Sept. 1, 1959 E. H. GRANBERRY 2,901,883

HYDRAULIC FLY FRAME DRIVE AND METHOD

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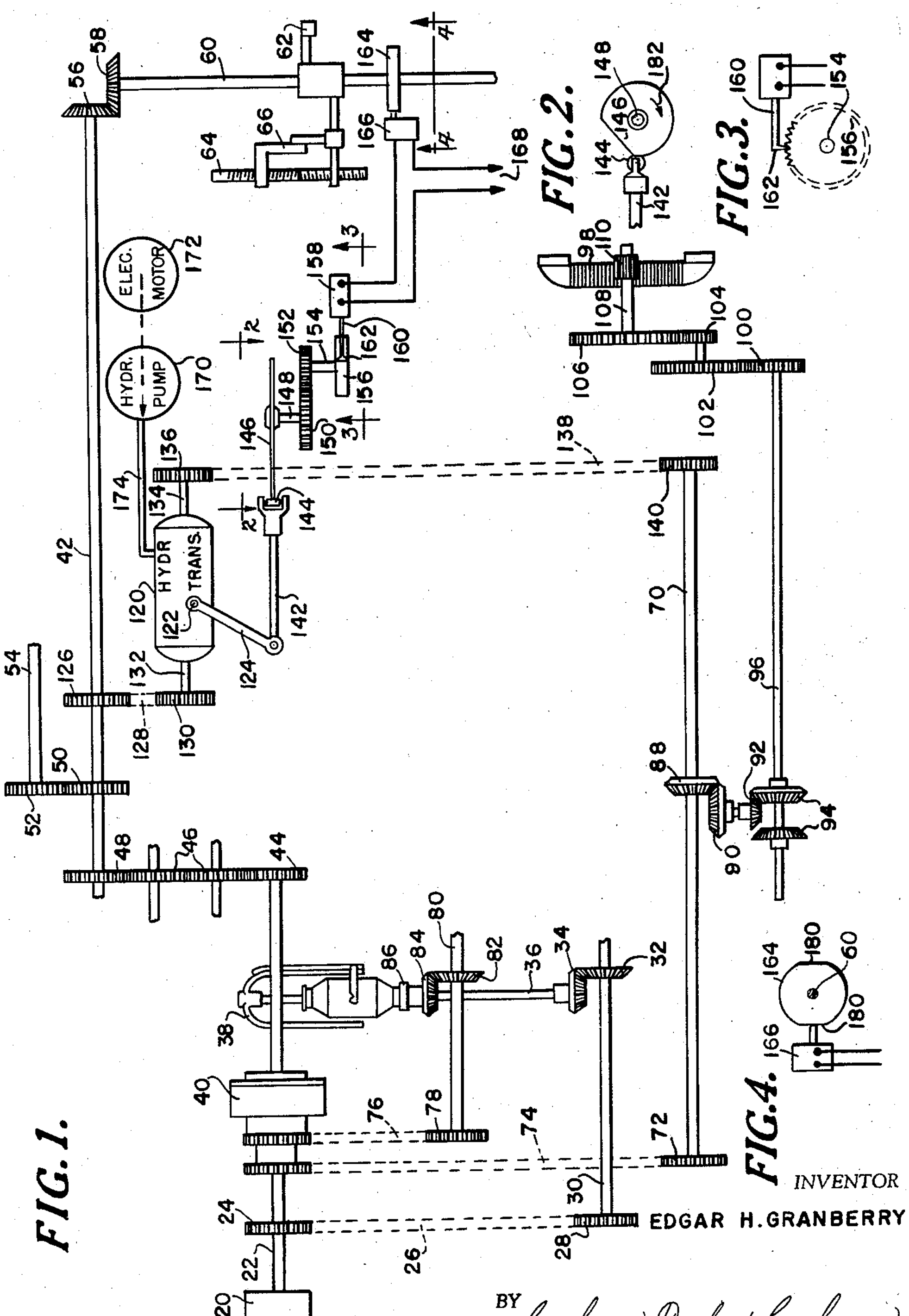

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HYDRAULIC FLY FRAME DRIVE AND METHOD

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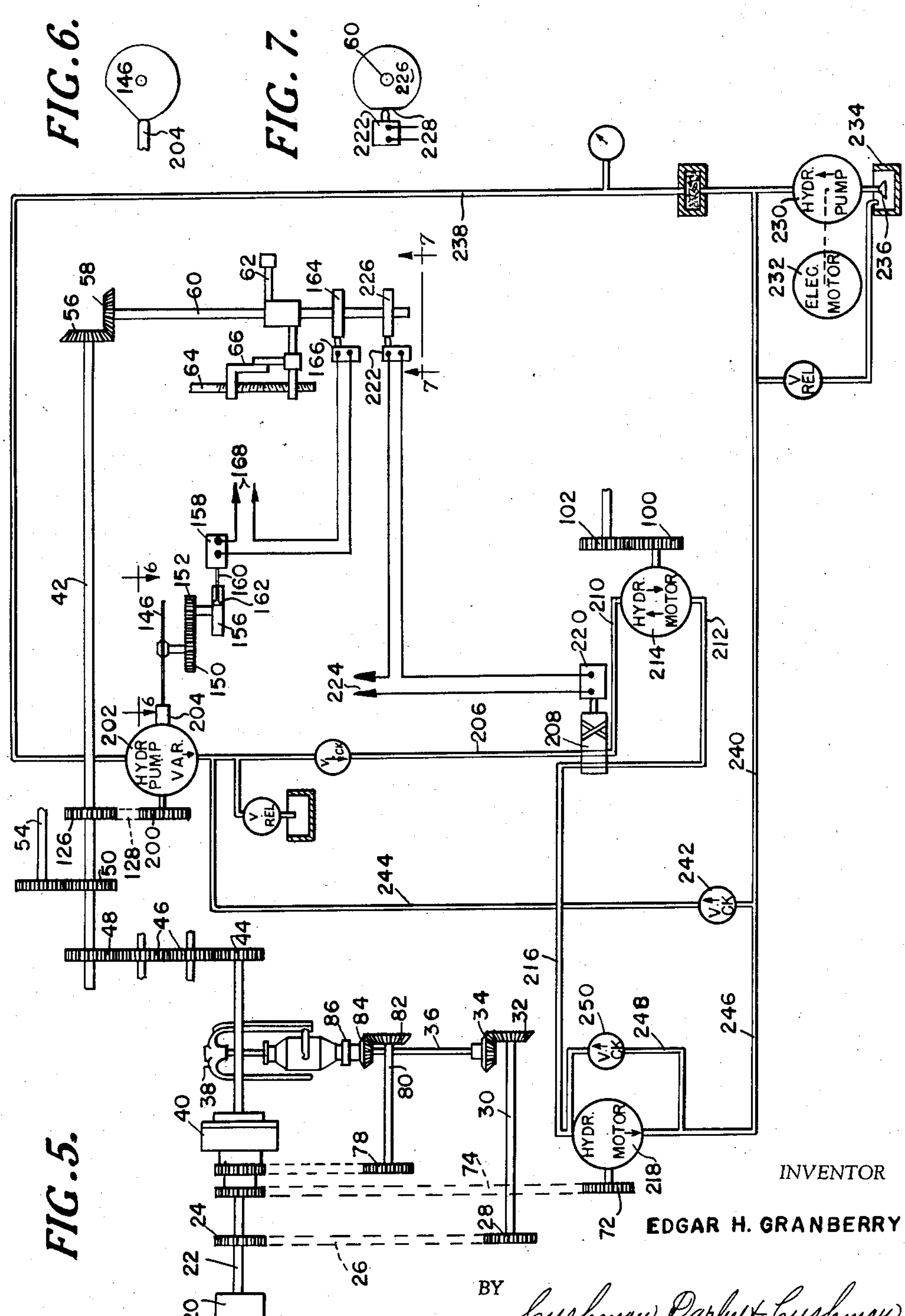

FIG. 6.

FIG. 7.

FIG. 5.

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HYDRAULIC FLY FRAME DRIVE AND METHOD

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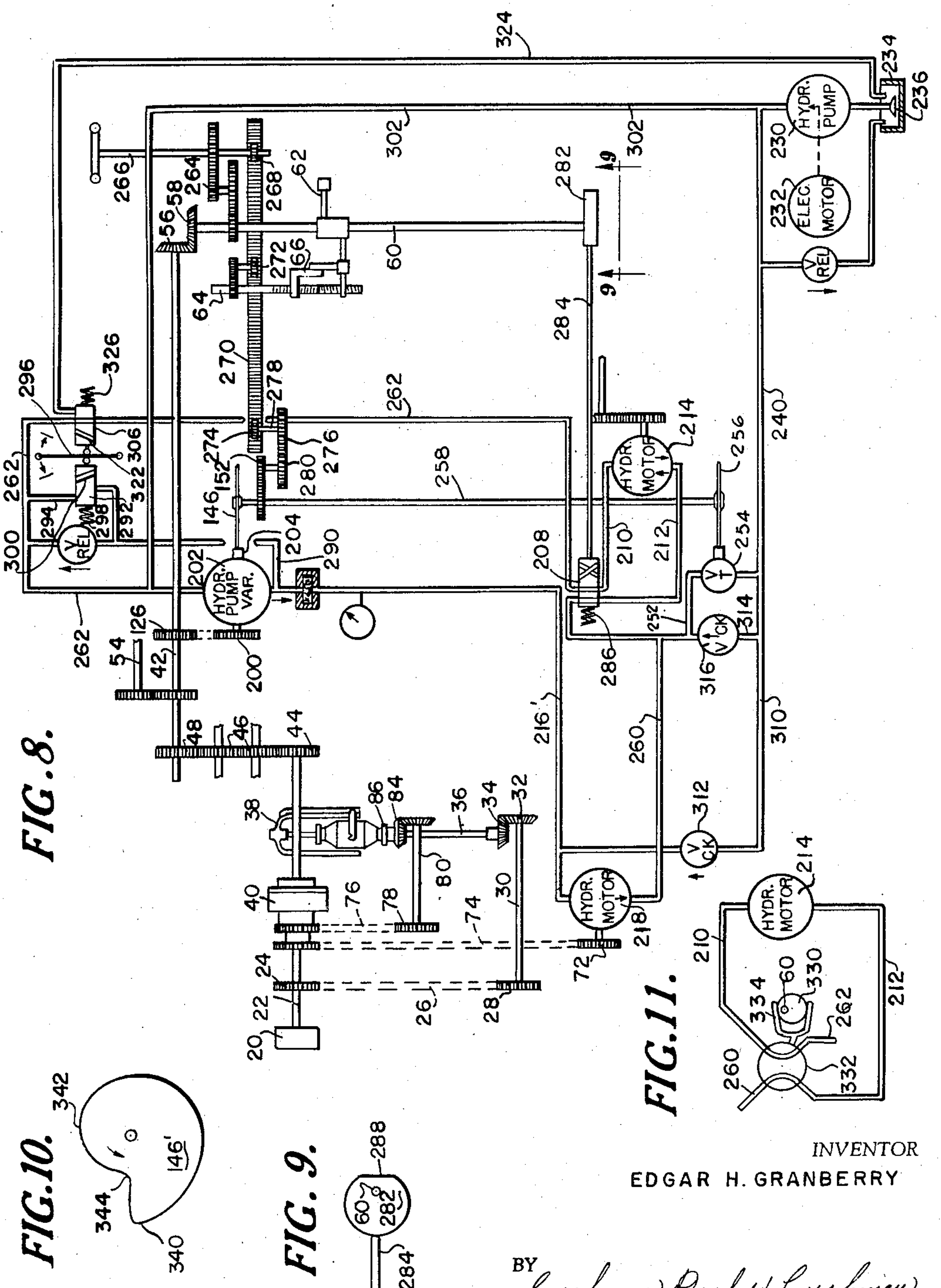

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HYDRAULIC FLY FRAME DRIVE AND METHOD

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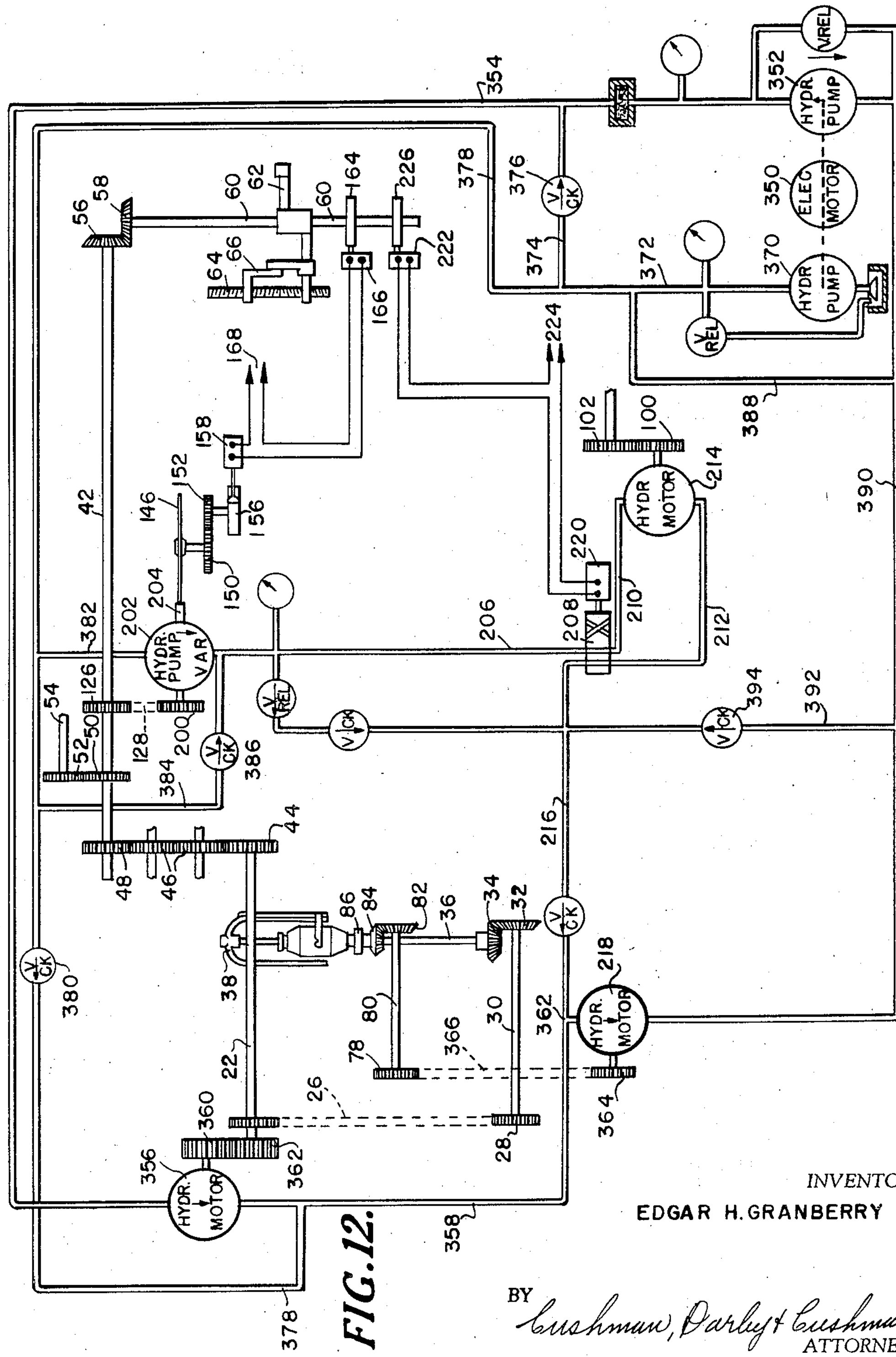

FIG. 12.

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HYDRAULIC FLY FRAME DRIVE AND METHOD

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Application November 5, 1956, Serial No. 620,488

44 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 a method of operating fly frames.

A principal object of the invention is the provision of a hydraulically driven fly frame, wherein hydraulic power transmission means is substituted for the variable speed drive (cones) of conventional frames, and, optionally, for the main drive and compound also.

Hydraulic power transmission to and in the fly frame involves many advantages. For example, hydraulic driving makes it possible to transmit more power in the frame, with better control, whereby larger and more uniform packages may be wound than ever before. It is well known that cone variable speed transmissions designed for use with large diameter packages, exceeding for example 6 inches, are exceedingly bulky, and the cones become progressively less sensitive (accurate) with increase in package diameter, to the point of impracticality. The variable hydraulic drive means of the present invention, distinctively, is sensitive and accurate, and effects even winding with uniform tension. This is particularly true at large bobbin diameters, the invention making possible accurate and uniform winding of packages 9 inches and more in diameter.

The improved variable speed transmission, further, is capable of precise speed control, producing accurate speeds which may be consistently repeated. Moreover, the hydraulic variable speed drive has little inertia and is capable of changing speeds almost instantaneously, these characteristics further contributing to sensitivity and accuracy. The hydraulic drive also reduces loss of speed in the variable speed transmission, and variation in the stock. Incidental advantages include the elimination of errors due to backlash, and the elimination of the well known variables inherent in cone operation, due to variations in temperaure, humidity, cleanliness and the like.

A further object of the invention is the provision of a hydraulically driven fly frame in which adjustment for different hank size ranges is greatly facilitated.

Another object of the invention is the provision of a fly frame drive system which facilitates kinking prior to doffing.

Still another object is the provision of a hydraulic fly frame drive which permits power movement of the bobbin carriage toward or to the end of a stroke while the frame is otherwise at rest. By this means, bobbins may be wound with a full or almost full first layer, regardless of the point at which the frame was stopped for the previous doff. A related object is the provision of a method of fly frame operation, involving independent movement of the carriage while the frame is at rest.

Still another object is the provision of a hydraulic fly frame drive having a supercharging system, whereby pumps and motors may be prestressed and all possibility of lost motion eliminated. 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 diagrammatic illustration of a conventional fly frame, wherein the cones are replaced by a simplified variable speed hydraulic transmission;

Figure 2 is a view of the transmission control cam, taken on the line 2—2 of Figure 1;

Figure 3 is a view taken on the line 3—3 of Figure 1, illustrating the control cam driving means;

Figure 4 is a view taken on the line 4—4 of Figure 1, illustrating the builder motion actuating means controlling the hydraulic transmission;

Figure 5 is a diagrammatic illustration of a fly frame similar to that of Figure 1, wherein a supercharged hydraulic system has been substituted for the conventional cones, and for the drive therefrom to the compound and to the lay;

Figure 6 is a view of the variable hydraulic pump control cam of Figure 5, taken on the line 6—6 of Figure 5;

Figure 7 is a view taken on the line 7—7 of Figure 5, illustrating the builder motion cam controlling the reversing of the lay motor;

Figure 8 is a diagrammatic illustration of a hydraulic fly frame drive system corresponding generally to that of Figure 5, but representing an alternative arrangement and incorporating means for kinking and for driving the carriage while the remainder of the frame is at rest. This embodiment of the invention utilizes conventional builder motion elements for mechanical control of the variable speed hydraulic drive, and for reversal of the lay motor;

Figure 9 is a view on the line 9—9 of Figure 8, illustrating a builder motion cam suitable for mechanical actuation of the lay motor reversing valve;

Figure 10 is an alternative variable hydraulic pump control cam, adapted to facilitate kinking at the end of a frame cycle;

Figure 11 is a diagrammatic illustration of an alternative arrangement for mechanically actuating the lay motor reversing valve; and

Figure 12 is a diagrammatic illustration of a fly frame having an all hydraulic drive, in which the hydraulic drive system replaces not only the cones of the frame, but also the usual compound.

Referring to the drawings in detail, the frame illustrated in Figure 1 corresponds generally to the type identified with the Whitin Machine Works, although it will be recognized that the invention is suitable for application to Saco-Lowell and other well known fly frame types. Power is supplied to the frame at pulley **20**, mounted on the main shaft **22**. Rotation of the main shaft is transmitted through its gear **24** and the diagrammatically illustrated gear train **26** to the gear **28** mounted on spindle shaft **30**. By means of bevel gears **32** and **34**, the spindle shaft **30** drives the spindles **36** and flyers **38** of the frame, these elements being driven in customary manner directly from the main drive, and at constant speed.

The constant speed main drive also drives the compound **40**, this constant speed, it will be understood, representing one component of input to the compound. The main shaft **22** also has a direct drive connection to the top cone shaft **42**, through twist change gear **44**, intermediate gears **46** and the top cone shaft gear **48**. The direct drive is also transmitted through gears **50** and **52** to the front roll shaft **54**, and thereby to the drawing rolls of the frame. By means of bevel gear **56** and gap gear **58**, the top cone shaft drives the usual tumbler shaft **60**, with which are associated the customary builder dogs **62**, builder shaft **64**, and builder jaws **66**.

In the conventional frame, power is transmitted from the top cone shaft **42** to the center lift driving shaft **70**, through a pair of cones which serve to convert the direct drive constant speed of the top cone shaft to a variable speed. The resultant variable speed of the center lift driving shaft is transmitted through its gear **72** and the diagrammatically illustrated gear train **74** to the compound **40**, 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 **76** and gear **78** to the bobbin shaft **80**. Bevel gears **82** and **84** transmit the variable speed rotation of the bobbin shaft to the bobbins **86**.

The variable speed rotation of the center lift driving shaft **70** is also transmitted through its bevel pinion **88** to the reverse stud bevel gear **90**. The reverse stud bevel pinion **92** is adapted to drive one side or the other of the twin bevel gear **94** mounted on the center lift shaft **96**, and the tumbler shaft **60** operates through conventional means not shown to periodically displace the shaft **96** in axial direction, whereby the direction of its rotation is reversed. The center lift shaft **96** is adapted to reciprocate the bobbin carriage of the frame by means of its rack **98**, the movement of the center lift shaft being transmitted through lay change gear **100**, center lift intermediate gear **102**, center lift intermediate pinion **104**, lifting shaft gear **106**, lifting shaft **108**, and the lifting shaft pinion **110**. All of the frame elements described to this point are conventional.

In accordance with a simplified embodiment of the present invention, the constant speed direct drive of the top cone shaft **42** is converted to a variable speed and transmitted to the center lift driving shaft **70**, through an hydraulic variable speed transmission **120**. The transmission **120** may be for example a Vickers Model TR 3, provided with the usual side control shaft **122** and control arm **124** extending therefrom. A gear **126** on the top cone shaft drives the transmission through a gear train or chain **128**, engaged to gear **130** mounted on the transmission input shaft **132**. The transmission output shaft **134** carries a gear **136** drivingly engaged by gear train or chain **138** to the gear **140** mounted on the center lift driving shaft **70**.

The variable output of the transmission **120** is controlled by movement of its control arm **124**, and means are provided to control the movement of the control arm by means of and in coordination with the operation of the builder motion. In the exemplary embodiment, a link **142** is pivotally engaged to the outer end of control arm **124**. The link **142** carries a cam following roller **144** at its opposite end, and the link is suitably guided and maintained in contact, by conventional means not shown, with the edge of disc cam **146**. The cam **146** is mounted on stub shaft **148**, which also carries a gear **150**. The gear **150** is drivingly engaged by a tension change gear **152**, mounted on a shaft **154**, which also carries a rack wheel **156**. A solenoid **158** is mounted adjacent rack wheel **156**, its arm **160** carrying at its outer end a pawl **162** adapted to engage and rotate the rack wheel **156**. An actuating cam **164** is mounted on the tumbler shaft **60** and a switch **166** disposed for actuation by said cam, as shown. The switch **166** is in circuit with solenoid **158** and a source of power **168**.

To prevent lost motion in the variable speed transmission **120**, an hydraulic pump **170**, driven by an electric motor **172**, may be provided, the output side of the pump being in fluid communication with the transmission through conduit **174**. The supercharging pump **170** maintains operating pressure in the transmission at all times, even while it is at rest, so that the transmission is prestressed and may start without any lost motion. The actuating cam **164**, as illustrated in Figure 4, may be circular except for two diametrically opposed flats **180**. Preferably, the switch **166** 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 **60** effects corresponding rotation of the actuating cam **164**, which serves thereby to momentarily depress the operating arm or button of switch **166**, and close the switch. Each closing of switch **166** is effective to retract the arm **160** of solenoid **158** (see Figure 3), whereby its pawl **162** correspondingly displaces or indexes the rack wheel **156**. Each rotary movement of rack wheel **156** is transmitted through shaft **154**, tension change gear **152**, gear **150**, and stub shaft **148** to the cam **146**, whereby the cam **146** is correspondingly indexed. As an alternative possibility, a rotary solenoid may be utilized to index the control cam **146**. In this manner, the output of the variable hydraulic drive means, specifically the hydraulic transmission, is controlled by electrical means actuated by the builder motion.

A suitable control cam **146** is illustrated in Figure 2, the direction of rotation being indicated by the arrow **182**. The cam is shown in starting position, at which the cam following roller **144** rests on the highest point thereof. As will be understood, the corresponding position of the transmission control arm **124** effects the speed output requisite at the beginning of a cycle of operation, this being the highest speed transmitted to the variable speed part of the frame, and corresponding to 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 **164** causes, in the manner described above, the cam **146** to be indexed a few degrees. The cam being substantially helical or spiral, the link **142** is thereby permitted to move slightly inwardly toward the cam, displacing the control arm **124** of the transmission and slightly reducing its output speed. In this manner, operation of the builder motion to effect reversal of the carriage direction is operable simultaneously to alter the output speed of the variable speed transmission. 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 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.

It will be noted that variable speed programming of the frame may be altered with facility, this involving merely replacement of the cam **146** with a similar cam of appropriate contour. Also, the cam **146** is indexed through the tension change gear **152**, which may be readily replaced as in conventional frames, and for the same purpose. The embodiment illustrated in Figures 1 to 4 may be incorporated into present frames with minimum expense, involving merely replacement of the conventional cone drive by the hydraulic variable speed transmission, and the mechanism for the control thereof. While an electrical control for the variable speed drive has been illustrated, it will be understood that mechanical or other means may be utilized as well.

Another embodiment of the invention is illustrated in Figures 5 to 7. In this embodiment, the conventional mechanical variable speed drive mechanism and carriage reversing mechanism is substantially entirely replaced by hydraulic means. As in the previous embodiment, direct constant speed drive is applied to the frame at pulley **20**, and transmitted in customary manner to the spindles **36**, the compound **40**, the front roll shaft **54**, and the builder motion. In this embodiment, gear **126** on the top cone shaft **42** is engaged in driving relationship by chain **128** to a gear **200**, which drives a variable output hydraulic pump **202**. The pump **202** may be, for example, a Vickers Model PV–2003, and is provided with the usual control plunger **204**. As in the previous embodiment, the control plunger **204** is engaged by the edge of disc cam **146**, which thereby controls the output of the pump. The disc cam may be indexed precisely in the manner described in connection with the previous embodiment.

In operation, the output of pump 202 is conveyed through conduit 206 to a four-way reversing valve 208, and then through either conduit 210 or conduit 212 to the fixed hydraulic motor 214. The motor 214, which may be, for example, a Vickers Model MF-2003, is adapted to rotate at a speed proportional to the volume of hydraulic fluid passed therethrough. As shown, the hydraulic motor 214 is drivingly engaged to the lay change gear 100 of the frame, which in turn is drivingly engaged, through conventional gearing already described or other arrangement, to the carriage drive rack, whereby it may drive and reciprocate the carriage. In place of motor 214, a hydraulic cylinder may be utilized to reciprocate the rack 98 or otherwise drive the bobbin carriage.

From hydraulic motor 214 and the reversing valve 208, the variable oil flow is conveyed through conduit 216 to a fixed hydraulic motor 218, which corresponds in type to the motor 214. The motor 218 in this embodiment supplies, through gear 72 and gear train 74, the variable speed input component to the compound 40, whereby the bobbins are driven at a variable speed representing the sum of the fixed and variable speed input components to the compound. From motor 218, the oil flow may return to the pump 202, or to a sump. In this manner, a variable oil flow is derived from the constant speed main drive of the frame, and utilized serially to provide variable speed drives for the bobbin carriage and for the compound.

The reversing valve 208 may be alternated between its two operative positions by a solenoid 220, operated by a switch 222 in series with the solenoid and with a power source 224. The switch 222 may be actuated by a cam 226 mounted on the tumbler shaft 60. As shown in Figure 7, the cam 226 may be circular, and provided with a single flat 228, adapted to be aligned with the actuating arm or button of the switch 222 in one of the two rest positions of the tumbler shaft. As will be understood, in the cam position shown, the switch 222 may be open whereby the valve 208 will be disposed in one of its two operative positions by spring pressure or otherwise. Rotation of the tumbler shaft 60 through 180° then, will close the switch, causing the solenoid 220 to displace the reversing valve 208 to its other operative position, and such relationship will persist until the tumbler shaft again rotates 180°.

In this embodiment the conventional builder motion is utilized to control the variable output of pump 202, and thereby the speed of the hydraulic driving motors 214 and 218, and also to effect reversal of the oil flow through motor 214, both operations being electrically actuated in simple manner. While in converting present machines it will usually be convenient to use the builder motion already provided, it will be recognized that in the Figure 5 embodiment of the invention only sufficient power is required to operate the two switches 166 and 222. 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 cam 146. 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.

The Figure 5 embodiment includes a distinct supercharging system, including a separate hydraulic pump 230 powered by an electric motor 232. The supercharging pump 230 may draw oil from a sump 234 through a strainer 236, and provides oil at working pressure, for example 250 lbs. p.s.i., to both sides of the variable pump 202 and motors 214 and 218. In this way, the variable pump and the hydraulic motors of the variable speed drive may be prestressed while the frame is not operating, and start up without any lost motion, thereby maintaining the accuracy of the variable speed drive through successive operations. In the circuit illustrated, supercharging pressure may be transmitted from the pump 230 to the input of variable pump 202 through conduit 238, and through conduit 240, check valve 242 and conduit 244 to the output side of pump 202, and to one side of motor 214. The supercharging pressure may also be transmitted through conduit 246 to the outlet side of motor 218, and through bypass conduit 248 and check valve 250 to conduit 216, and thereby to the infeed side of motor 218 and to the other side of motor 214. When the frame is in operation, the oil flow may bypass the supercharging pump 230, the output of motor 218 passing through conduits 246 and 240 directly into conduit 238, and thereby back to the variable pump 202.

A further embodiment of the invention is illustrated in Figures 8 and 9, wherein, as in the previous embodiment, the conventional mechanical direct and constant speed drive to the spindles, compound, drawing rolls and builder motion is retained. This embodiment is distinguished by the provision of hydraulic means facilitating kinking of the stock above the flyers immediately prior to doffing, and providing for driving the bobbin carriage toward or to the end of a stroke while the frame is otherwise at rest. Further, in this embodiment, the variable speed control cam and reversing valve for the lay motor are mechanically actuated by the builder motion.

As in the previous case, the power input to pulley 20 and main shaft 22 is transmitted directly to the spindles, the compound, the draft rolls and the building motion tumbler shaft, and by means of gear 200 to the variable output hydraulic pump 202, which is accordingly powered by the direct drive. The variable output flow of pump 202 is conveyed through hydraulic motors 214 and 218 in series, although in this case the oil flow passes first through conduit 216′ to the motor 218, and from motor 218 through conduit 260 to the reversing valve 208. On leaving the reversing valve, the oil flow is returned directly to the pump 202 through conduit 262. In this manner, as in the previous case, the constant speed main drive is converted by variable pump 202 to a variable oil flow, which flows successively through motors 218 and 214, delivering a variable speed to the compound and to the carriage drive. For independent control of the speeds of motors 214 and 218, a portion of the variable oil flow may be bypassed around motor 214 through conduit 252 and variable throttle valve 254. The operation of the throttle valve may be controlled by a disc cam 256, indexed in unison with the control cam 146, conveniently by means of a fixed connection 258. Such independent control and means therefor are disclosed and claimed in my copending application Serial No. 620,406, filed on even date herewith.

In this embodiment the conventional builder motion is used to drive the variable pump control cam 146 directly and mechanically. The movement of tumbling shaft 60 is transmitted in conventional manner through the tension change gear 264 to the winding shaft 266, and the periodic movement of the winding shaft is effective through its gear 268 to displace the rack 270, usually associated with the cone belt. The rack 270 actuates the builder shaft 64 through the twist change gear 272 in conventional manner, and in this case is utilized to rotate the gears 274 and 276, which may be mounted on a common shaft 278. The gear 276 may be engaged in driving relationship to a gear 280, which corresponds to the rack wheel 156 of previous embodiments, and is operative to index the cam 146 through the gear 152.

The action of the builder motion is also utilized to mechanically actuate the four way reversing valve 208. For this purpose, a reversing cam 282 may be fixed to the tumbler shaft **60**, and a rigid link **284** provided between the reversing valve and the reversing cam. Conventional means may be provided to guide the link **284**, and the assembly is desirably biased toward the reversing cam, as by spring **286**. The reversing cam **282** may be shaped as illustrated in Figure 9. In the position shown, the link **284** is displaced a maximum distance from the cam axis, and the valve **208** would be displaced, against the action of spring **286**, to the position opposite to that illustrated in Figure 8. Rotation of the reversing cam through 180° would permit the link **284** to move inwardly against the cam flat **288**, permitting the spring **286** to displace the valve **208** and the link **284**, to the relative relationship illustrated in Figure 8.

To facilitate kinking of the stock above the flyers, for the purpose of doffing, an auxiliary circuit may be provided to bypass the output of pump **202**, thereby effectively deactivating the variable speed drive. This circuit includes the branch **290** leading from the conduit **216′**, at a point adjacent the outlet of pump **202**, to the valve **292**, which is normally closed. A branch line **294** leads from the valve **292** to the return conduit **262**. A manually operated lever **296** may be provided adjacent valve **292**, pivotally mounted and adapted to move the valve to open position. As shown, movement of the operating lever to the left will displace the valve **292** to the left against the action of the spring **298**, whereby the valve passage **300** opens the conduit **290** to the conduit **294**. In this position, the valve **292** permits the output of pump **202** to circulate through conduits **290**, **294** and **262**, whereby the motors **214** and **218** are bypassed. As will be understood, the operating lever **296** may be manipulated as described somewhat before the frame comes to a stop at the end of a cycle, thereby terminating the variable speed drive to the bobbin carriage and to the compound. This allows the roving to kink or bunch up on top of the flyers so as to provide slack for removing the flyers prior to doffing. In conventional frames, it is customary to raise the bottom cone and thus disengage the cone pulley, to effect the same result.

An alternative arrangement for kinking at the end of a cycle is illustrated in Figure 10. As there shown, the disc cam **146′** corresponds to the control cam **146** described in connection with Figure 1 through the 270° segment corresponding to the winding cycle. That is, the periphery of the cam descends in a spiral from starting point **340** to point **342**, which represents the end of the winding cycle. Beyond point **342**, the cam **146′** descends to a low point **344**, adapted to position the control plunger **204** of pump **202** at a position corresponding to zero delivery. Near the end of a cycle, then, the variable pump control plunger may contact the cam **146′** at or near its point **342**, and the cam may then be indexed mechanically or manually to bring the pump plunger into contact with point **344**, whereby delivery of oil by pump **202** and through the motors **214** and **218** will be terminated, before the frame comes to a full stop. Running of the frame for about two or three revolutions of the bobbins after terminating the oil delivery will cause the sliver to kink above the flyers in precisely the same way as may be effected by the operation of valve **292** to bypass the pump. When the frame is reset for the next cycle, the special cam **146′** may be reset to starting position, manually or otherwise. Deactivation of the variable speed hydraulic drive for kinking may also be effected in the present invention by the interposition of clutch means between gears **126** and **200**, and declutching the pump **202** near the end of the cycle.

It is essential in ordinary fly frame operation to terminate a cycle with the carriage in a position intermediate the extremes of its possible travel. This follows from the shaping of packages with cone ends, and the termination of winding approximately at the middle of the outer layer. During the rest period for doffing, the frame is reset to starting condition, and winding on the new bobbins necessarily begins with the carriage in the same position at which the previous cycle was terminated. The inintial layer of roving on the new bobbins, accordingly, is a half or partial layer starting near the center of the bobbins and extending to one end thereof. The next roving layer is necessarily uneven, since it is partially on the first layer and partially on the bare wood. This introduces diversity in tension through the initial layers which is not equalized until several layers have been wound upon the bobbins. Usually, because of this inherent condition, the tension on the first two or three layers is made excessively tight, whereby the roving constituting these layers is unduly stretched with respect to the roving in the outer layers of the package. This undesirable non-uniformity may be eliminated by initiating winding at or near an end of the bobbin rather than in the middle, and means are provided in the present invention to move the bobbin carriage to or toward an end of its travel in either direction, while the remainder of the frame is at rest.

In the embodiment of Figure 8, the supercharge system and its pump **230** are utilized for traversing or resetting the carriage. As previously indicated the supercharge pump remains operative while the frame is at rest during doffing. At such times, of course, the direct drive to the frame is deactivated, and there is no input to the variable hydraulic pump **202**. The supercharge pump furnishes working pressure to the inlet side of pump **202** through conduit **302**. The same conduit conveys working pressure through conduit **262** and normally open valve **306** to the reversing valve **208**, and thence to one side of motor **214**. Working pressure is transmitted also through conduits **240** and **310** and check valve **312** to conduit **216′**, and thereby to the outlet side of pump **202** and to the inlet of motor **218**. From conduit **310**, a branch conduit **314** leads through check valve **316** and conduit **260** to the outlet side of motor **218**, and also to the reversing valve **208**, and thereby to the other side of motor **214**.

The normally open valve **306** has two positions, its normal position providing communication between connected sections of conduit **262**, as shown. In its other position, the valve by means of its passage **322** is adapted to connect conduit **262** with the return line **324**, which empties into the sump **234**. As indicated in Figure 8, the valve **306** may be normally maintained in the position illustrated as by a spring **326**, and disposed for operation to opposite position by the operating lever **296**.

When the operating lever is displaced to the right as shown in Figure 8, the valve **306** is moved against the action of spring **326** to connect conduit **262** with return line **324**. This permits a flow of oil through the lay motor **214**, while the motor **218** and the pump **202** are at rest. The oil path is from the supercharge pump **230** through conduit **240**, branch **314**, check valve **316**, reversing valve **208** (and, of course, conduits **210** and **212** and motor **214**), conduit **262**, valve **306** (in particular the passage **322** thereof), and through conduit **324** back to the sump **234**. As will be apparent, the position of the reversing valve is immaterial, and the supercharge pump will drive the bobbin carriage in the direction determined by the position of the reversing valve to or toward the end of its travel. The movement of the carriage may be terminated by return of the operating lever **296** to central inoperative position, or stop means may be provided on the frame or carriage to deactivate the hydraulic circuit just described at or near the end of the carriage stroke. In other words, an interlocking arrangement may insure that the carriage is not run beyond the end of its stroke, and such interlocking arrangement may be mechanical or electrical and associated with operating lever **296**, or hydraulic, or otherwise. In this manner the bobbin carriage may be reset during the doffing period, and winding on the new bobbins begun at an end thereof, with the attendant advantages indicated. If desired, to expedite subsequent operations or for other reason, the carriage may be reset to a position near an end of its travel, to permit initiation of winding with a partial layer representing a small fraction of a full layer.

Figure 11 illustrates an alternative arrangement for mechanical actuation of the reversing valve for the lay motor **214**. In this Figure, an eccentric **330** is mounted on the tumbler shaft **60**, and a rotary reversing valve **332** establishes alternative communication between conduits **260** and **262**, on the one hand, with the conduits **210** and **212** leading to the motor **214**, on the other hand. A bifurcated actuating arm **334** extending from the valve body may enclose the eccentric **330**. In the position illustrated, conduit **260** communicates with conduit **212**, and conduit **262** with conduit **210**. The eccentric **330** and the valve actuating arm **334** are so dimensioned and disposed that 180° rotation of the tumbler shaft **60** and the eccentric **330** will rotate the actuating arm **334** and the valve body to bring conduit **260** into communication with conduit **210**, and conduit **262** into communication with **212**, thereby reversing the direction of flow through the lay motor. As will be evident, the valve body may be otherwise engaged to the eccentric, or other mechanical arrangement may be provided to reverse the oil flow through motor **214** in accordance with operation of the builder motion. For example, the valve **208** may be substituted by a mechanically actuated snap-action valve, adapted to be tripped by means of cams mounted on the blocks or nuts of the builder motion. This would permit the reversing valve to be mounted on the bobbin carriage, being tripped at each end of the carriage stroke by engagement with a cam.

In Figure 12 is illustrated 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 **350** drives a fixed hydraulic pump **352** at constant speed, whereby a constant flow of oil is pumped thereby through conduit **354**. The hydraulic pump **352** is necessarily of considerable capacity, and may be for example a Vickers Model PV-2008. Conduit **354** carries the constant oil flow to a fixed hydraulic motor **356**, which may be a Vickers Model MF-2008, and the oil flow passes through the motor **356** to the conduit **358**. The motor **356**, as will be recognized, provides the constant speed main drive for the frame, driving a gear **360** which is drivingly engaged to a gear **362**, the latter being mounted on the main shaft **22** in place of the customary drive pulley. The constant speed drive is transmitted by gear train **26** to the spindles **36** and flyers **38**, and through twist change gear **44** and intermediate gearing to the top cone shaft **42**, and to the front roll shaft **54**.

A variable speed may be derived from the constant speed drive precisely in the manner illustrated in the embodiment of Figure 5, and described in connection therewith. That is, a variable hydraulic pump **202** may be driven from the top cone shaft, the output of the variable pump being controlled by a control cam **146**, which is indexed automatically in accordance with the operation of the builder motion. The variable output of pump **202** is carried by conduit **206** to the reversing valve **208**, and passes through the lay motor **214**, the direction of the oil flow through the lay motor being automatically reversed in the manner previously described by the reversing valve, the operation of which is controlled electrically in this case, by the builder motion. The oil flow, after leaving the lay motor **214**, is conducted through conduit **216** to the hydraulic motor **218**.

Before it reaches the hydraulic motor **218**, the variable oil flow passing through conduit **216** is combined with the constant oil flow passing through conduit **358**, at junction **362**, and the combined oil flows pass through and drives the bobbin motor **218**. The output of motor **218** is transmitted by means of gear **364** and gear train **366** to the gear **78** mounted on the bobbin shaft **80**, and thereby to the bobbins. It will be recognized that the speed of motor **218** and 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 **202**, the latter corresponding to the speed of the lay motor **214**. The combination of the two oil flows, then, serves the function of the usual compound, which in the present invention is replaced by a simple plumbing fitting such as a **T** at the junction **362**.

The motor **350** may also drive a supercharge pump **370**, adapted to maintain working pressure throughout the system while the frame is at rest. If a single electric motor **350** is used, suitable provision may be made to declutch the pump **352** or to bypass its output while the frame is at rest, the pump **370** remaining active during such periods. Alternatively, a separate motor may be provided for the supercharge pump **370**. In the Figure 12 embodiment, supercharging pressure is supplied through conduits **372** and **374** and check valve **376**, and conduit **354** to the inlet of motor **356**, and to the outlet of pump **352**. The supercharging pressure is transmitted also through conduits **372** and **378** and check valve **380** to the outlet side of motor **356** and to the inlet side of motor **218**. A branch **382** leads from conduit **378** to the inlet of variable pump **202**, this branch constituting the normal feed line for pump **202**, and another branch conduit **384** transmits supercharging pressure through check valve **386** to the outlet side of pump **202**, and to one side of motor **214**. Conduit **388** communicates with conduit **372**, and carries supercharging pressure to conduit **390**, which leads to the outlet of motor **218** and to the inlet of pump **352**, and through conduit **392** and check valve **394** to the other side of the lay motor **214**. The supercharging system described, then, provides access of supercharging pressure to both sides of all hydraulic pumps and motors of the system, prestressing these elements, whereby the frame may remain at rest for short or extended periods of time and then start up without lost motion.

The completely hydraulic drive system illustrated in Figure 12, obviously, can be adapted for kinking, and for resetting the carriage while the frame is at rest, in a manner corresponding to that described in connection with Figure 8. 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 hydraulic drive means engaged to said carriage and to said bobbin rotating means in driving relationship, and means actuated by said builder motion controlling the output of said hydraulic drive 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, variable 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 controlling the output of said hydraulic drive means.

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, variable hydraulic drive means engaged to said carriage and to said compound in driving relationship, and means actuated by said builder motion controlling the output of said hydraulic drive means.

4. 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, variable hydraulic drive means powered by said direct drive means engaged to said carriage and to said compound in driving relationship, and means actuated by said builder motion controlling the output of said hydraulic drive means.

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, said direct drive means being engaged also to said bobbin rotating means through a compound, variable hydraulic drive means powered by said direct drive means engaged to said carriage and to said compound in driving relationship, a cam controlling the output of said hydraulic drive means, and means for indexing said cam in accordance with the operation of said builder motion.

6. A fly frame as defined in claim 5, wherein said cam indexing means includes a tension change gear.

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, said direct drive means being engaged also to said bobbin rotating means through a compound, a variable speed hydraulic transmission powered by said direct drive engaged to said carriage and to said compound in driving relationship, and means actuated by said builder motion controlling the output of said hydraulic transmission.

8. A fly frame as defined in claim 7, including a supercharge pump connected to said transmission and adapted to eliminate lost motion therein.

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 variable speed hydraulic transmission powered by said direct drive engaged to said carriage and to said compound in driving relationship, a cam controlling the output of said hydraulic transmission, and means for indexing said cam in accordance with the operation of said builder motion.

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 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 controlling the speed of said motors.

11. A fly frame as defined in claim 10, including a supercharge pump and circuit adapted to maintain operating pressure and eliminate lost motion in said pump and motors at all times.

12. A fly frame as defined in claim 10, wherein said first hydraulic motor is engaged to said carriage through a lay change gear.

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 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, and means conveying the output of said pump through said motors in series.

14. A fly frame as defined in claim 13, wherein the output of said pump is conveyed first through said first hydraulic motor.

15. A fly frame as defined in claim 13, wherein the output of said pump is conveyed first through said second hydraulic motor.

16. A fly frame as defined in claim 13, wherein said means actuated by said builder motion includes a cam, and means for indexing said cam in accordance with operation of said builder motion.

17. A fly frame as defined in claim 13, wherein said means actuated by said builder motion includes a cam, a tension change gear, and means for indexing said cam through said tension change gear in accordance with operation of said builder motion.

18. A fly frame as defined in claim 13, wherein said means actuated by said builder motion includes a cam, and means for mechanically indexing said cam in accordance with operation of said builder motion.

19. A fly frame as defined in claim 13, including an electrically operated valve for reversing the flow through said first hydraulic motor, a cam driven by said builder motion, and a switch actuated by said cam controlling the operation of said reversing valve.

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 through said motors in series, and means for reversing the direction of said first hydraulic motor.

21. 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, 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.

22. 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 actu-

ated 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, an electrically operated valve for reversing the flow through said first hydraulic motor, a cam driven by said builder motion, and a switch actuated by said cam controlling the operation of said reversing valve.

23. 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, a mechanically operated valve for reversing the flow through said first hydraulic motor, a cam driven by said builder motion, and a mechanical linkage actuated by said cam controlling the operation of said reversing valve.

24. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, variable hydraulic drive means engaged to said carriage and to said bobbin rotating means in driving relationship, means actuated by said builder motion controlling the output of said variable hydraulic drive means, and means for deactivating said variable hydraulic drive means for kinking prior to doffing.

25. In a fly frame including drawing rolls, flyers, bobbin rotating means, a traversing bobbin carriage and a builder motion, variable hydraulic drive means engaged to said carriage and to said bobbin rotating means in driving relationship, means actuated by said builder motion controlling the output of said variable hydraulic drive means, and hydraulic means for driving said carriage while the frame is at rest.

26. 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, means actuated by said builder motion controlling the speed of said motors, and means for deactivating said hydraulic pump for kinking prior to doffing.

27. 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, means actuated by said builder motion controlling the speed of said motors, and means for deactivating said first and second hydraulic motors for kinking prior to doffing.

28. 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, means actuated by said builder motion controlling the speed of said motors, and hydraulic means for driving said first hydraulic motor while the frame is at rest.

29. 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, means actuated by said builder motion controlling the speed of said motors, a supercharge pump and circuit adapted to maintain operating pressure in said pump and motors at all times, and means for driving said first hydraulic motor by means of said supercharge pump while the frame is at rest.

30. In a fly frame including drawing rolls, fllyers, 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 hydraulic pump powered by said direct drive means, a second hydraulic motor engaged to said carriage in driving relationship, means conveying the output of said pump to said second motor, a third hydraulic motor engaging said bobbin rotating means in driving relationship, means conveying the discharge of said first and second motors to said third motor, and means actuated by said builder motion controlling the speed of said second and third motors.

31. 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, meant 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, a third hydraulic motor engaging said bobbin rotating means in driving relationship, and means conveying the discharge of said first and second motors to said third motor.

32. A fly frame as defined in claim 31, wherein said means actuated by said builder motion includes a cam and means for indexing said cam in accordance with operation of said builder motion.

33. A fly frame as defined in claim 31, wherein said means actuated by said builder motion includes a cam, a tension change gear, and means for indexing said cam through said tension change gear in accordance with operation of said builder motion.

34. A fly frame as defined in claim 31, wherein said means actuated by said builder motion includes a cam and electrical means for indexing said cam in accordance with operation of said builder motion.

35. A fly frame as defined in claim 31, wherein said means actuated by said builder motion includes a cam and mechanical means for indexing said cam in accordance with operation of said builder motion.

36. A fly frame as defined in claim 31, including a supercharge pump and circuit adapted to maintain operating pressure and eliminate lost motion in said pump and motors at all times.

37. A fly frame as defined in claim 31, wherein said second hydraulic motor is engaged to said carriage through a lay change gear.

38. A fly frame as defined in claim 31, including means for reversing the direction of said second hydraulic motor.

39. A fly frame as defined in claim 31, including a valve for reversing the flow through said second hydraulic motor, and means actuated by said builder motion controlling the operation of said reversing valve.

40. A fly frame as defined in claim 31, including means for deactivating said hydraulic pump for kinking prior to doffing.

41. A fly frame as defined in claim 31, including hydraulic means for driving said carriage while the frame is at rest.

42. A fly frame as defined in claim 31, including hydraulic means for driving said second hydraulic motor while the frame is at rest.

43. A fly frame as defined in claim 31, including a supercharge pump and circuit adapted to maintain operating pressure in said pump and motors at all times, and means for driving said second hydraulic motor by means of said supercharge pump while the frame is at rest.

44. 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 the drawing rolls, flyers and builder motion at constant speeds, driving the carriage and the bobbin rotating means at variable speeds, and independently driving the carriage while the frame is at rest.

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