Sept. 27, 1955 F. HONIG 2,718,747

APPARATUS FOR THE BELT-DRIVING OF HIGH SPEED SPINDLES

Filed May 24, 1952 2 Sheets-Sheet 1

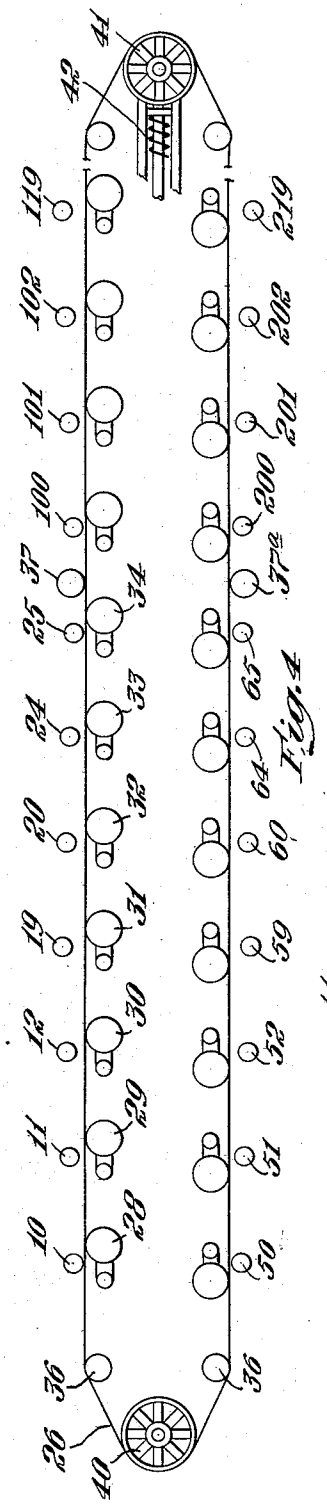


Fig. 4

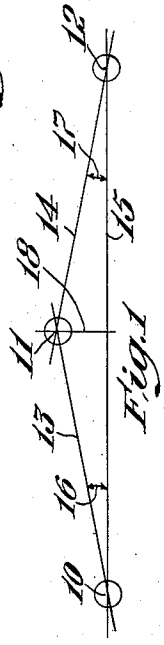


Fig. 1

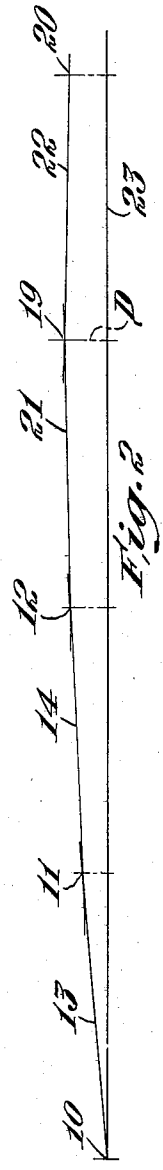


Fig. 2

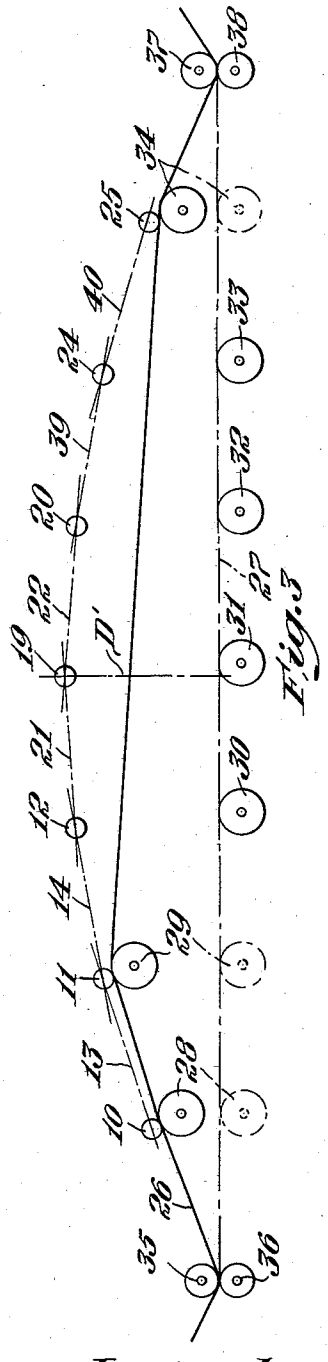


Fig. 3

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APPARATUS FOR THE BELT-DRIVING OF HIGH SPEED SPINDLES

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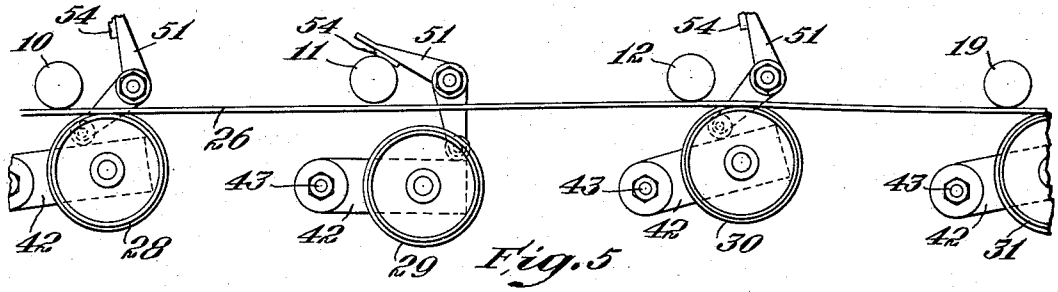


Fig. 5

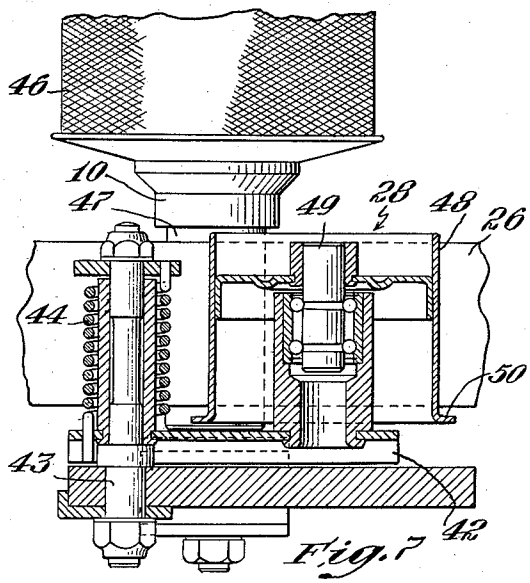


Fig. 7

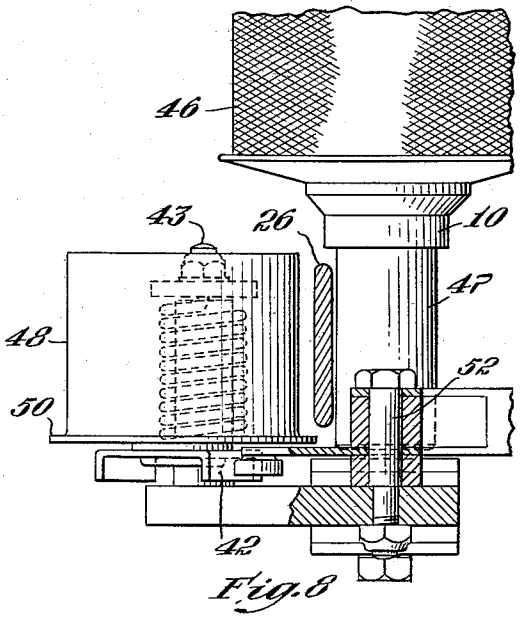


Fig. 8

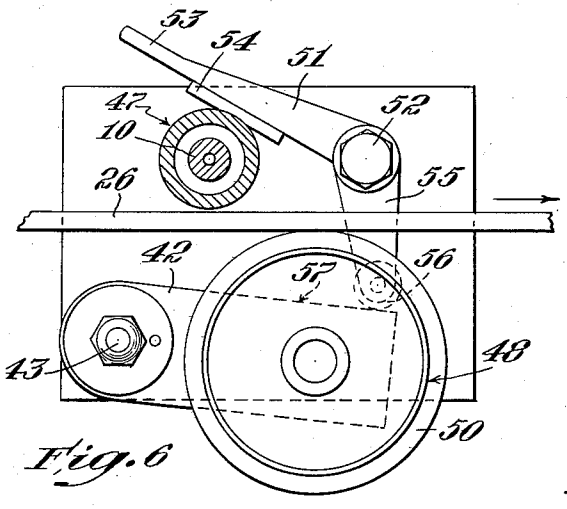


Fig. 6

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United States Patent Office 2,718,747 Patented Sept. 27, 1955

2,718,747

APPARATUS FOR THE BELT-DRIVING OF HIGH SPEED SPINDLES

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Application May 24, 1952, Serial No. 289,743

24 Claims. (Cl. 57—88)

This invention pertains to apparatus of the kind wherein a plurality of rotary spindles, having their axes substantially parallel are driven at high speeds of from 15,000 to 35,000 R. P. M. Textile machines such as spinning and twisting frames, winders, etc., may be cited as examples of apparatus in which such high speed spindles are employed. One customary way of driving the spindles of such apparatus is by means of an endless belt having a run which, by contact with the peripheral surfaces of the spindle pulleys, imparts rotation to all of the spindles simultaneously and at approximately the same speed. In the more usual type of machine of this character it has been necessary to stop all of the spindles preparatory to the doffing of any completed yarn package, but such a procedure is manifestly uneconomical since it stops all production during the doffing period. To avoid this difficulty it has been proposed to stop the individual spindle for doffing by applying a brake while the spindle pulley still contacts the driving belt, but this is very undesirable since the friction thereby created burns the belt so that frequent replacements of the belt become necessary. It has also been proposed to mount individual spindles so that any given spindle may be moved bodily away from the belt so as to cease contact of the spindle pulley with the belt, but this involves the difficulty of supporting the spindle upon a movable part with the requisite steadiness and accuracy of position during the winding operation, a matter which is especially difficult when the yarn packages are heavy and of large diameter, and driven at high speeds as in winders. It has likewise been proposed to employ individual high frequency electric motors or circulating fluid motors for the several spindles, but the cost of special generating, circulating or converting equipment and the cost of high frequency electrical motors, coupled with the energy loss involved in such conversion or circulation, make such expedients expensive, both in first cost and in subsequent operating cost.

The present invention is directed to improvements in apparatus of the belt-driven type (which is relatively low in first cost and in operating cost as compared with machines of the individual motor type) having a flexibility as to starting and stopping of individual spindles comparable to that inherent in machines of the individual motor type, but without occasioning frictional heating of the belt or involving excessive power loss through abnormal flexing of the drive belt, and without interfering with the desirable use of self-centering spindles such as are desirable when operating at very high speeds.

In accordance with the present invention each spindle is mounted to rotate in a fixed bearing (or the equivalent) as is customary in apparatus of this type, the bearings being fixedly mounted in the frame, that is to say the bearings are normally fixed in position, or contrasted with arrangements, such as above suggested, in which the bearings for the spindles are supported for bodily motion for adjustment. If desired, and as is customary in high speed machines, the spindles may be mounted

resiliently or otherwise in their bearings so that at high speeds they are self-centering, thus minimizing vibration and wear of the bearings. The invention is applicable to machines wherein there is a row of spindles at opposite sides respectively of the frame and likewise to machines in which spindles are arranged in two or more decks at one or both sides of the frame. For each deck an endless drive belt is provided; when there is a row of spindles at each side of the frame a single drive belt is so arranged as to have a spindle-driving run or span for turning the spindles at each side respectively; when more than one deck is employed a single motor at one end of the frame may be arranged to drive all of the belts; or an individual motor may be provided for each respective belt.

Customarily, in belt-driven machines of this kind, the axes of the spindles at a given side of the frame are all in a vertical plane parallel to the driving run of the belt and during operation the belt constantly contacts the spindle pulleys of the entire series. In accordance with the present invention and in the attainment of its desired objects, the axes of the spindles of a given row are not arranged in a vertical plane parallel to the neutral position of the drive run of the belt but are so located that a line, in a horizontal plane connecting the spindle axes, is a broken line consisting of a series of straight portions or facets, the adjacent facets intersecting at an angle, at a given spindle axis. Such a line, connecting the axes of a series, for instance seven spindles, has the contour of a "funicular polygon" with its chord or base line facing the drive run of the belt. Considering three adjacent spindles only of the series, their axes lie at the angles of a triangle, here shown as isosceles, whose apex angle is obtuse and whose base is toward the drive run or span of the belt, the opposite sides of such a triangle constituting what is here referred to as a "zigzag." Usually the base angles of such a triangle will be of the order of 0° 22′ 20″ of arc and the height of such a triangle will not ordinarily exceed 1/16 of an inch. The funicular polygon above referred to may be made up of a group of these zigzags so as to provide a composite zigzag of right-hand declination and another composite zigzag of left-hand declination. With a space of 9.5 inches between adjacent spindle axes, for example, and employing zigzags of the height and having the base angles above suggested, a clearance of 1/16 of an inch between the drive belt and any spindle pulley of the series may be obtained which is sufficient to stop the drive of any particular spindle; at the same time, the maximum deflection of the drive run of the belt from its neutral or straight line position need not exceed 5/16 of an inch, even when it is in driving contact with all of the spindle pulleys of the series. Such a deflection in such a length of belt is so little removed from a straight line that no undue wear of the belt or excess power loss is occasioned thereby.

The spindles may be arranged so as to form a plurality of the funicular polygons in longitudinal continuity (if desired, with idler pulleys for guiding the belt at the junctions of said polygons) thus permitting a single belt to drive 100 spindles, more or less, with a maximum deflection of the belt never exceeding 5/16 of an inch.

With this arrangement, although all of the spindle pulleys of the series may be in driving contact with the belt at one time, it is possible to separate the belt from any given pulley of the series, thereby to permit doffing of a completed yarn package, without stopping other spindles and while providing a clearance of approximately 1/16 of an inch between the belt and the pulley of the spindle being doffed. The drive belt may be driven in substantially conventional manner by a pulley carried by the vertically arranged shaft of a conventional electric motor,

the other end of the endless belt engaging an idler pulley mounted on a slide and tensioned by a spring or any other suitable means so as to hold the drive belt under proper tension, although permitting the drive run of the belt to be lengthened in deflecting it from a straight line for moving it into contact with any one or more of the spindle pulleys. To prevent undue vibration of the belt and to keep it under control, conventional idler pulleys may be arranged at intervals along the length of the belt at either its inside or outside face, or both.

With such an arrangement, belt speeds of from 8000 to 15,000 feet per minute constitute a practical operating range and under such conditions a belt life of from three to five years may be expected from a well made belt of conventional construction, such as is ordinarily used in machines of this type. As compared with this, it may be noted that in prior arrangements, where the spindle is moved bodily toward or from the belt or where the spindle is stopped by the action of a brake while the belt remains in driving contact with the spindle pulley, the belt speed does not ordinarily exceed about 4000 feet per minute and a belt life of about one year is considered good. Thus, as compared with usual prior procedures and arrangements, the present invention provides for a greater maximum spindle drive speed and at the same time for an extended life of the drive belt, thus reducing the cost of operation, as compared with usual prior constructions.

Among the objects of the present invention are to provide apparatus wherein a plurality of spindles are mounted in bearings which are fixedly supported in a frame and wherein any or all of the spindles may be started or stopped when desired without disturbing the operation or non-operation of any of the other spindles. A further object is to provide apparatus of the above type wherein any spindle of the series may be stopped or started without bodily shift of the axis of the spindle from its normal position. A further object is to provide a machine of the above type having provision for ceasing the frictional contact between a high-speed drive belt and the pulley of any given spindle without disturbing the driving contact between the belt and any other spindle pulley of the series. A further object is to provide apparatus of the above type wherein the spindles of a series are driven by an endless belt and wherein the drive run of the belt is never deflected to an injurious extent from a straight line but wherein provision is made for creating driving contact between the belt and any spindle pulley, although each of the spindles is mounted in a bearing which is fixedly supported in the frame. A further object is to provide apparatus of the above type wherein an endless belt, driven at high lineal speed, is deflected from a straight line thereby to create frictional driving contact between it and any selected spindle pulley of a series, but wherein the maximum angular deflection of the belt from a straight line is so small as to avoid undue waste of power or damage to the belt. A further object is to provide apparatus of the above type wherein the axes of a series of spindles are arranged in intersecting planes to form a zigzag arrangement and wherein, although the spindles are so arranged, nevertheless the maximum deviation of any spindle of the series from a straight line does not require excessive deviation of the drive belt in order that it may contact the pulley of any given spindle. Other and further objects and advantages of the invention will be pointed out in the following more detailed description and by reference to the accompanying drawings wherein:

Fig. 1 is a diagram illustrative of the basic principle underlying the present invention;

Fig. 2 is also a diagram further illustrative of the basic principle;

Fig. 3 is a diagram showing an arrangement of seven spindles in accordance with the present invention, but with certain dimensions being very much exaggerated to illustrate the principle of operation;

Fig. 4 is a diagrammatic plan view of a portion of a frame, supporting spaced series of spindles, showing the normal or neutral position of the drive belt with all of the spindles idle;

Fig. 5 is a fragmentary plan view, to larger scale, showing a portion of a frame with four spindles in series, three of the spindles being in driving contact with the belt and one being idle;

Fig. 6 is a fragmentary, horizontal section through one spindle, to still larger scale, showing a portion of the drive belt and showing the means whereby the drive belt may be deflected into contact with the spindle pulley;

Fig. 7 is a fragmentary, vertical section, longitudinally of the drive belt, showing in axial section the belt-deflecting pulley; and

Fig. 8 is a view at right angles to that of Fig. 7, showing the belt in transverse section and showing the spindle spaced from the belt in idle position.

Referring to Fig. 1, three adjacent spindles **10**, **11** and **12** are indicated, geometric lines **13** and **14** (in a horizontal plane) joining the axes of the spindles **10**, **11**, and **11**, **12**, form, with a line **15** joining the axes of spindles **10** and **12**, an obtuse isosceles triangle. However, it is not essential that the base angles of the triangle be equal or that the triangle be isosceles. As hereinafter more fully described, the base angles **16** and **17** of this triangle are preferably of the order of 0° 22′ 22″ of arc, while the height **18** of the triangle is of the order of 1/16 of an inch. The broken line, comprised of the several individual short lines or "facets" **13** and **14** constitute what is hereinafter referred to for convenience as a "zigzag," the intermediate spindle **11** being at the angle where the facets **13** and **14** intersect. The height **18** of this triangle (and of the zigzag) is small, as above suggested. A height of 1/16 of an inch is found ample to provide clearance between the drive belt and the spindle pulley, as hereafter described. Thus, as respects the triangle shown in Fig. 1, it may be supposed that the intermediate spindle **11** is idle (with a clearance of 1/16 of an inch between it and the neutral position of a drive belt) while the pulleys of the spindles **10** and **12** are in driving contact with the belt.

The simple zigzag of Fig. 1 has right and left declinations of equal angle, as referred to the base line **15**, it being understood that this base line **15** will face toward the drive belt. Fig. 2 illustrates the combination of three such simple zigzags as that of Fig. 1. Thus, in Fig. 2, the axes of the spindles **10**, **11** and **12** are so arranged that geometric lines **13** and **14** connecting the axes of spindles **10** and **11** and the axes of spindles **11** and **12** respectively form the facets of the first simple zigzag, but combined with these spindles are two others, indicated at **19** and **20**. The geometric lines **21** and **22** connect the axes of spindles **12** and **19**, and **19** and **20** respectively, forming the facets of a second simple zigzag whose base line would connect the spindles **12** and **20**; the lines **14** and **21** form the facets of a third simple zigzag whose base line would connect the spindles **11** and **19**. The compound zigzag, extending from the spindle **10** to the spindle **19**, has a left-hand declination with its maximum divergence D from the horizontal line **23** not exceeding 5/16 of an inch. The line **22** which connects the spindles **19** and **20** may form the first facet of another compound zigzag (the remainder of which is not shown) having a right-hand declination and which is similar to the zigzag extending from the spindle **10** to the spindle **19**, but in reversed position.

The diagram of Fig. 3 indicates a series of seven successive spindles **10**, **11**, **12**, **19**, **20**, **24** and **25** respectively. This diagram is intended for the purpose of illustrating the basic principle and mode of operation of apparatus according to the invention. For illustrative purposes the maximum deflection D′ of the belt is very

greatly exaggerated. In this diagram, the actual driving span or run of the endless belt is designated by the numeral **26** while the numeral **27** indicates the neutral or inoperative position of the tensioned driving run or span of the belt when no spindles are being driven. For each spindle there is a corresponding belt deflector, these deflectors being designated by the numerals **28** to **34** respectively. These deflectors are individually movable as hereafter described. Idler or guide pulleys **35**, **36** and **37**, **38** at opposite ends of the series of spindles define the position of the driving run or span of the belt when in its neutral position shown at **27**. It may be understood that the drive belt is under resilient tension such as to tend to hold the drive run of the belt at the position shown at **27**, although permitting the drive run or portions thereof to be displaced laterally from said position.

The spindles are mounted to turn in bearings which are fixedly supported by the machine frame, and the axes of the spindles **10**, **11**, **12** and **19** (in Fig. 3) are relatively located as in Fig. 2 so that the facet lines **13**, **14** and **21** form a compound zigzag of left-hand declination, while the facet lines **22**, **39** and **40** form a compound zigzag of right-hand declination. When all of the deflectors, **28** to **34** inclusive, are inoperative, all of the spindles are stationary and, the drive run of the belt is located, as indicated at **27**. This condition of the parts is herein referred to for convenience as the "normal" condition, that is to say, the non-operative condition of the spindles as contrasted with the condition under which the spindles are turning. However, if, as shown in Fig. 3, by way of example, the deflectors **28**, **29** and **34** are moved to operative position, the belt is deflected so that its driving run contacts the drive pulleys of the spindles **10**, **11** and **25** respectively, but still remains out of contact with the pulleys of any of the other spindles. By allowing any one of the deflectors **28**, **29** or **34** to return to its normal inoperative position the drive run of the belt retracts (by reason of the imposed tension) sufficiently to cease contact with the corresponding spindle pulley, thus allowing that spindle to come to rest. By adjusting all of the belt deflectors **28** to **34** to operative position, all of the spindles will be driven at the same time.

Inspection of the diagram of Fig. 3 will indicate that the geometric straight lines or facets **13**, **14**, **21**, etc. which connect adjacent spindle axes, collectively form a figure which closely resembles a funicular polygon, the base or chord of which faces toward the belt and extends from the spindle **10** to the spindle **25**, this polygon being symmetrical with respect to the center spindle **19**. The arrangement illustrated in Fig. 3, which includes seven spindles equally spaced apart, may be considered to constitute one section of a spinning frame or winder, this section being repeated throughout the length of the frame as many times as may be necessary to provide the desired number of spindles. At the junction between each adjacent section, idler pulleys such as the pulleys **37** and **38** will be provided to determine the position of the ends of the neutral run **27** of the belt.

In Fig. 4 there is diagrammatically illustrated a frame having a series of spindles at each side and illustrating a full section such as indicated in Fig. 3, associated with a second similar section, the left-hand portion only of the latter being shown. In this figure, the spindles **10**, **11**, **12**, **19**, **20**, **24** and **25** are arranged, as in Fig. 3 to form one section, this section terminating at the idler pulley **37** while at the same side of the frame a second section, comprising spindles **100**, **101**, **102** and **119** joins the first section at the idler pulleys **37**. At the opposite side of the frame spindles **50**, **51**, **52**, **59**, **60**, **64** and **65** form a first section which terminates at the idler pulley **37***a* while the first spindles **200**, **201**, **202** and **219** of a second section, beginning at the idler pulley **37***a*, extend to the right. The belt **26** passes about the drive pulley **40** at one end of the frame, this pulley being mounted upon a vertical shaft, for instance that of a suitable electric motor, while at the other end of the frame the belt **26** passes around the tensioning pulley **41** which is mounted in conventional manner to turn in bearings carried by a sliding support which is urged to the right by the spring **42**. The spring **42** tends to keep the drive runs of the belt rectilinear between the contacts of the belt with the idler pulleys, but permits the belt to be deflected outwardly toward the spindle pulleys by the operation of the deflectors **28**, **29**, **30**, etc.

In Fig. 5 four successive spindles, with their corresponding deflectors and the drive belt **26** are shown to larger scale, these spindles being indicated by the numerals **10**, **11**, **12** and **19**. The deflectors **28**, **29**, **30** and **31** are alike in construction, each being mounted upon a horizontally swinging arm **42** which is mounted to turn about a fixed stud **43** (Figs. 7 and 8) about which a spring **44** is coiled, the parts being so arranged that the spring tends to swing the arm **42** in a counterclockwise direction as indicated in Fig. 5 so as to bring the belt deflector into operative engagement with the belt. As illustrated in Figs. 7 and 8, each deflector preferably comprises a freely rotatable pulley **48** turning on antifriction bearings about a stud **49** carried by the arm **42**, and pulley preferably having a radial flange **50** at its lower edge to support the belt **26** when the deflector is in operative, belt-deflecting position.

Each of the spindles, for example the spindle **10** as shown in Figs. 7 and 8, is provided with a drive pulley or whirl **47** and carries a support for a yarn package **46**. For each deflector there is provided an actuating device, here shown as a bell crank lever having an arm **51** provided with an actuating handle **53** and which carries a brake shoe **54** which, at times, may contact the spindle drive pulley **47**. This bell crank lever is mounted to turn about a vertical stud **52** fixed to the machine frame and has a second arm **55**, here shown as provided with an antifriction roll **56** at its end which normally contacts the vertical edge surface **57** of the arm **42**. When a deflector is to be held in inoperative or idle position so that its pulley **48** does not contact the belt **26**, the actuator arm **51** is moved to the position shown in Fig. 6 where the roll **56** contacts the arm **42** near the free end of the latter. In this position the pulley **47** is spaced from the adjacent run of the belt **26**, a desirable spacing, as above described, being of the order of $\frac{1}{16}$ of an inch. When in this position the spring **44** urges the brake shoe **54** into contact with the pulley **47**, thus assisting in stopping the spindle and in holding the later stationary during the doffing and donning operation. When the spindle is to be restored to operation, the operator seizes the handle **53** and swings the actuator in a clockwise direction, as viewed in Figs. 5 and 6, thus moving the roll **56** so that its axis lies to the left of a line passing through the axis of the stud **52** and perpendicular to a line joining the spindle axis and the axis of the stud **52**. Thereupon, the spring **44** becomes effective to continue the movement of the actuator in the same direction and to bring the roll **48** of the deflector into contact with the belt **26**, thus moving the belt from the idle position shown in Fig. 6 to the operative position shown in Fig. 5, as respects either of the spindles **10** or **12**.

As above pointed out with respect to the diagram of Fig. 3, it is possible to deflect the drive belt so as to contact any one or all of the spindles of a given section with the drive belt and at will to cease contact between the drive belt and any one of the spindle pulleys, without affecting the driving of the others. When so deflected, the drive span of the belt comprises a succession of relatively short, substantially straight runs, so arranged that the slopes of adjacent runs intersect at an obtuse angle, the several short runs (with the line **27** representing the neutral position of the belt) defining a figure substantially

like a funicular polygon, whose angles represent the points of contact of the belt with corresponding spindle pulleys.

While certain idler pulleys have been illustrated it is to be understood that the arrangement of idler pulleys and their number may be varied according to requirements and that the spacing of the spindles will depend upon the particular type of machine and its intended function.

Fig. 3, as above noted, is greatly exaggerated as to the maximum deflection D' of the belt. Actually, the maximum deflection of the belt for any given section, that is to say for any given number of spindles intervening between sets of idler rolls, will usually not exceed 5/16 of an inch. Spindles for winders are intended to carry large packages, for example from 2 to 4 pounds, thus requiring substantial space between adjacent spindles. A spacing of from 6 to 10 inches is usually sufficient for the purpose and with such a spacing the facet angle (the angle between lines **13** and **15**, Fig. 1) will usually be less than 1° and seldom would exceed 3°. Under many conditions the maximum deflection of the belt in any section would not exceed ½ inch although, as previously stated, 5/16 of an inch may be more usual. In any event this maximum deflection should not exceed 2 inches in order to avoid undue wear of the belt and excessive power consumption.

While the actuator for each spindle is here shown as manually operable, it is contemplated that such actuator may be automatically controlled by any conventional mechanism such as usually employed in textile machines for stopping a part as the result of thread breakage. Such an automatic control may be especially desirable for use with twisting spindles since in such machines thread breaks occur very frequently. On the other hand, when certain modern types of spindle are employed, thread breakage is infrequent and under such circumstances the additional cost of an automatic stop device may not be warranted.

The axes of the deflector rolls **48** are spaced apart the same distance as the axes of the spindles, but preferably the axis of the deflector roll is located to one side of the axis of the spindle which it is to control, as clearly illustrated in Fig. 6, although the offset may be either to the right or left. As shown in Figs. 5 and 6 (when facing the machine from the operator's position) the axis of the deflector roll is mounted to the left of its respective spindle.

The spindles may be rotated to produce either S or Z twist by reversing the direction of the belt-driving motor by the use of a conventional switch, or otherwise, without requiring any adjustment of the conventional yarn takeup (not here shown).

While the invention is particularly desirable for driving spindles at very high speeds, where the linear speed of the belt is proportionately high, the invention is equally applicable to apparatus running at lower speeds where it is desired to stop any one of the spindles independently of the other.

While a desirable embodiment of the invention has herein been illustrated and described by way of example it is to be understood that the invention is broadly applicable to other situations and to other than textile machines and that any and all modifications falling within the scope of the appended claims are to be regarded as included in the invention.

I claim:

1. In combination with three spaced spindles having parallel axes, each spindle having a drive pulley, each spindle turning in a fixed bearing, the axis of each spindle being at an angle of a geometric triangle whose apex is obtuse, a constantly moving drive belt which does not contact any of said pulleys, and in relation to which all of said spindles are on one side thereof, guide means normally guiding the belt to form a substantially rectilinear run, and means for diverting said run of the belt into driving contact with the pulley of any selected one of said spindles.

2. In combination with a series of spindles, exceeding three in number, each having a driving pulley and wherein the axes of three successive spindles of the series are at the angles of an obtuse, geometrical triangle, a constantly running drive belt which normally moves in a path such that it does not contact any of the pulleys, and means for deflecting the moving drive belt from its normal path of movement into driving contact with the pulley of any selected spindle of the series thereby to drive said spindle.

3. In combination in apparatus of the class described, wherein rotary spindles, each provided with a driving pulley, turn in spaced bearings which are fixedly supported by the machine frame, the spindle axes being substantially parallel, and wherein an endless, constantly moving drive belt has a spindle driving run extending along the series of drive pulleys, the axes of the several spindles being so arranged that the axes of any three adjacent spindles are located at the angles of a geometric triangle having an obtuse apex angle and whose base is toward but normally spaced from the driving run of the belt, the bases of the several triangles being inclined relatively to each other and means for deflecting the driving run of the belt into driving contact with the pulley of a spindle located at any or all of said angles.

4. Apparatus according to claim 3, further characterized in that the triangle is isosceles with base angles of the order of 20 minutes of arc.

5. Apparatus according to claim 3, further characterized in that the maximum height of the triangle does not substantially exceed ½ inch.

6. Apparatuss according to claim 3, further characterized in that the distance between the spindle axis, nearest to the normal position of the driving run of the belt, and the spindle most remote from said run does not substantially exceed 2 inches.

7. In combination with a plurality of spaced rotary spindles each turning in a bearing which is fixedly supported by the machine frame and each having a driving pulley, the several spindles being arranged in a series with their axes substantially parallel, and so relatively arranged that geometric lines passing through the several axes form a series of geometric triangles whose bases are inclined relatively to each other, each of the spindles being located at a corner of one of said triangles, an endless drive belt having a spindle-driving run which does not normally contact any of the pulleys, means for driving the belt, means for so tensioning the belt that its driving run may vary in length, and means operative to create driving contact between two spindle-driving pulleys located at opposite sides respectively of a third while the belt remains out of contact with said third pulley.

8. In combination with a plurality of spaced rotary spindles each turning in a bearing which is fixedly supported by the machine frame and each having a driving pulley, the several spindles being arranged in a series with their axes substantially parallel, an endless drive belt having a spindle-driving run which does not normally contact any of the pulleys, means for driving the belt, means for so tensioning the belt that its driving run may vary in length, and means operative including a movable belt deflector corresponding to each respective spindle, to create driving contact between said run of the belt and any two selected spindle-driving pulleys, having other pulleys intervening between them, while said run of the belt remains out of contact with said intervening pulleys.

9. In textile apparatus wherein spaced rotary spindles, each turning in a bearing which is fixedly supported by the machine frame and each having a driving pulley, are arranged in a series and wherein an endless, constantly moving belt has a driving span extending along said series but normally spaced from all of the spindle driving pulleys, the axis of each spindle being at the apex of a triangle whose apex angle is obtuse and whose base angles are of the order twenty minutes of arc, the height of each triangle being of the order of 1/16" and the bases of the several triangles being angularly disposed relatively to

each other, said driving span of the belt being of variable length, and means for deflecting the driving run of the belt to form a plurality of substantially straight runs, adjacent runs being in intersecting planes, said runs being so relatively arranged that the belt has driving contact with a spindle pulley approximately at each intersection of adjacent runs of the belt.

10. In a textile apparatus wherein spaced rotary spindles, exceeding three in number and having their axes parallel, each turning in a bearing which is fixedly supported by the machine frame and each having a driving pulley, are arranged in a series and wherein an endless, constantly moving belt has a driving span extending along said series but normally spaced from all of the spindle driving pulleys, said driving span of the belt being of variable length, and a deflector associated with each spindle, the several deflectors being independently actuable, each deflector being operative, when actuated, to form two substantially straight facets in the belt which intersect at the point of engagement of the belt by the deflector, the deflectors being so located that at each intersection of two of said facets the belt makes driving contact with a spindle pulley.

11. In a textile machine of the kind wherein each spindle of a series turns in a bearing fixedly supported by the frame of the machine and wherein each spindle has a drive pulley, the axes of the several spindles being parallel, an endless drive belt having a spindle-driving run, means so tensioning and guiding the belt that its spindle-driving run is normally rectilinear, the axes of successive spindles of the series being at different distances from said normally rectilinear run of the belt, the spindle pulleys being normally spaced from the belt, and means operative to deflect the drive run of the belt into driving contact with any selected spindle pulley of the series.

12. In a textile machine of the kind wherein each spindle of a series turns in a bearing fixedly supported by the frame of the machine and wherein each spindle has a drive pulley, the axes of the several spindles being parallel, an endless drive belt having a spindle-driving run, means so tensioning and guiding the belt that its spindle-driving run is normally rectilinear, the axes of successive spindles of the series being at different distances from said normally rectilinear run of the belt, the axis of each spindle being at the apex of a geometric triangle whose apex angle is obtuse, the bases of the several triangles being inclined relatively to each other, the relative distances being such that the drive run of the belt may be deflected into driving contact with the pulley of any selected spindle without contacting it with any other pulley, and means for deflecting the belt.

13. In a textile apparatus wherein each of a series of spindles turns in a bearing which is fixedly supported by the machine frame, each spindle having a drive pulley, the axes of the several spindles being parallel, the series being divided into sections in each of which the axes of successive spindles are located first at progressively increasing and then at progressively decreasing distances from a line joining the axes of the endmost spindles of the section, an endless belt for driving the spindles, guide means at the end of each section tending to hold a drive run of the belt in a straight line which is spaced from the nearest spindle, and means for deflecting the belt into driving contact with any selected one or ones of said drive pulleys.

14. In a textile machine of the kind wherein each spindle of a series turns in a bearing fixedly supported by the frame of the machine and wherein each spindle has a drive pulley, the axes of the several spindles being parallel, an endless drive belt having a spindle-driving run, means so tensioning and guiding the belt that its spindle-driving run is normally rectilinear, the axes of successive spindles of the series being at different distances from said normally rectilinear run of the belt, the minimum distance between a drive pulley and the rectilinear run of the belt being of the order of $\frac{1}{16}$ of an inch and the maximum distance between any drive pulley and said rectilinear run of the belt not exceeding 2 inches, and means operative to deflect the belt into driving contact with any selected pulley of the series.

15. In a textile machine of the kind wherein each spindle of a series turns in a bearing fixedly supported by the frame of the machine and wherein each spindle has a drive pulley, the axes of the several spindles being parallel, an endless drive belt having a spindle-driving run, means so tensioning and guiding the belt that its spindle-driving run is normally rectilinear, the axes of successive spindles of the series being at different distances from said normally rectilinear run of the belt, the minimum distance between the first drive pulley of the series and the rectilinear run of the belt being not less than $\frac{1}{16}$ of an inch, the successive pulleys of the series being at progressively increasing distances from said rectilinear run of the belt until a maximum distance not exceeding 2 inches is reached, further successive pulleys of the series then being located at progressively decreasing distances from the rectilinear run of the belt until the last pulley of the series is at a distance not less than $\frac{1}{16}$ of an inch.

16. In a textile machine of the kind wherein each spindle of a series turns in a bearing fixedly supported by the frame of the machine and wherein each spindle has a drive pulley, the axes of the several spindles being parallel, a single endless belt for driving the spindles of the series, means so guiding and tensioning the belt that it does not normally contact any of the spindle pulleys, and means for deflecting the belt into operative contact with any selected pulley of the series.

17. In combination with a plurality of spaced rotary spindles each turning in a bearing which is fixedly supported by the machine frame and each having a driving pulley, the several spindles being arranged in a series with their axes substantially parallel, an endless drive belt having a spindle-driving run which is normally spaced from all of the drive pulleys, means for driving the belt, means for so tensioning the belt that its driving run may vary in length, and means operative to deflect the driving run of the belt from its normal course to create driving contact between it and any selected one or ones of the spindle-driving pulleys, the tension on the belt being sufficient to keep it out of contact with all pulleys except those selected.

18. In combination in apparatus of the class described, wherein rotary spindles, each provided with a driving pulley, turn in spaced bearings which are fixedly supported by the machine frame, the spindle axes being substantially parallel and wherein an endless, constantly moving drive belt has a spindle driving run extending along the series of drive pulleys, the axes of the several spindles being located respectively at the angles of a funicular polygon, the chord of said polygon facing the driving run of the belt, and a spindle deflector associated with each respective spindle, each belt deflector being operative individually to deflect a portion of the driving run of the belt into driving engagement with its respective spindle pulley.

19. In a textile machine wherein spaced rotary spindles, each turning in a bearing which is fixedly supported by the machine frame, are arranged in a series, one series at each side of the machine, and wherein an endless drive belt has a driving run extending along and adjacent to each series of spindles, each spindle having a driving pulley for engagement with the belt, the axes of any three adjacent spindles of either series being at the angles of an obtuse isosceles triangle whose base is toward the corresponding drive run of the belt and a deflector associated with each respective spindle, the several deflectors being individually actuable, each deflector being operative to deflect the adjacent driving run of the belt into driving contact with the pulley of the corresponding spindle.

20. In a textile machine wherein spaced rotary spindles, each turning in a bearing which is fixedly supported by the machine frame, are arranged in a series, one series at each

side of the machine and wherein an endless drive belt has a driving run extending along and adjacent to each series of spindles, each spindle having a driving pulley for engagement with the belt, the axes of the spindles of each series being at the angles of a funicular polygon whose chord is toward the corresponding driving run of the belt, and means for deflecting either drive run of the belt to contact any one or more spindle pulleys of the adjacent series without engaging it with spindle pulleys of other spindles.

21. In combination in apparatus of the class described, wherein a series of rotary spindles, exceeding three in number, each provided with a driving pulley, turn in spaced bearings which are fixedly supported by the machine frame, the spindle axes being substantially parallel, and wherein an endless, constantly moving drive belt has a spindle driving run extending along the series of drive pulleys, and belt deflectors whereby said driving run of the belt may be brought into driving contact with any selected spindle pulley without contacting it with any other pulley, each deflector comprising a movable support, a belt-contacting pulley mounted on the support, means for holding the support in a position such that its pulley does not deflect the belt, and means for moving the support to cause the pulley to contact and deflect the belt.

22. In combination in apparatus of the class described, wherein rotary spindles, each provided with a driving pulley, turn in spaced bearings, each fixedly supported by the machine frame, the spindle axes being substantially parallel, and wherein an endless, constantly moving drive belt has a spindle driving run extending along the series of drive pulleys, a belt deflector associated with each respective spindle, the several belt deflectors being independently actuable to deflect the driving run of the belt into driving contact with a corresponding driving pulley, means normally holding each belt deflector in inoperative position, and means for moving any selected belt deflector into operative position and for retaining it in operative position.

23. In combination in apparatus of the class described, wherein rotary spindles, each provided with a driving pulley, turn in spaced bearings each fixedly supported by the machine frame, the spindle axes being substantially parallel, and wherein an endless constantly moving drive belt has a spindle driving run extending along the series of drive pulleys, the driving run of the belt being normally substantially rectilinear, the axes of adjacent spindles being at different distances respectively from the normal location of the driving run of the belt, and an independently actuable deflector for deflecting the driving run of the belt into operative engagement with the driving pulley of any selected spindle, each deflector comprising a support mounted to swing about an axis parallel to the pulley-contacting face of the belt, a belt-deflecting roll carried by the support, a spring urging the support to swing the roll toward the belt, an actuator for swinging the support away from the belt, and a spindle brake associated with each actuator.

24. In combination a plurality of spaced spindles whose axes are parallel, a fixed bearing for each of the several spindles, the axis of each spindle being at the apex of a geometric triangle whose apex angle is obtuse, the bases of the several triangles being angularly disposed relatively to each other.

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