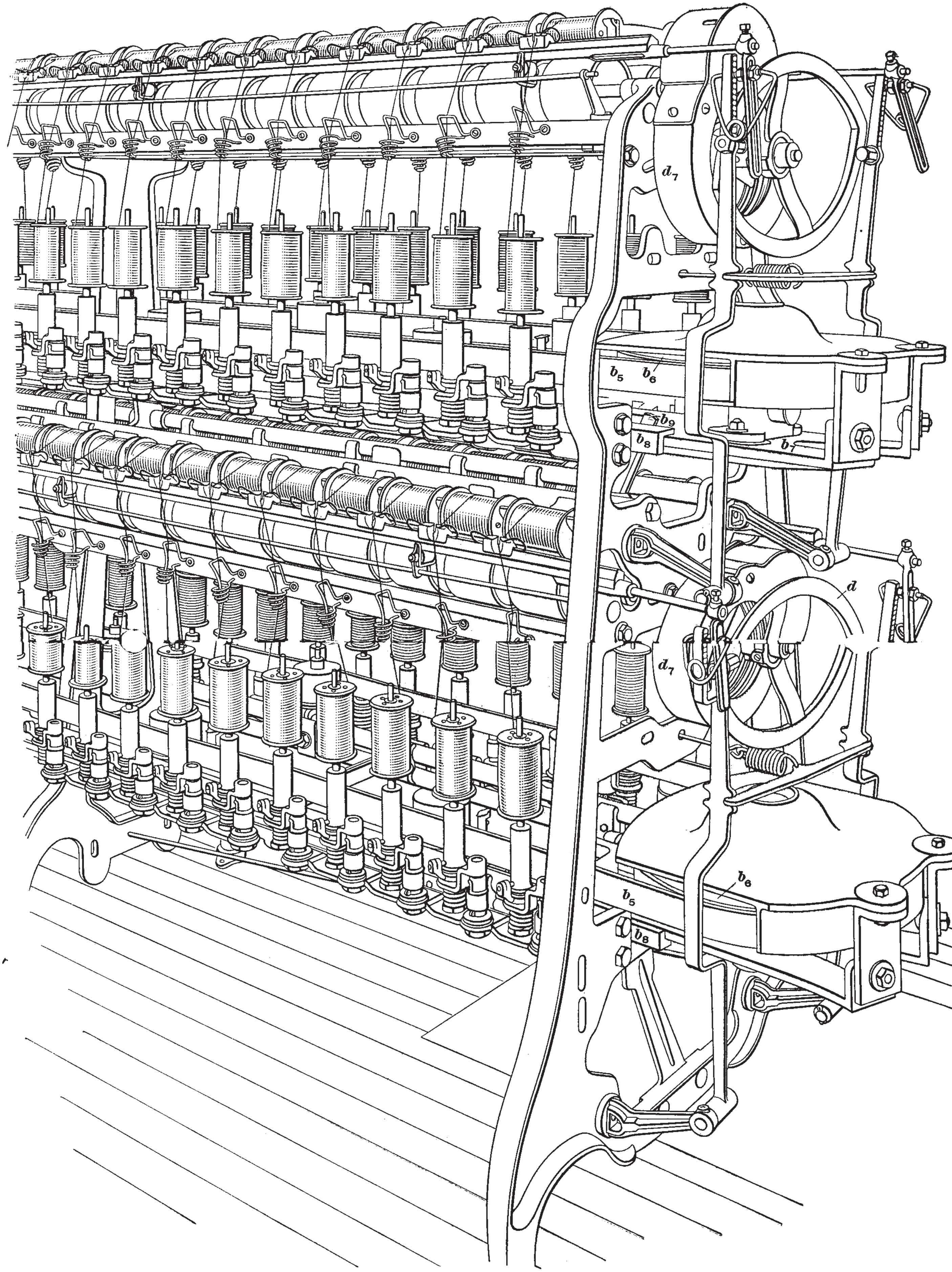
Fig. 9

supported by the arm b_{13}. One end of this arm extends past the idler b_{10} in the form of a forked guide in order to retain the drive belt on the idler when starting the machine. The opposite end of the arm is pinned to the link b_{14}, the upper end of which is secured in a similar manner to a casting b_{15} that is bolted to the end stand. Also bolted to the casting b_{15} is the adjustable rack b_{16}, which is constructed as shown. A small pinion b_{17} meshes with the rack and is fastened to a small shaft b_{18} that extends from both sides of the arm b_{13}. One end of the shaft is held by a support that is a part of the arm b_{13} while the opposite end of the shaft carries the handle b_{19}. Attached to the shaft b_{18} is a small lever b_{20} that turns on the threaded end of the shaft and is employed to lock the latter in position.

65. As illustrated in Fig. 9, the driving belt encircles the loose pulley b_1. In order to start the machine it is necessary to shift the belt upwards so that it will pass around the tight pulley b. This is accomplished by first swinging the small lever b_{20} to the left, thus unlocking the handle b_{19} so that it may be rotated. The latter is now turned in a clockwise direction so that the rotation of the pinion will cause it to traverse the length of the rack and carry the arm b_{13} upwards with it since the arm is connected to the pinion shaft. Besides moving upwards, the arm also swings outwards, due to the inclination of the rack and also to the manner of fastening the arm b_{13} to the casting b_{15} by means of the link b_{14}. This construction is necessary; for, as the idler b_{16} moves upwards, the belt becomes slack. However, the slackness is removed as the idler moves outwards. After the receiving idler reaches the running position, so that the drive belt is guided on the tight pulley, the lever b_{20} should be turned to the right to lock the handle b_{19} securely in position, thus preventing it from returning to its previous position.

66. The double-deck spinner is frequently equipped with individual electric-motor drive. When a spinner is to be equipped with a drive of this type, it is usually supplied with an end stand of a special design, in order that the individual motor may be properly located at the head of the frame. With a vertical drive, the motor is so placed that the vertical shaft of the motor may be coupled directly to the spinner shaft. Starting and stopping of the machine may then be easily accomplished by merely starting and stopping the motor, which eliminates the use of belt shippers.

67. Cam Drive.—A perspective view of the cam end of a double-deck spinner is shown in Fig. 10. The upper and lower decks are practically alike, being equipped with individual cams, traverse levers, and other parts that are common to



§11

Fig. 10

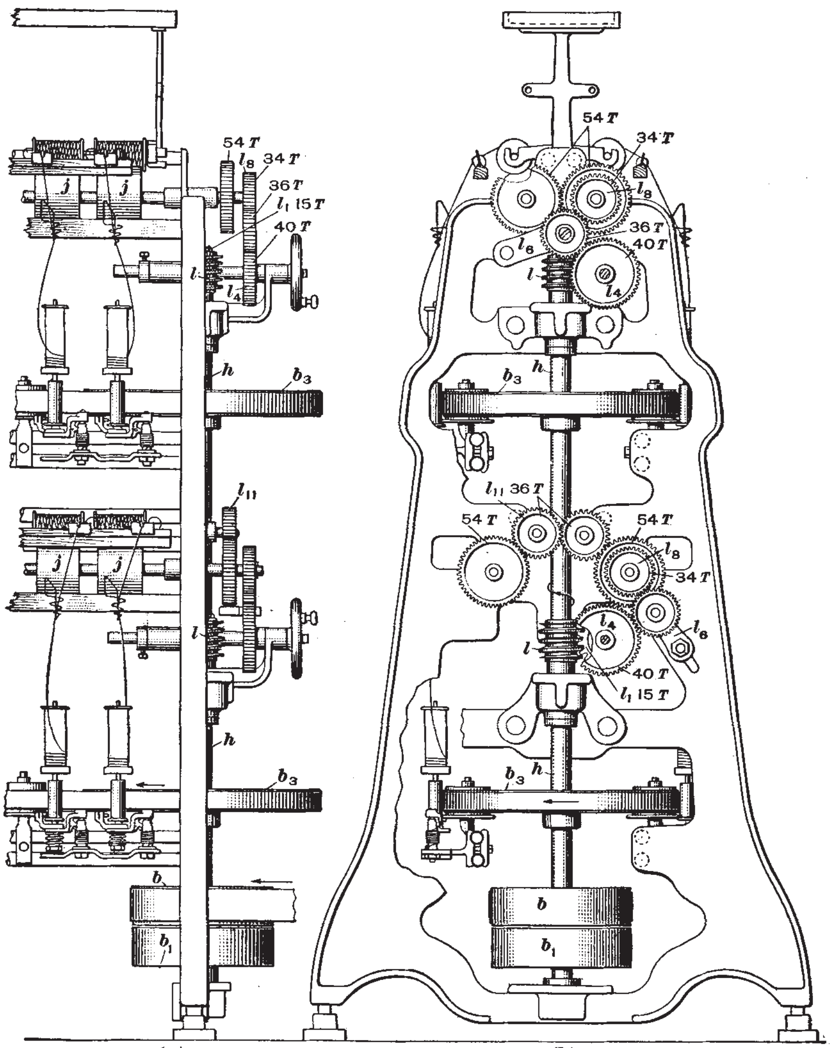
86414

Rotated 90° to fit on page.

previously described spinners. Two cams d are employed, one operating the traverse levers and bars on the upper deck, while the other cam operates similar parts on the lower deck. A spur gear, attached to one take-up shaft and meshing with two unevenly toothed gears, drives the cam and also produces the characteristic variable motion found on practically all silk-throwing machinery. The methods of driving the upper and lower cams are alike. The two unevenly toothed gears referred to are located in the same relative positions as on other machines, but are hidden from view in this illustration, since the guards, or safety covers d_7, are still in position.

68. Spindle-Belt Tension.—In traversing the length of the machine, Fig. 10, the spindle belts b_5 pass around the movable spindle-belt idlers b_6 located at the cam end of the machine. The tension given to the spindle belts is applied at this point; the method employed to retain the tension, however, is somewhat different from that employed on previously described spinners. Thus, the idler b_6 revolves on a stud that is supported by a carriage b_7. The carriage is held in position by means of a track-like arrangement b_8 that allows the carriage to slide in a direction parallel to that of the spindle belt. The idler is continuously kept in its proper position by a lever and spring arrangement. Thus, the lever b_9, which is partly seen in the upper deck of the spinner, is so arranged that its upper end is in contact with the carriage b_7 at all times, being held there by a strong coil spring, one end of which is fastened to the lower end of the lever while the opposite end is attached to a suitable part of the frame. Furthermore, the fulcrum of the lever is located in such a position that the spring will exert a sufficient pull to cause the carriage to move in the proper direction, thus retaining a suitable tension on the spindle belt. The idlers on both decks are arranged to take up the slack of the spindle belt in the same manner.

69. The spindle-belt drive pulleys driving the spindle belts b_5, Fig. 10, are larger than on the machines that have been previously described, measuring approximately 14 inches in diameter. The spindle-belt idlers b_6 therefore must also be larger and have a diameter corresponding in size to the idlers. With pulleys of this construction the spinner may be operated



(a) Fig. 11 (b)

at a reduced speed and still retain the necessary velocity of the spindle belt in order to drive the spindles at the required number of revolutions per minute. An advantage of this size of spindle-belt pulleys and idlers, and also of this method of maintaining the tension of the spindle belt, may be said to be the increased life of the belts; for, the spindle belt need not pass under the machine and around small pulleys, but always travel in the same plane and around large pulleys. One disadvantage that is readily apparent is the increased width of the machine, which naturally decreases the number of spindles in a given space, provided, of course, the comparison is made between two double-deck machines.

70. Take-Up Roll Drive.—As illustrated in Fig. 11 (*a*) and (*b*), the vertical shaft *h* carries at its upper end a single worm *l* suitable for a right twist. The worm meshes with a worm-gear l_1 located on the worm-gear shaft, thus transmitting motion through suitable gearing to the take-up rolls of the upper deck. Somewhat lower on the same shaft *h* is a second worm, exactly like the first, that in turn meshes with a worm-gear constructed and located in the same relative position to the remaining gears as the worm-gear of the upper deck. Obviously, the motion is transmitted through this, and other gears of the train, in order to drive the take-up rolls of the lower deck. Thus, the take-up rolls *j* of both decks are driven in practically the same manner and at the same speed, provided the corresponding gears have like numbers of teeth. The gearing for the upper deck is similar to that of the spinner previously described. The gearing for the lower deck, however, is slightly different, because the end stand is wider at the bottom than at the top. The object of this construction is to increase the stability of the machine; furthermore, it is necessary in order to support the lower-deck take-up shafts, which are slightly further apart than those of the upper deck. This difference in space, however, is bridged by the use of two 36-tooth idlers l_{1},, which are mounted on studs attached to the end stand.

71. The vertical shaft *h*, Fig. 8, which is driven directly by the drive belt, transmits its motion to the spindle belts and also to the take-up rolls. This method of driving these parts is unlike any that has been previously described and is not considered as advantageous as those already explained. Should a spindle belt break while the frame is in operation, the spindles would stop revolving, since their source of power has been removed. But, as the take-up rolls are positively driven from the vertical shaft, the rolls would continue to revolve and cause the bobbins to take up the silk. It is evident that since the spindles have ceased to revolve, the thread that is taken up during this period will not contain any twist, and an untwisted thread will be wound on the take-up bobbins. In all probability this will be waste, as it will be necessary to remove the silk from the bobbins to obtain the twisted end.

72. There is a possibility that the spindle-belt tension device may not work properly, thus allowing the spindle belt to slip. This would result in a reduction in the speed of the spindles. Since the take-up rolls are positively driven, the take-up of the thread would be unaltered; therefore, the reduction in spindle speed would cause less twist to be inserted in the thread. These difficulties are absent on the spinners previously described; for, by designing the machine so that the spindle drive belt passes around the pulley on the vertical shaft, located at the foot end stand that drives the take-up rolls, the correct relation between the spindle speed and the speed of the take-up roll is always maintained.

73. Reversing Twist.—According to the method of mounting the idlers b_{10} and b_{11}, Figs. 8 and 9, the frame is arranged for spinning a left twist in the thread; for, the receiving pulley b_{10} is arranged so that the direction of motion caused by the main drive belt will cause the vertical shaft to revolve in a counter-clockwise direction. By driving the spindle drive belt in this manner, the spindles will revolve in a clockwise direction, that is, in the proper direction for inserting a left twist in the thread.

When changing the direction of twist, as has been previously explained, it is necessary first to change the direction of motion of the drive belt from the line shaft, in order that the rotation of the spindles will be reversed. Before this may be accomplished, however, it is necessary to use another casting, similar to that supporting the idler b_{10}, Fig. 9, but designed for the opposite side of the machine. This is substituted for the casting holding the idler b_{11}. The reason for this procedure is that the belt will be received on the opposite side of the drive pulley, and therefore it must be guided properly.

74. Sometimes, in order to eliminate the inconvenience of exchanging the castings supporting the idlers, the machine is fitted with two castings, one for the right side and the other for the left side. In this case one idler is considered the fixed idler, while the other is shifted; when reversing the twist, the fixed idler in the former case is employed for shifting the belt and the other idler is employed as a fixed idler.

After the direction of rotation of the spindles has been reversed, the direction of rotation of the take-up rolls must be changed in order that the thread will be properly taken up. To accomplish this it will be necessary to loosen the bolts holding the vertical shaft bearings to the end stand, draw the shaft away from the machine, and remove the two worms that drive the worm-gears of both decks. After this is completed the remaining operations are performed in exactly the same manner as when reversing the twist on the machine illustrated in Fig. 5; therefore, a repetition of the process will be unnecessary.

75. Single-Deck Type.—Closely resembling the double-deck spinner just described, is a single-deck spinner that is constructed for throwsters desiring a single-deck machine of this type. It is exactly like the upper deck of the double-deck spinner, having the take-up roll shafts the same distance apart, similar twist gears arranged in the same positions, like spindle-belt pulleys, and the same methods of driving. For this reason a further description of the single-deck spinner is unnecessary.

76. Twist Calculations.—The method of determining the proper gears to be employed to obtain the desired twists, is exactly the same as on previous machines. When determining the constants, and later the gears or turns of twist from the constants, the calculations are performed in exactly the same manner.

In Tables VI, VII, and VIII are given the various gears to cause the take-up rolls to revolve at the correct speed so that turns per inch ranging from 1 to 75 will be inserted in the thread. The tables are applicable to the double-deck machine that has just been described and also to the single-deck machine referred to in the preceding article. The twists given in the tables are based on the following data: The circumference of the take-up rolls *j*, Figs. 8 and 11, is approximately 11.75 inches; the diameter of the pulley b_3 on the vertical shaft is 14 inches; and the diameter of the spindle whorl is 1 inch.

77. For twists ranging from 1 to 6 turns per inch, inclusive, Table VI should be employed. Because of the low num-

TABLE VI

TWIST CHANGE GEAR

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
1	32	38	3½	44	30
1½	38	30	4	40	23
2	40	23	5	48	23
2½	41	38	6	54	21
3	38	30			

ber of turns of twist being inserted in the thread, it will be necessary to mount spiral even gears at *l* and l_1, thus causing the worm-gear shaft to revolve at the same speed as the vertical shaft *h*. When 1 to 2 turns of twist, inclusive, are being inserted in the thread, a single intermediate having 36 teeth is located on the movable stud l_6; but if the twist should range from 2½ to 6 turns of twist, inclusive, a compound gear having 24 and 28 teeth is substituted for the 36-tooth intermediate. This compound gear is placed on the stud so that the 24-tooth gear meshes with the take-up gear.

Table VII is employed for twists ranging from 7 to 47 turns, inclusive. In this case a single worm *l* is mounted on the vertical shaft to mesh with a 15-tooth worm-gear on the worm-gear shaft. A single intermediate is placed on the

TABLE VII

TWIST CHANGE GEARS

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
7	16	40	28	48	30
8	18	40	29	50	30
9	21	40	30	52	30
10	23	40	31	44	25
11	25	40	32	46	25
12	28	40	33	48	25
13	30	40	34	49	25
14	32	40	35	50	25
15	34	40	36	52	25
16	36	40	37	53	25
17	38	40	38	55	25
18	41	40	39	45	20
19	43	40	40	46	20
20	45	40	41	47	20
21	48	40	42	48	20
22	50	40	43	49	20
23	40	30	44	50	20
24	41	30	45	52	20
25	43	30	46	53	20
26	44	30	47	54	20
27	46	30			

stud l_6 and adjusted to mesh with the gear on the take-up shaft and also on the worm-gear shaft.

78. For twists ranging from 50 to 75 turns, inclusive, the following gearing is employed in conjunction with the gears given in Table VIII: The single worm is attached to the vertical shaft to mesh with a 15-tooth worm-gear on the worm-gear shaft, and a 24- and 48-tooth compound gear is put on the stud l_6 with the 24-tooth gear meshing with the gear on the take-up shaft.

EXAMPLE 1.—Find the turns of twist per inch inserted in a thread, the machine being geared as shown in Fig. 11. The diameter of the

TABLE VIII

TWIST CHANGE GEARS

Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_8 on Take-Up Shaft	Gear l_4 on Worm-Gear Shaft
50	43	30	65	47	25
55	47	30	70	50	25
60	52	30	75	54	25

pulley b_3 on the vertical shaft is 14 inches, the circumference of the take-up roll j is 11.75 inches, and the diameter of the spindle whorl is 1 inch.

SOLUTION.—The number of turns of twist per inch is

$$\frac{34\times15\times14}{40\times1\times11.75\times1}=15.191. \text{ Ans.}$$

EXAMPLE 2.—Find the twist constant, employing the data of example 1 and considering the gear on the take-up shaft as the change gear.

SOLUTION.—The twist constant, which is the constant factor in this case, is $\frac{1\times15\times14}{40\times1\times11.75\times1}=.4468.$ Ans.

EXAMPLE 3.—Find the change gear required to give 15 turns per inch, if the constant factor is .4468.

SOLUTION.—The number of teeth in the change gear is

$$15\div.4468=33.572$$

Hence, a 34-tooth gear is required. Ans.

EXAMPLE 4.—Find the twist constant, employing the data of examples 1 to 3, and considering the gear on the worm-gear shaft the change gear.

SOLUTION.—The twist constant, which in this case is the constant dividend, is $\frac{34\times15\times14}{1\times1\times11.75\times1}=607.659.$ Ans.

VARIATIONS IN DOUBLE-DECK SPINNERS

79. Drive.—Another type of spinner that is employed to a considerable extent in certain localities is illustrated in Fig. 12, which is a perspective view of the drive end of the machine. It is of the double-deck type and has many parts in common with previously described machines; but one of the principal differences in point of construction is the method of guiding the belt to the tight and loose pulleys. Usually the tight and loose pulleys are arranged on the machine so that they may only rotate on or with a shaft. The pulleys on this spinner, however, may be shifted in a vertical direction when it is desired to shift the drive belt from the loose to the tight pulley or vice versa. The drive belt from the overhead line shaft passes around the idler m, and thence to the tight pulley b on the vertical shaft h. Leaving the pulley on the latter shaft, the drive belt passes around the idler m_1 and returns to the pulley on the line shaft. Both idlers m and m_1 are fastened by setscrews to short shafts that rotate in ball bearings. The hangers supporting the bearings are rigidly attached to the frame and retain the idlers in the correct positions at all times.

80. In accordance with the methods employed on previously described spinners, it is customary to shift the drive belt when starting and stopping the machine. On the spinner shown in Fig. 12, the drive belt is not shifted, but the tight and loose pulleys are shifted to receive the drive belt as it leaves the idler. The construction of the shifting arrangement is illustrated in Fig. 13, which is an end elevation of the driving mechanism shown partly in cross-section. The tight pulley b and the loose pulley b_1 are located, one above the other, on the vertical shaft h. Instead of being mounted directly on the vertical shaft, however, the pulleys are mounted on the cast-iron sleeve m_2, the tight pulley being keyed and fastened by a setscrew to the sleeve that acts as a bearing for the loose pulley. The sleeve, in turn, is keyed to the vertical shaft by two long keys m_3, only one being shown in the illustration, since the other is located on the opposite side of the vertical shaft.

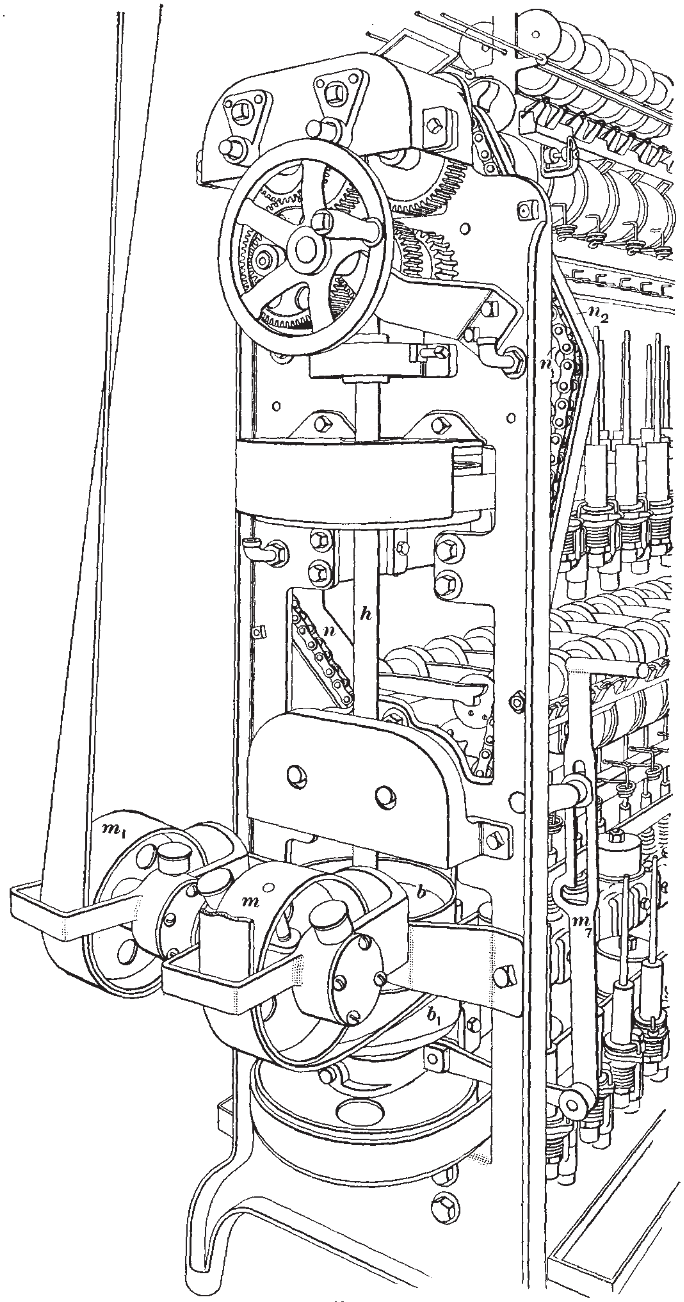


FIG. 12

Therefore, since the tight pulley b is keyed to the sleeve and the latter is keyed to the shaft, the result is equivalent to keying the pulley to the shaft, and the shaft will rotate with the tight pulley. To reduce friction, the lower end of the sleeve is supported in a bronze shifting yoke m_4 that is held on the yoke lever m_5. When in operation the sleeve m_2 rests on the lower spindle-belt pulley b_3, which drives the spindle belt for the lower deck of spindles, thus reducing the amount of wear on the shifting yoke.

81. The yoke lever m_5, Fig. 13, is supported at one side of the end stand by the bracket m_6, and, the lever, passing to the opposite side of the stand, is pivoted to the starting handle m_7. The latter is located alongside the end stand and is equipped with a slot that engages with the latch stud m_8. In the operation of starting and stopping the frame, the shipping of the drive belt is accomplished by raising or lowering the starting handle. When the handle is lowered, as illustrated in Figs. 12 and 13, the tight pulley b will be in proper line with the under side of the idlers m and m_1, causing the belt to be guided on the driving pulley. When stopping the frame, the handle m_7 is drawn upwards which causes the pulleys to move upwards until the loose pulley will be in the position originally occupied by the tight pulley. On reaching the latter position, the horizontal opening at the lower end of the slit in the handle m_7 will engage with the latch stud and thus be held in the off position.

82. The spindle belts and take-up rolls are driven directly from the vertical shaft, which, as previously referred to, is not considered the most advantageous method of driving. The spindles are driven by contact with the spindle belts, the latter being maintained at the proper tension by movable idlers located at the foot end of the machine. The take-up rolls of the upper deck are driven from the vertical shaft, through suitable gearing, at the proper speed to take up the thread so that the correct number of turns of twist per inch will be inserted in the thread. The take-up rolls of the lower deck are driven at the same speed as those of the upper deck by means of a roller-

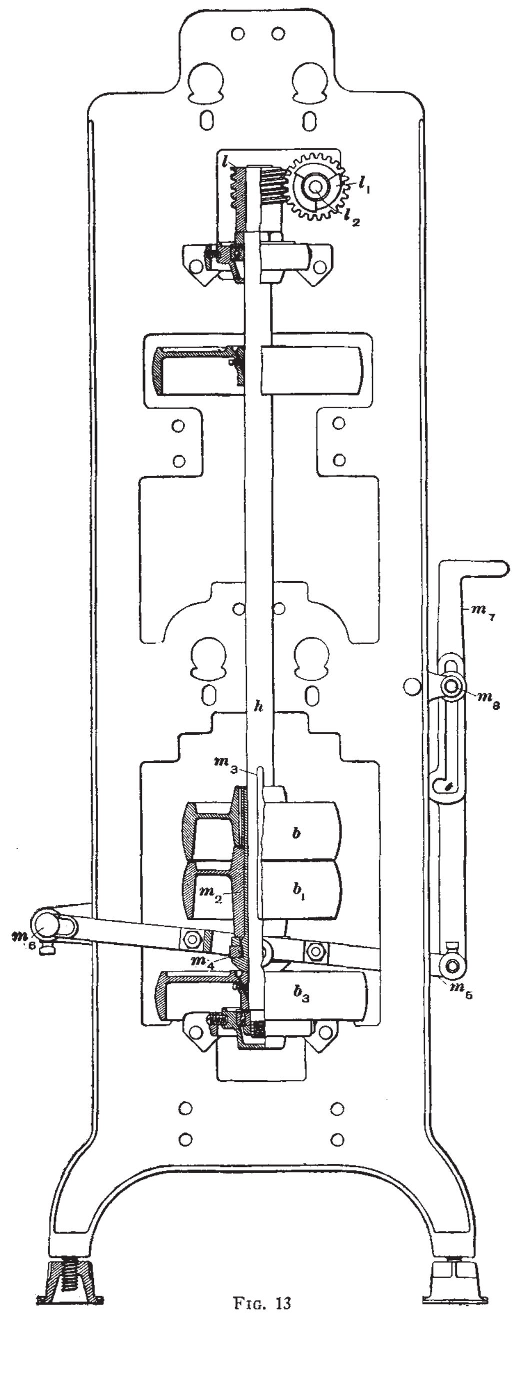


Fig. 13

chain drive that transmits the motion from an upper take-up shaft. This chain, which is partly shown at n, Fig. 12, consists of ninety-two $\frac{3}{4}$-inch links. It passes over a driving sprocket attached to one of the take-up shafts on the upper deck, and is led downwards over an idler sprocket n_1 that is mounted on a stud attached to the end stand and partly shown. The chain is thence guided downwards and around a sprocket attached to one of the lower take-up shafts, after which it passes around an idler on the opposite side of the end stand and thence to the driving sprocket on the upper take-up shaft. The entire chain is adequately enclosed in a metal guard n_2 that prevents the chain from catching silk waste while in motion. Moreover, the guard allows the chain to be lubricated thoroughly, and prevents the oil from spattering when the frame is in operation.

83. Traverse Motion.—The spinner being described, while of the double-deck type and equipped with two traverse bars for each deck, is constructed with only one cam. This cam is located so as to be driven by one of the take-up shafts of the upper deck and is in the same relative position as on spinners that have previously been described. The traverse bars, of course, are operated by the motion of the cam imparted to the traverse levers; but instead of having levers of the conventional design, the traverse levers are of a greater length. They are pivoted in the center so that when the upper traverse bar is moved outwards, the lower traverse bar on the same side of the spinner will move in the opposite direction.

84. Twist Change Gears.—Several variations exist in the arrangement of the twist change gears and also in the manner of changing from a right to a left twist and vice versa on the spinner that is being described. By referring to Fig. 13 it will be seen that the vertical shaft h carries at its upper end a steel worm l that meshes with a bronze worm-gear l_1 mounted on the worm-gear shaft l_2. The worm-gear is of the reversible type; that is, it is constructed with right-hand ratchet teeth on one side and left-hand ratchet teeth on the other side, so that the gear may be employed for either a right or a left twist, as the case may be. This, of course, eliminates the necessity of using an additional worm-gear when changing the direction of twists.

85. The arrangement of the gearing for inserting a left twist in the thread is illustrated in Fig. 14. The worm-gear shaft l_2 carries the 40-tooth change gear l_3, which is firmly held to the shaft by a setscrew. The gear l_3 meshes with a 36-tooth idler or single intermediate l_4 that rotates on the stud l_5 attached to the end stand. The latter gear merely transmits the motion to the 36-tooth change gear l_6 mounted on the left-hand take-up shaft j_1. Mounted on the take-up shaft j_1 is the spur gear l_7 that meshes with a like size of spur gear l_8 mounted on the right-hand take-up shaft j_2. Therefore, both take-up shafts will revolve at the same speed.

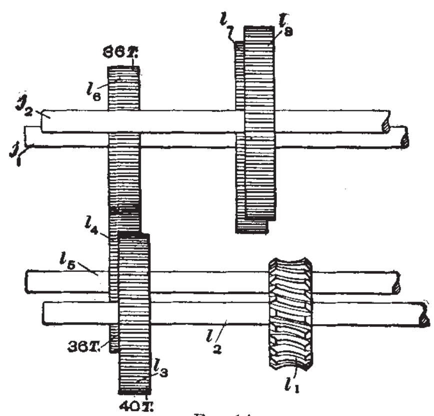


Fig. 14

All twists cannot be produced with the single intermediate l_4 in position; therefore, it will be necessary at times to substitute a compound gear for the intermediate gear referred to. When left twist is being inserted in the thread and it is found, according to the twist chart, that a compound gear is necessary, one containing 30 and 60 teeth should be placed on the stud. The stud should then be adjusted so that the 30-tooth gear of the compound meshes with the gear l_6 on the left-hand take-up shaft j_1, while the 60-tooth gear meshes with the gear on the worm-gear shaft l_2.

86. When right twists are to be inserted in the thread and a single intermediate is located on the stud l_5, the latter should be adjusted so that the intermediate will mesh with the gear l_3 on the worm-gear shaft and the gear l_6, which has previously been mounted on the right take-up shaft j_2. Should it be necessary to employ a compound gear, when inserting right twists, one having 24 and 48 teeth must be obtained. The compound is mounted on the stud l_5 so that the 24-tooth gear will mesh with the change gear l_6 that has previously been placed on the right take-up shaft, while the 48-tooth gear of the compound meshes with the gear l_3 on the worm-gear shaft. Thus, it should be remembered, when inserting a right twist in the thread, the change gear l_6 should be placed on the right-hand take-up shaft, whereas, when left twists are inserted the change gear should me mounted on the left-hand shaft.

87. Twist Chart.—Twists from 1 to 80 turns per inch, inclusive, may be inserted in the thread on the type of spinner

TABLE IX

TWIST CHANGE GEARS

Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Worm-Gear Shaft
1	32	38	3½	46	31
1½	38	30	4	47	27
2	40	23	5	52	25
2½	41	38	6	54	21
3	44	35			

being described. The proper gears for these twists may be found, either by referring to a twist chart, or by calculation. Tables IX, X, and XI are arranged from a twist chart furnished by the manufacturer of the spinner.

By referring to Table IX, the gears for twists ranging from 1 to 6 turns, inclusive, may be found. When inserting 1, 1½, or 2 turns of twist, spiral even gears are employed on the vertical shaft and the worm-gear shaft, while a single intermediate is located on the stud l_5. In addition to these, the gears mentioned in the table must also be employed. When twists of from 2½ to 6 turns per inch are desired, a compound is placed on the stud l_5 so that the smaller gear of the compound meshes with the gear on the take-up shaft and the larger gear meshes with the gear on the worm-gear shaft. The spiral even gears are employed to transmit the power from the vertical shaft to the worm-gear shaft.

88. Table X shows the gears to be selected for inserting twists ranging from 7 to 45 turns, inclusive. In this case, a

TABLE X

TWIST CHANGE GEARS

Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Shaft Worm-Gear	Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Worm-Gear Shaft
7	16	40	27	46	30
8	18	40	28	48	30
9	21	40	29	50	30
10	23	40	30	52	30
11	25	40	31	35	20
12	28	40	32	36	20
13	30	40	33	37	20
14	32	40	34	38	20
15	34	40	35	39	20
16	36	40	36	41	20
17	38	40	37	42	20
18	41	40	38	43	20
19	43	40	39	44	20
20	45	40	40	45	20
21	48	40	41	45	20
22	50	40	42	48	20
23	40	30	43	48	20
24	41	30	44	50	20
25	43	30	45	50	20
26	44				

single worm is mounted on the vertical shaft h while a 22-tooth worm gear l_1 is attached to the worm-gear shaft and properly meshed with the worm. A single intermediate placed on the stud l_5 meshes with the gear on the worm-gear shaft and also the gear on the take-up shaft. When twists between 46 and 80 turns, inclusive, are desired, it will be necessary to refer to Table XI. A single worm and a 22-tooth worm-gear are employed for transmitting the power from the vertical shaft to the worm-gear shaft, while a suitable compound is placed on the stud l_5 with the smaller gear of the compound meshing with the gear on the take-up shaft, while the larger gear meshes with the gear on the worm-gear shaft.

TABLE XI

TWIST CHANGE GEARS

Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Worm-Gear Shaft	Turns of Twist per Inch	Gear l_6 on Take-Up Shaft	Gear l_3 on Worm-Gear Shaft
46	44	33	64	50	28
47	44	33	65	50	28
48	45	33	66	51	28
49	45	33	67	51	28
50	47	33	68	50	26
51	47	33	69	50	26
52	47	32	70	51	26
53	47	32	71	51	26
54	46	30	72	50	25
55	46	30	73	50	25
56	48	30	74	51	25
57	48	30	75	51	25
58	50	30	76	52	25
59	50	30	77	52	25
60	52	30	78	52	24
61	52	30	79	52	24
62	49	28	80	52	23
63	49	28			

89. Reversing Twist.—When reversing the twist, the direction of rotation of the spindles is first altered so that they will revolve in the opposite direction. After this the worm-gear l_1, Figs. 13 and 14, is removed from the worm-gear shaft, reversed, and then replaced on the shaft. This is possible since the gear is fitted with ratchet teeth on one side suitable for right twists, while the teeth on the opposite side are suitable for left twists. The worm-gear, of course, will then revolve in the opposite direction, but the teeth of the ratchet will have the correct slant to carry the worm-gear shaft l_2 with it. The reversal of direction of rotation of the take-up rolls is accomplished by placing the change gear l_6 on the proper take-up shaft. Thus, when inserting right twist, the gear is placed on the right-hand take-up shaft, while for left twists it is mounted on the left-hand shaft.

Since the calculations for this spinner are identical with those used for the preceding spinners, they need not be repeated. It may be mentioned, however, that the take-up rolls are approximately 11.75 inches in circumference, the pulley located at the bottom of the vertical shaft is approximately 9 inches in diameter, and the whorls of the spindles are 1 inch in diameter. With this information, in addition to that which may be obtained from the tables, the twists, constants, and other desired data may be readily calculated.

MANAGEMENT OF SPINNERS AND TWISTERS

90. Cleaning.—Spinners and twisters should be regularly cleaned, not only to maintain a clean appearance in the room but also as an aid to the production of good work. While it is true that spinners could be operated for a considerable time without removing any accumulations of dirt, most mills adopt a program of periodic cleaning, consisting usually of from 15 to 30 minutes once each week, during which time all machinery is stopped. Of course, this operation could be performed with greater or less frequency.

When cleaning the machine, the dust should be wiped from the bobbin shelf, traverse bars, guide rails, and other parts. The spindles and spindle rails should be brushed and any collection of fuzz that adheres to the oily surfaces should be removed. During cleaning, the various shafts and many moving parts may be carefully examined, and any silk waste that is wrapped around the shafting should be removed by cutting it with a knife or other sharp instrument. The waste obtained should be deposited in a separate waste bag. Sometimes the thread is wrapped around the take-up shaft near a bearing, which causes the shaft to be forced to one side. Accumulations of waste similar to this should be removed and avoided as much as possible, for they cause strains to be placed on various parts of the machine.

91. Oiling.—As the spinner is usually run at a high speed, it is very important that it should always be well oiled. Spinners and twisters that are properly oiled at regular intervals usually have a longer life and also give more satisfactory results than machines that are given careless attention. To insure the proper care in oiling, only a careful attendant should be selected for the work. A good oiler will save money both in the saving of oil and in attending to his duty, and will increase the production and the life of the machinery. In oiling, a sufficient amount of oil to lubricate the part thoroughly should be used. Excessive amounts should be avoided, as the oil may drip on the silk or be thrown from the rapidly revolving parts. In other words, it is better to use a small quantity at short intervals than to use large quantities of oil at long intervals. The different revolving parts and pivots on which friction occurs, such as the loose pulley, idlers, take-up shaft bearings, and so on, should be oiled at least once each week. Other parts equipped with oil reservoirs, which should be kept filled, will require less attention. On machines equipped with grease cups, the cups should have grease in them, and should be screwed down from time to time, thus forcing the grease into the bearings. In connection with the grades of oil, it is not advisable to use the cheap oils with a high viscosity. These oils are likely to gum and stick. An oil of a medium to light specific gravity is better—not so light as to leak through the pores of the cast-iron spindle bases and not so heavy as to cause additional friction.

92. Care of Spindles.—The sockets of the spindles act as the bearings for the spindle blades, and naturally, after being in continuous service for a long time, they wear and become unfit for further use. This, of course, is due to the rapid revolution of the spindle blade together with the continual pressure between the spindle belt against the whorl. Worn sockets may be easily detected on a spinning frame by a careful observation of the spindles while the frame is in operation. Thus, a spindle blade supported in a worn socket has a tendency to wobble or vibrate when running, which allows it to be found quickly. Then after the frame has been stopped the spindle blade may be held between the fingers and rocked from side to side, and if the amount of wear thus disclosed is sufficient to warrant a new socket, one should immediately be provided. It is evident that the socket will wear more rapidly than the spindle blade, since the latter is made of high-carbon steel while the former is constructed of cast iron; thus, one spindle blade may sometimes outwear several sockets.

93. Old or worn sockets of the cast-iron type are of no value after they have been removed from the frame, and since they cannot be repaired, they are usually scrapped. The bronze-bushed spindle that has been described, however, is constructed so that the bronze bushing may be removed when it becomes worn and a new bushing put in its place. This, of course, eliminates the necessity of purchasing a new socket for the socket acts as a holder for the bushing.

When a new socket is placed on the spinning frame, it is very important that the spindle blade be properly fitted to the socket; that is, it should be neither too tight nor too loose, but should revolve freely. After it is certain that the spindle and socket are satisfactory, the proper amount of oil should be placed in the oil well of the socket, after which the spindle blade may be replaced in the socket and locked. An adequate amount of oil should always be supplied to new spindles, or in cases where new sockets or blades have been provided.

94. After a frame has been in operation for some time, the oil in the oil wells of the spindles may tend to become gummy, which increases the friction in the spindle. For this reason the spindles should be removed from the frame and the sockets and lower parts of the spindle blades should be washed in some liquid that will cut the gummy oil so that the socket will be thoroughly cleaned. The sockets may then be replaced on the frame, and after the oil wells have been filled with oil and the blades are replaced, the spindles are in readiness for operation. This thorough cleaning is usually performed about once each year. A very efficient manner of examining the machine and the spindles is to disassemble it completely. All parts that are subjected to wear may then be carefully examined and any necessary replacements may be made.

95. When removing the sockets from the machine or from the swing gate of the swing spindle for this yearly inspection, new felt washers should be provided where needed. The washers become hard and worn in time, due to the constant pressure and vibration of the spindle. New felt washers placed against the flange of the sockets absorb the vibration and result in smoother running spindles.

After the socket is in place, the steel spring is slipped over the threaded portion and the nut that holds the socket is started on the threads. The nut is drawn up until it holds the spindle quite rigidly; but it should not be tightened so that the coils of the spring will come in contact with each other. This would defeat the object of the construction, which is to give the spindle a certain amount of flexibility.

96. Oiling Spindles.—Although the spindles do not require as frequent attention as the remaining parts of the machine, they should be carefully examined and oiled according to the operating conditions. Thus, should the spinner be operated during the day only, it will not require as much attention as when it is operated both day and night. When spinners and twisters operate during the day only, it is customary to oil the spindles at intervals, depending, to a large extent, on the speed of the spindles. For instance, spindles that run very slowly do not require oiling as frequently as spindles running at a high speed, as on the first-time spinner. Spindles on some types of machines are oiled once every month, while sometimes it is only necessary to oil them only once every two or three months. When machines are in operation both day and night the spindles will require oiling approximately twice as frequently; that is, if the spindles were oiled once a month when running one shift, they should be oiled twice a month when running two shifts.

97. It should be remembered that the construction of the spindle must be taken into consideration, as spindles made by one manufacturer may operate for a longer period with one oiling than spindles constructed by another manufacturer. For this reason, the spindles should be carefully observed while running, and from their mode of running, it may sometimes be determined whether they are properly oiled. When the spindles are not oiled at sufficiently close intervals and the oil in the wells becomes exhausted, the spindles vibrate and wobble, causing the nuts holding both the compression springs and the spindles to drop off. Besides this, the spindles often become hot and stick, thus stopping the bobbins. Both conditions are detrimental to the life of the spindle and should be avoided, which can be done by proper oiling.

98. As is evident after a study of the construction of the spindles, the blade must first be removed from the socket in order that the oil may be injected into the oil well. The oiling, proper, is accomplished in several ways. Sometimes the oil can, or squirt can, has a small plunger pump to force the oil through the nozzle. This should be of such a size that when the plunger is pressed once, enough oil will be forced into the oil well to lubricate the spindle. Again, an oiling spindle is often employed. In shape it closely resembles a spindle blade, but it is hollow so that the oil may be injected through a hole in its top to a predetermined level. The oil then passes through the hollow spindle and escapes from another hole in the bottom of the spindle and into the oil well of the socket as the oiling spindle is lifted. In this manner a sufficient quantity of oil will be placed in the spindle, eliminating guess work and reducing the oil wastage.

99. Oiling should be very carefully attended to under all conditions and after the oil has been injected into the sockets, care should be taken to see that the spindles are replaced in the spindle sockets from which they were removed. If this is not done, the spindles are likely to wobble or stick. When the spindle is replaced, it should not be dropped into the socket, but should be inserted, very carefully, so that the oil will not splash from the well. The reason for this latter procedure is to prevent the oil from splashing on the inner side of the whorl, then running to the lip, and possibly coming in contact with the belt, since mineral oil is very harmful to leather. After the spindle blades are in their respective sockets it should be noted that all spindle-whorl locks have been properly returned to their former positions before putting the machine in operation.

100. Swing spindles have the swing gate pivoted on a pin that is subjected to more or less wear that occurs during the operation of the frame. The swing spindle is held against the spindle belt by the tension of a small coil spring; hence, should there be any high spots in the belt, they will cause the spindle to move, or *jump*, slightly away from the belt and then return. This continuous motion of the gate, of course, will cause the pin to wear very gradually. For this reason, an oil hole is provided in the gate through which lubricating oil may be directed to the wearing surfaces. A sufficient amount of oil should always be provided at this point, which may be attended to when oiling the spindles, and also between these periods, if deemed necessary.

The oil for the various parts of the spindle should be of the proper viscosity and of a good quality. A number of spindle oils of good quality are on the market and tests may be made to determine which oil has the best qualities.

101. Tension of Swing-Spindle Springs.—Sometimes when adjusting swing spindles and swinging idlers, a small scales is employed to measure the pressure with which the spindle or idler presses against the belt. The scales that are employed are of the ordinary spring type capable of supporting as much as 4 pounds. Moreover, the scales should be equipped with a hook in order that the object to be tested may be held. In operation, the hook is applied to the spindle and the body of the scales is drawn away from the spindle causing the pointer to move away from the zero mark. While the spindle and belt are carefully watched, the scales are slowly moved away from the spindle and the instant the spindle leaves the spindle belt, the number of pounds and ounces required should be noted. It is a good plan to test all spindles in this manner at times, for thus they will be adjusted with an equal amount of tension.

102. Plumbing Spindles and Idlers.—In order to operate a spinning or twisting frame in an efficient manner, it is of the utmost importance that all spindles be properly adjusted; in other words, the spindles must be plumb. When a spindle is referred to as out of plumb, it is meant that the spindle is out of a perpendicular adjustment in regard to the spindle belt that drives it. The benefits that are derived by having the spindles properly plumbed are many, but among the most important ones may be mentioned a saving in power and an increase in the life of the spindles. Therefore, all spindles should be perpendicular and true, provided, of course, the spindle rail is level, and be driven by a proper contact with the belt.

103. There are several methods of plumbing spindles, of which probably the simplest procedure is to plumb them by sight. This is accomplished by first leveling the frame, which is easily performed by placing a level lengthwise on the spindle rail and then raising or lowering the leveling nuts under the end stands and middle stands until the frame is level in this direction. The level is then removed and placed crosswise on the machine and it is then leveled in that direction; but, when it has been leveled in this direction, it should again be tested lengthwise, for it is possible that it was thrown out of adjustment. Thus, the first operation is properly to level the machine. Next, a perpendicular object as an end stand, middle stand, and so on, is chosen on the frame to serve as a guide to gauge the spindle. A perpendicular part of the spindle, as the whorl, is now allowed to come between the eye and the first chosen object; if both coincide, the spindle is again sighted in a direction at right angles to the line of the first sighting. Thus, the spindle will be perpendicular to the spindle rail. It may be stated here that little difficulty should be encountered when leveling machines in a new mill where the floors are level and not worn. In older mills, however, where machines are sometimes changed to different positions, difficulty will be encountered where the floors are worn. In cases of this nature, it will be necessary to insert blocks of wood under the legs of the machine until the proper height is secured.

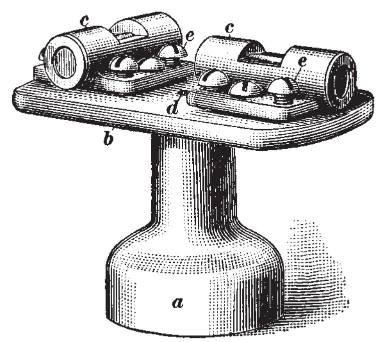


Fig. 15

104. Besides plumbing the spindles by sight, a small leveling apparatus, known as a *spindle plumb,* is very frequently employed. The use of an instrument of this nature results in a more accurate adjustment of the spindles than when they are adjusted by sighting. A perspective view of an ordinary spindle plumb is given in Fig. 15. It consists of the bell-shaped base *a* that tapers upwards slightly toward the flat plate *b* cast integral with the base. The flat plate is machined on its upper side so that its face is parallel to the base of the plumb. On the plate *b* are mounted, at right angles to each other, two small levels or bubble glasses *c,* which are so adjusted that they will properly indicate whether the object on which the plumb rests is level. Passing through the center of the plumb and at right angles to the plate is a taper hole *d,* corresponding in size to a tapered spindle blade. Therefore, when the hole *d* is in a perpendicular position, the bubble glasses that are at right angles to it should register a level condition. Furthermore, the bases of the bubble glasses are provided with adjusting screws *e* whereby the levels may be easily readjusted if necessary.

105. In operation, the spindle plumb is slipped into place on the tapered spindle blade so that the latter engages with the taper hole of the plumb throughout its entire length. The position of the bubble in each level is noted, and the spindle is adjusted until both glasses indicate that they are level, that is, that the spindle is perpendicular. It is evident that since the levels are designed at right angles to each other, the leaning of the spindle in two directions may be simultaneously discovered.

106. Since the bottom, or bell-shaped base, is parallel to the plate *b*, Fig. 15, non-tapering, or straight-blade spindles, such as are found on combination machines to be described later, may also be tested. In this case the plumb is slipped on the spindle so that the base rests on the top of the whorl; and since the latter is at right angles to the spindle blade, improper adjustment of the spindle may be readily seen. Besides being used for adjusting the type of spindles just described, the plumb is frequently used when adjusting idlers. This is possible since idlers are frequently constructed with their tops machined at right angles to the face. Therefore, by placing the base of the plumb on top of the idler, improper adjustment of the latter may be easily seen by noting the positions of the bubbles in the level.

107. Should a spindle or idler be tested and found to be out of plumb, it will be necessary to readjust the spindle so that its whorl or face will properly come in contact with the spindle drive belt. This operation is frequently referred to as packing, and is accomplished in the following manner: When a spindle is found to lean to one side, the nut holding it in place should be loosened and a small strip of cardboard or tin should be placed under the low side of the spindle, that is, the side toward which the spindle is leaning. The nut should then be tightened and the spindle again tested. If it still leans to one side, it will be necessary again to loosen the nut and place additional packing under the spindle. When the levels on the spindle plumb indicate that the spindle is perpendicular after the nut has been tightened, it may be considered correct.

108. It is evident that a spindle or idler that is out of plumb will cause the belt to travel slightly in a curved direction. This, of course, is due to the action of the spindles or idlers that are out of plumb, for a spindle that is inclined in the direction that the belt is running will cause the belt to move upwards. In a like manner, when a spindle is inclined in an opposite direction to that in which the belt is moving the spindle will cause the belt to move downwards, causing undue friction in both cases. Hence, after considering these conditions, it will be easy to comprehend that a spinner operating in this manner will unnecessarily consume more power than one that is properly adjusted. For this reason, when a spinner is running, and a spindle is observed that causes the belt to rub the lip of the whorl or causes the spindle blade to jump, the spindle should be adjusted so that the belt will run straight, thus consuming a minimum amount of power.

109. Care of Spindle Belts.—Spindle belts on spinning or twisting frames are made of high-grade leather carefully spliced in order to produce an endless belt with good joints. Before starting a frame on which a new belt has been placed it is advisable to treat the belt with a belt dressing manufactured by a reliable concern. The application of dressing tends to keep the belt soft and pliable and prevents it from absorbing the oil that is usually found where parts revolve at a very high speed. As previously explained, the oil that is employed for lubricating the various parts is a mineral oil, which is very injurious to leather and shortens the life of the belt with which it comes in contact. Thus, it should be avoided as much as possible. Oil is very often splashed on the spindle belt when the oil wells have been given too much oil, or when the blades are carelessly dropped in the sockets.

110. When the belt is soaked with oil and causes undue slippage, it may be cleaned in the following manner: A lump of chalk, which tends to absorb oil, should be held against the belt while it is running. The chalk deposited on the belt should then be scraped from the belt by holding a piece of wood or some other suitable object against the belt while the belt is in motion. This operation may be repeated several times until the oil has been removed from the surface as much as possible.

111. Spinner and Twister Bobbins.—Bobbins obtained for a spinner or twister where a friction roll drive is employed, should be constructed so that only a small amount of clearance exists between the edge of the take-up roll and the heads of the bobbins. Should the barrel be too long, the bobbin will not run smoothly but is liable to have a jerky motion. On the other hand, should the bobbin be too narrow, the heads will bind at the edges of the roll and take up the silk very unevenly, producing a corresponding variation in the twist. For instance, suppose that the take-up roll measures 3 inches across its face, that is, from side to side. For that size of roll, the bobbin should measure about $3\frac{1}{8}$ inches between the heads which may be considered a sufficient amount of clearance. Bobbins measuring $3\frac{1}{4}$ inches or more should be avoided for this width of roll. As the silk is wound on such a bobbin, there is a constant danger that it will pile at the heads, causing a deficient bobbin for the following operation.

112. When running organzine, the supply bobbins, or bobbins that are placed on the spindles of the first-time spinner are received from the winder and should be taper-hole fiber-headed bobbins. The take-up bobbins on the first-time spinner are usually fiber-headed bobbins, either taper-hole or straight-hole, since they are transferred to the doubler when filled. The jack-pins of the doubler are straight; hence, they will support either a straight-hole or a taper-hole bobbin. The take-up bobbins on the doubler must be of the taper-hole variety, for when removed from the doubler they are transferred to the tapered spindles of the second-time frame where the ply threads are twisted. The receiving bobbin on this frame may be either a fiber-head or iron-head type of bobbin. However, the iron-head type is heavier and assures a better take-up, since it rests on the take-up roll with greater pressure.

Should the machine be employed for twisting crêpe, a take-up bobbin that will withstand the action of steam, such as the iron-head bobbin or steaming shaft, should be utilized. As will be explained later, crêpes are usually steamed on bobbins; hence this type of bobbin must be used.

113. Bobbin Rack.—In order to facilitate the operation of carrying the iron-head steaming shafts from one department to another, and when placing the shafts in the steam box prior to steaming, suitable receptacles are usually provided. One type that is frequently employed in silk-throwing mills, known as a *bobbin rack,* is illustrated in Fig. 16. It consists of a box-like frame *a*, divided into three compartments by wooden boards *b* running lengthwise. These boards are constructed with small notches *c* that are cut into the upper edges for the reception of the gudgeons that are permanently attached to the steaming shaft. Sometimes a small piece of heavily galvanized iron *d* is affixed to each corner, as illustrated, to

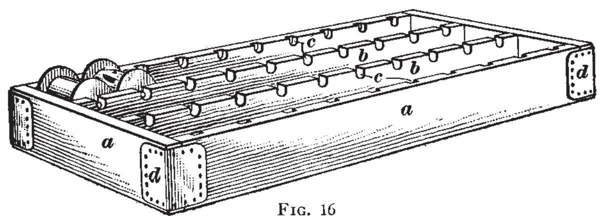


Fig. 16

increase the rigidity of the rack. Bobbin racks are usually constructed of sufficient size to contain at least thirty bobbins. These are usually arranged in three rows of ten bobbins in each row.

114. Rewiring Flyers.—The speed of the spindles and the type of thread being twisted are two factors that cause the greatest wear in flyers; but under average conditions flyers run about one month before rewiring is necessary, although sometimes they become cut in 3 weeks. When noticed, they should be replaced, as they may cause scratched or hairy silk and many broken ends. The operation of rewiring flyers is usually done in the mill or by a flyer manufacturer. The flyers may be rewired a great number of times; but after the wooden block becomes worn so that it does not run true when on the spindle, new flyers or flyer blocks should be obtained. When rewiring flyers, the proper length of wire required for one flyer is cut while one end is twisted into a pigtail. One end of the wire is then inserted in the wooden block and the untwisted end of the wire is made into a pigtail. After this is completed, the wires are turned downwards at the point.

115. The operation of rewiring the flyer may be delayed for a short time by turning the pigtail at the end of the drop arm so that the thread will come in contact with another part of the loop while passing through it. This is easily accomplished with the aid of round-nose pliers in the following manner: One nose of the pliers is inserted in the loop and the handle is firmly pressed to grip the wire, while at the same time the pliers are gradually turned, thus increasing the number of turns of the loop. While turning, the cut in the wire should be observed, and when the cut is in the same position as was previously occupied by the end of the wire, the pliers should be removed. The excess part of the loop, that is, the portion of wire extending from the cut to the end of the pigtail, should be removed, which is easily done by the aid of an end-cutting pliers. In this manner the loop will be reduced to its original size. After the flyer is in operation a sufficient length of time to be cut again, the wire should be removed from the block and a new wire substituted for it. This procedure is necessary; for should the pigtail again be turned as described, the loop would be too high on the bobbin to operate efficiently.

DEFECTIVE WORK

116. Long Knots.—It is very important when tying broken ends during the first-time operation, that long knots should be avoided; that is, the tails should be cut so that they will be about $\frac{1}{8}$ inch in length. Difficulties in future operations may be sometimes traced to the knots made during the first-time spinning, and so all precautions should be taken. For instance, should a bobbin of silk having a number of long knots be doubled with another thread, there is a liability that both threads will break on the second-time spinning. More often, however, the long tails of the knots are twisted with the doubled thread, producing a thick or heavy place in the thread, which has the appearance of a long slug. Eventually, these heavy places may be detected in the finished product and if present to a great extent they will decrease the quality of the fabric.

117. Waste.—In the sense of defective work, waste is the term applied to all droppings of waste silk, such as tails cut from knots, fuzz, silk pulled from bobbins, pieces of lacing string, etc., which, when falling to the floor catch on the rapidly twisting threads, are twisted with them, and wind on the take-up bobbins. These droppings, of course, produce heavy or coarse parts in the thread very similar to those produced by long knots. Waste in silk may be traced to the carelessness of employes.

118. Split Ends.—As the name implies, split ends is a term employed to designate threads that have broken or split into several parts, or in which the minute fibrillæ have been fractured. Split ends that are produced during throwing operations may result at various points, but cut porcelain guides probably produce a considerable part. Besides the guides, the tension wires and flyers are also subjected to cutting, since the silk is in contact with practically the same part of the guide or wire at all times while the machine is in operation and the thread is intact and running. For this reason, it is well to maintain a periodical inspection of all guides, wires, flyers, etc., that are in direct contact with the silk.

119. Many times the small cuts are not readily discernible to the eye, hence it is well to draw the sharp edge of a knife over the cut portion, and the small cuts will immediately be found. Besides this, a small pick glass or magnifying glass is sometimes employed whereby the parts may be more rigidly examined. All guides that are found to be cut should be discarded and replaced with new ones. In addition to splitting the raw-silk thread into the respective baves or brins, the minute fibrillæ are scratched and fractured, which is not noticeable at this stage of manufacture. However, after the gum is boiled off, the small fibers protrude in many directions, thus reducing the smooth appearance. It may be said that ends that have been split or cut in winding usually break in the first-time spinning and excessive breakage may be traced to cut guides in a preceding process.

120. Soft Bobbins.—When soft bobbins are regularly found on a spinning or twisting frame, the fingers between which the bobbin was held should be marked and then carefully examined. It should be noted whether the fingers are adjusted to cause the bobbin to be in contact with the take-up roll at a point directly above the center of the roll. Should this be found, the fingers should be adjusted so that the bobbin will come in contact with the roll at a point slightly forward of the top center. By adjusting the bobbin in this manner, the tendency will be to produce a hard, firm, bobbin, which is always desirable.

121. Burnt Silk.—When a shaft or bobbin is not properly adjusted between the fingers holding it while on the frame, it may stick or bind at times. Since the take-up roll revolves continuously, it will be in contact with the same silk on the bobbin when its revolution is stopped and the resulting friction will cause the silk to become heated and burn, leaving a charred strip across the barrel of the bobbin. The burnt silk has a color varying from brown to black, depending, of course, on the length of time the bobbin failed to revolve. The silk, now unfit for further use, should be removed from the bobbin and considered as waste. Faults of this nature should be avoided whenever possible as they increase the percentage of waste, and if they occur frequently, slightly reduces production. Sometimes warped bobbin heads produce the same results, for the bobbin may bind as it becomes filled and rises in the fingers.

122. Snarls.—Sometimes, when a spinner or twister is stopped, the silk that has been passing from the spinner bobbin to the take-up bobbin becomes slack, and, due to the twist that has been inserted in the thread, many small loops or snarls result. Such snarls should be removed from the thread in spite of their frequency or the thread will present kinky portions whenever the machine is stopped. They are usually removed before the machine is started, 5 to 15 minutes being usually allowed. The common method of removing the snarls is to treat each thread individually. The thread is grasped between the fingers of one hand while it is gently stroked or rubbed between the fingers of the other hand. As the snarls disappear, the take-up bobbin must be turned by hand in order that the thread will be taken up and thus keep the thread taut, preventing snarls from reappearing. Each thread must be worked in a similar manner until all, or at least the majority, of the snarls have been removed. The bobbins, after being turned to take up the silk, rest on the take-up rolls so that the thread will be taken up immediately when the machine commences to operate.

In some mills, instead of employing the hand take-up as described, the ends are broken down before stopping the machine at the close of a working period. When starting in the following period it is necessary for the attendant to tie up all of the ends and in doing so all snarls and kinks will be removed.

123. Slack Twist.—Slack twist may be traced to various causes. One cause of a very intermittent nature is the improper turning of the hand wheel that is designed to prevent the formation of snarls. This may be accounted for by the attendant turning the wheel too quickly in relation to the decreasing speed of the spindle. Thus after the drive belt has been shipped to the loose pulley, or the electric current has been switched off, causing the individual motor to stop, the attendant should grasp the handle of the hand wheel and allow its motion to carry his hand with it. Then, when the speed has decreased considerably, the hand wheel should be turned so that it will move slightly faster than it would if it were still driven, which can be judged by a clicking sound as the spring pin passes the ratchet teeth. It is evident that only a slight increase in speed is necessary to prevent the formation of snarls; hence, under no circumstances should the wheel be turned rapidly, as this will cause the take-up rolls to revolve more quickly, taking up the thread in which a smaller number of turns of twist per inch is inserted in the threads being wound on each bobbin, since all take-up rolls are controlled by the same hand wheel.

124. Besides resulting from turning the hand wheel too rapidly, slack twist may result from other causes. For instance, when the spindles are oiled carelessly and several are skipped, those that were not oiled become dry. As a spindle becomes dry the socket and blade become hot while the spindle, turning with difficulty, finally sticks and stops. Then, again, the tension of the coil spring that pulls the swing gate and causes the spindle whorl to be in contact with the spindle belt may become weakened or released. When the friction is decreased between the spindle whorl and the belt, the spindle will naturally slip, thus causing slack twist. The spindle may be improperly adjusted, or the belt may be guided so as to come in contact with the lip of the spindle whorl, which would have the same effect as operating the machine with spindle whorls of a greater diameter. This naturally causes the spindle to operate at a reduced speed, thus decreasing the twist. Care should always be taken to see that no slack twist is being produced. Slack twist in the first-time operation has a tendency to cause soft bobbins, which are more difficult to double, and hence should be avoided.

125. Variations in Twist.—Should a bobbin be found with a thread that has a greater amount of twist than should be inserted according to the arrangement of the gears on the machine, the difficulty may be assumed to arise from at least two points. If the twist gears are arranged to produce 16 turns of twist and a test of the thread shows a greater amount, an examination of the spindles and the rolls should be made. The spindles that are found to insert an increased amount of twist in the thread should be marked, and the diameter of the whorl should be measured with a caliper. The remaining spindle whorls should also be measured in order to determine whether all whorls are of equal diameter. It sometimes happens that frames equipped with spindles having 1-inch whorls have several spindles with smaller whorls which have been accidentally placed on the machine as it was set up. It is evident that a smaller spindle whorl would cause the spindle to revolve faster, thus inserting a greater amount of twist in that thread.

If examination of the spindle whorls shows that they are all of the same diameter, attention should be turned to the take-up rolls. It sometimes happens that the setscrew holding the take-up roll becomes loosened and allows the roll to slip or creep very slightly which causes the thread to be taken up at a reduced rate, causing an increase in the twist per inch. This variation would not be continuous as would be the case where whorls of various sizes are employed, since the slippage of the take-up roll on the shaft would be intermittent and would probably be more noticeable. However, should the roll turn on the shaft, the setscrews provided for holding it should be tightened after the roll has been moved to its proper position.

126. Sometimes slippage may occur between the take-up roll and the bobbin after the frame has been in service for some time. Such slippage also causes increased twist in the thread. For instance, suppose a cork-covered, a paper-covered, and a leather-covered roll were placed on the same frame for test purposes. After a sufficient length of operating time had elapsed, each thread was carefully tested to determine accurately the twist. If the rolls were old and slippery, and it was found that the twists were 16, $16\frac{1}{2}$, and $17\frac{1}{2}$ turns for the cork, paper, and leather rolls, respectively, it would be known immediately that the greatest amount of slippage occurred where the bobbin was driven by the leather-covered roll. Hence, it should always be remembered, where slippage occurs between the bobbins and spindles, the threads that have the greatest number of turns of twist, therefore, are from the bobbins that have the greatest amount of slippage.

Due to the slippage of spindles, belts, and bobbins, the threads on the spinner or twister should be tested from time to time in order to detect any serious variation in the twist. This is especially true after changing the twist change gears. In this case, the gears for the correct twist should be placed on the frame, which is then started in operation. Bobbins are placed on only a few spindles, however, and after running for a short time, the twisted threads should be carefully tested. If the twist is found to be correct, the bobbins may be placed on the remaining spindles and started in operation. Should the twist be incorrect, different gears should be substituted for the gears on the machine and after running a short time with only a few bobbins taking up thread, the twist should again be tested. If it is then found to be correct, the entire frame may be started in operation.

127. Humidity.—In order to operate the spinning room as efficiently as possible, it is very important that the humidity be carefully regulated. When the air is dry, the silk is liable to become charged with static electricity, causing threads to fly and spread. They then break, sometimes falling in the path of a running end, which in turn breaks an adjoining end until a number of ends have been broken. Static electricity in the silk also hinders the operative in tying ends for they have a tendency to separate. This condition of the silk may be remedied to a certain extent by maintaining the spinning room at the proper relative humidity and temperature. For all practical purposes, the relative humidity should average about 65 per cent., although a variation of several degrees will do no harm. The temperature should be maintained at about 70° F., although lower temperatures will aid in working the thread.

SILK THROWING

(PART 6)

Serial 5002F — Edition 1

EXAMINATION QUESTIONS

Notice to Students.—*Study the Instruction Paper thoroughly before you attempt to answer these questions.* **Read each question carefully and be sure you understand it;** *then write the best answer you can. When your answers are completed, examine them closely and correct all the errors you can find; then mail your work to us.*

(1) (*a*) How is the twist of the thread affected if the speed of the take-up roll is increased? (*b*) If the take-up roll speed is unchanged and the spindle speed is reduced, how will the twist be affected?

(2) State the object of the twist change gears of a spinner.

(3) With a spinner geared as illustrated in Fig. 3, but with the intermediate gear h_8 meshed with the 48-tooth gear of the i series of gears, what twist per inch will be inserted in the thread?

(4) Why may a frame that is used for the first-time operation of spinning be run faster than a frame employed for second-time spinning?

(5) How are swing spindles adjusted so that they will exert an equal pressure against the spindle belt?

(6) After the direction of rotation of the spindles has been reversed on the spinner illustrated in Fig. 1, how are the take-up rolls made to rotate in the direction required to take up the thread?

(7) In throwing tram, what is the thread take-up speed if the spindle speed is 8,400 revolutions per minute and $3\frac{1}{2}$ turns of twist are being inserted in the thread?

(8) (*a*) Describe the method of leveling a spinner. (*b*) How are the spindles tested with a spindle plumb?

(9) What will be the effect of each of the following defects on the twist of the thread? (*a*) Take-up roll slipping on shaft. (*b*) Weak spring on swing gate. (*c*) Spindle belt in contact with lip of spindle whorl. (*d*) Bobbin slipping on take-up roll.

(10) What are split ends and what causes them?

(11) Describe an oiling spindle and explain its use.

(12) (*a*) What is the object of a hand take-up mechanism? (*b*) Describe how the hand take-up device is operated.

(13) What would be the effect on the thread if a spindle belt should break on the spinner illustrated in Fig. 8?

(14) How is the speed of a spinner or twister designated?

(15) Explain the advantage of large spindle-belt pulleys and idlers, as illustrated in Figs. 8 and 10.

(16) If a spindle belt becomes oil-soaked and causes the spindles to slip, how may the defect be remedied?

(17) What is burnt silk and what causes this defect?

(18) It is desired to throw 300 pounds of 3-thread tram in a week of 50 hours. If 45 spindles are required to produce 1 pound per hour and 10 per cent. is allowed for stoppage, how many spindles will be required? Ans. 300 spindles

(19) If the actual production of a spinner is .025 pound per spindle-hour, how many spindles will be required to throw 10 pounds of silk in a 10-hour day? Ans. 40 spindles

(20) If the amount of silk thrown in a day, plus the amount of waste made, is 36 pounds 5 ounces and the calculated, or theoretical, production is 41.5 pounds, what is the percentage of stoppage? Ans. $12\frac{1}{2}$ per cent.


INTERNATIONAL CORRESPONDENCE SCHOOLS
INSTRUCTION BY MAIL

86414