May 11, 1937. S. L. G. KNOX 2,079,619

TUBE SPINNING HEAD

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Fig. 1

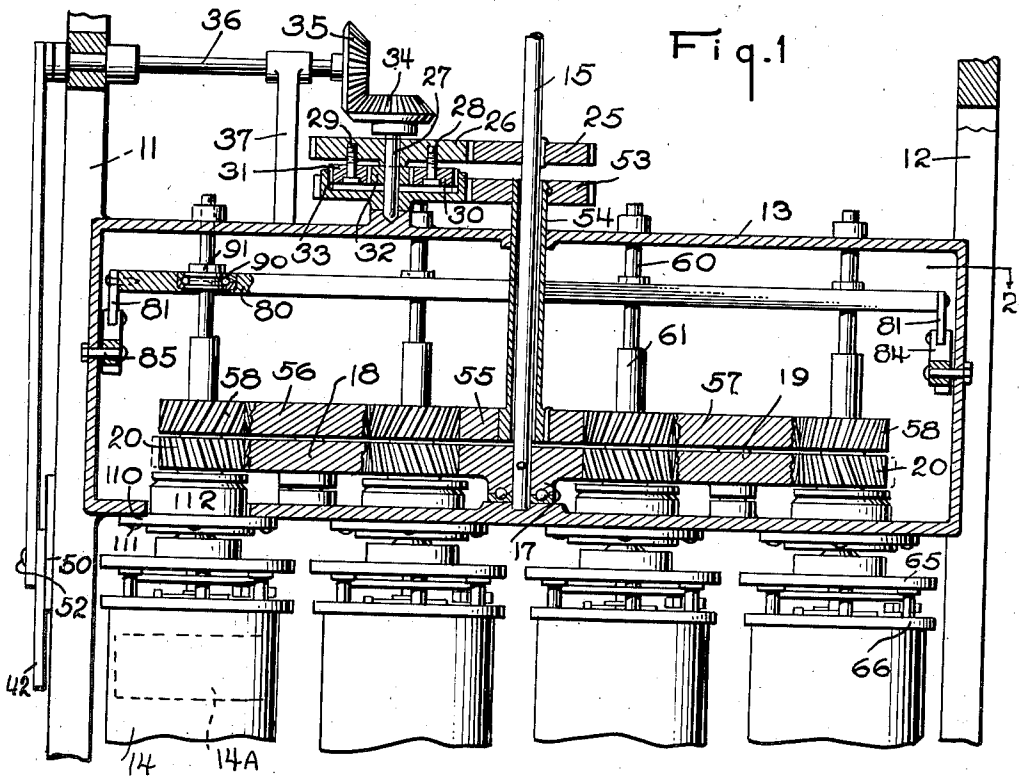
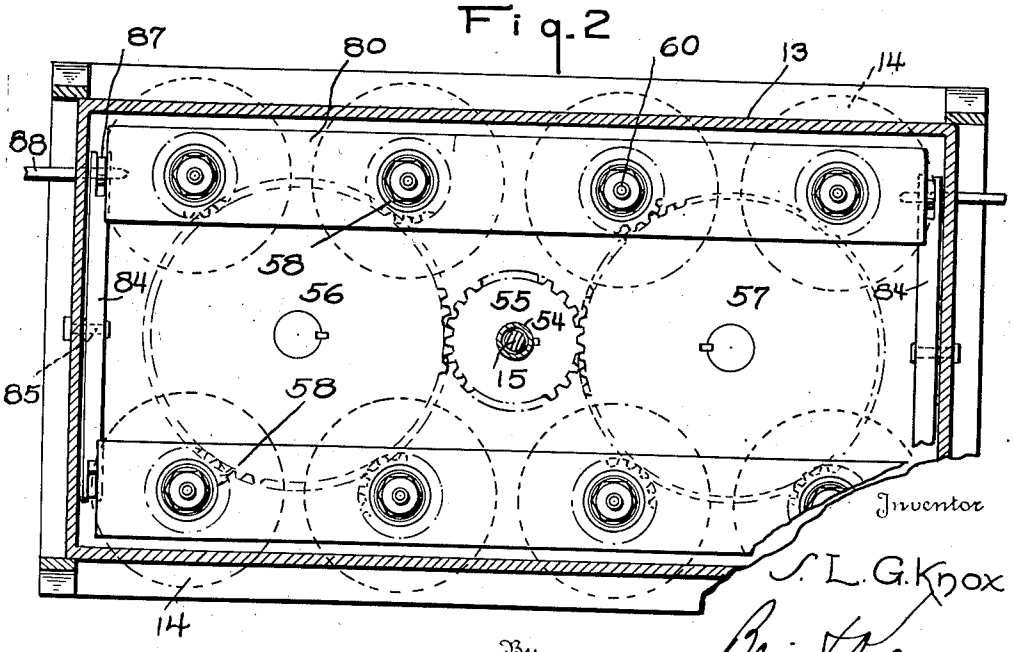


Fig. 2



Inventor

S. L. G. Knox

By Blair Kilcoyne & Attorneys

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TUBE SPINNING HEAD

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Fig. 4

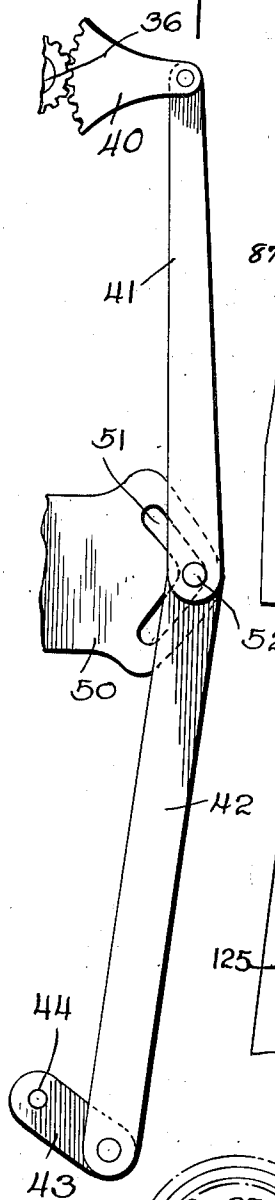


Fig. 5

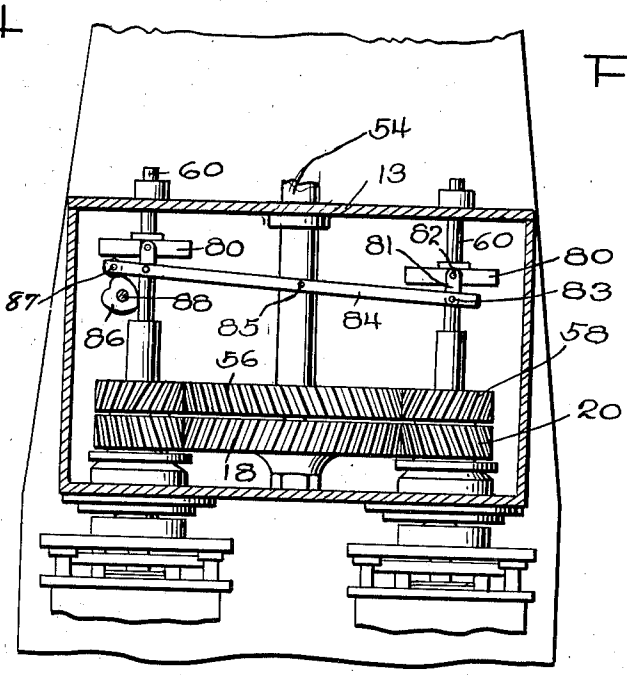
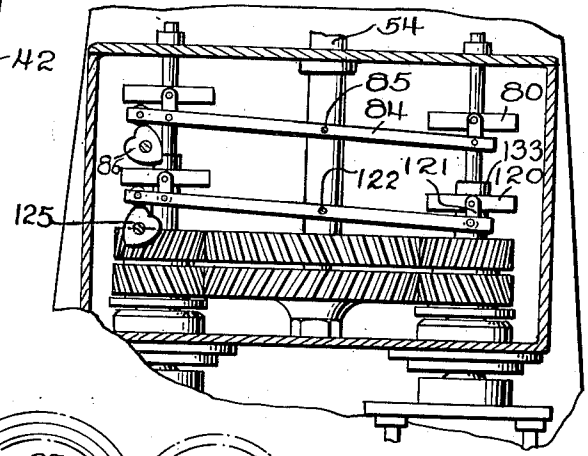


Fig. 9



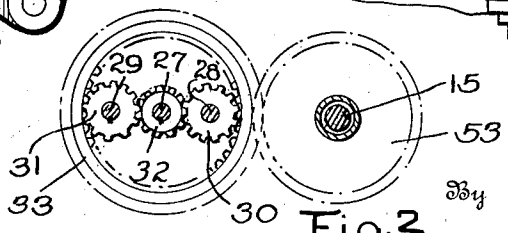


Fig. 3

Inventor

S. L. G. Knox

By Beall & Mulcoyne

Attorneys

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TUBE SPINNING HEAD

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Fig. 6

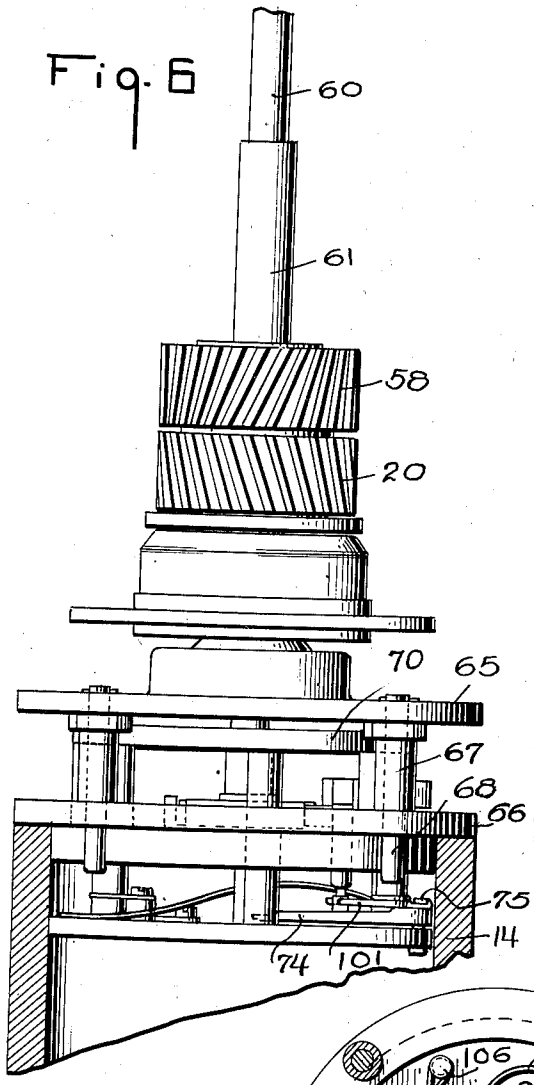


Fig. 7

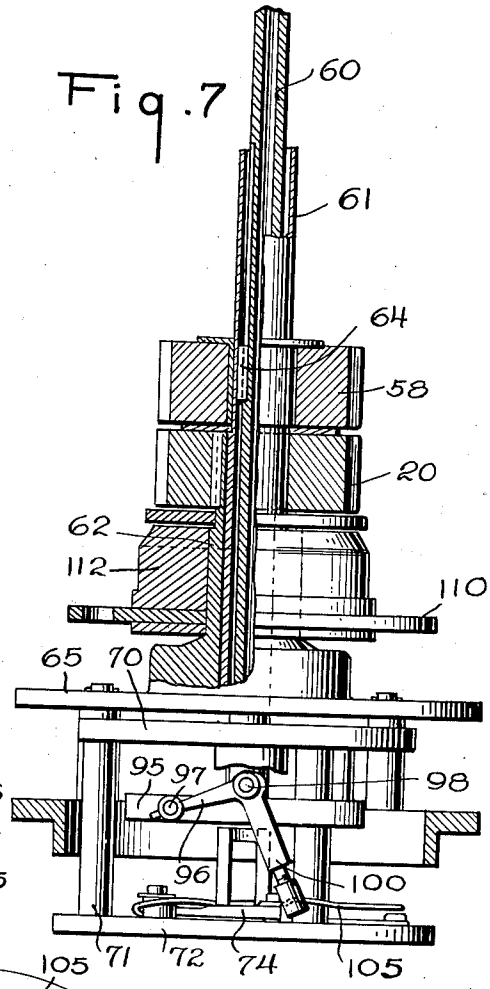
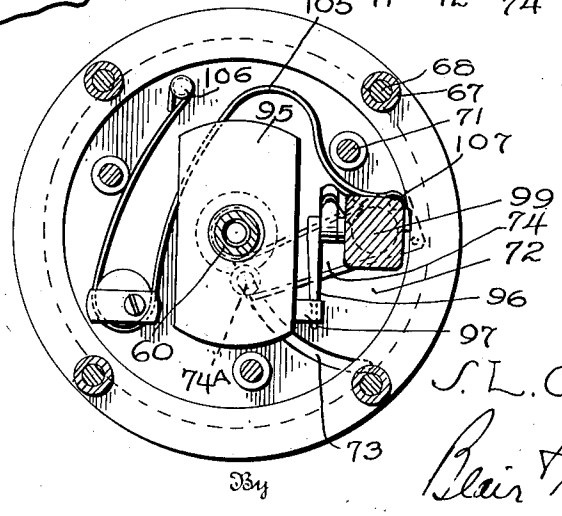


Fig. 8



Inventor

S. L. G. Knox

By Blair & Kilcoyne

Attorneys

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TUBE SPINNING HEAD

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Fig. 10

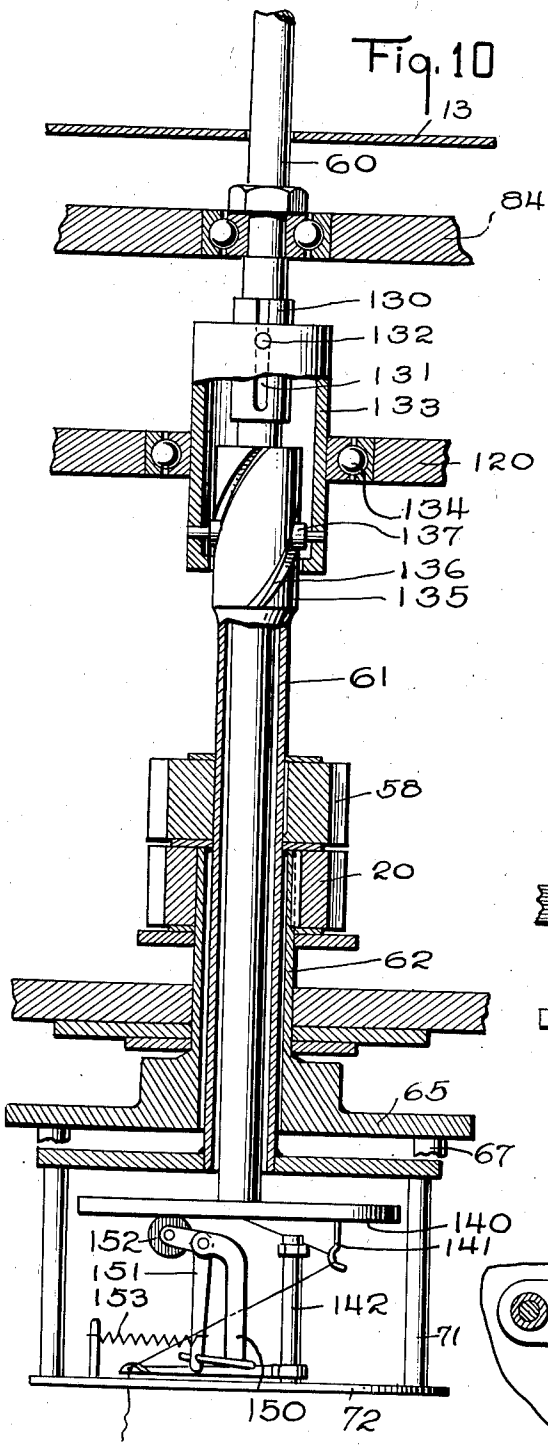


Fig. 11

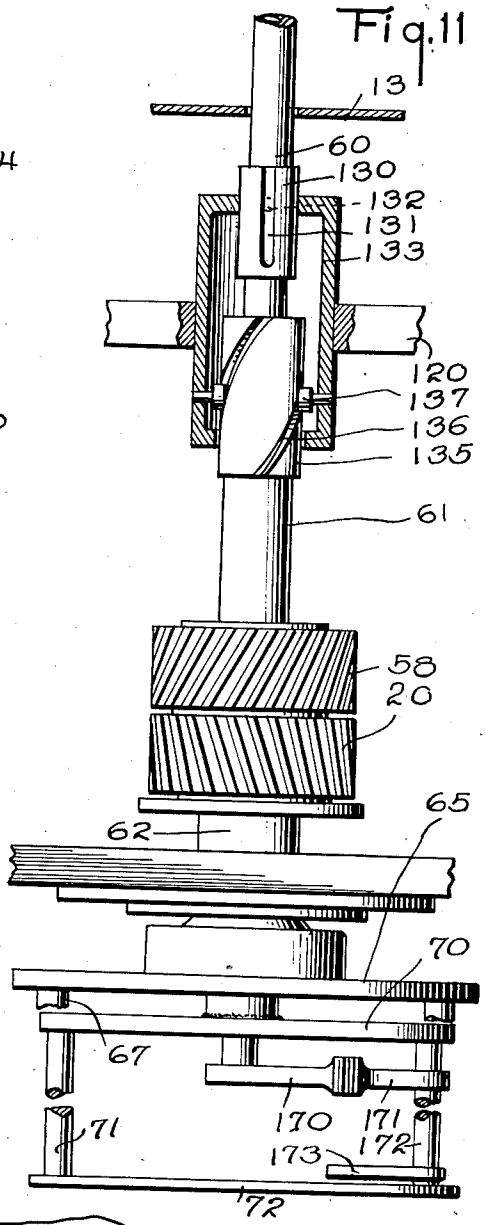
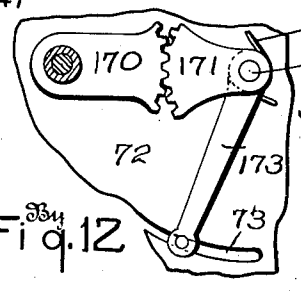


Fig. 12



Inventor
S. L. G. Knox
By Blair & Mulcahy
Attorneys

Patented May 11, 1937 2,079,619

UNITED STATES PATENT OFFICE

2,079,619

TUBE SPINNING HEAD

Samuel Lippincott Griswold Knox,
Englewood, N. J.

Application June 13, 1936, Serial No. 85,164

20 Claims. (Cl. 118—49)

This invention relates to tube spinning machines, and more particularly to improvements in machines for spinning yarn into a tube, as generally disclosed and claimed in United States Letters Patent No. 795,980, dated August 1, 1905, to Charles W. Hubbard.

In the machine of the prior patent aforesaid, which will be hereinafter referred to as the Hubbard machine, yarn is drawn from the rough sliver carried by spools at the top of the machine framework by conventional drawing means and is laid in a rotating tube in the shape of heart-shaped spirals, referred to as "hearts", the tube rotating at high speed, thus to put the necessary twist into the yarn and to draw in the yarn at the same rate at which it passes through the drawing mechanism. The hearts are suitably processioned to form a layer, that is to say, the hearts are laid in a procession so that one overlaps the other, and the operation of the machine is such that successive layers of yarn are built up in the tube.

The laying of the yarn in the form of hearts is accomplished in the Hubbard machine by a spinning head which includes a tube head connected to and driving the tube, and below the tube head a laying plate which moves at a constant but somewhat different speed from that of the head and tube, the difference between these speeds being such as to cause the yarn to be drawn into the tube. The laying plate may move either faster or slower than the head, but the difference must be such that the yarn is drawn into the tube at the rate at which it passes into the head from the drawing rolls above.

In laying the yarn in the form of hearts, or in the form of spirals generally, it is necessary to take care of the slack which forms in the yarn when the heart or spiral is being laid at its smaller radii and of the increased demand for more yarn when the longer radii are being formed. This taking up of slack during the time of minimum demand for yarn and the feeding out of yarn during the time of maximum demand will be hereinafter termed "compensation", and one of the major objects of the present invention is the provision of improved and simplified means for effecting such compensation as aforesaid.

According to my preferred arrangement, I effect compensation, either in whole or in part, by means of a planetary gear system interposed in the laying plate drive, the arrangement being such as to cause the laying plate cyclically to speed up and slow down while the tube head and the tube run at a constant speed. Alternatively, of course, the variation could be applied to the tube head and tube, rather than to the laying plate, and the same result obtained. Thus yarn is drawn in between the laying plate and tube at a uniform rate despite the constantly changing radius on which it is being laid. With such an arrangement, compensation may be had by means of a single planetary gear simultaneously for all of the heads of a battery of spinning heads, and by mechanism located exteriorly of the heads, with the result that not only is there a marked reduction in the number of working parts and a pronounced simplicity of operation, but also slack can be taken up in amounts not possible with compensating means located within the head, as heretofore. This latter feature is advantageous when, instead of hearts, which may be thought of as 180° spiral of increasing radius combined with 180° spiral of decreasing radius, it is desired to lay the yarn in spirals of larger angles, as for instance, 360° or even more degrees in and 360° or even more degrees out.

Another major feature of my invention is the provision of simple mechanism for operating a laying arm within the spinning head, such preferably comprising means for imparting a reciprocating or oscillating movement to an inner spindle rotating at the same, or same average, speed as the laying plate, by means of which through a simple system of levers or meshing gear segments located in each spinning head, the laying arm is caused to oscillate over a slot in the laying plate as more particularly explained below.

Since the accomplishment of absolutely correct compensation is difficult of attainment by means of a single compensating mechanism, I also propose, under certain conditions, the provision of a planetary gear system of compensation as aforesaid, by which primary compensation is effected, with additional compensating means located within the head to take up any slack which the planetary gear system of compensation has failed to eliminate. Such additional compensating means preferably comprises means, independent of the means aforesaid for actuating the laying arm, adapted to impart rotary oscillating movement to the spindle which is independent of its reciprocatory movement as aforesaid, the rotary oscillatory movement of the spindle controlling actuation of a compensating arm within the head and functioning to maintain tension on the yarn en route between the spindle and the laying arm, in the event that the primary (plan-

etary gear system) compensating means has not taken up such slack sufficiently.

Other objects will be in part obvious and in part hereinafter pointed out in connection with the following analysis of this invention, wherein is illustrated one of the various possible embodiments of the present invention, together with certain modifications in detail.

In the drawings, wherein like reference characters designate like parts throughout the several views,—

Fig. 1 is a broken-away elevation, with parts shown in section, of such parts of the machine in accordance with the present invention as are necessary to a general understanding thereof;

Fig. 2 is a section along lines 2—2 of Fig. 1;

Fig. 3 is a transverse section through the planetary gear system illustrated in Fig. 1;

Fig. 4 is a detail of certain parts illustrated in Fig. 1;

Fig. 5 is a vertical front-to-rear section illustrating a preferred form of spindle reciprocating mechanism;

Fig. 6 is an elevation of a spinning head and associated driving elements;

Fig. 7 is a view similar to Fig. 6, with certain parts shown in section;

Fig. 8 is a section through the spinning head as illustrated in Figs. 6 and 7;

Figs. 9 and 10 are partial views illustrating a modified construction; and

Figs. 11 and 12 are partial views illustrating a further modified construction.

From the drawings it will be understood that I have illustrated only such parts of a spinning machine as will be helpful to an understanding of the present invention, the spools carrying the rough sliver and the drawing mechanism by which the rough sliver is drawn from the spools and delivered to the spinning heads being omitted, as such form no part of the present invention and may be more or less conventional.

Referring now to the drawings in detail, and particularly Figs. 1–8 inclusive, reference characters 11 and 12 designate parallel side frames of a spinning machine in accordance with my invention, between which extends a gear box or housing generally indicated at 13, within which is contained the gear mechanism forming the drive for a battery of front and rear spinning heads, laying plates and associated tubes, of which the spinning heads are more clearly shown in Figs. 6–8, with the tubes indicated at 14 being arranged below the gear box and extending to the horizontal base (not shown) of the machine framework. While I have illustrated a machine embodying front and rear batteries of four spinning heads, laying plates and associated tubes, it will be understood that the number and arrangement of such parts is arbitrary and may be increased or decreased in accordance with particular requirements.

A vertical drive shaft 15, which is driven by suitable means (not shown), extends into the gear box 13 and may have its lower end suitably journaled as in the bottom horizontal wall thereof. A gear 17 keyed to the drive shaft 15 acts to drive a train of gears in the plane of gear 17, such gear train including large gears 18 and 19, meshing with a plurality of pinions generally designated 20 and keyed to outer spindles to which are connected the tube heads as will be hereinafter more fully described. By reference to Figs. 1 and 2, it will be seen that drive shaft 15 thus serves to drive all the tube heads of the front and rear battery of spinning heads through gear train 17, 18 and 19, and pinions 20.

Suitably keyed to the driving shaft 15 is a gear 25 which drives a planetary gear train including a spur gear 26 meshing with gear 25, the gear 26 rotating freely on a vertical stub shaft 27 which may be journaled at its lower end in the top of the gear box 13. Fastened to the spur gear 26 are the pins 28, 29 on which are mounted the planet pinions 30, 31, respectively. Pinions 30 and 31 mesh with the sun pinion 32, and with the internal teeth of an internal-external gear 33. The sun pinion 32 is keyed to the vertical stub shaft 27, on which is also mounted the bevel pinion 34 meshing with bevel pinion 35 which is keyed to the horizontal rock shaft 36 suitably supported as by a standard 37.

By reference to Fig. 4, wherein is illustrated one means of imparting rocking movement to the shaft 36, the said shaft is operatively connected to a rock lever 40 which is in turn connected as through the hinged connecting rods 41, 42 with a rotating crank 43 driven from a constantly rotating shaft 44. Fastened to the side frame of the machine is a plate 50 provided with a cam slot 51 in which is adapted to travel the hinge pin 52 of the hinged connecting rods 41, 42.

Meshing with the external teeth of the internal-external gear 33 is a gear 53 which is suitably keyed to a sleeve 54 disposed concentrically about the driving shaft 15, the sleeve at its lower end having keyed thereto a gear 55 which is disposed in the gear box and preferably above the gear 17, and is adapted to drive all of the laying plates to be hereinafter described through a gear train including gears 56, 57, with which latter engage pinions 58 fast on intermediate spindles forming a part of the spinning heads to be described.

In the planetary gear system as above described, the sun pinion 32 constitutes the floating gear of the system, the arrangement and gear ratios being such that when sun pinion 32 stands still, pinions 58 and laying plates associated therewith run at a fixed ratio to the speed of the pinions 20 and the tube heads associated therewith, such ratio being established by the gear train comprising gears 25, 26, planet pinions 30, 31, sun pinion 32, internal-external gear 33, and gear 53. If, however, the sun pinion 32 is revolved in one direction as by turning movement of rock shaft 36 which acts to drive bevel pinions 34, 35, stub shaft 27, and sun pinion 32 keyed thereto, pinions 58 and the laying plates driven thereby will be speeded up with relation to the speed of the pinions 20 and tube heads. Conversely, if the sun pinion 32 is revolved in the opposite direction, pinions 58 and laying plates will be slowed down.

Turning or rocking movement of shaft 36 results from actuation of the crank 43, through hinged connecting rods 41, 42, with the hinged pin 52 operating in cam slot 51 of the cam plate 50. The cyclical rocking movement of the shaft 36 thus causes speeding up and slowing down of the pinions 58 and laying plates relative to the pinions 20 and the tube heads, with the tube head running at a steady speed, and the above described arrangement is such that a practically uniform rate of drawing yarn into the tubes is maintained, despite the constantly changing radius at which it is laid by the in and out movement of the laying arm to be described.

In the construction illustrated in Fig. 4, the cam slot 51 functions to change the effective length of the connecting rods 41, 42 upon actu-

ation of crank 43, thus making compensation independent of the rigid relationship established by rotation of crank 43 and rocker lever 40, if the connecting rod were rigid. Other means of obtaining the flexible relationship and/or of rocking shaft 36 may of course be substituted for the specific mechanism illustrated.

Referring now to Figs. 6, 7 and 8, wherein is illustrated a tube head in accordance with the present invention, reference character 60 designates an elongated tubular spindle, hereinafter referred to as the inner spindle; reference character 61 designates an intermediate tubular spindle arranged concentrically about spindle 60; and reference character 62 designates the outer spindle arranged concentrically about the intermediate spindle 61. Inner and intermediate spindles 60 and 61 are provided with a feather and slot connection designated 64 whereby inner spindle 60 is rotated with intermediate spindle 61, the inner spindle 60 being, however, arranged for vertical movement independently of the intermediate spindle 61. Intermediate and outer spindles 61, 62, respectively, are maintained against vertical movement, but may revolve independently of each other, outer spindle 62 being driven by one of the pinions 20 keyed thereto as previously described, the spindle 62 being in consequence driven from the driving shaft 15. A pinion 58, as previously described, and driven through the interposed planetary gear system from driving shaft 15, is keyed to the intermediate spindle 61 which is accordingly driven at speeds which increase and decrease with reference to its average speed, which may be faster or slower than the fixed rate of rotation of the outer spindle 62.

The outer spindle 62 carries the tube head which is preferably constituted by an upper plate 65 and a lower concentric ring 66 spaced from the plate 65 by tubular posts 67 which serve as a housing for spring-pressed pins 68 which are adapted to project into bores in the top portion of the tubes 14. Upon proper relation of the tube 14 with the ring 66, with the pins 68 being properly related in the tube bores, it will be appreciated that plate 65 and ring 66 form a driving head for a tube 14.

The intermediate spindle 61 carries at its lower end a circular plate 70 of lesser diameter than the tube head parts 65, 66, and is disposed on a plane intermediate such parts. Spaced from the plate 70, as by spaced posts 71, is the laying plate 72, the plane of such plate being below that of the ring 66 whereby the laying plate may extend into the tube 14 held to the tube head 65, 66, the laying plate being circular and of a diameter slightly less than the inside diameter of the tube. The laying plate 72 is provided with an arcuate slot 73, over which the laying arm, to be hereinafter described, oscillates about its pivot 75. It will be obvious from the foregoing that intermediate spindle 61 driven through the planetary gear system above described acts to drive the laying plate 72.

Considering now the mechanism for oscillating the laying arm 74, reference is made to Fig. 5 wherein is diagrammatically illustrated a preferred mechanism for imparting vertical movement to the inner spindle 60. Such may include front and rear reciprocating bars 80, of which the front bar causes vertical movement of all of the spindles 60 of the front battery of spinning heads and the rear bar causes vertical movement of all of the spindles 60 of the rear battery of spinning heads. Each bar 80 adjacent its ends is provided with a link 81, one end of which is pinned as at 82 to the bar end and its other end being pivotally connected as at 83 to an oscillating lever 84 fulcrumed at its mid point as at 85 and cooperating with a suitably shaped cam 86 through a cam roller 87. Cam 86 is driven by a shaft 88 which is interconnected with the crank arm driving shaft 44 to move at the same speed as said crank shaft. Actuation of cam 86 causes lever 84 to oscillate about its fulcrum point 85 and thus imparts, through link 81, vertical movement to the bar 80. By reference to Fig. 1, inner spindle 60 on the spinning heads extends through reciprocating bar 80 and is connected thereto in such manner that reciprocation of the bar 80 imparts reciprocatory movement to spindle 60. Such form of connection may comprise a ball bearing 90 seating in a shouldered recess in the reciprocating bar 80, one element of the bearing race being suitably secured to the spindle 60 and being further held thereto and to bar 80 as by means of a nut 91, whereby spindle 60 may rotate freely with respect to the bar 80 but is reciprocated thereby.

The lower end of the inner spindle carries a transverse arm 95 which in its lowermost position is disposed at the approximate plane of the tube head ring 66. One end 96 of a bell crank lever is flexibly connected to the arm 95, said lever end extending loosely into a hole formed in a connecting stud 97 carried by a side of the transverse arm 95. The intermediate portion of said bell crank lever is fulcrumed through the intermediary of a horizontally disposed pin 98 extending from a block 99 carried by the under face of the plate 70. The other end 100 of the bell crank lever flexibly coacts with a pin 101 fixed to and extending substantially laterally from the laying arm 74.

A spring 105, which may have one end fixed to the laying plate 72 as at 106 and its other end secured as at 107 to a point on the laying arm, is preferably provided to take up back-lash or lost motion at the moment of starting, so that the outer or free end of the laying arm 74 is normally urged to its innermost position at the inner end of the laying slot 73. The laying arm is so balanced that as centrifugal force builds up, the free end of the laying arm 74 tends to hold toward the inner end of the slot, with the spring 105 producing the same tendency before centrifugal force so functions.

With the machine in operation, the rotating spindle 60 is moved vertically upon upward movement of the reciprocating bar 80, and thereby raises the transverse arm 95, thus causing the bell crank lever to swing about its fulcrum 98, with the end 100 of the bell crank thereupon through pin 101 actuating the laying arm 74 on its out stroke about its pivot point 75 on the laying plate 72. As reciprocating bar 80 moves downwardly to its initial position, it carries with it the inner spindle 60 and causes return movement of laying arm 74 to the inner end of slot 73, the spring 105 aiding in the return movement of the aforesaid parts. As is illustrated in Fig. 8, the laying arm 74 is provided with an eye 74A through which yarn is threaded, such eye 74A following the laying slot 73 during oscillation of the laying arm 74, as descibed.

By reference to Fig. 1, the spinning heads as above described are secured to the gear box 13 in such manner that the tube head 65 and parts of the spinning head below the level of the tube

head extend below the gear box, with the spindles 61 and 62 and pinions 20 and 58 being encased within the box, and with the inner spindle 60 extending through the box and its open end projecting above the top horizontal wall thereof. One form of so mounting the spinning head may comprise, as illustrated, a circular holding plate 110 which is secured to the under side of the gear box as by bolts 111, the plate 110 carrying a spacing bushing 112 which extends through a suitable opening in the bottom of the gear box. The outer spindle 62 of the spinning head is freely rotatable with respect to the fixed securing plate 110 and spacing bushing 112.

In operation of the machine as aforesaid, yarn is drawn from the sliver spools over the drawing mechanism (not shown) and is threaded through the bore of the inner spindle 60 to pass into the spinning head and between the plate 70 and laying plate 72. As the yarn emerges from the lower end of the spindle 60, it may be passed around one of the posts 71 adjacent the pivot point 75 of the laying arm 74, or around a vertical extension of the pivot center of the laying arm, and thence is threaded through the eye 74A thereof, whereupon it passes through the laying head slot 73 to the tube 14.

As the tube head and tube 14 are rotated from drive shaft 15 through the gear train including gears 17, 18 and 19, and pinions 20, the necessary twist is put into the yarn being laid and by suitably proportioning the speeds of the tube and laying plate 72, the yarn is drawn into the spinning head at the rate with which it passes through the drawing mechanism. Due to the action of the planetary gear system in driving the laying plate and parts carried thereby at speeds which throughout each cycle of operation increase or decrease with reference to the average speed of the laying plate, compensation, or the taking care of slack when the spirals are laid at their shorter radii and feeding out the yarn under periods of greater demand, as when the longer radii are being laid, is effected. As a consequence of the oscillatory travel of the laying arm over the laying slot 73 as the laying plate is rotating, yarn passing through the laying arm eye 74A and slot 73 is laid in the tube in the form of spirals with the spirals being "processioned", i. e. laid side by side, as by suitably timing the cycle of the laying arm 74 and rotation of the laying plate with reference to the tube. In this connection it will be understood that the number of spirals laid and their length, for each layer of spirals, is determined by the speed of the cyclical movement of the laying arm with respect to the differential of speed between the tube and laying plate.

Within each tube is disposed a plug generally indicated at 14A, Fig. 1, such plug being in the nature of a block very slightly smaller than the inside diameter of the tube and held frictionally to the inner surface of the tube. As is usual, upon starting of the machine, the plug 14A is positioned at the top of the tube, and the yarn is laid on top of the plug. As successive layers of yarn are built up on the plug, the plug is gradually forced down into the tube until it reaches the bottom, whereupon operation of the machine is interrupted for substitution of empty tubes for the full ones.

According to the foregoing description of the invention, compensation is effected wholly by the action of the planetary gear system in causing the laying plate to be driven at varying rates of speed with reference to the average difference in speed between the laying plate and tube head. Under some conditions where especially precise compensation is desirable, I may utilize the planetary gear method of compensation as above described to obtain primary compensation and utilize additional means for taking up such slack in the yarn as the primary compensation system fails to eliminate. Such additional compensating means, which may effect compensation within the head itself as distinguished from the functioning of the planetary gear compensating system whereby compensation is effected externally of the head, is diagrammatically illustrated in Figs. 9 and 10, of which Fig. 9 illustrates one simple means of obtaining, in addition to the vertical reciprocating movement of the spindle 60, an independent oscillating rotational movement thereof, which latter movement controls actuation of a compensating finger effecting compensation within the spinning head. According to such an arrangement, there is provided, in addition to the bars 80 and oscillating arms or levers 84 as previously described in relation to Fig. 5, a second set of reciprocating bars 120 cooperated with the spindles 60, in the manner to be described in relation to Fig. 10, to provide oscillating rotational movement of the spindles 60, the bars 120 being driven through links 121 and levers 122 from cams 125 whose axes bear definite angular relationship to the axes of the cams 86.

Considering now Fig. 10, the said inner spindle 60 may be provided with an enlarged portion 130 having therein a vertical slot 131 in which engages a pin 132 carried by a relatively enlarged and tubular cage element 133. The said cage element has secured thereto the inner race of a ball bearing 134, the outer race of which is fastened in the reciprocating bar 120, whereby the cage is reciprocated by said bar 120.

The intermediate spindle 61 may be provided at its upper end with an enlarged section 135 which extends into the cage 133, said enlarged section having one or more inclined cam slots or grooves 136 cut or otherwise formed therein, in which engage pins or rollers 137 fixedly carried by the cage 133 and interiorly thereof.

By the above described arrangement, vertical movement of spindle 60 upon reciprocation of bar 80 is independent of rotational movement of spindle 60 with respect to intermediate spindle 61. Vertical reciprocation of the cage 133, however, resulting upon reciprocation of the bar 120, imparts oscillating rotational movement to the spindle 60 with respect to intermediate spindle 61 through the pin and cam slot connection 137, 136, between the cage 133 and spindle 61 and the further pin and slot connection 132, 131 between the cage 133 and enlargement 130 of spindle 60, and such rotational movement of spindle 61 is independent of the position vertically of spindle 60 with respect to intermediate spindle 61.

The oscillating rotational movement of the inner spindle 60 with respect to the intermediate spindle 61 is transmitted to a disc or equivalent member 140 carried by and at the lower end of spindle 60. Said disc 140 is arranged within the spinning head and carries a downwardly extending compensating finger 141 around which the yarn emerging from the spindle 60 and guided around a guide post 142, is passed prior to its reaching the laying arm eye. The rotational oscillating movement of the spindle 60 causes the

compensating finger 141 to relatively approach and recede from the laying arm eye, and, by properly relating and predetermining such rotational oscillating movement as transmitted to the compensating finger, as by means of the cam 125, compensation is effected within the spinning head in a manner supplementary to the compensation effected through the planetary gear system as aforesaid.

Because of the rotational oscillating movement given to the disc part 140, it is impractical to connect the upper end of a bell crank lever, such as the end 96 of the crank illustrated in Fig. 7, in order utilize the vertical movement of spindle 60 for actuating the laying arm, as in the construction illustrated in Figs. 7 and 8. In Fig. 10, I have shown mechanism whereby the laying arm is actuated solely by the vertical movement of the spindle in which reference character 150 represents an upstanding post carried by the laying plate 72, on an upper lateral extension of which is fulcrumed the bell crank 151. The upper leg of the said crank may carry a roller 152 whose axis extends normal to the axis of spindle 60. A spring 153 may be provided for the purpose of maintaining the crank in such position that roller 152 is pressed against the under face of disc part 140 when the machine is starting up or stopping, it being understood that during normal operation of the machine, centrifugal force acting on the parts will maintain this contact, and hence exert an inward tendency on the laying arm. Alternatively, of course, spring 153 and centrifugal force could be utilized to exert outward tendency on the laying arm, if such is desired. The lower end of the bell crank is flexibly connected to a laying arm pin such as pin 101 previously described, and it will be seen, therefore, that vertical movement of spindle 60 actuates the laying arm quite independently of any rotational or rotational oscillating movement that may be impressed on said spindle or on disc part 140.

While in the foregoing analysis of the Figs. 9 and 10 modification I have referred to the planetary system of compensation as the primary means of taking up slack, with the compensating means within the head being referred to as means additional to the primary system which functions to take up slack within the head which the primary system has failed to eliminate, it is to be understood that either means can effect main or primary compensation, with the other introducing "harmonic wave" effects, as it were, on the main compensation curve of the operation of the means selected as the main or primary system of compensation. Under less exacting conditions where especially precise compensation is not necessary or desirable, it is to be understood further that either means of compensation can be omitted, with compensation thereupon being effected by the remaining means.

In connection with the above described arrangement in which vertical movement of the spindle 60 causes actuation of the laying arm, with the rotational oscillating movement of spindle 60 being used to control operation of one compensating means, it is to be understood also that either movement can be used for either purpose; that is to say, the rotational oscillating movement of spindle 60 with respect to the laying plate may be used either for operating the laying arm or the compensating finger, and the reciprocating movement of the spindle can take on the operation not controlled by the rotational movement.

In Figs. 11 and 12, I have shown diagrammatically simple mechanism for utilizing rotational oscillating movement of the spindle to operate a laying arm as aforesaid, such rotational oscillating movement being impressed on the spindle 60 by reciprocating bar 120, cage 133, and the pin and slot connections 137, 136, and 132, 131, as described in connection with Fig. 10. In the construction under description, spindle 60 is not vertically reciprocated and is preferably suitably restrained against vertical reciprocation. Accordingly reciprocating bar 80, its actuating means, and the means connecting it with the spindle 60, may be omitted.

The rotational oscilating movement thus imparted to the spindle is transmitted to a gear segment 170 carried at the lower end of the spindle and arranged concentrically therewith and within the spinning head. Said segment meshes with a pinion segment 171 fast on the pivot pin 172, to which is in turn keyed or otherwise secured the laying arm 173, the eye of which is related to the slot of the laying plate 72 as previously described.

By the aforesaid arrangement, the rotational oscillating movement of spindle 60 is transmitted to the gear segment 170 which in turn, through pinion segment 171, functions to oscillate the pin 172, thus to oscillate the laying arm so that its eye 174 follows the slot of the laying plate 172. A spring 175 is provided and has the tendency of maintaining the laying arm at the inner end of the laying plate slot during starting and stopping of the machine, the parts being so balanced, that during machine operation, centrifugal force tends to operate, as does the spring 175, to urge laying arm 173 towards the inner (or outer) end of the laying plate slot. By this arrangement, the required oscillating movement of the laying arm is accomplished with few parts which may be of a more rugged construction than parts required to transmit the vertical movement of the spindle into oscillating movement of the laying arm within the head. In the last described modification, compensation will be accomplished outside the spinning head as by means of the planetary or equivalent gear system described above in connection with Figs. 1–8.

In connection with the terms "spirals" or "laid in spirals" as used in the foregoing description, I intend that a broad construction be given thereto, as I use the term "spirals" in a generic sense to include all yarn patterns such as can be formed by mechanism as above described or mechanism generally equivalent thereto. Accordingly, the term "compensation" is intended to designate such compensation as is necessary in laying such yarn patterns referred to as "spirals" when construed in the light of the foregoing explanation.

While in accordance with the statute I have illustrated and described one preferred embodiment of my invention with certain modifications, it will be understood that the apparatus as described is capable of change and modification, and all such are intended to be embraced within the scope of the appended claims.

I claim:

1. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals, and a spinning head operatively related thereto, driven tube head and laying plate elements included within the spinning head, means driving said driven elements at different speeds, and means varying cyclically the speed of one of said

elements with reference to the differential speed between said elements.

2. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals, and a spinning head operatively related thereto, the spinning head including a tube head and a laying plate, means driving said tube head, and means driving the laying plate at speeds varying cyclically with reference to the differential speed between the laying plate and the tube head.

3. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals and a spinning head operatively related thereto, the spinning head including a laying plate and a tube head, means driving said tube head at a constant speed, and means driving said laying plate at speeds varying cyclically with reference to the differential speed between the laying plate and the tube head.

4. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals and a spinning head operatively related thereto, the spinning head including a laying plate and a tube head, means driving said tube head and laying plate at different speeds, and means interposed in the drive to said laying plate operative to vary cyclically the speed of said laying plate with reference to the differential speed between the laying plate and the tube head.

5. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals and a spinning head operatively related thereto, the spinning head including a laying plate and a tube head, means driving said tube head and laying plate at different speeds, and a planetary gear system interposed in the drive to said laying plate and operative to vary cyclically the speed of said laying plate with reference to the differential speed between the laying plate and the tube head.

6. In a tube spinning machine, the combination of a plurality of tubes and associated spinning heads, each of the spinning heads including a tube head and a laying plate, driving means for all of said tube heads and laying plates, said means being operative to drive said tube heads at a constant speed and said laying plates at a different speed, and means interposed in the driving means to said laying plates and operative to vary cyclically the speed of said laying plates with reference to the differential speed between the laying plates and the tube heads.

7. In a tube spinning machine, the combination of a plurality of tubes and associated spinning heads, each of the spinning heads including a tube head and a laying plate, driving means for all of said tube heads and laying plates, said means being operative to drive said tube heads at a constant speed and said laying plates at a different speed, and planetary gear means interposed in the drive to said laying plates and operative to vary cyclically the speed of said laying plates with reference to the differential speed between the laying plates and the tube heads.

8. In a tube spinning machine, the combination of a tube in which yarn is laid in the form of spirals, an associated spinning head through which the yarn passes en route to said tube, said spinning head and tube including means for drawing yarn into the tube at the rate at which it is delivered to the spinning head, and means exteriorly of the spinning head providing compensation of the yarn required as the yarn spirals are laid on varying radii.

9. In a tube spinning machine, the combination of a tube in which yarn is laid in the form of spirals, an associated spinning head through which the yarn passes en route to said tube, said spinning head and tube including means for drawing yarn into the tube at the rate at which it is delivered to the spinning head, and a plurality of means effecting compensation of the yarn required as the yarn spirals are laid on varying radii.

10. In a tube spinning machine, the combination of a tube in which yarn is laid in the form of spirals, an associated spinning head through which the yarn passes en route to said tube, said spinning head and tube including means for drawing yarn into the tube at the rate at which it is delivered to the spinning head, and a plurality of means effecting compensation of the yarn required as the yarn spirals are laid on varying radii, one of said compensating means effecting compensation exteriorly of the head.

11. In a tube spinning machine, the combination of a tube in which yarn is laid in the form of spirals, an associated spinning head through which the yarn passes en route to said tube, said spinning head and tube including means for drawing yarn into the tube at the rate at which it is delivered to the spinning head, and a plurality of means effecting compensation of the yarn required as the yarn spirals are laid on varying radii, one of said compensating means effecting compensation exteriorly of the head, and the other being disposed within the head.

12. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a laying plate, operatively related to said intermediate spindle, a tube head operatively related to said outer spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the intermediate and outer spindles at different speeds, said means being operative to rotate said intermediate spindle at speed varying cyclically with reference to the differential speed between said intermediate and outer spindles.

13. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, and means for imparting reciprocatory movement to said inner spindle.

14. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, and means operative to impart rotational oscillating movement to said inner spindle.

15. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube

head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, said means being operative to rotate said intermediate spindle at speeds which vary cyclically with respect to the speed of said outer spindle, and means for imparting reciprocatory movement to said inner spindle.

16. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, said means being operative to rotate said intermediate spindle at speeds which vary cyclically with respect to the speed of the outer spindle, and means operative to impart rotational oscillating movement to said inner spindle in cyclical relation to the intermediate spindle.

17. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, said means being operative to rotate said intermediate spindle at speeds which vary cyclically with respect to the speed of said outer spindle, and further to impart rotational oscillating movement to said inner spindle, and means imparting reciprocatory movement to said inner spindle independent of its rotational oscillating movement.

18. In a tube spinning machine, the combination of a tube into which yarn is laid in spirals and a spinning head associated therewith, said spinning head including concentrically arranged inner, intermediate and outer spindles, a tube head operatively related to said outer spindle, a laying plate operatively related to said intermediate spindle, a laying arm operatively related to said laying plate for actuation by said inner spindle, means for rotating the several spindles, said means including mechanism operative to impart rotational oscillating movement to said inner spindle, and means responsive to such rotational oscillating movement of said inner spindle to effect compensation as the yarn spirals are laid on varying radii.

19. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals, and a spinning head operatively related thereto, the spinning head including a tubular spindle through which yarn passes to the interior of said spinning head, a laying plate, and a tube head, means for rotating said laying plate and tube head at speeds operative to effect drawing of the yarn into the tube at the rate at which it is delivered to the spinning head, and means imparting independent vertical and rotational oscillating movements to said inner spindle, one of said movements effecting compensation within the spinning head of the yarn passing therethrough.

20. In a tube spinning machine, the combination of a tube in which yarn is laid in spirals, and a spinning head operatively related thereto, the spinning head including a tubular spindle through which yarn passes to the interior of said spinning head, a laying plate, and a tube head, means for rotating said laying plate and tube head at speeds operative to effect drawing of the yarn into the tube at the rate at which it is delivered to the spinning head, and means imparting to said spindle rotational oscillating movement related to the speeds of rotation of said laying plate and tube head whereby to effect compensation within the spinning head of the yarn passing therethrough.

S. L. G. KNOX.