

July 21, 1959

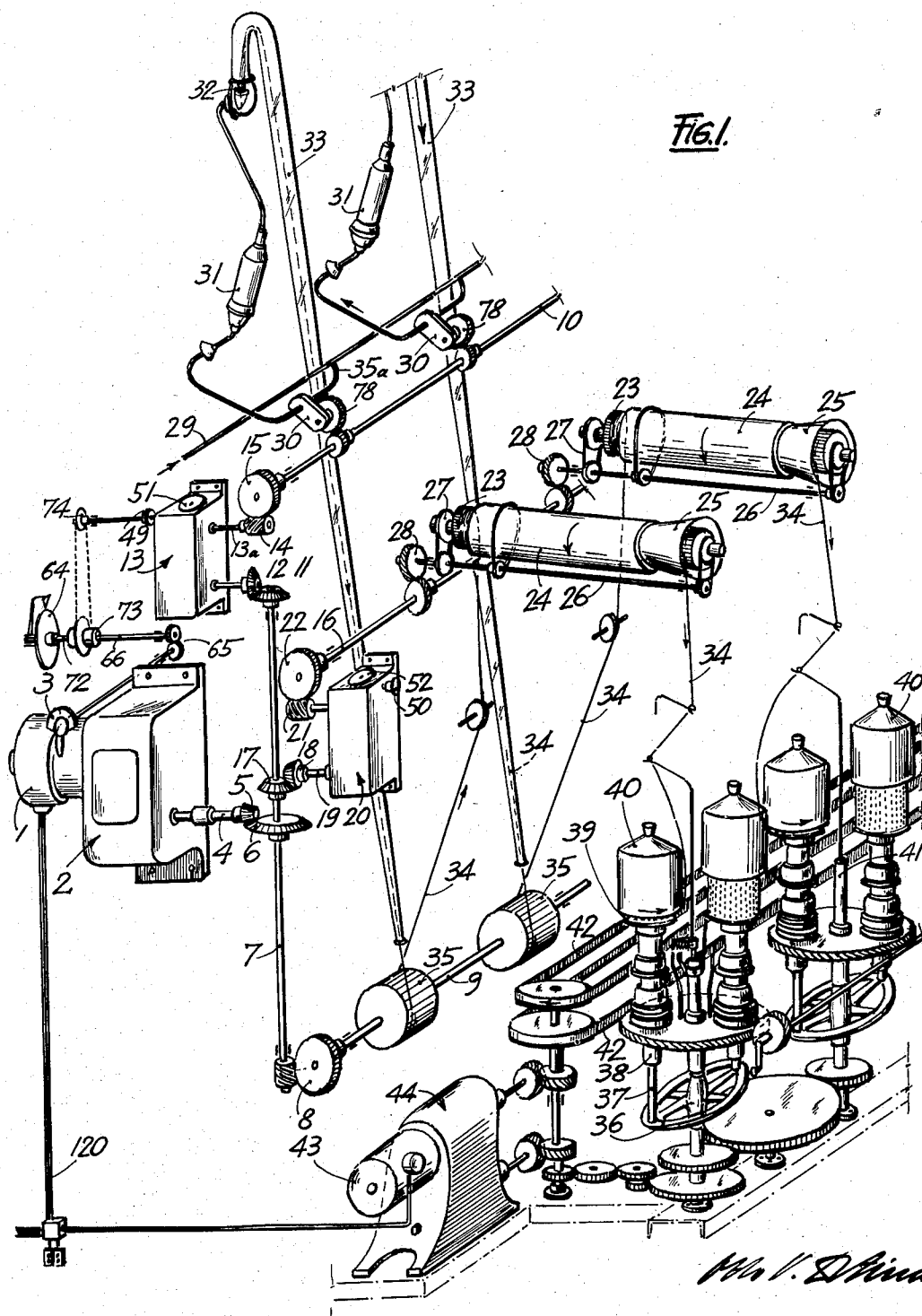
O. V. DRTINA

2,895,284

SYNTHETIC FIBER SPINNING MACHINE DRIVE

Filed May 29, 1957

4 Sheets-Sheet 1



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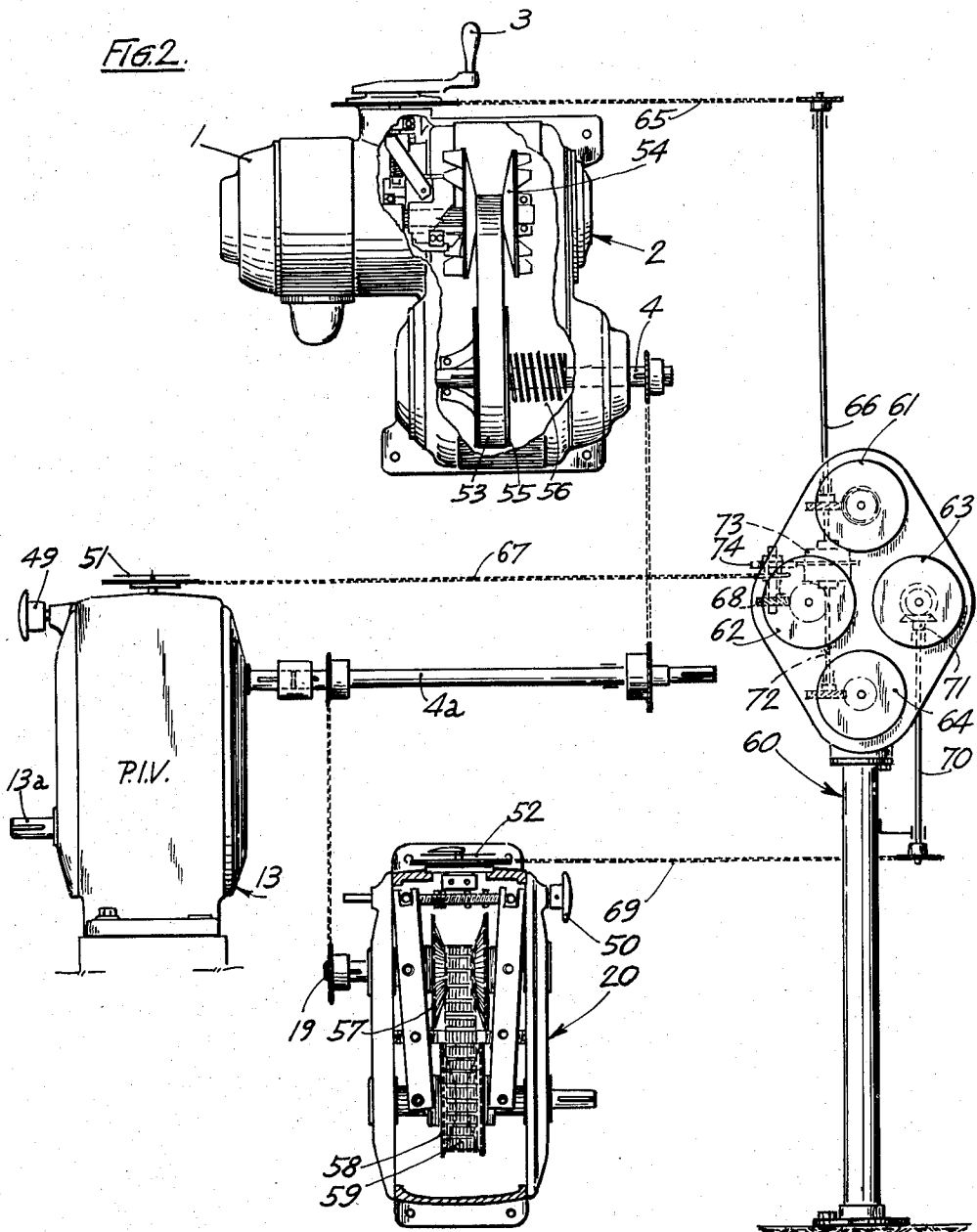
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SYNTHETIC FIBER SPINNING MACHINE DRIVE

Filed May 29, 1957

4 Sheets-Sheet 2



INVENTOR.

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July 21, 1959

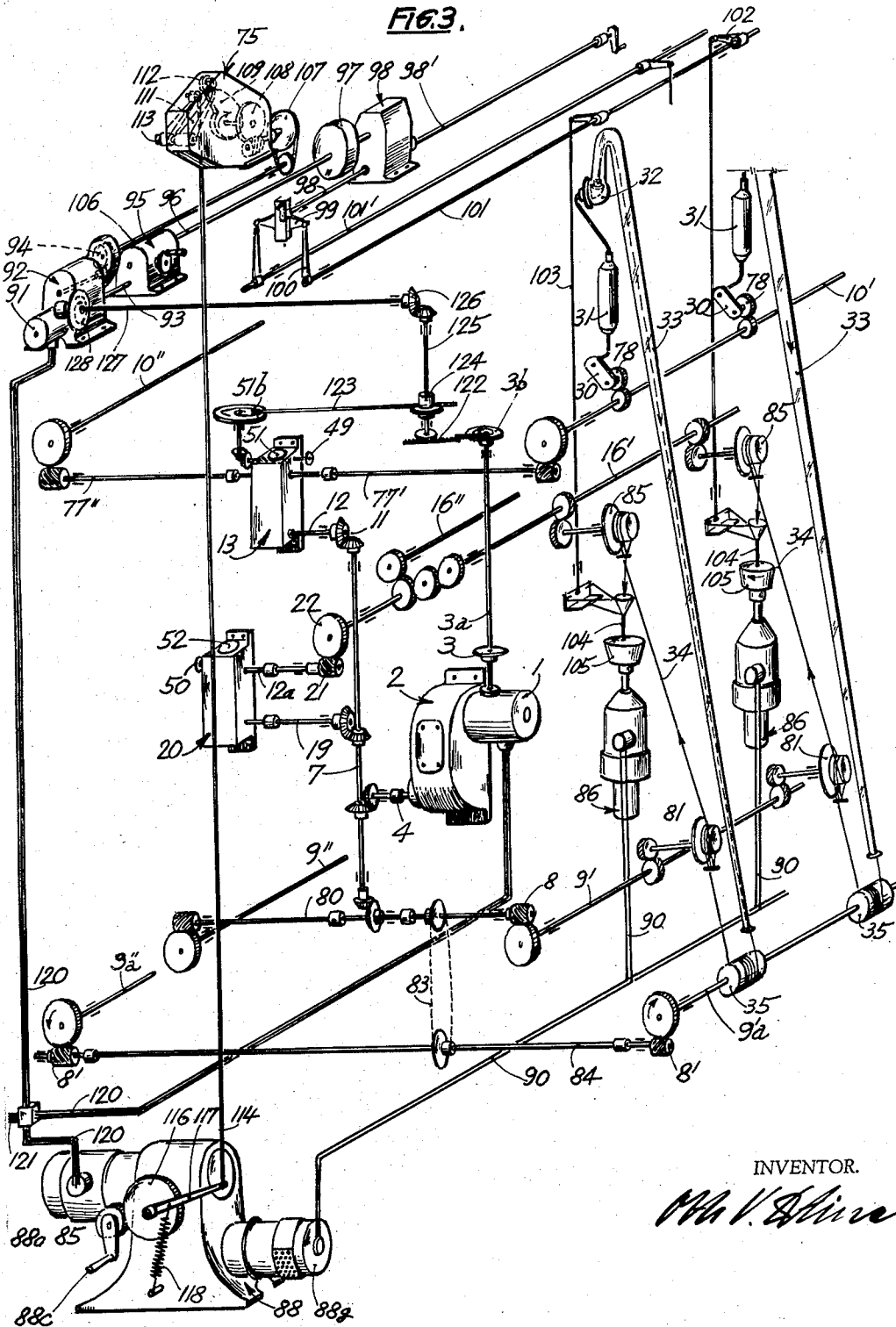
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SYNTHETIC FIBER SPINNING MACHINE DRIVE

Filed May 29, 1957

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O. V. DRTINA

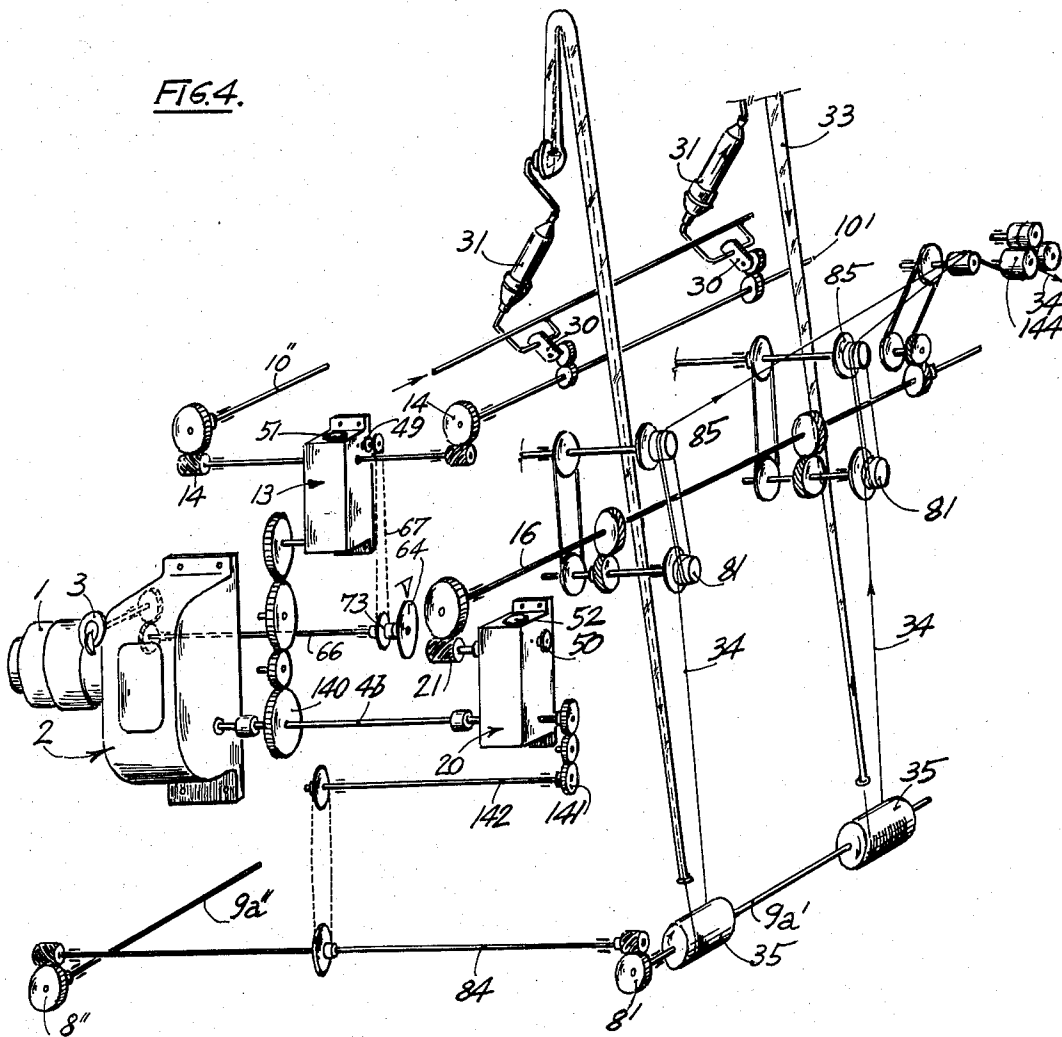
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SYNTHETIC FIBER SPINNING MACHINE DRIVE

Filed May 29, 1957

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FIG. 4.



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SYNTHETIC FIBER SPINNING MACHINE DRIVE

Otto V. Drtina, Cleveland, Ohio

Application May 29, 1957, Serial No. 662,543

5 Claims. (Cl. 57-77)

This application is a continuation-in-part of my co-pending application Serial No. 535,053, filed September 19, 1955, now abandoned entitled "Drive for the Rayon Spinning Machine."

In general, drive arrangement for rayon spinning machinery comprises (1) drive of a pump shaft, (2) drive of first stretching godet wheels or stretching and elutriating reels, (3) drive of second godets or processing cylinders. All three of the drives must be variable within certain limits and still have a positive ratio without slippage between the three units.

The prior art provides some solutions but their common disadvantages seem to be high initial cost and difficulty of adjustments for different spinning speeds, different deniers, and different stretch.

It is an object of the present invention to provide simple and inexpensive means for overcoming the above-mentioned difficulties.

Another object of the invention is to provide a novel interlocking drive arrangement.

Another object is to simplify operation of pot spinning machines by providing a pot spinning speed compensator and allowing same to adjust itself automatically to denier and speed.

Still another object is to indicate speed, denier, stretch and pounds produced, by simple and positive means.

Other objects and advantages will become apparent and the invention may be better understood from consideration of the following description taken in connection with the accompanying drawings where like functioning parts are like numbered in the various figures and in which:

Fig. 1 is a schematic representation illustrating the interlocking drive according to the invention and for a continuous filament rayon or the like continuously spinning and processing machine;

Fig. 2 is a schematic view showing a portion of interlocking drive and a control stand according to the invention with four indicators, additional to the different types of variable drives with their own indicators;

Fig. 3 is a schematic representation showing a self-contained drive for a rayon pot spinning machine;

Fig. 4 is a schematic representation of my improved interlocking drive applied to a staple fiber tow spinning machine.

Description

Referring first to Fig. 1, I have shown an axiomatic view, particularly showing the drive, for a continuous filament rayon spinning machine where it is assumed that an electric motor 1 is connected directly to a variable speed drive 2 provided with a manual control and indicating dial 3. Through an output shaft 4 and gears 5, 6, torque is transmitted from the variable speed drive to a vertical shaft 7. As shown the vertical or king shaft 7 carries a worm 8 to drive a lower stretching godet or processing reel shaft 9 at a relatively slow speed, for example, 80 to 250 r.p.m.

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A pump shaft 10 which is to have a variable range of speed of, for example, 15 to 90 r.p.m. is driven from vertical shaft 7, by way of gears 11, 12 and a variable speed device 13, preferably of the type known to the art as PIV or positively infinitely variable drive comprising opposed discs and interlocking chain drive as more fully described hereafter in connection with Fig. 2. The output of PIV 13 is shown driving a worm 14 which in turn drives a gear 15 to operate the pump shaft 10.

A processing cylinder shaft 16 which may, for example, have speeds between 80 and 240 r.p.m. is driven from the vertical shaft 7 by beveled gears 17, 18, a PIV unit input shaft 19, PIV drive 20, and a worm 21 and meshing gear 22. A plurality of processing cylinders each having parts 23, 24, and 25 (as fully described in my co-pending application Serial No. 585,116, filed May 15, 1954) are driven each from its own auxiliary shaft 26 by a timing belt drive 27 while each shaft 26 obtains its drive from the shaft 16 through spiral gearing 28.

Viscose introduced through a conduit 29 is supplied in measured quantities by pumps 30 and delivered under pressure through candle-filters 31 to spinnerets 32, where it is submerged in flowing sulphuric acid bath in fully enclosed gravity stretch spinning equipment as more fully shown and described in my co-pending application Serial No. 603,707, of August 13, 1956. Thus, the viscose in contact with properly concentrated and heated H_2SO_4 is regenerated and then stretched in long stretch spinning tubes 33 to produce cellulosic yarn filament 34 which in following steps may be washed, stretched on processing reels 35 (on shaft 9), and then desulphurized, washed, bleached, washed and dried in processing cylinder 23, 24, 25 and finally twisted into a yarn and coned on cap twisting spindles 36-41 driven by belt drives 42, 42, all steps being performed in one continuous operation.

As shown in Fig. 1 a separate motor 43 and its vari-drive 44 is used to operate this coning and rotating cap twisting spindles with quick package changing apparatus (35-41) all as described in my patent application Serial No. 539,577, filed October 10, 1955, now abandoned and replaced by continuation-in-part application Serial No. 624,649, filed November 27, 1956.

Both the PIV drives 13 and 20 have manual control knobs 49, 50, respectively, varying the output speeds individually, which speeds are indicated on dials 51 (for PIV 13) and 52 (for PIV 20).

Referring now to Fig. 2, I have shown in outline interlocking drive comprising a main motor 1, and, shown partially cut away, a so-called vari-speed (V belt) drive indicated generally at 2, and comprising a wide V belt 53, running over two pairs of smooth conical discs 54 and 55. Discs 54 are axially adjustable by crank 3, which usually incorporates a speed indicator. The other pair of discs 55 is actuated axially by a helical spring 56 and by the belt itself. The interlocking drive of Fig. 2 also has a PIV drive 13 deriving its input from a shaft 4a (driven by the output shaft 4 of vari-speed unit 2) and delivering a speed varied output through PIV 13 output shaft 13a.

As described above in connection with Fig. 1, the first variable speed output shaft 4 may drive a vertical shaft or, as schematically shown in Fig. 2, otherwise be caused to power a shaft 4a operating as the input to PIV unit 13 and also provide power for a shaft 19 operating as the input to PIV unit 20 shown in partial section in Fig. 2 and (like unit 13) comprising a type of a variable drive manufactured in this country and well known for its positive infinite variation possibilities without slippage, as it uses two pairs of axially adjustable grooved discs 57, 58 into which meshes specially made self-pitching slat chain 59 with self-forming metal teeth that engage

with radial grooves in the two pairs of cone-shaped discs. When one pair of discs is pressed axially together by mechanism operated by the hand knob 50, the other pair simultaneously spreads apart, causing the chain to transfer itself to a larger diameter on the first pair, and automatically to a small diameter on latter pair. The amount of speed variation (i.e., variation ratio) is shown on the indicator 52.

If desired there may be, as also shown in Fig. 2, an instrument stand 60 with indicators 61-64, arranged to indicate:

- 61—Spinning speed
- 62—Denier
- 63—Stretch
- 64—Pounds produced per unit time

To this end, and so that the respective indicators will show the spinning speed, denier being spun, amount of stretch, and pounds of yarn produced per unit of time, the indicators are connected to existing shafts and variation-ratio indicators located on the variable drives by power transmitting means so that the drive for indicator 61 is derived from unit 2 as by a chain drive 65 and shaft 66; indicator 62 is driven from PIV 13 indicator 51 through a chain drive 67 and helix gearing 68; indicator 63 is driven from PIV 20 indicator 52 through a chain 69 onto a shaft 70 and bevel gearing 71; and indicator 64 showing produced yarn in pounds per unit of time is driven from a shaft 72 by a fractional HP differential 73 which integrates movements of adjusting means from the spinning speed controlling vari-drive 2 and the denier determining PIV drive 13. The differential 73 is mounted as shown in Fig. 2 between the two indicators 61-64 on shafting 66 and 72. The differential input shaft 66 is connected to the main vari-drive 2, indicator 3, and its output shaft 72 to indicator 64 showing pounds produced while the differential 73 is also driven by the denier determining PIV 13 by spur-gearing 74 meshing into a gear mounted on the outer circumference of the differential 73 which thus operates on the principle that theoretically yarn in pounds per hour is a product of denier spun and speed of spinning.

Fig. 3 shows a self-contained drive for an entire pot spinning machine requiring no specially modified current or voltages and operable on a standard power line, and which has added advantages that all adjustments of the whole machine are reduced to very simple operations.

Similar parts are numbered as before and there is, additionally, a compensator 75 used to enable spinning rayon at constant tension into pots, while adjusting automatically to spinning speed and denier being spun, as hereafter described.

The machine is again assumed of a type with long spinning funnels 33 and but here plural driving shafts 16' and 16'' are arranged above the machine main V belt vari-drive 2, and there are both upper and lower stretching godets. Drive 2, output shaft 4, and adjoining bevel gears drive the vertical or king shaft 7 from which branch drives go as follows:

(1) To pump shafts 10', 10'' by pair of top bevel gears 11, 12 to PIV 13, and from there to each side by shafts 77', 77'', through worm gearing onto said shafts 10', 10'' on which are mounted gears driving spur gears 78, 78 to drive the viscose pumps 30, 30.

(2) To lower godets from king shaft 7 through a pair of lower bevel gears, a horizontal shaft 80, worm gears 8, 8 located at each side, and shafting 9', 9'' on which individual helix gears are arranged to drive godets 81, 81.

(3) To processing-reel shafts 9a', 9a'' on which properly spaced reels 35 are mounted. This drive is from the above-mentioned shaft 80 by a chain drive 83, intermediate shaft 84, worm gears 8', 8'' and thus to shafts 9a', 9a''.

(4) To upper stretching godets 85 mounted to be driven by shafts such as 16', 16'' driven from the king shaft 7 through intermediate bevel gearing and short shaft

19, PIV unit 20, and worm gearing 21-22 and a gear train ultimately causing opposite turning of the shafts 16', 16'' on which are mounted helical gear drives for the respective godets 85.

Spinning motors 86 carrying pots 105 are arranged in more or less conventional manner, but in order to enable spinning evenly and at constant tension as the cake builds up on the pot, the spinning motors have variable speeds caused by variable electrical supply. For that reason, a small vari-dyne unit 88 comprises an electric motor 88m arranged on the machine. The unit has a regular V belt vari-drive driving an integrally mounted frequency changer 88g. The individual spinning motors are connected to the frequency changer by wiring 90 and their speeds are automatically controlled to provide constant tension on spun yarn.

A drive for traverse mechanism (hereafter described) and for the compensator 75 comprises a motor 91 integrally built into a V belt vari-drive 92 having an extension (motor speed) shaft 93 and a variable speed shaft shown driving spur gearing 94.

The vari-drive motor speed shaft 93 is connected to another vari-drive 95 serving the traverse mechanism only. Unit 95 has an output shaft 96 equipped with a flywheel 97 and driving a variable velocity gear box 98.

Outgoing shafts 98', 98'' have on each far end a crank meshing into a standard traverse Scotch yoke mechanism (one being shown at 99) mounted on arms 100, fixed on traversing shafts 101, 101'. On such shafts there are mounted levers 102 actuating connecting rods 103 to cause a constant up and down traverse movement of spinning funnels 104 leading yarn 34 into pots 105.

Meanwhile the compensator 75 is driven from the vari-drive 92 through gears 94, a shaft 106, a chain drive 107, and (inside of compensator housing) a worm gear drive 108 and a cam 109. Also in the housing, arranged on a short shaft, is an arm 111 with a cam-roller 112 transmitting angular movement outside the housing onto another arm 113 to the end of which a long rod 114 or cable is attached to transmit movement onto speed control mechanism arranged on the vari-dyne unit 88 which, on its standard speed control shaft and behind the usual crank 88c carries a spur gear 115, meshing into another spur 116 on which is firmly attached an arm 117, to the other end of which is attached rod 114. As shown, the arm 117 is constantly urged downwardly by a spring 118.

The three electric motors required to drive the machine are connected by wiring 120 from a central source of power 121, e.g., of three phase, 60 cycles.

In accordance with the illustrated embodiment of Fig. 3 the following mechanism is used for the automatic control of the compensator vari-drive 92.

The main vari-drive 2 has its speed control wheel 3 arranged on a control shaft extension 3a, on top of which is arranged a disc 3b with a logarithmic cam-groove. Pump shaft PIV drive 13 has its indicator shaft extended somewhat and carrying a top disc 51b provided with a logarithmic curved groove. Radial movement produced by both cams (3b and 51b) are transmitted by racks 122, 123 onto gears on a differential 124. Outgoing integrated movement is transmitted by a shaft 125, gear 126, and a shaft 127 to a logarithmic curved grooved disc 128 which controls the speed of the vari-drive 92.

In Fig. 4, I have schematically shown my improved drive as applied to a staple-fiber spinning machine. As in the prior figures, there is a main V belt vari-drive 2 with integrally built-in motor 1 and operated by a hand control crank 3. As shown in Fig. 4 unit 2 drives a gear train (140) consisting of four spur gears.

Pump shafts such as 10', 10'' are driven from gear train 140 through PIV drive 13 and worm-gearing 14 arranged on both sides of horizontal shafting output from said PIV 13 which is provided with individual speed-control knob 49 and speed indicator 51.

Yarn receiving reels 35 on shafts such as 9a' are driven

by V belt drive 2 output shaft 4b and straight through PIV unit 20 (at input speed), a gear train 141, shaft 142, shaft 84, gearing 8, to shafts 9a', 9a''.

Lower stretching godets 81 are driven from shaft 4b, PIV drive 20, worm gear drive 21, shaft 16 and unnumbered spiral gearing to said godets 81, and as illustrated in Fig. 4, the yarn delivering upper godets 85 (and other yarn delivering machinery 144, etc.) are also driven by interconnection through shaft 16.

Operation

Operation of mechanism according to the invention will now be described, first in connection with the embodiment shown in Figs. 1-2. For any given spinning speed, the control lever 3 of vari-drive 2 is set, preferably when the machine is running. For any given denier to be spun, the control knob 49 on PIV 13 is set to produce a properly corresponding pump speed and proper initial stretch. Final stretch meanwhile is adjusted in the PIV 20 by its control hand wheel 50, the setting of which is shown on the dial 52. For all these settings specially prepared tables can be kept at hand, so that nothing is required to be computed during the production operation.

After all the vari-drives are properly adjusted, the machine is ready to be started for spinning. When a change of spinning speed is needed, all that need be done is to reset the control lever 3 on vari-drive 2 (without any shutdown required) and all the rest of the settings will still be correct for given denier and stretch. If a change in stretch or denier is called for, the only manual operation required is individual adjustment of knob 49 (unit 13) or knob 50 (unit 20).

Similar considerations apply in considering operation according to the embodiment illustrated in Fig. 3 which differs from that of Fig. 1 mainly in having oscillating funnels for pots and the compensator mechanism (75, etc.) which integrates on the following basic principles:

$$W(\text{Weight of yarn}) = \frac{V(\text{speed of yarn}) \times D(\text{denier})}{K(\text{a constant})}$$

so that,

$$\log W = \log V \text{ plus } \log D - \log \text{ constant}$$

Pot (105) traversing rate can be manually changed by the crank on vari-drive 95, for example, so that the outgoing shaft 96 will revolve at 68 to 315 r.p.m. such that the range of traverse speed (assuming a stroke of 4'') is 34 to 158 strokes per minute.

As for horse power requirements, good results may be obtained where motor 1 for vari-drive 2 is 5 H.P., motor 91 for traverse and compensator PIV unit 92 is 1.5 H.P. and where motor 88m for driving varidyne 88 supplying power for driving pots 105 (assuming fifty pots arranged on each side of spinning machine and requiring 89 watts of power per unit) is 10 H.P. Use of varidyne here permits constant tension in yarn throughout the spinning of cake to minimize yarn breakage during the spinning.

Centrifugal force of

$$\frac{MV^2}{R}$$

acting on yarn should always be constant, no matter if the pot is empty (e.g., $R_1 = 0.0875$ meters) or cake fully formed (e.g., $R_2 = 0.0625$ meters); therefore the circumferential velocity may be expressed:

$$V = \sqrt{\frac{cf \times R}{M}}$$

where

cf=centrifugal force
R=radius
M=mass

For given denier:

$$\frac{cf}{M} = \text{a constant } K (=157,753,600)$$

and

$$V = \sqrt{K \times R}$$

and, since

$$V = 2\pi Rn \text{ (meters per minute)}$$

5 where $n = \text{r.p.m.}$; or $n_1 = \text{empty r.p.m.}$; etc. combining the equations

$$n_1 = \sqrt{\frac{K \times R_1}{2\pi R_1}}; \text{ e.g. } n_1 = 8000 \text{ r.p.m.}$$

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$$n_2 = \sqrt{\frac{K \times R_2}{2\pi R_2}}; \text{ e.g. } n_2 = 6755 \text{ r.p.m.}$$

as may readily be achieved through the variable V belt driven generator variable frequency drive of A.C. motors, though of course variable voltage drive of D.C. motors might be used instead. In any event something like the compensator 75 is useful to adjust the unit 88 to provide proper range of speed.

15 It is also necessary to consider the variation in twists per formation of cakes. The basic formula is:

$$T(\text{twists per meter}) =$$

$$\frac{\text{r.p.m. of balloon}}{VS(\text{spinning speed in meters per minute})}$$

25 Assuming the spinning speed $VS = 240 \text{ m./min.}$, certain back revolutions of balloon are needed, so the yarn will be wound into the cake.

$$\text{Rev. of balloon} = \text{Rev. of pot} - nb.$$

30 where

$$nb = \text{back revolutions; } nb_1 \text{ (empty) etc.}$$

$$nb = \frac{VS(\text{spinning speed})}{\pi d}$$

35 Substituting

$$nb_1 = 616 \text{ r.p.m. of balloon (empty)}$$

$$nb_2 = 436 \text{ r.p.m. of balloon (full) and}$$

$$\text{Rev. of balloon} = 8000 - 616 = 7384 \text{ empty.}$$

$$6755 - 436 = 6319 \text{ full.}$$

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$$T_1 = 7384/240 = 30.8 \text{ turns/meter}$$

$$T_2 = 6319/240 = 26.3 \text{ turns/meter and}$$

$$\text{Mean twist value} = 28.55$$

$$\text{Twist variations for cake} = \pm 6\%$$

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In operation, according to the embodiment of Fig. 3 for a rayon pot spinning machine, first the hand wheel 3 is set for desired spinning speed. For a given denier to be spun, the control hand knob 49 on PIV 13 is set for a corresponding pump speed. For a definite required stretch the upper godets speed is set on PIV 20 by its control knob 50. Rate of traversing is set through the hand-crank on unit 95. Automatically then, according to spinning time elapsed for spinning the cake of proper weight, the compensator 75 sets itself.

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To provide a cake of proper shape traversing mechanism for the funnels 104 is arranged to have substantially constant (but adjustable) linear speed with quick reversal at dead points to control the up and down movement of the funnels actuated from the motorized vari-drive 92.

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Considering now the operation of the staple fiber spinning machine as illustrated in Fig. 4, there is somewhat of a difference at the end where the yarn is subjected to additional stretch between godets 81 and 85, and individual strands 34 are then collected into tow, which is further stretched and conveyed to the next processing equipment 144, etc.

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Advantages

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One advantage of all the Figs. 1-4 arrangements is lower cost (e.g., because of installation and maintenance economies resulting from use of simplified V belt vari-drive for main drive at one carefully chosen place where slippage is tolerable) combined with more fully automatic operation, for example, rendering unnecessary, for

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any variation of spinning speed, any supplemental re-adjustments of godet wheels, or pump drives or (Fig. 3 embodiment) compensator.

The interlocking drives of Figs. 1-4 are fully ratio-positive without any slippage between branch shafts such as 10 (10', 10''), 16 (16', 16''), and 9 (9a', 9a'') and still all variable speed needs are fully met. The pump shaft 10 has to have range of speeds, for instance 15 to 90 r.p.m., and is driven from the king shaft through PIV 13. The lower godet shaft 9' (Fig. 3) driven from the king shaft usually operates at 80 to 250 r.p.m. The lower processing reels 35 arranged on shaft 9a' (Fig. 3) are driven with a ratio such as to provide desired prefixed stretch between lower godets and the reels 35. The upper godet shaft (16' in Fig. 3) may have usual speeds between 80 to 240 r.p.m. and is driven from the king shaft 4 through PIV 20.

But in each case (Figs. 1-4) the speed of the whole spinning machine is controlled by one hand-crank 3 on the motorized vari-drive, without changing the relation to or between all driven units and still both the initial and the final stretches and denier can be easily adjusted individually with knobs such as 49 and 50, as follows:

(1) Setting the V belt vari-drive 2 to proper required spinning speed (shown directly on dial 3).

(2) Setting the PIV drive 13 to proper denier needed (shown on dial 51).

(3) Setting the PIV drive 20 to proper required amount of final stretch (shown on dial 52).

Supervisory personnel can easily keep track of such settings by centralized direct reading of all the indicators of spinning speed, denier, stretch, and pounds produced as shown in Fig. 2 and as is very helpful in the daily checking routine of spinning department supervisors on the synthetic fiber spinning equipment.

The scope of the invention is not limited to any particular type of spinning or processing machine. It could be used for tire-cord yarn spinning machinery or for "Tow to Tow" equipment for spinning and blending natural and synthetic fibers, for while I have illustrated and described particular embodiments, various modifications may obviously be made without departing from the true scope of the invention which I intend to define in the appended claims.

I claim:

1. Mechanical drive arrangement for spinning machinery comprising first, second and third processing groups, said arrangement comprising a motorized speed ratio adjustable V belt variable drive, a first power transmitting means arranged to drive the first processing group by the output of the V belt variable drive, a speed ratio adjustable chain belt type positive variable drive, power transmitting means arranged to drive the second processing group by the output of the V belt variable drive through said chain belt type positive variable drive, a second speed ratio adjustable chain belt type positive variable drive, and power transmitting means arranged to drive the third processing group by the output of the V belt variable drive through said second chain belt type positive variable drive, whereby to provide a minimal cost arrangement but with all processing groups interlocked with respect to one another without slippage while speed of the whole arrangement may be regulated from one place and speed of each processing group may be regulated independently when necessary.

2. Drive arrangement as in claim 1 further characterized by an indicator arranged to be driven by two of the drives to show pounds produced per unit of time as product of spinning speed and denier spun.

3. Mechanical drive arrangement as in claim 1 further characterized by each of the three variable drives having a speed ratio governing and indicating shaft, and there being an indicator stand carrying four indicators for respectively showing (1) spinning speed, (2) denier, (3) stretch and (4) pounds produced per unit time, and mechanical means for driving one indicator on the stand from the V belt variable drive speed ratio governing and indicating shaft, mechanical means for driving another indicator on the stand from the first chain belt type positive variable drive speed ratio governing and indicating shaft, mechanical means for driving a third indicator on the stand from the second chain belt type positive variable drive speed ratio governing and indicating shaft, and mechanical means for driving the fourth indicator on the stand differentially responsive to either and both of two of the variable drives speed ratio governing and indicating shafts.

4. Mechanical drive arrangement as in claim 1 further characterized by at least one additional separately motorized adjustable speed drive and a fourth processing group driven thereby and a compensator mechanism for adjusting the speed of said additional adjustable speed drive, and means for actuating the compensator mechanism responsive to change of speed of both the V belt variable drive and one of the chain belt type variable drives.

5. Interlocking drive for a rayon pot spinning machine as claimed in 1 comprising a motorized V belt variable speed ratio drive having a speed setting and indicating shaft, first process machinery shafting driven from said V belt drive without further possibility of speed adjustment, an adjustable speed ratio chain belt drive having a speed setting and indicating shaft, second process machinery shafting driven from said chain belt drive without further possibility of speed adjustment, another adjustable speed ratio chain belt drive having a speed setting and indicating shaft, third process machinery shafting driven from said last mentioned chain belt drive without further possibility of speed ratio adjustment, a vari-drive comprising a three unit integrally built combination of a motorized mechanical speed variator and a generator driven thereby, said speed variator having a speed setting shaft, a plurality of pot driving spinning motors arranged to be energized from said generator to operate at a speed corresponding to generator speed, a compensator arranged to reset the speed setting shaft of the speed variator of said three unit combination to produce speed variation of spinning motors according to increased build up of cake to provide constant tension of yarn, and means for actuating the compensator through differential integration of values of variable speed settings of at least two of the first three mentioned drives.

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