

Sept. 1, 1959

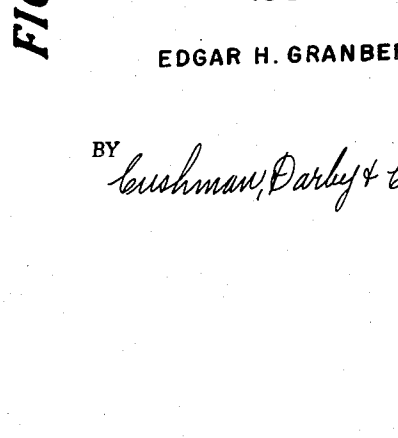
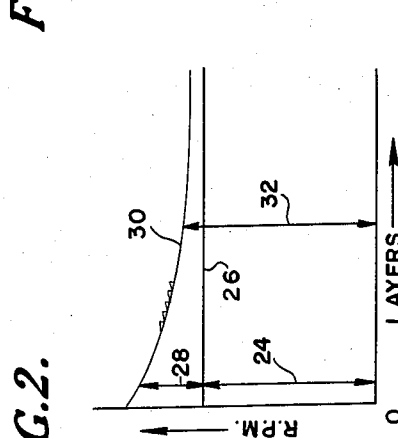
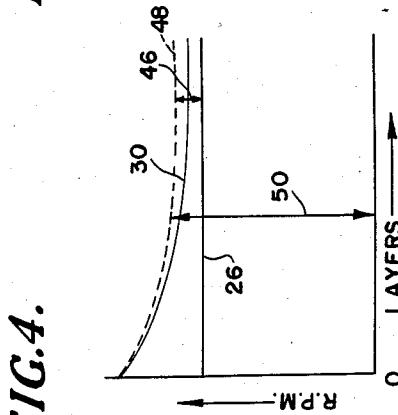
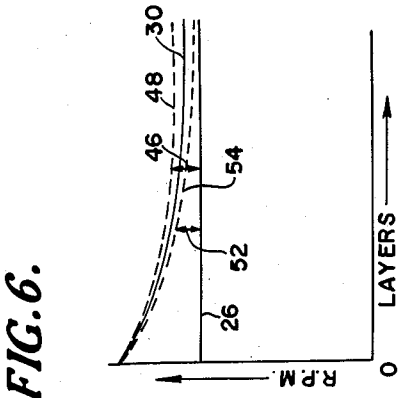
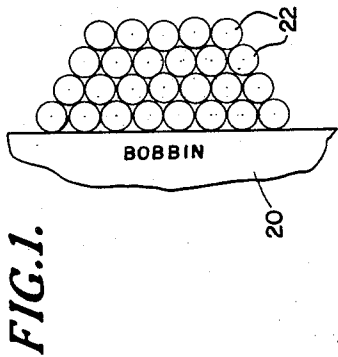
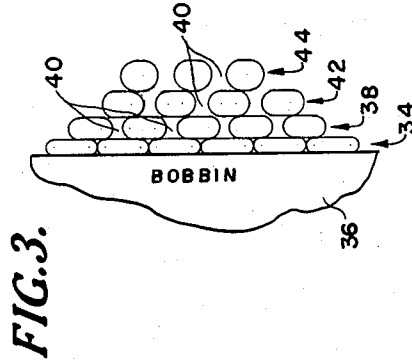
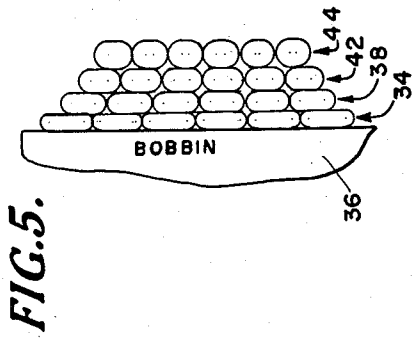
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2,901,882

FLY FRAME WITH INDEPENDENTLY VARIABLE SPEED DRIVES AND METHOD

Filed Nov. 5, 1956

5 Sheets-Sheet 1



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FLY FRAME WITH INDEPENDENTLY VARIABLE SPEED DRIVES AND METHOD

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FIG. 7.

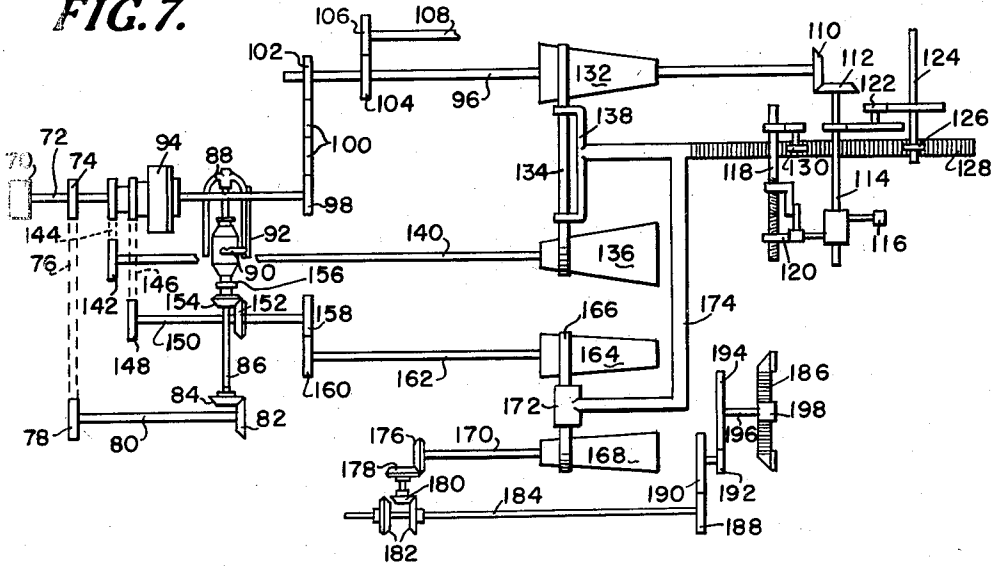


FIG. 8.

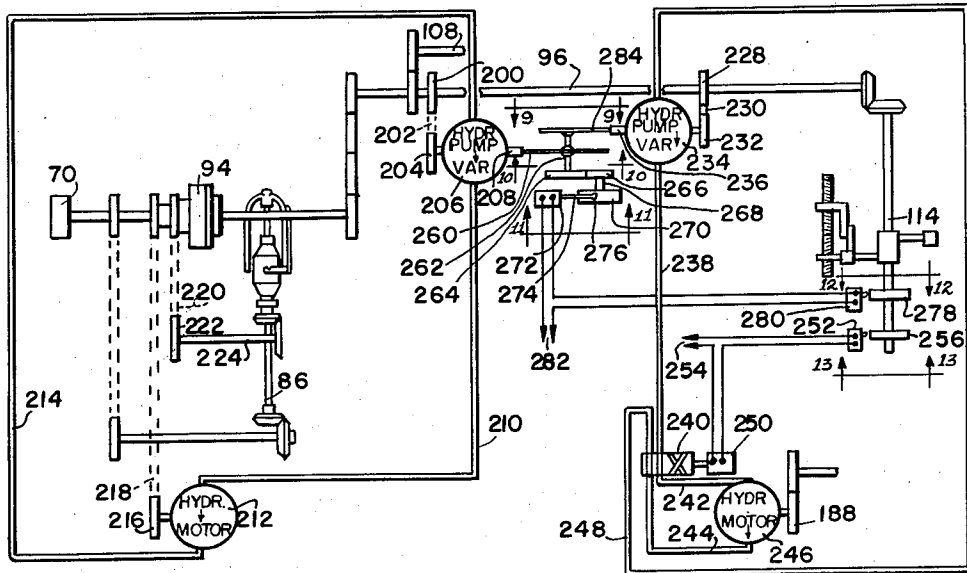
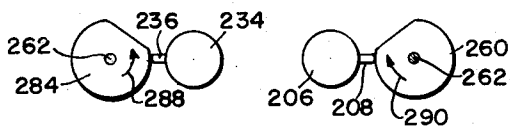


FIG. 9.

FIG. 10.



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FIG. 11.

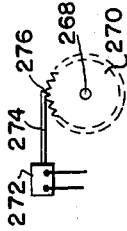


FIG. 12.

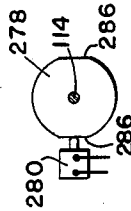


FIG. 13.

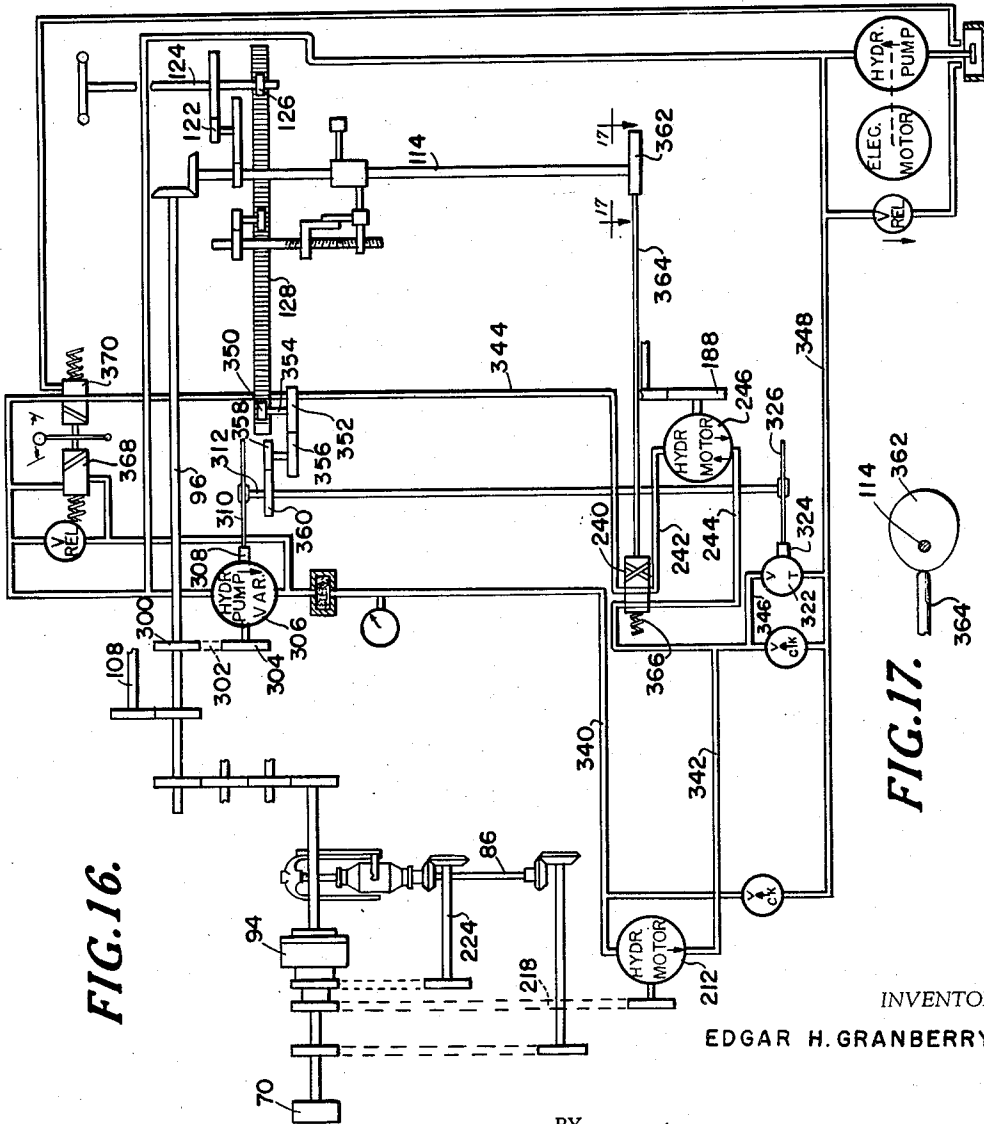
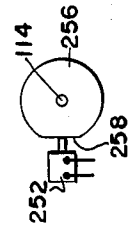
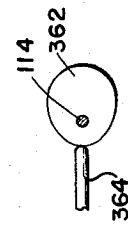


FIG. 16.

FIG. 17.



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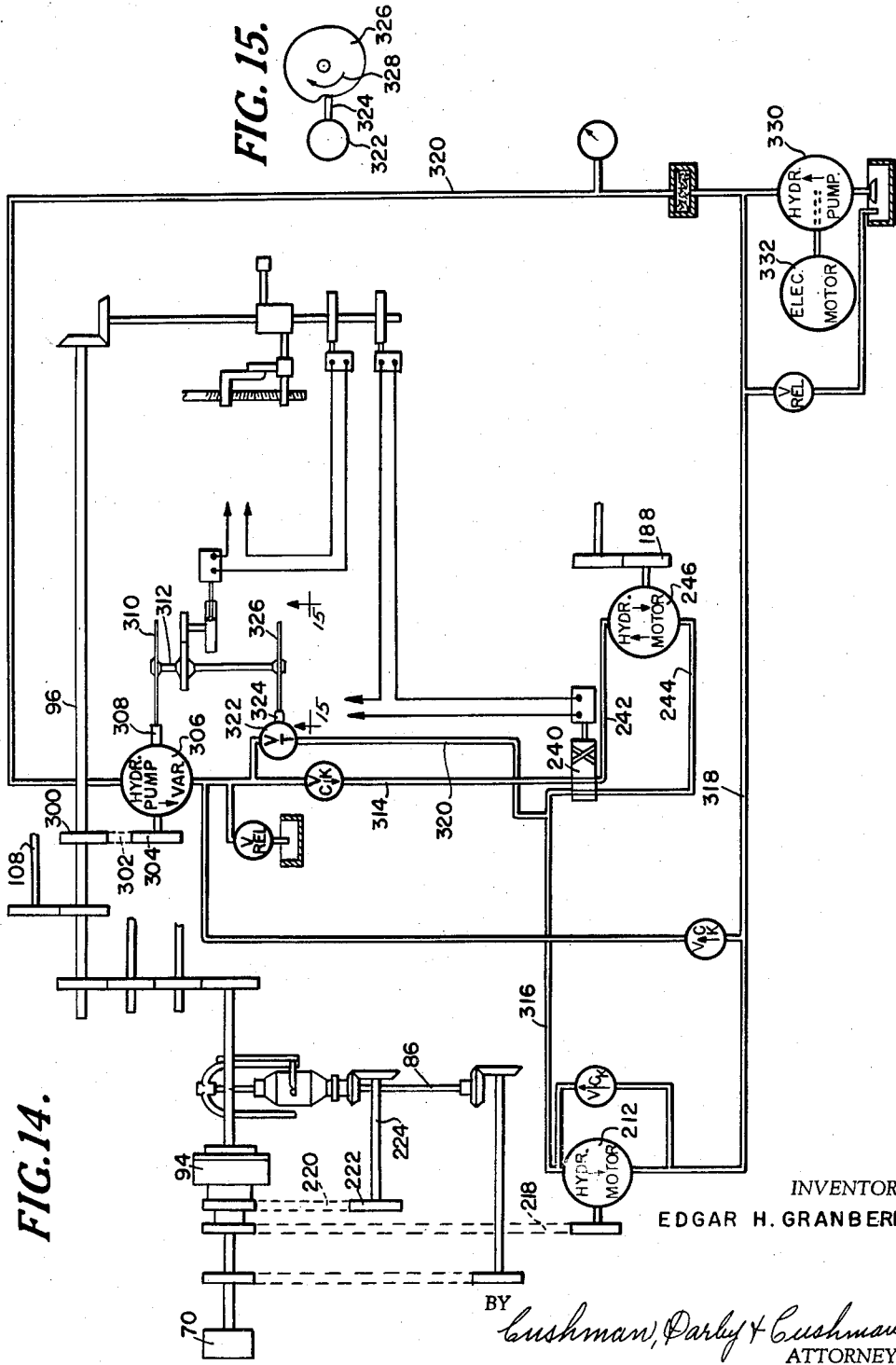


FIG. 15.

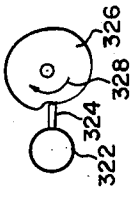


FIG. 14.

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5 Sheets-Sheet 5

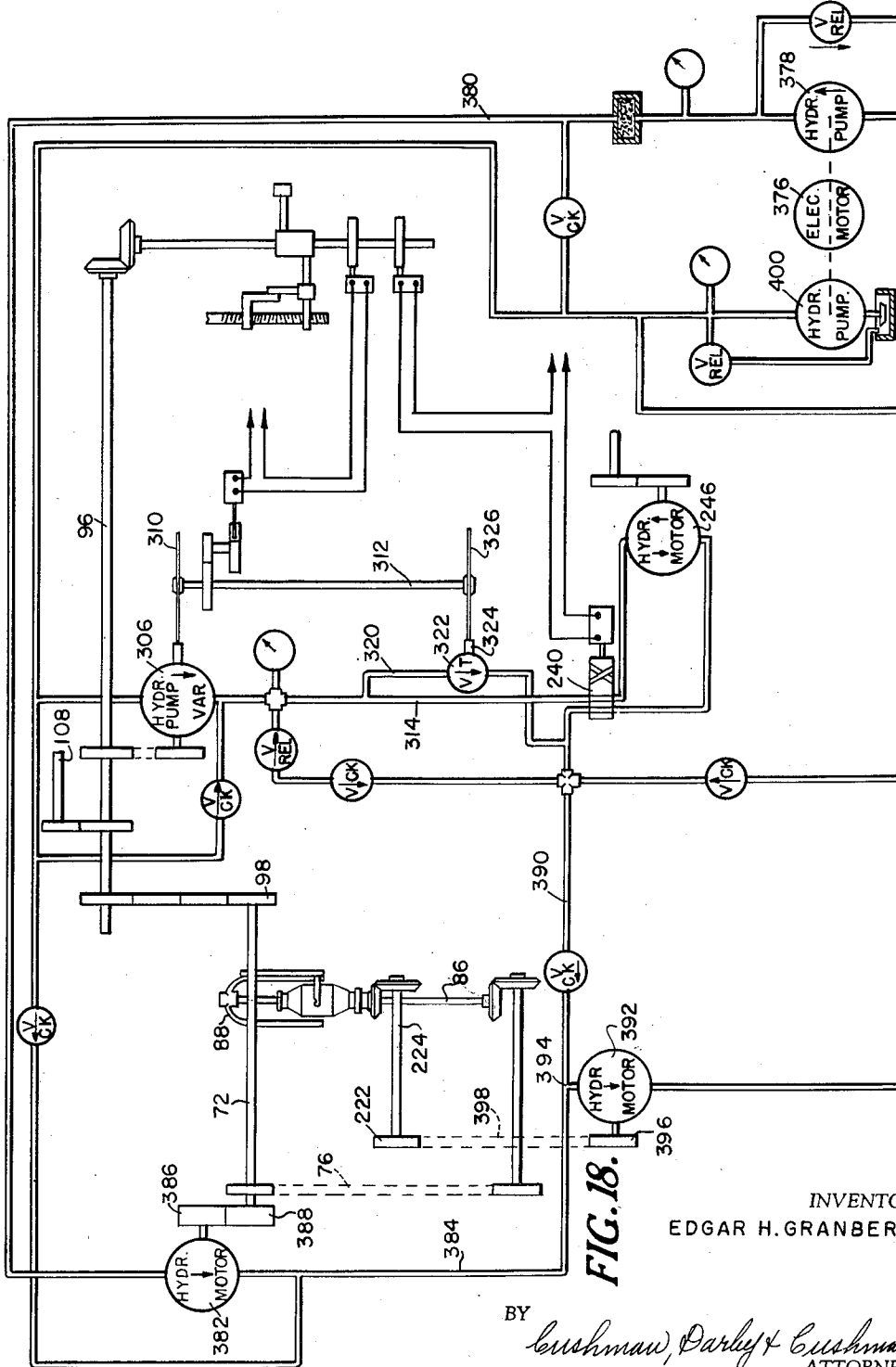


FIG. 18.

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FLY FRAME WITH INDEPENDENTLY VARIABLE SPEED DRIVES AND METHOD

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Application November 5, 1956, Serial No. 620,406

35 Claims. (Cl. 57—98)

This invention relates to fly frames, also known as roving frames, which are designed to draft stock (usually sliver) by means of rolls, twist it by means of flyers, and wind it onto bobbins. The invention relates also to novel methods of operating fly frames.

Fly frames, as is well known, are extremely complex, and subject to numerous variables and errors. Conventional frames are driven by a constant speed direct drive, which is transmitted to the drawing rolls, spindles and flyers, builder motion and compound. The frames are also provided with a variable speed drive, powered by the direct drive and transmitted through cones to the bobbin carriage drive means, and also to the compound, where the variable speed is added to the constant speed to achieve a total variable speed utilized to rotate the bobbins. The fly frame incorporates numerous provisions for correction and adjustment, but since the variable speed drives to the bobbin carriage and to the bobbin rotating means are effected by the same mechanism, they may not be adjusted independently, and adjustments to improve or correct some conditions necessarily affect and aggravate others. The winding of full, closely laid bobbins with uniform tension, accordingly, is seldom achieved.

A principal object of the present invention is the provision of apparatus and methods facilitating precision build of bobbins on the fly frame, whereby the bobbins may be closely and accurately laid throughout with roving of outstanding uniform weight and tension. Related objects are increased production per doff, and the production of bobbins of maximum weight and improved strand quality. These objects are attained primarily by the provision of independently variable speed drives to the bobbin carriage and to the bobbin rotating means, and independently controlling the variable speeds of these elements. The independent variable speed drives and/or control may be by mechanical, electrical, hydraulic or other means.

A particular object of the invention is the provision of fly frame mechanism and operating methods permitting precise corrective adjustment for the inherent variation in pressure exerted by the presser foot of the flyer against the roving. As will be understood, the centrifugal effect of the balance rod or counterweight of the flyer decreases as the bobbin fills, and the centrifugal effect of the associated presser foot increases with bobbin diameter, whereby the effective force exerted by the presser foot against the roving decreases progressively throughout the winding operation. For this reason, inner layers of roving are flatter than layers outward thereof, and in accordance with the present invention this condition may be accommodated without opening up the lay or otherwise detrimentally affecting the winding operation. The invention also provides for precise adjustment for the processing of different types of fibers, which may vary in compressibility.

Further objects include the provision of means and methods permitting precision control of the variable lay and winding speeds in the fly frame. In accordance with the invention, the relationship between lay speed and

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winding speed may be readily and quickly altered to meet changing conditions. Moreover, the lay speed-winding speed relationship, once established, may be maintained constant and free from disturbance by related frame adjustments, such as replacement of the lay change gear. That is, it is possible in accordance with the present invention to vary the lay, for example, without affecting the lay speed-winding speed relationship. The term "lay" connotes the number of coils per inch along the length of the bobbin. "Lay speed" is the rate of movement of the bobbin carriage, or the rate of traversing movement of the bobbins relative to the flyers, and "winding speed" is the difference in rotational speeds between the bobbins and the flyers.

Another object is to provide fly frame operating controls for the variable speed drive which are not utilized for the transmission of power, whereby such control is exceedingly sensitive and accurate. Further objects will be in part evident, and in part pointed out hereinafter.

The invention and the novel features thereof may best be made clear from the following description and the accompanying drawings, in which:

Figure 1 is a diagram illustrating theoretically ideal winding, wherein the roving is perfectly round, and closely and accurately laid;

Figure 2 is a speed diagram corresponding to the winding of Figure 1;

Figure 3 is a diagram illustrating the effect on winding of the variable pressure of the flyer presser foot;

Figure 4 is a speed diagram corresponding to the winding of Figure 3;

Figure 5 is a diagram illustrating precision build made possible by the present invention, wherein the lay of the Figure 3 winding has been closed by independent control of the lay speed;

Figure 6 is a speed diagram corresponding to the winding of Figure 5;

Figure 7 is a diagrammatic illustration of a simplified mechanical embodiment of the present invention, incorporated in a conventional fly frame;

Figure 8 is a diagrammatic illustration of a simple hydraulic embodiment of the invention, with electrical control, incorporated in a fly frame similar to that of Figure 7;

Figures 9 and 10 are views of the variable hydraulic pump control cams of Figure 8, taken respectively on the lines 9—9 and 10—10 thereof;

Figure 11 is a view taken on the line 11—11 of Figure 8, illustrating the control cam driving means;

Figure 12 is a view taken on the line 12—12 of Figure 8, illustrating the builder motion actuating means controlling the variable pumps;

Figure 13 is a view taken on the line 13—13 of Figure 8, illustrating the builder motion cam controlling the reversing of the lay motor;

Figure 14 is a diagrammatic illustration of another embodiment of the invention, employing a hydraulic variable speed drive and electrical control thereof;

Figure 15 is a view taken on the line 15—15 of Figure 14, illustrating the throttle valve control cam thereof;

Figure 16 is a diagrammatic illustration of still another embodiment of the invention, employing a hydraulic variable speed drive and mechanical control thereof;

Figure 17 is a view taken on the line 17—17 of Figure 16, illustrating the reversing valve control cam of the builder motion, and

Figure 18 is a diagrammatic illustration of a fly frame having an all hydraulic drive, with the present invention incorporated therein.

Referring to the drawings in detail, in Figure 1, 20 represents a section of a bobbin, with coils of roving 22 wound thereon. In this theoretical and idealized dia-

gram, the cross-sectional shape of each roving coil is perfectly round, and the roving is accurately and closely laid in all layers. The radial distance from layer to layer is constant, and in each layer adjacent coils are evenly spaced and contiguous. Fly frame cone design is frequently premised on the assumption of such theoretical strand relationship.

The speed diagram of Figure 2 corresponds to the theoretical winding of Figure 1. In this diagram, the abscissa represents the layers wound, beginning at zero and extending to, for example, 60 or more. The ordinate represents speed. The value 24 represents the constant speed drive of the frame, which is transmitted through the main shaft of the frame to the drawing rolls, spindles, flyers, builder motion and compound. While these elements may rotate at different speeds, they bear a constant relationship to each other, and remain constant through the winding cycle, as indicated by the horizontal line 26. The value 28 represents the variable speed drive of the frame, in particular the lay speed and the winding speed. This variable speed drive is derived from the constant speed drive of the frame through the cones, and decreases in value as the diameter of the bobbin increases. The curve 30, with respect to the line 26, represents the variable speed through the winding cycle. While a smooth curve is illustrated, it will be understood that these speeds remain constant through each layer on the bobbin, and are decreased as each layer is completed to a lesser value which persists through the succeeding layer, so that the curve 30 is in reality a series of small steps.

The variable speed drive of the frame is transmitted to the bobbin carriage and also to the compound, where it is added to the constant speed input component to produce a total speed which is also variable. This total speed or bobbin speed is represented by the value 32 on the diagram. As shown, the value 32 follows the same descending curve 30 as does the value 28. In the case of the theoretical winding illustrated in Figure 1, the curves followed by the values 28 and 32 are desirably coincident. In known fly frames, wherein the variable speeds of both the bobbins and the bobbin carriage are derived through a common pair of cones, the curves followed by the values 28 and 32 are necessarily and inherently coincident.

In actual practice, the presser foot of the flyer exerts considerable pressure against the roving as the roving is laid down on the bobbin. This pressure is greatest on the first row or layer, which is deposited on the hard wood. On each succeeding layer of roving the presser foot of the flyer operates on a bobbin of larger diameter, and is accordingly displaced radially with respect to the bobbin axis. The relative radial displacement of the presser foot alters its centrifugal force effect and that of its balance rod, in such manner that the effective pressure of the presser foot against the strand is reduced. It has been noted that the layers immediately adjacent the bobbin are for this reason flattened to a considerable degree, and successive layers outwardly thereof are flattened to a progressively lesser degree. This condition is illustrated in exaggerated form in Figure 3. As there shown, the innermost roving layer 34 on the bobbin 36 is very greatly flattened. The lay of the frame ordinarily is adjusted for this condition, so that the flattened individual coils of the innermost layer 34 are contiguous, but not overlapping.

The next outer roving layer 38 illustrated, which may be representative of for example the tenth or twelfth layer of roving on the bobbin, is laid with considerably less presser foot pressure, and is accordingly relatively thicker than is layer 34. Being thicker, the roving strand coils are also correspondingly narrower than in row 34. Since the lay remains inherently constant through the winding cycle, small gaps 40 appear between adjoining coils of the layer 38. Successive layers 42 and 44, which

represent layers substantially separated, progressively approach circular cross-sectional shape, whereby the strands of these outer layers are progressively thicker in the radial direction, and narrower in the longitudinal direction (axially of the bobbin). The gaps 40 between adjacent coils, accordingly, become progressively larger and larger as the winding proceeds.

As will be apparent, if the speed diagram of Figure 2 is followed in winding the bobbin illustrated in Figure 3, ignoring the variable effect of the presser foot, the outer layers of roving will have considerably less than desired tension. This condition has been recognized, and the cones are commonly designed to compensate for it. Since the layer to layer increase in the diameter of the package is less than theoretical, or less than in the case of round roving, the winding speed in all layers after the first must be greater than in the theoretical round roving case. Accordingly, by redesign of the cones the winding speed is commonly increased to a value such as 46, which follows along the curve 48, as shown in Figure 4. The curve 48, of course, lies above the curve 30 on the speed diagram.

In altering the variable speed cone drive to effect a winding speed which follows an elevated curve such as 48, the lay speed also is increased to the value 46, the bobbin speed being increased to the value 50. The lay speed-winding speed relationship is thus preserved, and the lay remains substantially constant from layer to layer. Redesign of the variable speed cone drive, then, compensates for the variation in presser foot pressure and the corresponding variation in layer thickness, but cannot compensate for the variation in width of the individual strand coils from layer to layer, whereby the lay becomes progressively more open as the winding proceeds, resulting in light packages and reduced production. In other words, cone redesign to compensate for the variable pressure of the presser foot through the winding cycle inherently opens up the lay.

Figure 5 illustrates a winding corresponding to that of Figure 3, in that the successive roving layers 34, 38, 42 and 44 on the bobbin 36 are of progressively increasing thickness, and the individual coils of roving are of progressively decreasing width from the innermost layer outward. In the Figure 5 winding, however, the gaps 40 have been completely eliminated, and adjoining coils of each layer are closely laid and contiguous. In other terms, in the Figure 5 winding the lay has been increased from layer to layer. To accomplish this, the Figure 2 speed diagram must be varied, by progressively reducing the lay speed from the theoretical round roving value. The lay speed must correspond to a value such as 52; see Figure 6, following a curve 54 lying below the theoretical curve 30. Meanwhile, the winding speed must remain as in Figure 4, at the value 46 following the curve 48 lying above the curve 30. To achieve the winding of Figure 5, then, the winding speed must follow the curve 48 while the lay speed follows the diverging line 54.

In known fly frames, as previously indicated, the winding speed and the lay speed are derived through a common means, the cones, and a constant winding speed-lay speed relationship is maintained throughout the winding cycle. It is obviously impossible, accordingly, for these values to follow divergent paths, or to be independently varied. Increase in winding speed involves a corresponding increase in lay speed, and an open lay as illustrated in Figure 3. Decrease in lay speed to close up the lay involves a corresponding decrease in winding speed, resulting in loose and unevenly tensioned packages. An outstanding feature of the present invention involves independent control of the winding speed and lay speed, whereby these values may follow divergent paths or be in other manner varied one with respect to the other.

A simplified embodiment of the invention is illustrated in Figure 7, wherein the fly frame shown corresponds generally to the type identified with the Whitin Machine

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Works, although it will be recognized that the invention is applicable as well to Saco-Lowell, and other well known fly frame types. In the frame of Figure 7, power is supplied to pulley 70, mounted on the main shaft 72. Rotation of the main shaft is transmitted through its gear 74 and the diagrammatically illustrated gear train 76 to the gear 78 mounted on spindle shaft 80. By means of bevel gears 82 and 84, the spindle shaft 80 drives the spindles 86 and flyers 88 of the frame, these elements being driven in customary manner directly from the main drive, and at constant speed. Each flyer 88 is provided with the customary presser foot 90 and balance rod 92 therefor. The constant speed main drive also drives the compound 94, this constant speed, it will be understood, representing one component of input to the compound. The main shaft 72 also has a direct drive connection to the top cone shaft 96, through twist change gear 98, intermediate gears 100 and the top cone shaft gear 102. The direct drive is also transmitted through gears 104 and 106 to the front roll shaft 108, and thereby to the drawing rolls of the frame. By means of bevel gear 110 and gap gear 112, the top cone shaft drives the usual tumbler shaft 114, with which are associated the customary builder dogs 116, builder shaft 118, and builder jaws 120. The movement of the tumbler shaft 114 is transmitted in conventional manner through the tension change gear 122 to the winding shaft 124, and the periodic movement of the winding shaft is effective through its gear 126 to displace the rack 128. The rack 128 actuates the builder shaft 118 through the twist change gear 130 in conventional manner.

In the conventional frame, power is also transmitted from the top cone shaft 96 through top cone 132, belt 134 and bottom cone 136 to a driving shaft engaged to the compound in driving relationship, and through reversing mechanism to the carriage traversing rack, the belt 134 being engaged by a belt shifting fork 138, which is in turn engaged to and displaced by the rack 128. By these means, a variable speed is powered by and derived from the constant speed direct main drive of the machine, and transmitted to the bobbins, and to the carriage traversing mechanism.

In the frame illustrated in Figure 7, however, the bottom cone 136 is drivingly engaged to a shaft 140. The resultant variable speed of the shaft 140 is transmitted through its gear 142 and the diagrammatically illustrated gear train 144 to the compound 94, whereby a variable speed input component is fed into the compound. The variable speed output of the compound, representing the sum of the constant speed and the variable speed input components, is transmitted therefrom through gear train 146 and gear 148 to the bobbin shaft 150. Bevel gears 152 and 154 transmit the variable speed rotation of the bobbin shaft to the bobbins 156.

In the conventional frame, the variable speed of the shaft 140 would be transmitted also, through reversing mechanism, to the carriage traversing rack. In accordance with the present invention, however, it is desired to have an independently controlled variable speed transmitted to the carriage traverse. This is accomplished most simply by providing another pair of cones. In the embodiment illustrated, the second cone pair may be powered by the variable speed drive of the bobbin shaft 150, as by the gear 158 engaged in driving relationship to gear 160 mounted on shaft 162, which also carries the top cone 164. The top cone 164 is drivingly engaged by a belt 166 to the bottom cone 168, mounted on the center lift driving shaft 170. The belt 166 is engaged by shifting fork 172, which conveniently may be engaged by arm 174 to the rack 128, and displaced thereby in coordination with the shifting fork 138 and belt 134. In this manner, both belts may be shifted by the conventional builder motion.

As will be understood, the variable speed rotation of the center lift driving shaft 170 is distinct from the vari-

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able speed rotation of the bobbin shaft 150, and the relationship therebetween is established by the design of the cones 164 and 168. The variable speed rotation of the center lift driving shaft 170 is transmitted through its bevel pinion 176 to the reverse stud bevel gear 178. The reverse stud bevel pinion 180 is adapted to drive one side of the other of the twin bevel gear 182 mounted on the center lift shaft 184, and the tumbler shaft 114 operates through conventional means not shown to periodically reciprocate the shaft 184 in axial direction, whereby the direction of its rotation is reversed. The center lift shaft 184 is adapted to reciprocate the bobbin carriage of the frame by means of its rack 186, the movement of the center lift shaft being transmitted through lay change gear 188, center lift intermediate gear 190, center lift intermediate pinion 192, lifting shaft gear 194, lifting shaft 196, and the lifting shaft pinion 198.

By the provision of the second cone pair 164, 168, the variable speed drives to the bobbins and to the carriage are diverse and independently controlled, each by its own pair of cones. The variable speed of the bobbins, and accordingly the winding speed, is determined by the cones 132, 136, and the lay speed is determined primarily by the cones 164, 168. The variable speed transmissions, in this case cones, are both controlled by means actuated by the builder motion.

Alternative and equivalent constructions will be obvious. For example, the cone 164 may be driven directly from the main drive of the frame, as from the top cone shaft 96. Similarly, the cone pair constituting the variable speed drive to the carriage may be driven directly from the main drive, and the cone pair constituting the variable speed drive to the compound may be driven by the variable speed drive to the carriage, conversely to the arrangement illustrated.

Another embodiment of the invention is illustrated in Figure 8, wherein the conventional cones are replaced by hydraulic variable speed transmission means, distinct variable speed drive systems being provided for the compound and for the carriage traversing mechanism. In this embodiment, both hydraulic drive systems are controlled by electrical means, which is in turn actuated by the builder motion. As in the embodiment of Figure 7, direct constant speed drive is applied to the frame at pulley 70, and transmitted in customary manner to the spindles 86, the compound 94, the front roll shaft 108, and to the builder motion. In this embodiment, gear 200 on the top cone shaft 96 is engaged in driving relationship, as by chain 202, to a gear 204, which drives a variable output hydraulic pump 206. The pump 206 may be, for example, a Vickers Model PV-2003, and is provided with the usual control plunger 208. The output of pump 206 is transmitted through conduit 210 to a fixed hydraulic motor 212, which may be for example a Vickers Model MF-2003, and which is adapted to rotate at a speed proportional to the volume of fluid pumped there-through. The fluid leaving motor 212 is returned to the pump 206 through conduit 214. The hydraulic circuit is illustrated here only in essential detail, and it will be recognized that customary reservoirs, filters, gauges and the like may be provided. As will appear more fully hereinafter, the circuit may be provided also with a supercharging pump and lines, adapted to maintain working pressure on both sides of pump 206 and motor 212 at all times, to prestress these elements and permit them to stop and start without lost motion.

The hydraulic motor 212 drives a gear 216, which is engaged to the compound 94 by the chain or gear train 218, whereby the motor 212 supplies the variable speed input component to the compound. The variable speed output of the compound, which represents the total of the constant and variable speed inputs thereto, is transmitted by means of gear train 220 and gear 222 to the bobbin shaft 224, and thereby establishes the rotational speed of the bobbins, and the winding speed of the frame.

Another gear 228 mounted on the top cone shaft 96 is engaged in driving relationship, as by a chain 230, to a gear 232, which drives a variable output hydraulic pump 234, similar to the pump 206, and provided with control plunger 236. The variable output of pump 234 is transmitted through conduit 238 to a four way reversing valve 240, and then through either conduit 242 or conduit 244 to the fixed hydraulic motor 246, which corresponds in type to motor 212. As shown, the hydraulic motor 246 is drivingly engaged to the lay change gear 188 of the frame, which in turn may be drivingly engaged, through conventional gearing already described or other arrangement, to the carriage drive rack, whereby it may drive and reciprocate the carriage. From hydraulic motor 246 and the reversing valve 240, the oil is returned to the pump 234 through conduit 248. This circuit also is illustrated only in essential detail.

The reversing valve 240 may be alternated between its two operative positions by a solenoid 250, operated by a switch 252 in series with the solenoid and a power source 254. The switch 252 may be actuated by a cam 256 mounted on the tumbler shaft 114. As shown in Figure 13, the cam 256 may be circular, and provided with a single peripheral flat 258, adapted to be aligned with the actuating arm or button of the switch 252 in one of the two rest positions of the tumbler shaft. As will be understood, in the cam position shown in Figure 13, the switch 252 may be open whereby the valve 240 will be disposed in one of its two operative positions by spring pressure or otherwise. Rotation of the tumbler shaft 114 through 180°, then, will close the switch, causing the solenoid 250 to displace the reversing valve 240 to its other operative position, and such relationship will persist until the tumbler shaft again rotates 180°. The conventional builder motion is utilized in this manner to effect reversal of the oil flow through motor 246, the operation being electrically actuated.

The builder motion is also utilized to actuate means controlling the variable outputs of pumps 206 and 234, and thereby the speeds of the hydraulic driving motors 212 and 246. For this purpose the control plunger 208 of pump 206 is engaged by the edge of a disc cam 260, mounted on a shaft 262 which also carries a gear 264. The gear 264 is drivingly engaged by a tension change gear 266, mounted on a shaft 268 which also carries a rack wheel 270. A solenoid 272 is mounted adjacent rack wheel 270, its arm 274 carrying at its outer end a pawl 276 adapted to engage and rotate the rack wheel 270. An actuating cam 278 is mounted on the tumbler shaft 114, and a switch 280 disposed for actuation by said cam, as shown. The switch 280 is in circuit with solenoid 272 and a source of power 282. The control plunger 236 of pump 234 is similarly engaged by the edge of a disc cam 284, conveniently mounted on the shaft 262.

The actuating cam 278, as illustrated in Figure 12, may be circular except for two diametrically opposed flats 286. Preferably, the switch 280 is normally open, and disposed so that its operating arm or button engages one of the cam flats while the tumbler shaft is at rest. Periodically, as is well known, the tumbler shaft rotates 180°, and each 180° rotation of the tumbler shaft 114 effects corresponding rotation of the actuating cam 278, which serves thereby to momentarily depress the operating arm or button of switch 280, and to momentarily close the switch. Each closing of switch 280 is effective, it will be understood, to retract the arm 274 of solenoid 272 (see Figure 11), whereby its pawl 276 correspondingly displaces or indexes the rack wheel 270. Each rotary movement of rack wheel 270 is transmitted through shaft 268, tension change gear 266, gear 264 and the shaft 262 to the cams 260 and 284, whereby the cams are correspondingly indexed in unison. As an alternative possibility, a rotary solenoid may be utilized to control

cams 260 and 284. In this manner, the outputs of the variable speed transmissions, specifically the variable hydraulic pumps, are controlled in synchronism by electrical means actuated by the builder motion.

A suitable control cam 284 is illustrated in Figure 9, the direction of its rotation being indicated by arrow 288. The cam is shown in starting position, at which the pump plunger 236 rests on the highest point thereof. As will be understood, this disposition of the plunger 236 effects a pump output requisite at the beginning of a winding cycle. With the pump plunger so positioned, in other words, the output of pump 234 is at a maximum, and effects rotation of motor 246 at suitable speed to impart to the bobbin carriage a lay speed appropriate for winding of the initial layer on the bobbins. On the first reversal of the frame carriage, the tumbler shaft by means of its actuating cam 278 causes, in the manner described above, the cam 284 to be indexed a few degrees. The cam being substantially helical or spiral and descending, the control plunger 236 is thereby permitted to move slightly outwardly toward the cam, thereby slightly reducing the output of pump 234. In this manner, operation of the builder motion to effect reversal of the carriage direction is operable simultaneously to alter the output of the variable speed transmission, and accordingly to alter the lay speed of the carriage. The reduction in speed so effected is substantially instantaneous, and controlled with extreme accuracy by the contour of the cam. The helical form of the cam may extend through for example 270° of its periphery, this extent corresponding to the programmed number of layers, that is to a complete winding cycle. During doffing, the cam may be returned to initial starting position, either manually or automatically.

A suitable control cam 260 is illustrated in Figure 10, the direction of its rotation being indicated by arrow 290. This cam also is shown at starting position, at which the control plunger 208 of pump 206 rests on the highest point thereof. In such relationship, the cam 260 is adapted to effect maximum pump output requisite at the beginning of a winding cycle. That is, the initial output of pump 206 effects rotation of motor 212 at suitable speed to impart to the compound 94 a variable speed component adapted to impart to the bobbins a speed appropriate for winding of the initial layer thereon, in other words to effect a suitable winding speed. The cam 260 is also substantially helical in form, and descends through approximately 270° of its periphery, this extent corresponding to the programmed number of layers.

While the control cams 260 and 284 are substantially similar, and are indexed in unison, it will be apparent that they may vary in contour so as to achieve independent and different variable speed drives to the carriage traversing mechanism, and to the compound. In other words, the contour of cam 260 may be such as to effect a winding speed corresponding to a curve such as 48 in Figure 6, and the cam 284 may be contoured so as to achieve a lay speed corresponding more or less to the curve 54 on that figure. In this manner, the variable speed drives to the carriage and to the compound are separate and independently controlled, although control of both drives is effected in synchronism by common means actuated by the builder motion.

It will be noted that the variable speed programming of the frame illustrated in Figure 8 may be altered with facility, this involving merely replacement of either or both of the cams 260 and 284 with similar cams of appropriate contour. Also, the control cams are indexed through the tension change gear 266, which may be readily replaced as in conventional frames, and for the same purpose.

In this embodiment, the conventional builder motion is utilized to control the variable outputs of pumps 206 and 234, and thereby the speed of the hydraulic drive

motors 212 and 246, and also the reversal of the oil flow through motor 246, all these operations being electrically actuated in simple manner. While in converting present machines, it may be convenient to use the builder motion already provided for control actuation, it will be recognized that in the Figure 8 embodiment of the invention, only sufficient power is required in the builder motion to operate the switches 252 and 280. It is possible, accordingly, to greatly reduce the size of the builder motion, and to incorporate it into a small control box at any convenient location on the frame. The builder motion, for example, may be built into a small gear box including the indexing mechanism for the cams 260 and 284. It will be further understood, accordingly, that the term "builder motion" as used in this specification and the accompanying claims is intended to include not only conventional mechanical builder motions, but similar programming mechanisms also, that is to include any device effective to control the direction, rate and extent of travel of the bobbin carriage.

Alternative arrangements equivalent to the embodiment of Figure 8 will be obvious. For example, the pumps 206 and 234 may be substituted by fixed, constant volume pumps, and the motors 212 and 246 by variable speed hydraulic motors, the latter being controlled in precisely the same manner as are the variable pumps 206 and 234. Similarly, variable speed hydraulic transmissions powered by the direct drive of the frame and controlled in the manner described may be utilized to drive, respectively, the compound and the lay mechanism.

A further embodiment of the invention is illustrated in Figure 14, wherein a single variable hydraulic pump is utilized to provide variable speed drives to the carriage and to the compound. As in the previous embodiment, direct constant speed drive is applied to the frame at pulley 70, and transmitted in customary manner to the spindles 86, the compound 94, the front roll shaft 108 and the builder motion. In this embodiment, gear 300 on the top cone shaft 96 is engaged in driving relationship by chain 302 to a gear 304, which drives the variable output hydraulic pump 306, provided with the control plunger 308. The pump 306 is controlled by a disc cam 310, mounted on shaft 312. The control cam 310 may correspond in structure and function to the control cams 260 and 284 previously described, and may be indexed by builder motion actuation precisely in the manner described in connection with the Figure 8 embodiment.

The variable output of pump 306 is transmitted through conduit 314 to the four way reversing valve 240, and then through either of the conduits 242 or 244 to the fixed hydraulic motor 246, which is drivingly engaged to the lay as previously described. As shown, the reversing valve 240 may be controlled by a solenoid, actuated by a cam associated with the builder mechanism, as in the Figure 8 embodiment. The oil flow passing through motor 246 and the reversing valve 240 is then conveyed by means of conduit 316 to the hydraulic motor 212, which drives the compound 94 by means of chain 218 and thereby supplies the variable speed input thereto. The variable speed output of compound 94 is transmitted by means of chain 220 and gear 222 to the bobbin shaft 224. The oil flow discharged from motor 212 is returned via conduits 318 and 320 to the variable pump 306.

By means of the hydraulic system above described, the single pump 306 drives the motors 246 and 212 in series, providing a variable speed drive to the carriage, and to the compound. This corresponds to the conventional function of the cones, and results in a constant winding speed-lay speed relationship. To provide for variation of this relationship in the course of the winding cycle, that is to provide independent control for the variable speed drives to the carriage and to the compound, in accordance with the present invention, a by-

pass conduit 320 is provided between the conduits 314 and 316, this conduit bypassing the reversing valve 240 and the motor 246. A variable throttle valve 322, which may be a feed control valve such as a Vickers Model FG-02, is provided in the bypass conduit 320, the throttle valve being provided with control plunger 324. The control plunger 324 of the throttle valve is operatively engaged by a disc cam 326, conveniently mounted on the same shaft 312 which carries the control cam 310 for the variable pump.

The control cam 326 may be shaped as illustrated in Figure 15, wherein its direction of rotation is indicated by arrow 328. The control cam 326 is shown in starting position, at which the control plunger 324 contacts the low point of the cam. This relationship establishes maximum opening of the throttle valve 322, in which condition a small portion of the outflow of pump 306 may pass through the valve and bypass motor 246. At the beginning of the winding cycle, then, all the outflow of pump 306 passes through the motor 212, whereas a lesser quantity of this flow passes through motor 246, the remainder passing through the bypass conduit 320 and throttle valve 322 to rejoin the oil stream in conduit 316.

With the completion of each layer on the bobbins, the control cam 326 is indexed a few degrees, by actuation of the builder motion and in synchronism with cam 310. The cam 326, in the example shown, rises spirally from its low point, reaching maximum elevation about 90° beyond this point, and is circular throughout the remainder of its periphery. At the beginning of the winding operation, accordingly, each time the cam 326 is indexed, it displaces the control plunger 324 inwardly toward the throttle valve 322, to progressively close the valve and reduce the quantity of oil bypassing through conduit 320. In this manner, the variable speeds transmitted to the carriage and to the compound are differentiated, and are independently controlled. The cam 326, it has been found, may rise from low point to high point in approximately 90° of its periphery, which corresponds to about 1/3 of the winding cycle, to completely close the throttle valve 322 after the winding of twenty layers or so. The throttle valve may remain closed thereafter until the next cycle is started. It has been found effective, in other words, to independently control the variable speed drives through the initial portion of the winding cycle only, and to then permit the lay speed-winding speed relationship to remain constant through the remainder of the cycle. As seen in Figure 6, once the winding speed curve 48 and the lay speed curve 54 are suitably differentiated, the relationship therebetween may remain substantially constant.

In the embodiment of Figure 14, a supercharge pump 330, driven by an electric motor 332, is provided. The supercharge pump is driven at all times, even while the frame is at rest, and serves to maintain working pressure on both sides of pump 306 and motors 212 and 246 at all times. These elements, accordingly, are pre-stressed, even while the frame is at rest for doffing, and may start up without any lost motion. The supercharging elements and circuitry are disclosed in detail and claimed in my companion application Serial No. 620,488, filed on even date herewith.

A similar embodiment of the invention is illustrated in Figure 16, wherein however the oil flow from the single variable pump is passed through the motors 212 and 246 serially but in opposite order. In the Figure 16 embodiment, the variable pump and the variable throttle valve are controlled by mechanical means actuated by the builder motion, as is also the reversing valve for the lay driving motor 246. As in the Figure 14 embodiment, the direct constant speed drive is applied at pulley 70, and transmitted directly to spindles 86, compound 94, front roll shaft 108, and the builder motion. The gear 300 on top cone shaft 96 is drivingly engaged by

chain 302 to gear 304, which drives the variable hydraulic pump 306, provided with control plunger 308. The pump 306 is controlled by the disc cam 310, mounted on shaft 312. In this case, the variable output of pump 306 is transmitted initially to the motor 212 via conduit 340, the motor 212 driving the compound 94 through chain 218 and supplying the variable speed input thereto. As previously stated, the variable output of the compound 94 is transmitted to the bobbin shaft 224.

After passing through hydraulic motor 212, the oil flow is carried through the conduit 342 to the reversing valve 240, and then through either of the conduits 242 or 244 to the lay motor 246. Upon leaving the motor 246 and reversing valve 240, the oil flow returns to pump 306 through conduit 344.

A bypass conduit 346 is provided between conduit 342 and the auxiliary return conduit 348, the conduit 346 constituting a bypass around motor 246, and having therein the variable throttle valve 322, which corresponds precisely to the feed control valve of the Figure 14 arrangement, and has the same function and operation. The entire output oil flow of variable pump 306 passes through motor 212. A minor portion of the oil flow, after passing through motor 212, is bypassed around motor 246, so that the oil flow through motor 246 is reduced somewhat from that passing through motor 212. Since the variable speed provided to the compound is usually most critical, this arrangement may be preferable to that of Figure 14, in that the oil flow from the pump goes directly to the motor 212, and the possibility of leakage in the reversing valve 240 and the motor 246 is avoided.

The variable throttle valve 322 may be controlled as before by the disc cam 326, also mounted on shaft 312 to index with the cam 310. The control cams are indexed, in this embodiment, by mechanical action of the builder motion. As previously indicated, periodic rotation of the tumbler shaft 114 is transmitted by gearing through the tension change gear 122 to the winding shaft 124, and by means of its gear 126 to the rack 128, whereby the periodic rotation of the tumbler shaft displaces the rack 128 in step-wise fashion. As shown, the rack is adapted to rotate gears 350 and 352, mounted on a common shaft 354. The gear 352 is engaged in driving relationship to a gear 356, which corresponds to the rack wheel 270 of the Figure 8 embodiment, and is operative to index the cams 310 and 326 through tension change gear 358 and gear 360 mounted on shaft 312. In this manner, the control cams are indexed mechanically, in unison, and in synchronism with the builder motion.

The action of the builder motion is also utilized to mechanically actuate the four way reversing valve 240. For this purpose, a reversing cam 362 may be fixed to the tumbler shaft 114, and a rigid link 364 provided between the reversing valve and the reversing cam. Conventional means may be provided to guide the link 364, and the assembly is desirably biased toward the reversing cam, as by spring 366. The reversing cam 362 may be shaped as illustrated in Figure 17. In the position there shown, the link 364 is positioned as closely as possible to the cam axis, and the valve 240 would be displaced, as by the action of spring 366, to the position illustrated in Figure 16. Rotation of the reversing cam through 180° would displace the link 364 outwardly from the cam axis, compressing the spring 366 and displacing the valve 240 to the position opposite to that illustrated in Figure 16.

As in Figure 14, a supercharge pump 330 driven by motor 332 may be provided, and circuitry adapted to convey working pressure to both sides of pump 306 and motors 212 and 246 when the frame is at rest. An auxiliary circuit including valve 368 is also illustrated, these being provided to facilitate kinking of the stock

above the flyers for the purpose of doffing. Valve 370 and the associated circuitry is provided to permit power movement of the carriage while the frame is otherwise at rest, as during doffing periods, whereby the carriage may be reset during doffing to a position near an end of its travel, so that winding may be initiated with a full or substantially full first layer. The latter features are described in detail and claimed in my companion application already referred to.

In Figure 18 the invention is illustrated in connection with a fly frame having a completely hydraulic drive, that is a drive system in which both constant and variable speed inputs are effected hydraulically. In this embodiment, the conventional compound is eliminated, and replaced by a simple plumbing fitting such as a T.

As illustrated, an electric motor 376 drives a fixed hydraulic pump 378 at constant speed, whereby a constant flow of oil is pumped thereby through conduit 380. The hydraulic pump 378 is necessarily of considerable capacity, and may for example be a Vickers Model PV-2008. Conduit 380 carries the constant oil flow to a fixed hydraulic motor 382, which may be a Vickers Model MF-2008, and the oil flow passes through motor 382 to conduit 384. The motor 382, as will be understood, provides the constant speed main drive for the frame, driving a gear 386 which is drivingly engaged to a gear 388, the latter being mounted on the main shaft 72 in place of the customary drive pulley. The constant speed drive is transmitted by gear train 76 to the spindles 86 and flyers 88, through twist change gear 98 and intermediate gearing to the top cone shaft 96 and the front roll shaft 108, and to the builder motion.

A variable speed drive may be derived from the constant speed drive precisely in the manner illustrated in the embodiment of Figure 14, and described in connection therewith. That is, a variable hydraulic pump 306 may be driven from the top cone shaft, the output of the variable pump being controlled by a control cam 310, which is indexed automatically in accordance with the operation of the builder motion. As in the case of the Figure 14 arrangement, the variable output of pump 306 is carried by conduit 314 to the reversing valve 240 and passes through the lay motor 246, the direction of the oil flow being automatically reversed as in the similar embodiment. The oil flow, after leaving the lay motor 246, is conducted through conduit 390 to the hydraulic motor 392.

Before it reaches the hydraulic motor 392 the variable oil flow passing through conduit 390 is combined with the constant oil flow passing through conduit 384, at junction 394, and the combined oil flows pass through and drive the bobbin motor 392. The output of motor 392 is transmitted by means of gear 396 and chain or gear train 398 to the gear 222 mounted on the bobbin shaft 224, and thereby to the bobbins. It will be recognized that the speed of motor 392 and the resultant bobbin speed accordingly represent a combination of the constant speed component of the main drive of the frame plus the variable speed component derived from pump 306. The combination of the two oil flows, then, serves the function of the usual compound, which in the present place is replaced by a simple plumbing fitting such as a T at the junction 394.

As in the Figure 14 embodiment, a bypass conduit 320 is provided around reversing valve 240 and the lay motor 246, extending in this case from conduit 314 to conduit 390. The variable throttle valve 322 is disposed in the bypass conduit 320, and its control plunger 324 is operatively engaged by the control cam 326, mounted on the shaft 312 which also carries control cam 310. The function and operation of the variable throttle valve 322 may be exactly as previously described in connection with Figure 14. Oil bypassed around motor 246 is combined with the flow passing through this motor in conduit 390,

so that the entire variable output of pump 306 reaches junction 394 and passes through the bobbin motor 392. In Figure 18, the electric motor 376 may also drive a supercharge pump 400, adapted by appropriate circuitry to prestress pumps 306 and 378, and motors 246, 382 and 392.

It will thus be seen that there has been provided by this invention an article and method in which the various objects hereinbefore set forth, together with many practical advantages, are successfully achieved. As various possible embodiments may be made of the novel features of the above invention, all without departing from the scope thereof, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative, and not in a limiting sense.

I claim:

1. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, variable speed drive means engaged to said carriage and to said bobbin rotating means in driving relationship, and means actuated by said builder motion for independently controlling the variable speed drive to said carriage and to said bobbin rotating means.

2. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable speed transmission powered by said direct drive means engaged to said compound in driving relationship, a second variable speed transmission powered by said direct drive means engaged to said carriage in driving relationship, and means actuated by said builder motion for controlling the output of said transmissions.

3. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable speed transmission powered by said direct drive means engaged to said compound in driving relationship, a second variable speed transmission powered by said compound engaged to said carriage in driving relationship, and means actuated by said builder motion for controlling the output of said transmissions.

4. A fly frame as defined in claim 3, wherein said variable speed transmissions comprise cones.

5. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, variable speed hydraulic drive means powered by said direct drive means engaged to said carriage and to said bobbin rotating means in driving relationship, and means for independently controlling the variable speed drive to said carriage and to said bobbin rotating means.

6. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, variable speed hydraulic drive means powered by said direct drive means engaged to said carriage and to said bobbin rotating means in driving relationship, and means actuated by said builder motion for independently controlling the variable speed drive to said carriage and to said bobbin rotating means.

7. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, a first variable speed hydraulic drive means powered by said direct drive means engaged to said carriage in driving

relationship, a second variable speed hydraulic drive means powered by said direct drive means engaged to said bobbin rotating means in driving relationship, and means for independently controlling the variable speed drives to said carriage and to said bobbin rotating means.

8. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, a first variable speed hydraulic drive means powered by said direct drive means engaged to said carriage in driving relationship, a second variable speed hydraulic drive means powered by said direct drive means engaged to said bobbin rotating means in driving relationship, and means actuated by said builder motion for independently controlling the variable speed drives to said carriage and to said bobbin rotating means.

9. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a first hydraulic pump powered by said direct drive means, a first hydraulic motor engaged to said carriage in driving relationship, means conveying the output of said first pump to said first motor, a second hydraulic pump powered by said direct drive means, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said second pump to said second motor, and means actuated by said builder motion for independently controlling the speeds of said motors.

10. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a first variable hydraulic pump powered by said direct drive means, a first hydraulic motor engaged to said carriage in driving relationship, means for conveying the output of said first pump through said first motor, a second variable hydraulic pump powered by said direct drive means, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said second pump through said second motor, and means actuated by said builder motion for independently controlling the output of said pumps.

11. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a first variable hydraulic pump powered by said direct drive means, a first hydraulic motor engaged to said carriage in driving relationship, means for conveying the output of said first pump through said first motor, a second variable hydraulic pump powered by said direct drive means, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said second pump through said second motor, a cam controlling the output of each of said variable hydraulic pumps, and means for indexing said cams in accordance with the operation of said builder motion.

12. A fly frame as defined in claim 11, including a valve for reversing the flow through said first hydraulic motor, and means actuated by said builder motion controlling the operation of said reversing valve.

13. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a hydraulic pump

powered by said direct drive means, a first hydraulic motor engaged to said carriage in driving relationship, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said pump through said motors in series, and means actuated by said builder motion independently controlling the speeds of said motors.

14. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable hydraulic pump powered by said direct drive means, means actuated by said builder motion controlling the output of said pump, a first hydraulic motor engaged to said carriage in driving relationship, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said pump through said motors in series, and variable means for bypassing a part of said output around said first motor.

15. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable hydraulic pump powered by said direct drive means, means actuated by said builder motion controlling the output of said pump, a first hydraulic motor engaged to said carriage in driving relationship, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said pump through said motors in series, variable means for bypassing a part of said output around said first motor, and means actuated by said builder motion controlling said variable bypass means.

16. A fly frame as defined in claim 15, wherein said variable bypass means is a throttle valve.

17. A fly frame as defined in claim 15, including a valve for reversing the flow through said first hydraulic motor, and means actuated by said builder motion controlling the operation of said reversing valve.

18. A fly frame as defined in claim 15, wherein said means controlling the output of said pump is a cam and said means controlling said variable bypass means is a cam, said cams being linked together, and including a tension change gear and means for indexing said cams through said tension change gear in accordance with operation of said builder motion.

19. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable hydraulic pump powered by said direct drive means, means actuated by said builder motion controlling the output of said pump, a first hydraulic motor engaged to said carriage in driving relationship, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said pump first through said first motor and then through said second motor, variable means for bypassing a part of said output around said first motor, and means actuated by said builder motion controlling said variable bypass means.

20. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, means engaging said drawing rolls, flyers and builder motion in direct driving relationship, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable hydraulic pump powered by said direct drive means, means actuated by said builder motion controlling the output of said pump, a first hydraulic motor engaged to said carriage in

driving relationship, a second hydraulic motor engaged to said compound in driving relationship, means conveying the output of said pump first through said second motor and then through said first motor, variable means for bypassing a part of said output around said first motor, and means actuated by said builder motion controlling said variable bypass means.

21. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, a first hydraulic motor engaging said rolls, flyers and builder motion in direct driving relationship, a variable hydraulic pump powered by said direct drive means, means actuated by said builder motion controlling the output of said pump, a second hydraulic motor engaged to said carriage in driving relationship, means conveying the output of said pump to said second motor, variable means for bypassing a part of said pump output around said second motor, a third hydraulic motor engaging said bobbin rotating means in driving relationship, and means conveying the discharge of said first and second motors and of said variable bypass means to said third motor.

22. A fly frame as defined in claim 21, including means actuated by said builder motion controlling said variable bypass means.

23. A fly frame as defined in claim 21, wherein said means controlling the output of said pump is a cam and said means controlling the output of said variable bypass means is a cam, said cams being linked together, and including a tension change gear, and means for indexing said cams through said tension change gear in accordance with operation of said builder motion.

24. A fly frame as defined in claim 21, including a valve for reversing the flow through said second hydraulic motor, and means actuated by the builder motion controlling the operation of said reversing valve.

25. In the operation of a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speeds, driving said carriage and said bobbin rotating means at variable speeds, and independently controlling the variable speeds of said carriage and said bobbin rotating means.

26. In the operation of a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speeds, driving said carriage and said bobbin rotating means at variable speeds, and independently controlling the variable speeds of said carriage and said bobbin rotating means in synchronism with the operation of said builder motion.

27. In the operation of a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speeds, independently driving said carriage and said bobbin rotating means by means of variable speed transmissions, and independently controlling said variable speed transmissions in synchronism with the operation of said builder motion.

28. A method as defined in claim 27, wherein said variable speed transmissions are hydraulic.

29. In the operation of a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speeds, driving said carriage and said bobbin rotating means at variable speeds by means of a variable hydraulic drive powered by said constant speed drive, and independently controlling the hydraulic drive to said carriage and to said bobbin rotating means in synchronism with the operation of said builder motion.

30. In the operation of a fly frame including drawing

rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speed, driving said bobbin rotating means by said constant speed drive through a compound, deriving a flow of hydraulic oil from said constant speed drive, driving said carriage and said compound successively by means of said oil flow, and bypassing a variable portion of said oil flow around said carriage whereby the hydraulic drives to said carriage and to said compound are independently controlled.

31. A method as defined in claim 30, wherein the portion of said oil flow bypassed around said carriage is varied in synchronism with the operation of said builder motion.

32. A method as defined in claim 30, wherein said oil flow is utilized first to drive said compound, and then to drive said carriage.

33. A method as defined in claim 30, wherein said flow of said hydraulic oil derived from said constant speed drive is variable, and is varied in synchronism with the operation of said builder motion.

34. In the operation of a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin

carriage and a builder motion, the method comprising the steps of driving said drawing rolls, flyers and builder motion at constant speed by means of a constant flow of hydraulic oil, deriving a variable flow of hydraulic oil from said constant speed drive, varying said variable oil flow in synchronism with the operation of said builder motion, driving said carriage by means of said variable oil flow, bypassing a variable portion of said variable oil flow around said carriage, combining said constant oil flow and said variable oil flow, including the bypassed portion of the latter, and driving said bobbin rotating means by means of said combined oil flow.

35. A method as defined in claim 34, wherein the portion of said variable oil flow bypassed around said carriage is varied in synchronism with the operation of said builder motion.

References Cited in the file of this patent

UNITED STATES PATENTS

2,101,395	Kato	Dec. 7, 1937
2,186,696	Harris	Jan. 9, 1940
2,507,904	Heller et al.	May 16, 1950