Dec. 5, 1939. W. FERRIS 2,182,745

RECIPROCATING MECHANISM

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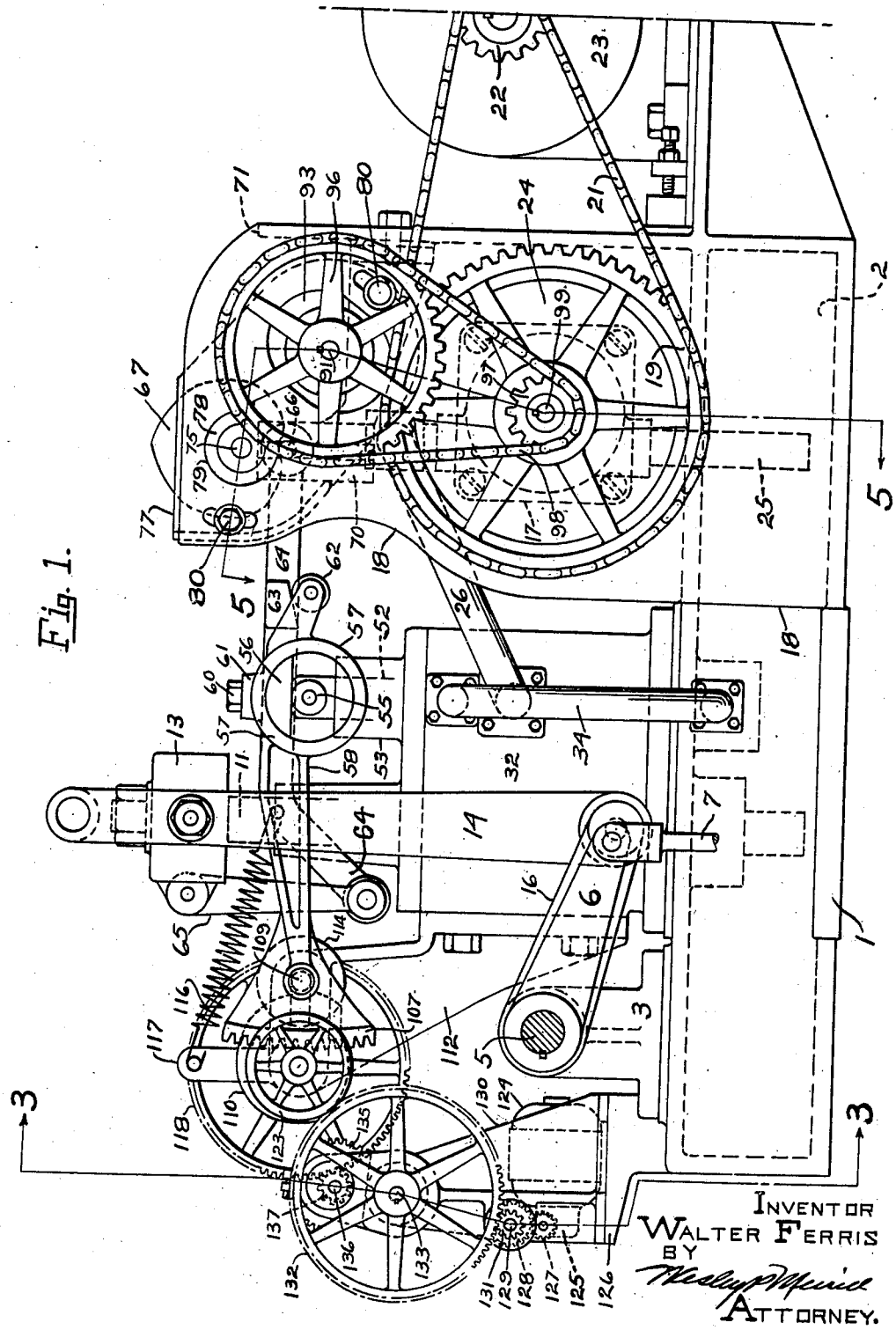


Fig. 1.

INVENTOR
WALTER FERRIS
BY
Wesley P. Mueller
ATTORNEY.

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RECIPROCATING MECHANISM

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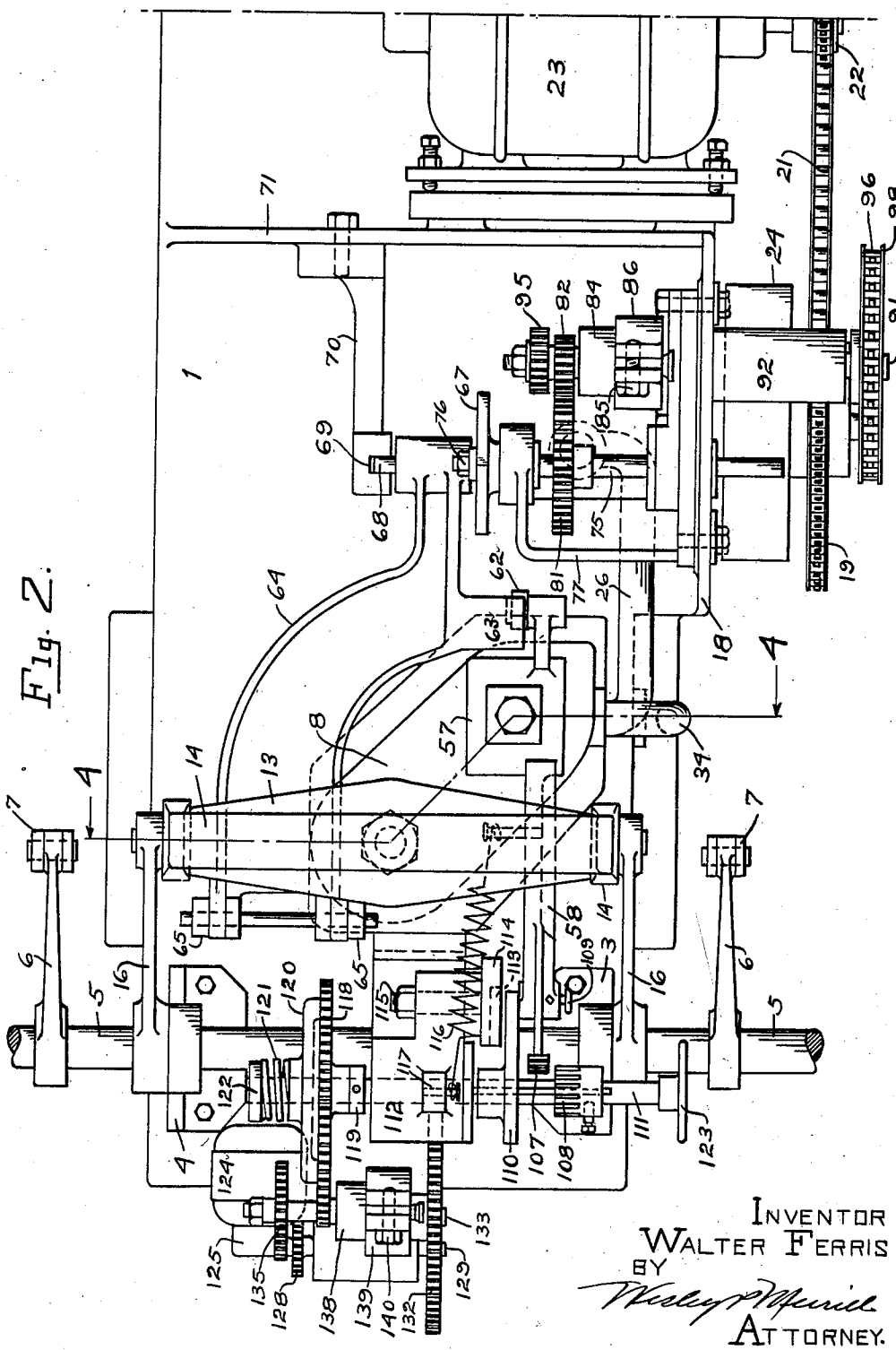


Fig. 2.

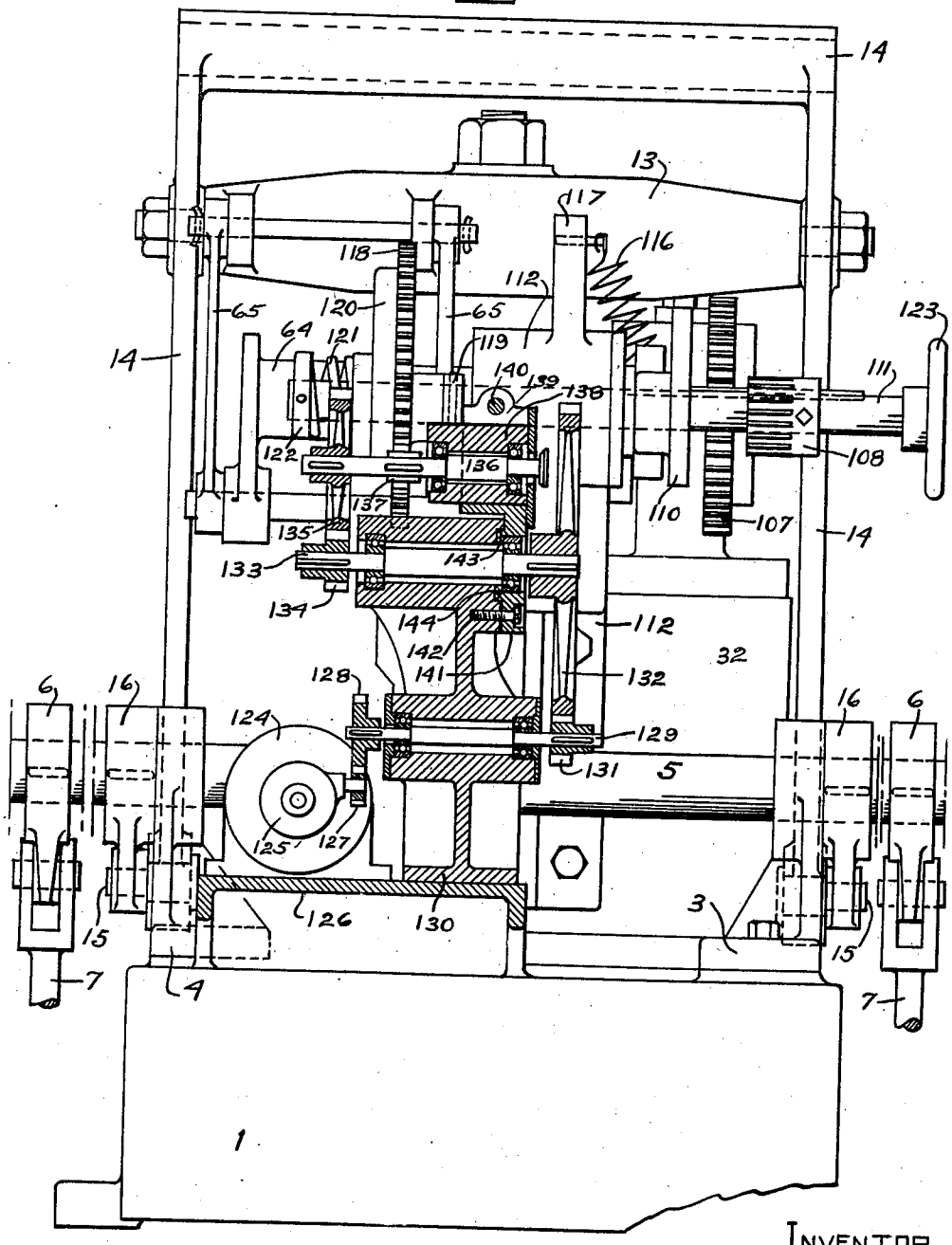
INVENTOR
WALTER FERRIS
BY
Wesley P. Merrick
ATTORNEY.

Dec. 5, 1939. W. FERRIS 2,182,745

RECIPROCATING MECHANISM

Filed June 24, 1935 11 Sheets-Sheet 3

Fig 3.



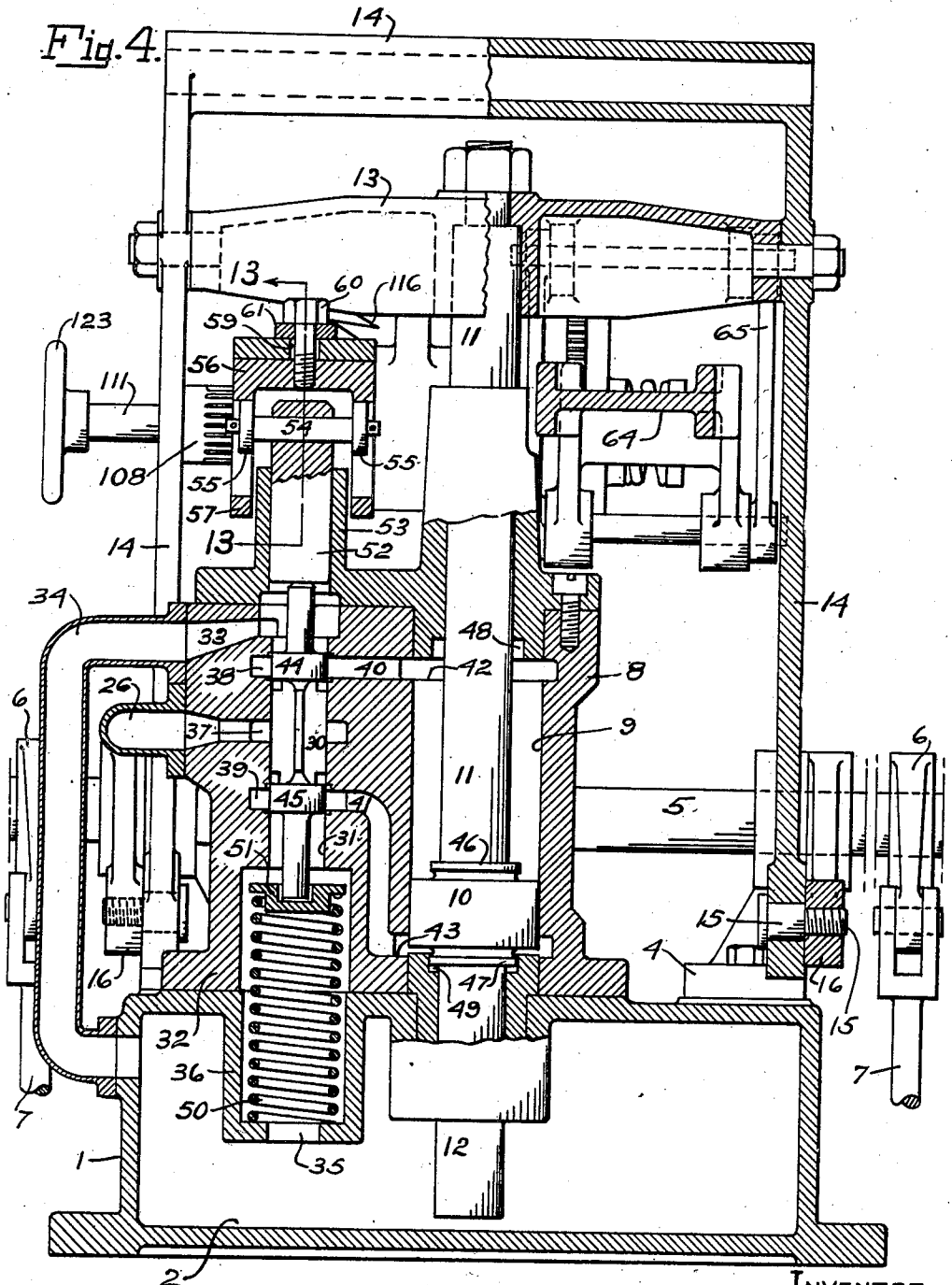
INVENTOR
WALTER FERRIS
BY
Wesley Merrick
ATTORNEY.

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RECIPROCATING MECHANISM

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Fig. 4.



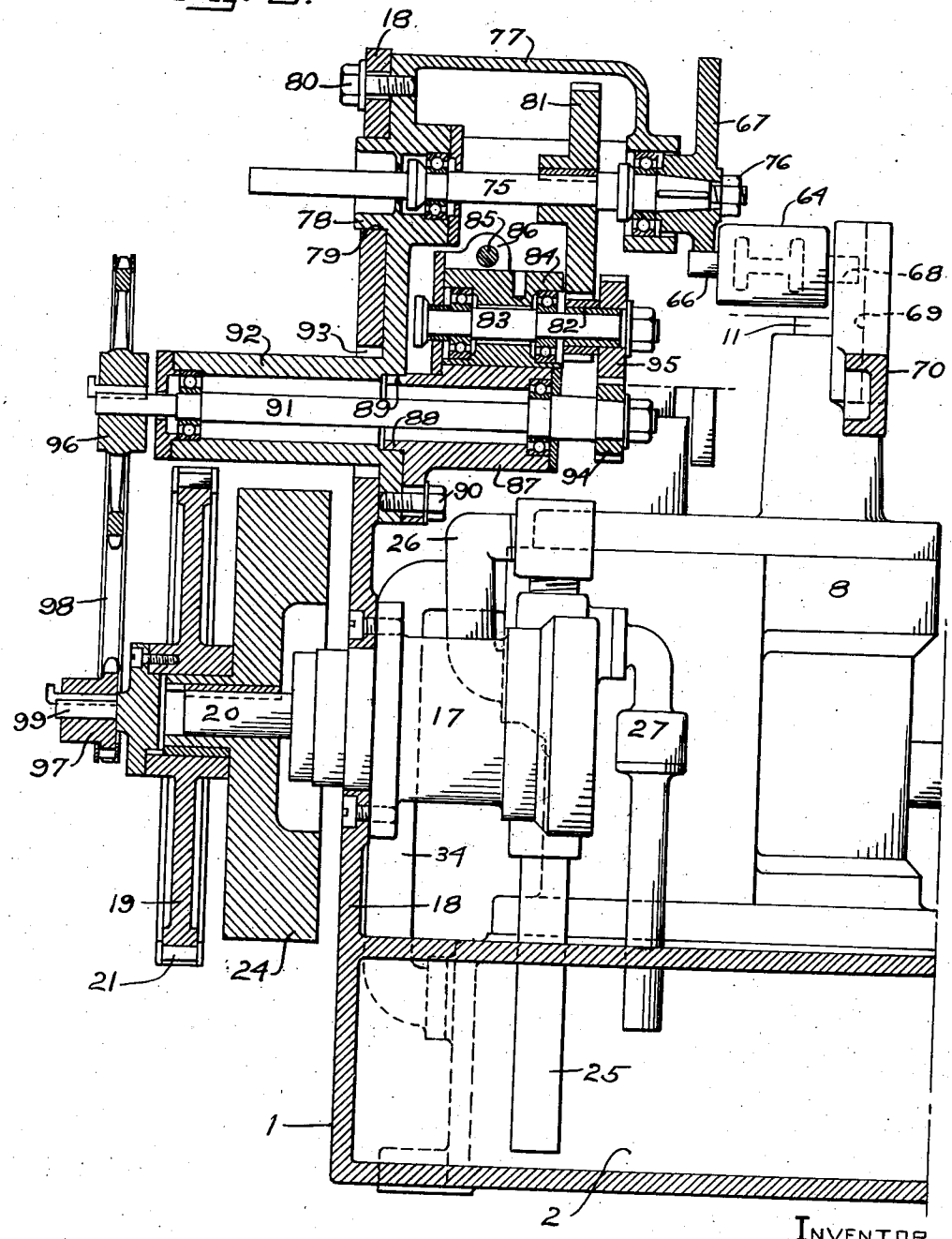
INVENTOR
WALTER FERRIS
BY
Wesley P. Merrill
ATTORNEY.

Dec. 5, 1939. W. FERRIS 2,182,745

RECIPROCATING MECHANISM

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Fig. 5.



INVENTOR
WALTER FERRIS
BY
Wesley P. Merrill
ATTORNEY.

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RECIPROCATING MECHANISM

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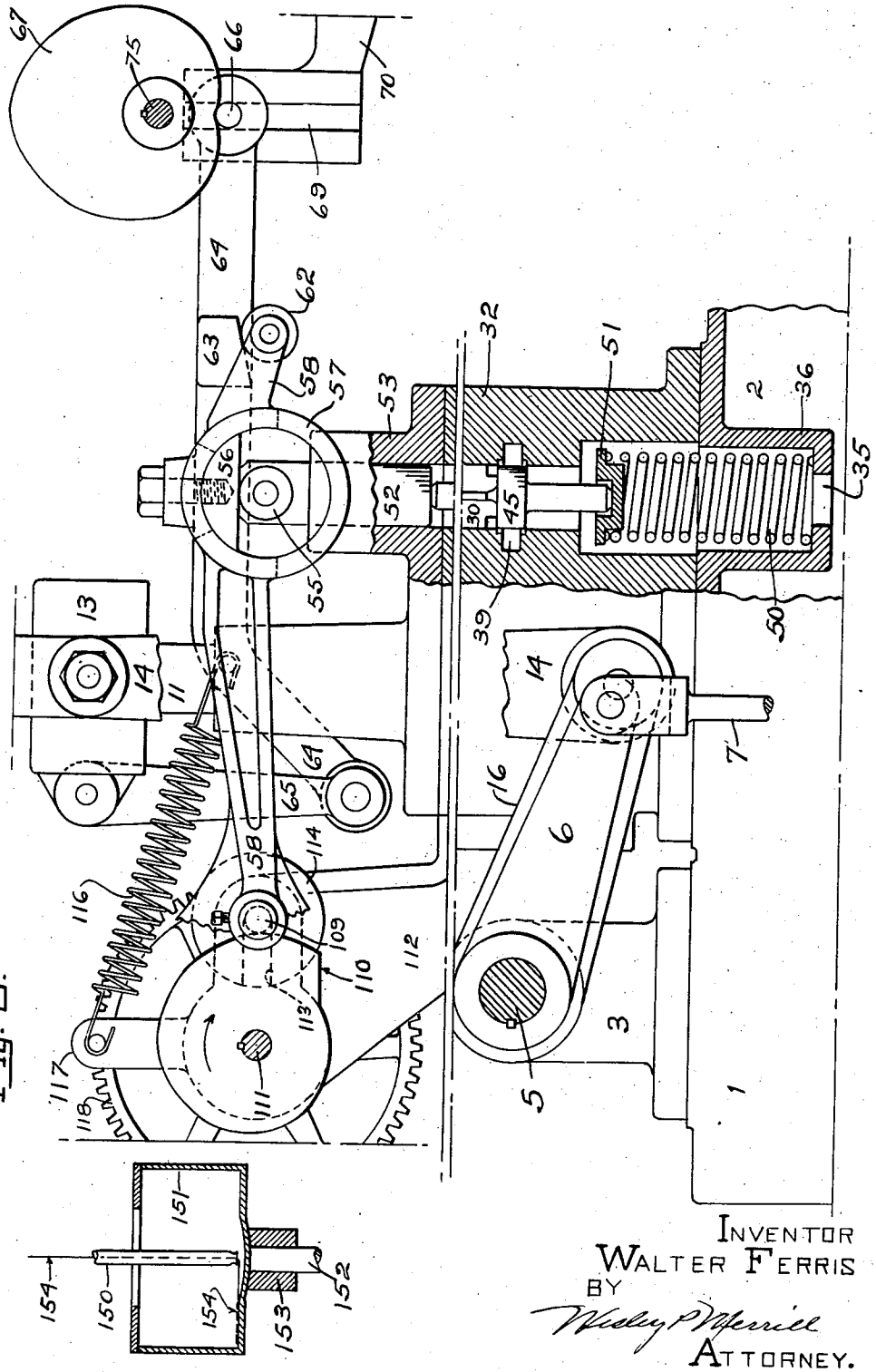


Fig. 6.

INVENTOR
WALTER FERRIS
BY
Wesley P. Merrill
ATTORNEY.

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RECIPROCATING MECHANISM

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Fig. 13.

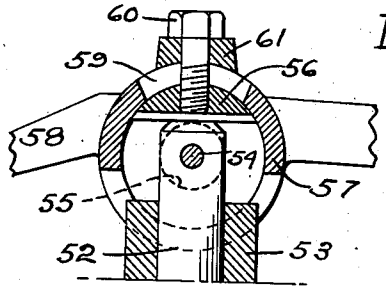


Fig. 7.

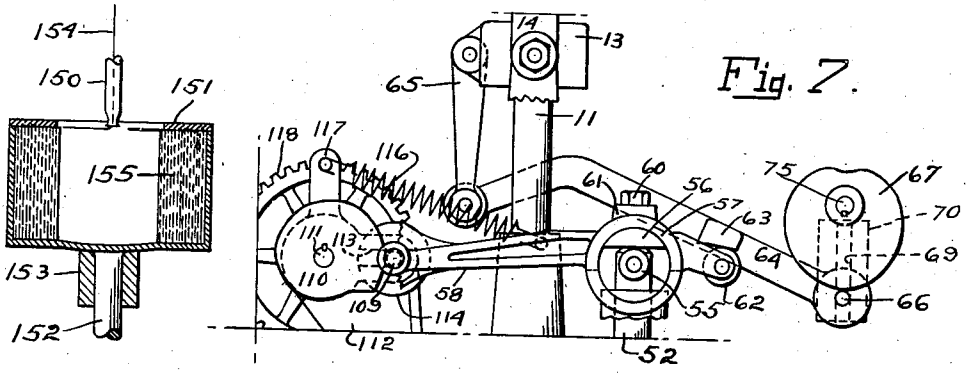


Fig. 8.

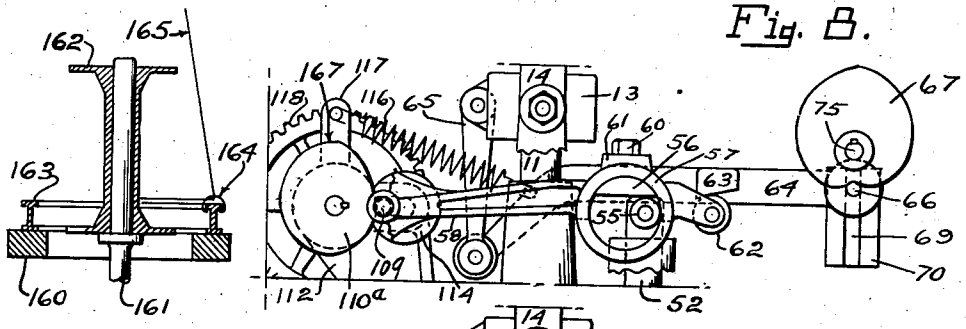
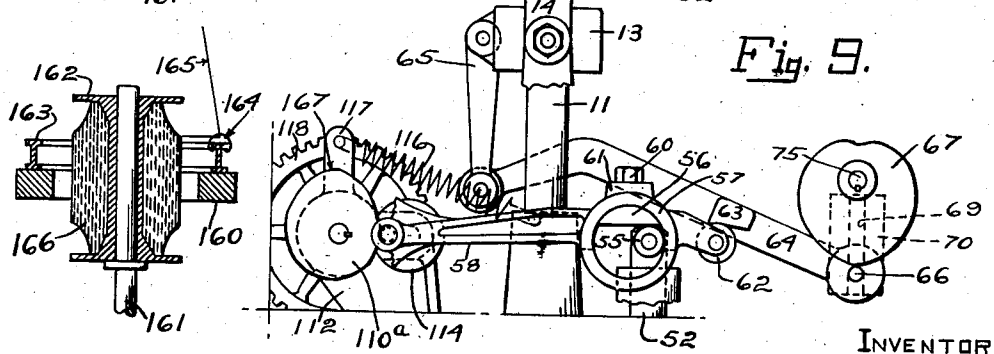


Fig. 9.



INVENTOR
WALTER FERRIS
BY
Wesley Merrill
ATTORNEY.

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RECIPROCATING MECHANISM

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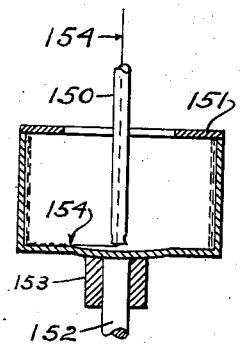
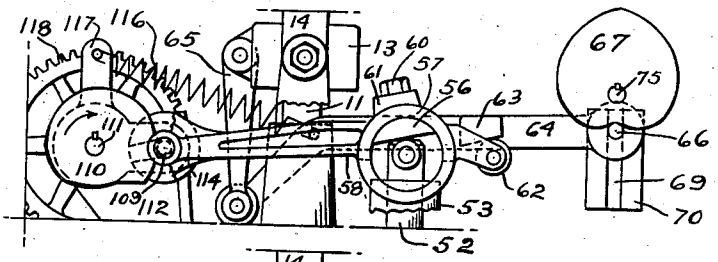


Fig. 10.



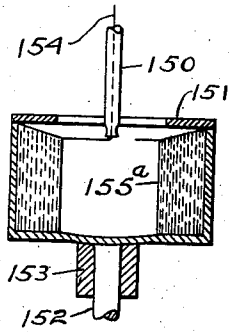


Fig. 11.

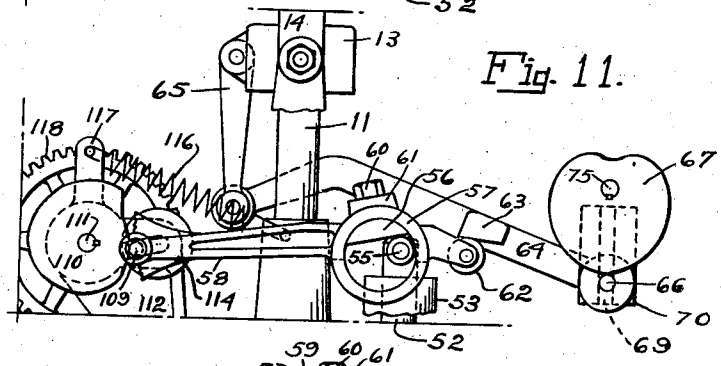
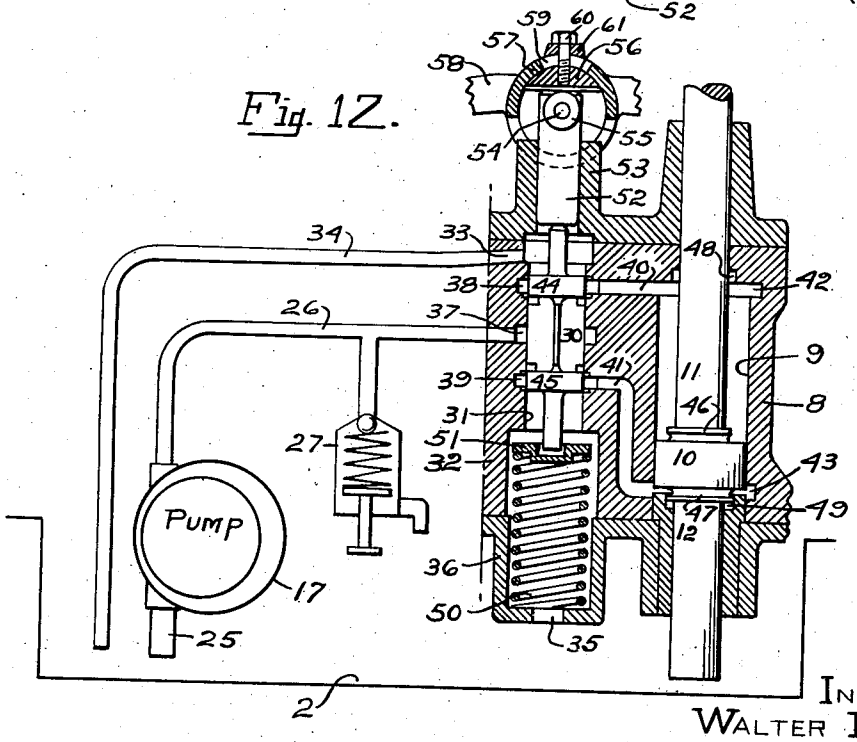


Fig. 12.



INVENTOR
WALTER FERRIS
BY
ATTORNEY.

Dec. 5, 1939. W. FERRIS 2,182,745

RECIPROCATING MECHANISM

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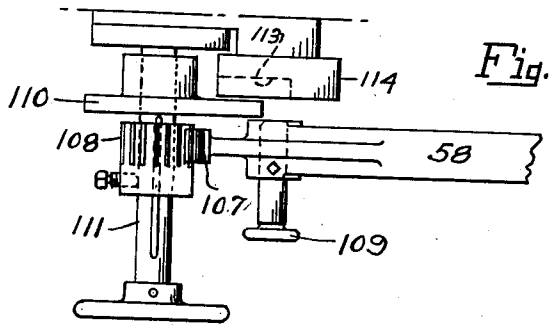


Fig. 14.

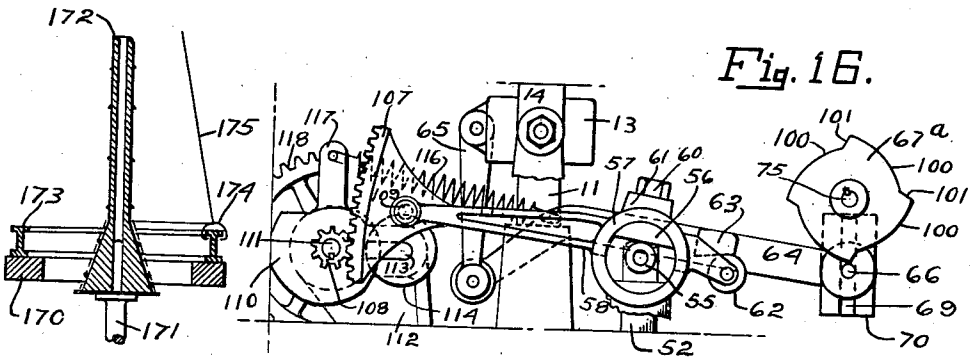


Fig. 16.

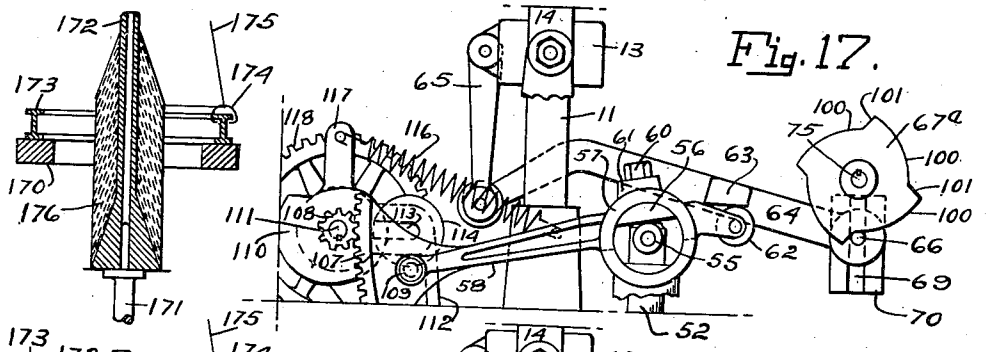


Fig. 17.

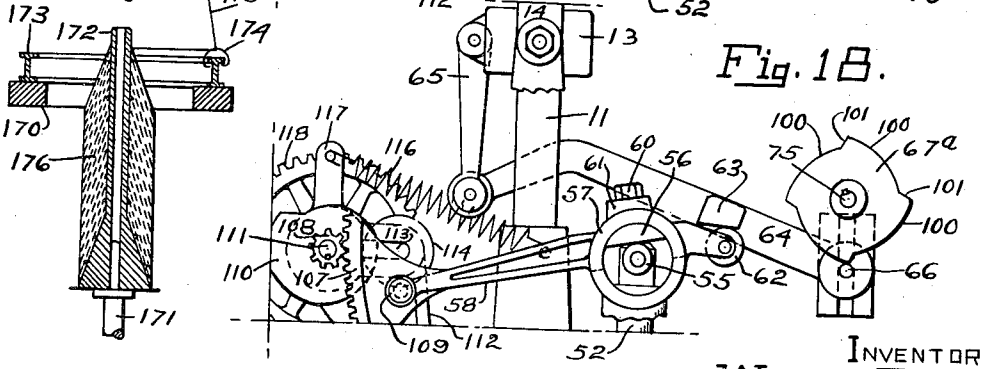


Fig. 18.

INVENTOR
WALTER FERRIS
BY
Wesley P. Morris
ATTORNEY.

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RECIPROCATING MECHANISM

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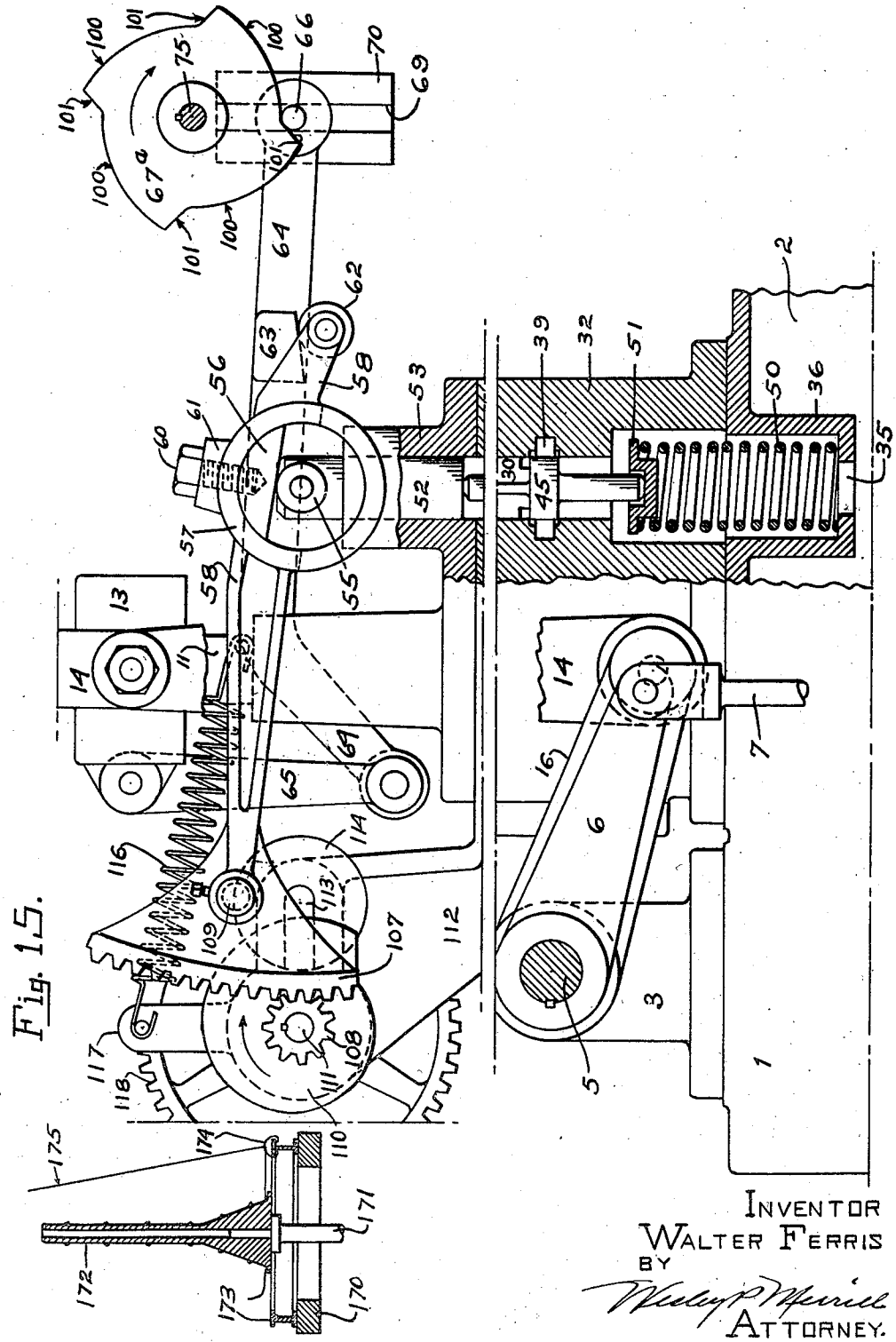


Fig. 15.

INVENTOR
WALTER FERRIS
BY
Wesley P. Merrill
ATTORNEY.

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RECIPROCATING MECHANISM

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Fig. 19.

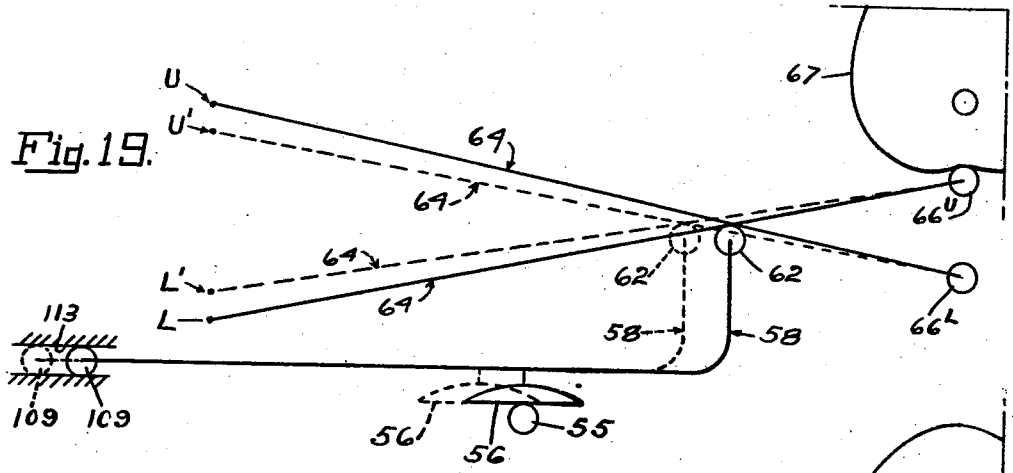


Fig. 20.

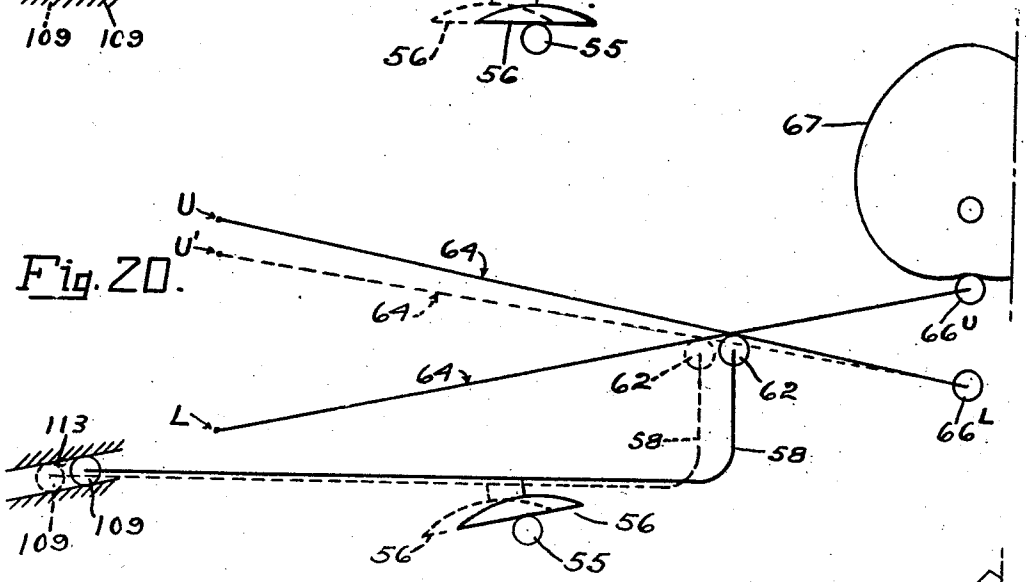
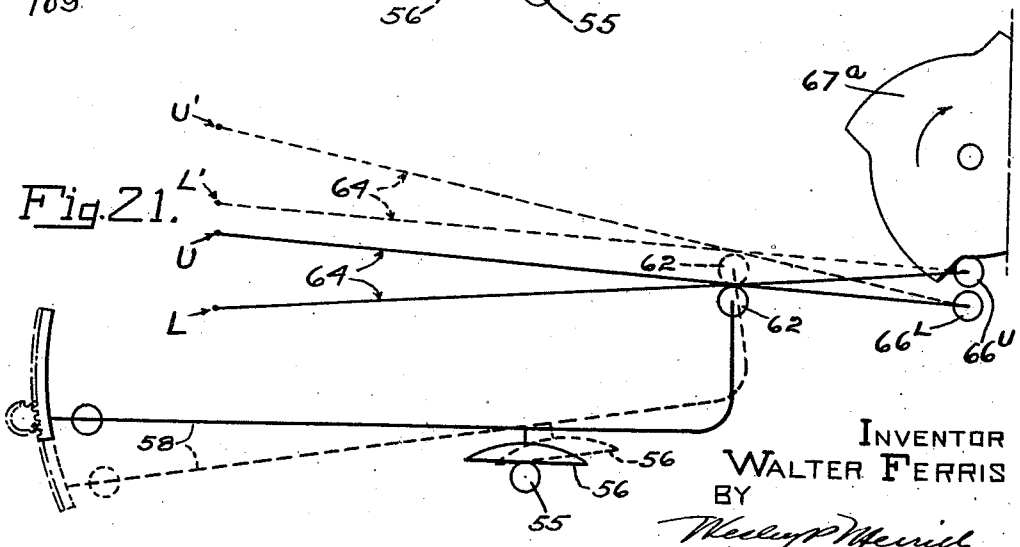


Fig. 21.



INVENTOR
WALTER FERRIS
BY
Wesley P. Merrick
ATTORNEY.

Patented Dec. 5, 1939 2,182,745

UNITED STATES PATENT OFFICE

2,182,745

RECIPROCATING MECHANISM

Walter Ferris, Milwaukee, Wis., assignor to The Oilgear Company, Milwaukee, Wis., a corporation of Wisconsin

Application June 24, 1935, Serial No. 28,117

19 Claims. (Cl. 60—52)

This invention relates to reciprocating mechanisms and is particularly adapted for reciprocating machine parts or members such as the ring rails or the traverse bars of textile spinning machines.

Ring rails are employed to guide yarn or thread along predetermined paths and to cause the same to be twisted during the winding thereof upon suitable carriers, such as bobbins and the like, upon which the thread or yarn remains until unwound therefrom for use or for further processing.

Traverse bars are employed to guide rayon threads during the winding thereof upon or within suitable carriers. In one type of machine, the rayon threads are wound upon the inside of a hollow "bucket" or cup from which the thread is removed in a single annular mass or cake.

If the thread or yarn is to be unwound by withdrawing it radially from the winding, it is wound upon the carrier in a form known as "warp-winding". In this form, the thread or yarn is wound in uniform layers with each turn in each layer in contact with the adjacent turn in that layer.

In guiding the thread or yarn to make a warp-winding, the ring rail or traverse bar should travel at a uniform speed in both directions and, unless the thread or yarn is being wound between flanges which extend at right angles to the axis of the winding, the stroke or traverse of the ring rail or traverse bar should be gradually increased or decreased at one end or at both ends of the stroke as the winding progresses.

If the thread or yarn is to be unwound by withdrawing it axially from the winding, it is wound in a form known as "filling-winding". In this form, the thread or yarn is wound in short overlapping layers with the thread or yarn wound in tight spirals in alternate layers and in open spirals in the intermediate layers to prevent the thread or yarn from sloughing off the end of the winding when drawn axially therefrom.

In guiding the thread or yarn to make a filling-winding, the ring rail must travel at one speed in one direction, in order to wind the thread or yarn in tight spirals, and at a much greater speed in the opposite direction to wind the thread or yarn in open spirals. Also, its range of reciprocation must be gradually moved or advanced in order to produce the overlapping layer characteristic of the filling winding.

Ring rails, traverse bars and the like have heretofore been reciprocated mechanically by means of cams, gears and suitable linkage but, due to the inertia of the moving parts, both the speed and the permissible weight of the reciprocating parts have heretofore been limited and in some instances the wear on the cams and other parts is so great that frequent renewal is required.

The present invention has as an object to provide a reciprocating mechanism which may be operated at high speeds without injury to itself or to any part of the machine with which it is associated.

Another object is to provide a reciprocating mechanism which is capable of reciprocating relatively heavy machine parts without injury to itself or to the machine with which it is associated.

Another object is to provide a reciprocating mechanism which is positive and precise in operation, and which is capable of reversing much more quickly than is possible with the mechanical cams heretofore used.

Another object is to provide a reciprocating mechanism which is susceptible of close adjustment and control.

Other objects and advantages will appear from the description hereinafter given of a reciprocating mechanism in which the invention is embodied.

According to the invention in its general aspect, the mechanism is provided with a reciprocating hydraulic motor, a valve for controlling the motor, and mechanism to operate the valve to obtain both the desired speed and length of stroke.

According to the invention in another aspect, the reciprocating mechanism is provided with means for changing the length of its stroke.

According to the invention in another aspect, the reciprocating mechanism is provided with means for changing the range of its stroke.

The invention is exemplified by the reciprocating mechanism shown in part schematically and in part in detail in the accompanying drawings in which the views are as follows:

Fig. 1 is a front elevation of a hydraulically operated reciprocating mechanism which is adapted to reciprocate or traverse the ring rail or traverse bar of a spinning machine.

Fig. 2 is a top plan view thereof and shows the parts in the positions occupied when the machine is employed to reciprocate or traverse

a ring rail or traverse bar during the production of a warp-winding.

Fig. 3 is in part an end view and in part a transverse vertical section taken on the line 3—3 of Fig. 1.

Fig. 4 is a transverse vertical section taken approximately on the irregular line 4—4 of Fig. 2.

Fig. 5 is in part a transverse vertical section and in part a sectional plan view taken on the irregular line 5—5 of Fig. 1.

Fig. 6 is a partial front view with certain parts omitted and other parts broken away to expose other parts which control the functioning of the mechanism during the production of a warp-winding, the several parts being shown in the positions occupied when the traverse bar is at the bottom of its traverse and about to start a warp-winding having flat ends.

Fig. 7 is a view showing a part of the mechanism illustrated in Fig. 6 but with the parts thereof in the positions occupied at the completion of a warp-winding having flat ends.

Fig. 8 is a view similar to Fig. 7 but showing the parts in the positions occupied just after starting a warp-winding which will have a tapered shoulder at each end thereof.

Fig. 9 is a view similar to Fig. 8 but showing the parts in the positions occupied at the completion of a winding having tapered shoulders at the ends thereof.

Fig. 10 is a view showing a part of the mechanism illustrated in Fig. 6 but with the parts thereof in the positions occupied at the beginning of a warp-winding which will have one flat end and a tapered shoulder at the other end.

Fig. 11 is a view similar to Fig. 10 but showing the parts in the positions occupied at the completion of a winding having one tapered end.

Fig. 12 is a diagram of the hydraulic circuit.

Fig. 13 is a detail sectional view taken on the line 13—13 of Fig. 4.

Fig. 14 is a partial top plan view showing the parts in the positions occupied when the mechanism is employed to reciprocate a ring rail or traverse bar during the production of a filling-winding.

Fig. 15 is a partial front view with certain parts omitted and other parts broken away to expose other parts which control the functioning of the mechanism during the production of a filling-winding, the several parts being shown in the positions occupied when the ring rail is at the bottom of its lowermost traverse, that is, in position to start the first layer of a filling winding.

Figure 16 is a view showing a part of the mechanism illustrated in Fig. 15 but with the parts thereof in the positions occupied at the completion of the first layer of a filling-winding.

Fig. 17 is a view similar to Fig. 16 but with the parts in the positions occupied at the beginning of the last layer of a filling-winding.

Fig. 18 is a view similar to Fig. 16 but with the parts in the positions occupied at the completion of the last layer of a filling-winding.

Fig. 19 is a diagram illustrating how the stroke of the reciprocating mechanism may be shortened at both ends thereof as is necessary during the production of a winding having both ends tapered.

Fig. 20 is a diagram illustrating how the stroke of the reciprocating mechanism may be shortened at one end only as is necessary during the production of a winding having one tapered end.

Fig. 21 is a diagram illustrating how the range of reciprocation may be advanced as is necessary during the production of a filling-winding.

The reciprocating mechanism is provided with a base 1 which supports the other parts of the mechanism and has formed therein a reservoir 2 to contain a supply of motive liquid, such as oil.

The base is shown provided with two bearing brackets 3 and 4 which support a relatively long rockshaft 5 having a plurality of levers 6 fixed thereon. Each lever 6 is provided at its outer end with a link 7 the lower end of which may be connected to the ring rail or traverse bar of a textile machine (not shown).

The shaft 5, levers 6 and links 7 are ordinarily parts of a textile machine, and the shaft 5 is ordinarily supported independently of the reciprocating mechanism but, for the purpose of illustration, the shaft 5 is shown supported at least in part by the base 1.

When the shaft 5 is rocked or rotated in opposite directions through a limited angular distance, the links 7 will be raised and lowered and thereby reciprocate or traverse the ring rail or traverse bar to which they may be connected.

The shaft 5 is rocked by a hydraulic motor 8 (Figs. 4 and 12) which has its cylinder arranged upon the base 1 intermediate the front and rear sides thereof and provided with a vertical bore 9 in which a piston 10 is closely fitted to reciprocate therein.

The piston 10 has secured thereto or formed integral therewith a piston rod 11 and a tail rod 12 which are equal in diameter so that the upper and lower ends of the piston have equal pressure areas. The piston rod 11 extends upward through the end of the motor cylinder and is connected at its upper end to a crosshead 13 intermediate the ends thereof. The tail rod 12 extends through the lower end of the motor cylinder into the reservoir 2.

The crosshead 13 is arranged between and has its ends pivoted to the depending arms of a yoke 14 which has the lower end of each of its arms connected by a pin 15 to the outer end of a lever 16 fixed upon the rockshaft 5. The crosshead 13 and the head or crossrail of the yoke 14 form a rigid truss which holds the several parts in correct alinement during operation of the motor 8.

When the motor 8 is operated, it will reciprocate the crosshead 13 and the yoke 14 which will oscillate the levers 16 and thereby rock the shaft 5 and cause the levers 6 and links 7 to reciprocate or traverse the ring rail or traverse bar to which the links are connected.

Liquid for operating the motor 8 is supplied thereto by a pump 17 which is shown fastened to a front plate 18 secured to or formed integral with the base 1 and extending vertically upward from the front side thereof.

The pump is driven by a sprocket wheel 19 which is fixed upon the shaft 20 of the pump and connected by a chain 21 to a sprocket wheel 22 fixed to the shaft of an electric motor 23 carried by the base 1.

The electric motor 23 drives the pump 17 at a constant speed and, in order that variations in the load upon the pump due to opening and closing of the cylinder ports as later described may not cause sudden fluctuations in the speed thereof, a flywheel 24 may be fixed upon the pump shaft 20.

The pump 17 draws liquid from the reservoir 2 through a suction pipe 25 and discharges liquid into a supply pipe 26 at a rate somewhat in

excess of the rate required to operate the motor 8 at the desired speed, the liquid delivered by the pump in excess of motor requirements being discharged into the reservoir 2 through a relief valve 27 which enables the pump to keep the pressure of the liquid in supply pipe 26 constant.

Delivery of liquid from the pump 17 to the motor 8 is controlled by a follow-up valve 30 fitted in a bore 31 formed in a block 32 which is shown as being integral with the cylinder or casing of the motor 8.

The ends of the bore 31 are open at all times to the reservoir 2 to permit liquid discharged from the motor 8 to return to the reservoir 2. As shown, the upper end of the bore 31 is open to a discharge port 33 which is connected to the reservoir by a pipe 34, and the lower end of the bore 31 communicates with the reservoir through an opening 35 formed in the bottom of a socket 36 which is carried by the base 1 in alinement with the bore 31.

The supply pipe 26 is connected to the block 32 in communication with an annular groove or port 37 which is formed in the wall of the bore 31 between two annular grooves or ports 38 and 39 also formed therein. Two fluid channels 40 and 41 formed in the block 32 connect the ports 38 and 39, respectively, to two annular grooves 42 and 43 formed in the wall of the bore 9 at the uper and lower ends thereof.

The ports 38 and 39 are controlled, respectively, by two heads or pistons 44 and 45 which are formed upon the valve 30 and closely fitted in the bore 31 to reciprocate therein. The pistons 44 and 45 are spaced apart exactly the same distance that the ports 38 and 39 are spaced apart and each is the same width as the port which is controls.

When the valve 30 is in the position shown in Fig. 4, the pistons 44 and 45 block the ports 38 and 39 and prevent any liquid from being delivered to or discharged from the bore 9 so that the piston 10 is stationary.

When the valve 30 is lowered, liquid delivered by the pump 17 into the port 37 may flow through the bore 31, the port 39 and the passage 41 to the lower end of the bore 9 and raise the piston 10 which will discharge liquid from the upper part of bore 9 through the pasage 40, the port 38, the bore 31, the port 33 and the pipe 34 to the reservoir 2.

When the valve 30 is raised, motive liquid may flow from the port 37 through the bore 31, the port 38 and the passage 40 to the upper end of the bore 9 and move the piston 10 downward, thereby causing liquid to be exhausted from the lower end of the bore 9 through the pasage 41, the port 39, the bore 31 and the opening 35 into the reservoir 2.

Since the pump 17 delivers liquid at a constant pressure and at a rate in excess of motor requirements as previously explained, the speed of the motor 8 will be dependent upon the rate at which the valve 30 permits liquid to flow to and from the bore 9. That is, the farther the valve 30 is moved from its central or neutral position the faster the motor will operate.

In practice, the valve 30 is moved only a very short distance (for instance, about $\frac{1}{32}$ of an inch) in each direction from its central position so that the liquid must flow to and from the bore 9 through restricted openings which limit the flow to the rate necessary to produce the desired motor speed. If that distance is increased or decreased, the speed of the motor will be increased or decreased accordingly.

The maximum stroke of the motor 8 is definitely limited by the heads which close the ends of the bore 9, and the distance between the end heads is such that a machine part reciprocated by the piston 10 can not overrun far enough to damage the machine before the piston stalls against the end head of the motor cylinder.

The motor 8 is ordinarily reversed before the piston 10 reaches the end of the bore 9 but, in order to cushion the blow should the motor not be reversed in time to prevent the piston from striking the end of the motor cylinder, the piston 10 is provided upon its upper end with a dashpot plunger 46 and upon its lower end with a dashpot plunger 47 to cooperate, respectively, with dashpots 48 and 49 formed in the heads of the motor cylinder.

The valve 30 is urged upward by a helical compression spring 50 (Fig. 4) which has its lower end supported in the socket 36 and its upper end provided with a washer 51 to engage the lower end of valve 30. The spring 50 urges the valve 30 upward against a plunger 52 which is fitted for reciprocation in the bore of a cylinder 53 formed on the cap of the block 32 with its bore in alinement with the bore 31.

The plunger 52 carries at its upper end a pin 54 having rollers 55 arranged upon the ends thereof in engagement with the bearing faces of a segmental bearing block 56 (Figs. 4 and 13) which is fastened in a ring 57 formed in a lever 58 intermediate the ends thereof. That part of the ring 57 which extends below the lever 58 is bifurcated to straddle the cylinder 53.

The ring 57 has a slot 59 formed in the upper part thereof to permit the passage therethrough of a bolt 60 which is threaded into the bearing block 56 and clamps it against the upper inner peripheral surface of the ring 57, the head of the bolt 60 bearing against a washer 61 which bears upon the ring 57 upon both sides of the slot 59.

As shown, the bearing faces of the bearing block 56 are arranged at right angles to the axis of the plunger 52 when the motor is at mid-stroke but, by loosening the bolt 60, the bearing block 56 may be moved around the inner periphery of the ring 57 in one direction or the other and then the bearing faces will be inclined to the axis of the plunger 52.

The lever 58 is urged upward by the action of the spring 50 but its left end is either retained in a stationary position or moved at a relatively slow speed during the production of various types of windings as will be presently explained, and its right end has a roller 62 (Figs. 1 and 2) arranged thereon in engagement with the underface of a lug 63 which is carried by a floating lever 64 and prevents the right end of the lever 58 from moving upward except when the lug 63 is moved upward.

The lever 64 (Figs. 1 and 2) has its left end connected to the crosshead 13 by a pair of links 65 and its right end provided with a pin or roller 66 (Fig. 5) which engages the lower edge of a rotary cam 67 and is held in firm contact therewith by the action of the spring 50. In order to restrain the lever 64 from longitudinal movement, a pin or roller 68 (Figs. 2 and 5) is arranged upon the right end thereof and fitted in a vertical slot 69 formed in a bracket 70 which is fixed to a transverse plate 71 extending vertically upward from the base 1 and secured to

or formed integral with the base 1 and the front plate 18.

The function of the floating lever 64 is to actuate valve 30 both in response to movements transmitted to the right end of the lever 64 by rotation of the cam 67 and in response to movements transmitted to the left end of the lever 64 from the piston 10 through the crosshead 13 and the links 65. The movement caused by rotation of the cam 67 acts to open the valve 30 and admits motive fluid to the bore 31 at one side or the other of the piston 10. The motive fluid moves the piston 10 in one direction or the other, and in each instance the piston movement transmitted to the lever 64 through the links 65 tends to close the valve 30 as fast as it is opened by rotation of the cam 67. Thus at any given instant the valve 30 can open only just enough to permit motive fluid to pass therethrough at the rate required to drive the motor 8 at the speed determined by the contour and rotary speed of the cam 67.

The cam 67 rotates continually at a uniform speed when the mechanism is in operation. As it rotates, it will move the right end of the lever 64 downward during one part of a revolution and permit it to be moved upward by the spring 50 during another part of a revolution, the pin 68 and the slot 69 causing the right end of the lever 64 to be reciprocated in a vertical plane.

When the cam 67 first starts to move the right end of the lever 64 downward, the left end of the lever 64 is held stationary by its connection to the crosshead 13 and the left end of the lever 58 is held stationary by its connection to stroke-changing mechanism to be presently described. Consequently downward movement of the right end of the lever 64 will cause the lug 63 to depress the right end of lever 58 which, acting through the block 56, the rollers 55, the pin 54 and the plunger 52, will depress the valve 30 and thereby open the port 39 to the pressure port 37 and open the port 38 to the exhaust port 33.

As soon as the ports 38 and 39 are opened slightly, liquid will flow at a limited rate into the bore 9 and start the piston 10 on its up stroke. Upward movement of the piston 10 causes the crosshead 13 and the links 65 to raise the left end of the lever 64 and thereby tend to permit the spring 50 to close the valve 30 but, since the cam 67 is rotating continuously, it moves the right end of the lever 64 steadily downward so that the lever 64 rocks upon the roller 62 and holds the valve 30 substantially stationary in its slightly open position.

The piston 10 moves upward at a speed exactly proportional to the speed at which the right end of the lever 64 is moved downward by the cam 67. If it should move faster momentarily, the pivot point on the lug 63 would be raised and the spring 50 would raise the valve 30, thereby reducing the delivery of liquid to the bore 9 and decelerating the piston 10. If it should move slower momentarily, the lug 63 would depress the right end of the lever 58 and thereby depress the valve 30 to increase the delivery of liquid to the bore 9 and accelerate the piston 10. Consequently, the speed of the motor is dependent upon the contour and the speed of rotation of the cam 67.

In Figs. 1 to 11, the mechanism is shown provided with a cam 67 which has but one high point and one low point. At the beginning of the above described operation, the parts are in the positions shown in Fig. 6 and the cam 67 is rotating. When the cam 67 has opened the valve 30, the piston 10 will move upward and raise the crosshead 13 which will raise any ring rail or traverse bar carried by the links 7 and will also raise the left end of the lever 64 as the cam 67 depresses the right end thereof.

The piston 10 will continue to move upward and the cam 67 will continue to move the right end of the lever 64 downward until the high point on the cam 67 is on the pin 66 at which time the several parts are in the positions shown in Fig. 7 and downward movement of the pin 66 ceases.

Since the cam 67 is rotating continuously, the valve 30 and the right end of the lever 64 will move steadily upward after the high point on the cam passes the pin 66. At the beginning of the upward movement of the right end of the lever 64, the piston 10 is still raising the left end thereof. Therefore, the lever 64 is moved bodily upward until the valve 30 blocks the ports 38 and 39 to stop the motor 8.

Continued upward movement of the right end of the lever 64 permits the valve 30 to rise until the ports 38 and 39 are opened wide enough to cause the piston 10 to move downward at the desired speed. The piston 10 then moves the left end of the lever 64 downward at a speed exactly proportional to the speed at which the cam 67 permits the right end of the lever 64 to rise so that the lever 64 simply rocks upon the roller 62 and its point of contact therewith remains stationary but in a higher plane than when the piston 10 was moving upward.

The piston 10 moves downward and thereby moves the links 7 and the ring rail or traverse bar connected thereto downward at a speed determined by the contour and rotative speed of the cam 67, and as previously explained it cannot vary from that speed. While the cam 67 is shown as having a contour which will cause the motor 8 to operate at the same speed in both directions, its contour may be changed to cause the motor 8 to operate at one speed in one direction and at another speed in the opposite direction as will be explained hereinafter.

The piston 10 will continue to move downward and the cam 67 will continue to permit the right end of the lever 64 to move upward until the low point on the cam 67 is on the pin 66 at which time the several parts are again in the positions shown in Fig. 6 and upward movement of the pin 66 ceases.

After the low point on the cam 67 passes the pin 66, the cam will force the right end of the lever 64 steadily downward. At the beginning of the downward movement of the right end of the lever 64, the piston 10 is still lowering the left end thereof. Therefore, the lever 64 is moved bodily downward until the valve 30 blocks the ports 38 and 39 and stops the motor.

Continued downward movement of the right end of the lever 64 depresses the valve 30 until the ports 38 and 39 are opened wide enough to cause the piston 10 to move upward at the desired speed as previously explained.

The cam 67 may be rotated at a constant speed from any suitable power source. As shown, it is fixed upon a cam shaft 75 (Figs. 2 and 5) and driven through a change speed drive from the electric motor 23 which drives the pump 17. In order that the cam 67 may be readily removed and replaced by a cam having a different contour, it is keyed upon the tapered rear end of the shaft 75 and retained thereon by a locknut 76.

The cam shaft 75 is journaled in suitable bear-

ings carried by a bearing bracket 77 which is supported by the front plate 18 upon the rear side thereof by an annular hub 78 which is formed upon the front of the bracket 77 and closely fitted in a circular opening 79 formed in the front plate 18.

The axis of the hub 78 coincides with the axis of the shaft 75 in order that the bracket 77 may be turned upon the hub 78 about the axis of the shaft 75 to adjust it upon the plate 18 and then clamped in adjusted position by means of two bolts 80 which are threaded into the front wall of the bracket and extend through slots formed in the front plate 18.

The cam shaft 75 has a gear 81 fixed thereon intermediate the ends thereof and in mesh with a pinion 82 fixed upon a shaft 83 which is journaled in suitable bearings arranged in an eccentric cylindrical bushing 84 at one side of the axis thereof.

The bushing 84 is clamped by means of a bolt 85 in a split sleeve 86 which is shown as being formed integral with a bearing 87 having an annular hub 88 formed upon its front end and closely fitted in a circular recess 89 formed in the bracket 77.

The bearing block 87 is fastened to the bracket 77 by two or more bolts 90 which extend through the flange of the bearing block 87 and are threaded into the bearing bracket 77. The flange of the bearing block 87 may be provided with a slot for each bolt 90 and the bearing bracket 77 may be provided with one or more threaded holes for each bolt 90, the slot and the threaded holes being arranged at the same distance from the axis of the hub 88. Then the bearing block 87 may be rotated upon its hub 88 through a limited angular distance by simply loosening the bolts 90, and it may be rotated through a greater angular distance by withdrawing the bolts 90 from the threaded holes and inserting them into other threaded holes.

The bearing block 87 has a shaft 91 arranged therein with its axis coincident with the axis of the hub 88. The shaft 91 has its inner end journaled in a bearing carried by the bearing block 87, and its outer end journaled in a bearing arranged in a tubular projection 92 which is formed upon the front of the bearing bracket 77 concentric with the recess 89 in which the hub 88 of the bearing block 87 is journaled.

The projection 92 extends through an opening 93 which is formed in the front plate 18 and is large enough to permit the bracket 77 to turn upon its hub 78 through a given angular distance.

The shaft 91 has its rear end provided with a gear 94, which meshes with a gear 95 fixed upon the rear end of the shaft 83, and its front end provided with a sprocket wheel 96 which is connected to a sprocket wheel 97 by a chain 98. The sprocket wheel 97 may be keyed direct to the pump shaft 20 but, in order to avoid the necessity of providing the pump 17 with a special shaft, it is shown fixed upon a stub shaft 99 which is fastened to the hub of the sprocket wheel 19.

When the electric motor 23 is energized, the pump 17 will be driven through the sprocket wheels 19 and 22 and the chain 21, and the cam 67 will be simultaneously driven through shaft 99, sprocket wheel 97, chain 98, sprocket wheel 96, shaft 91, gears 94 and 95, shaft 83, pinion 82, gear 81 and shaft 75.

In order to vary the speed of the cam 67 relative to the speed of the pump 17, the gears 82, 94 and 95 and the sprocket wheels 96 and 97 are arranged upon the ends of their respective shafts. By replacing the sprocket wheels 96 and 97 with other sprocket wheels having different ratios, the speed of the cam 67 may be varied through a wide range. After the sprockets 96 and 97 have been changed and whenever the chain 98 should become slack, the tension of the chain 98 may be adjusted by loosening the bolts 80, turning the bearing bracket 77 upon its hub 78 until the correct tension is obtained and then tightening the bolts 80. Since the bearing bracket 77 is turned upon the axis of the shaft 75, the cam 67 remains in its permanent position, and since the shafts 75, 83 and 91 are carried by the bracket 77, the relative positions thereof are not changed.

While the speed of the cam 67 may be varied through a wide range by changing the sprocket wheels 96 and 97, the difference of one tooth more or less on either sprocket wheel will make a material change in the speed of the cam 67. In order to obtain finer graduations in speed change, the gears 82, 94 and 95 may be replaced by gears having a different ratio.

If it is desired to replace the gear 82 with a larger or smaller gear, the bolts 90 may be loosened or removed, the bearing block 87 turned its hub 88 until the replaced gear meshes properly with the gear 81 and then the bolts 90 tightened or replaced. Since the block 87 turns upon the axis of the shaft 91 and since the shaft 83 is carried by the block 87, the distance between the centers of the gears 94 and 95 will remain unchanged.

If it is desired to replace the gears 94 and 95 with other gears having a ratio such that the distance between gear centers must be changed to permit the gears to mesh properly, the bolt 85 may be loosened and the bushing 84 turned until the axis of the shaft 83 is spaced the correct distance from the axis of the shaft 91.

From the foregoing it will be apparent that, by changing one or more of the gear and/or sprocket wheel ratios, the cam 67 may be rotated at almost any speed within a wide range.

The cam on the cam shaft 75 may have one or more high points formed thereon and the pitch of the cam surfaces or tracks on opposite sides of each high point may be the same or different. If the cam is provided with but one high point, as shown, the motor 8 will make one complete reciprocation each time the cam shaft 75 makes a complete revolution. If the cam is provided with more than one high point, the motor 8 will make as many complete reciprocations per revolution of the cam shaft 75 as there are high points on the cam.

If the cam surfaces or tracks on both sides of the high point on the cam have the same pitch, the motor 8 will operate at the same speed in both directions as is necessary during the production of warp-winding. If the cam surface or track on one side of the high point has a different pitch than the cam surface or track on the other side thereof, the motor 8 will operate at one speed in one direction and at another speed in the opposite direction as is necessary during the production of a filling-winding.

In Figs. 1 to 11, the shaft 75 is shown provided with the cam 67 which has but one high point and similar cam tracks on opposite sides of the high point so that the motor 8 operates at the same speed in both directions and makes one complete reciprocation per revolution of the cam

shaft 75. In Figs. 15 to 18, the cam shaft 75 is shown provided with a cam 67a which has four identical lobes formed thereon and so shaped that the cam surface or track 100 on one side of the high point on each lobe has a different pitch than the cam surface or track 101 on the other side thereof.

During rotation of the cam 67a, the cam track 100 will ride over the pin 66 and slowly depress the right end of the lever 64, thereby opening the valve 30 wide enough to cause the motor 8 to raise the crosshead 13 at a predetermined rate which is ordinarily the speed required to permit the spinning machine to wind the thread in tight spirals on a bobbin or other carrier.

When the high point on the lobe of the cam passes the pin 66, the right end of the lever 64 will rise and the pin 66 will travel along the cam track 101. Since the cam track 101 has a steeper pitch than the cam track 100, the right end of the lever 64 will rise at a rate greater than the rate at which it was depressed by the cam track 100, thereby opening the valve 30 more rapidly and consequently to a greater extent than it was opened during the upstroke of the piston 10 and causing the motor 8 to lower the crosshead 13 at a rate which is greater than the rate at which it was raised and which is ordinarily the rate required to permit the spinning machine to wind the thread in open spirals on a bobbin or other carrier.

The movement of the crosshead 13 upward at one speed and downward at another speed causes the ring rail or traverse bar connected to the links 7 to be moved upward at one speed and downward at another speed, the upward and downward speeds being such that a thread guided by the ring rail or traverse bar will be wound in tight spirals or contiguous turns during the upstroke and in open spirals during the down stroke. By providing a cam on which the cam tracks 100 and 101 are reversed, the upward and downward speeds of the ring rail or traverse bar will be reversed.

The mechanism thus far described will reciprocate a ring rail or traverse bar at the same speed in both directions, as is necessary during the production of a warp-winding, or at different speeds in opposite directions as is necessary during the production of a filling-winding. The distance through which the ring rail or traverse bar is reciprocated may be changed by changing the contour of the cam on the shaft 75 but, after the mechanism is adjusted, the range of reciprocation and the distance through which the ring rail or traverse bar is reciprocated or traversed will not vary regardless of the number of reciprocations so that all of the layers of thread on the spool, bobbin, or other carrier will be the same length and the finished winding will have flat ends.

In order to produce a winding in which each layer of thread overlaps and extends beyond the preceding layer, such as in a filling-winding, or a winding having both ends tapered, or a winding having one flat end and one tapered end, it is necessary to change the range of reciprocation, or to change the length of stroke, or to simultaneously change both the range of reciprocation and the length of stroke, and it is the function of the lever 58 to modify the motions transmitted from the cam 67 or 67a to the valve 30 to thereby produce those results.

The length of piston stroke is changed by moving the lever 58 bodily to the right or left at right angles to the axis of the valve 30 to thereby move the roller 62 toward or from the pin 66. That is, to shorten or lengthen the distance between the point at which the lever 58 contacts the lug 63 on lever 64 and the point at which the cam 67 or 67a contacts the pin 66 on lever 64 to thereby vary the speed at which the cam first moves and later tends to move the valve 30.

The range of reciprocation of the piston 10 is changed by moving the lever 58 in a direction to move the roller 62 along a path substantially parallel to the axis of the valve 30 to thereby progressively move in one direction or the other the points at which the piston 10 is reversed.

In other words, the point of contact between the roller 62 and the lug 63 is moved transverse to the axis of the valve 30 to change the length of stroke of the piston 10 and is moved substantially parallel to the axis of the valve 30 to change the range of reciprocation of the piston 10. For this purpose the lever 58 is provided at its left end with a segmental gear 107 to engage a range changing pinion 108 and near its left end with an adjustable pin 109 to engage a stroke changing cam 110.

When the mechanism is adjusted for the production of a warp-winding, the pin 109 is in engagement with the cam 110 as shown in Figs. 2 and 6 and the gear 107 is out of mesh with the pinion 108 as shown in Fig. 2. When the mechanism is adjusted for the production of a filling-winding, the gear 107 is in mesh with the pinion 108 as shown in Figs. 14 and 15 and the pin 109 is out of engagement with the cam 110 as shown in Fig. 14.

The pinion 108 and the cam 110 are arranged upon a control shaft 111 which is journaled in suitable bearings carried by a bearing bracket 112 (Figs. 1 to 3) fixed to the block 32 in which the valve 30 and the piston 10 are arranged. The shaft 111 has the cam 110 keyed thereon immediately in front of the bearing bracket 112 and the pinion 108 splined thereon in front of the cam 110 and restrained from axial movement by a suitable set screw which, when loosened, permits the pinion 108 to be moved along the shaft 111 into mesh with the segmental gear 107, as shown in Fig. 14, or out of mesh therewith as shown in Figs. 2 and 3.

In order to prevent the left end of the lever 58 from being moved vertically by the motor 8 when the pinion 108 is out of mesh with the gear 107, the pin 109 is adapted to be extended past the cam 110 and into a slot 113 formed in a disk 114 which is fastened to the front face of the bearing 112. As shown, the disk 114 is fastened to the bracket 112 by a bolt 115 which is rigidly secured to or formed integral with the disk 114. The bolt 115 is ordinarily arranged upon the axis of the disk 114 so that, by loosening the nut, the disk may be rotated upon the axis of the bolt to change the angle of the slot 113 for reasons which will be presently explained. The pin 109 is clamped by a suitable set screw either in its operative position, as shown in Fig. 2, or in its inoperative position as shown in Fig. 14.

The pinion 108 and the pin 109 should never be in their operative positions at the same time, that is, the pinion 108 should be moved out of mesh with the gear 107 when the pin 109 is inserted into the slot 113 and the pin 109 should be withdrawn from the slot 113 when the pinion 108 is moved into mesh with the gear 107.

The lever 58 is urged toward the left, to hold the pin 109 in contact with the cam 110 or to hold the segmental gear 107 in mesh with the pinion

108 as the case may be, by a spring 116 which has one of its ends connected to the lever 58 and its other end connected to a lug 117 formed upon the bearing bracket 112 and extending upward therefrom.

The control shaft 111 has a gear 118 journaled thereon at the rear of the bracket 112 between a collar 119, which is fixed to the shaft 111, and a friction disk 120 which is splined upon the shaft 111 and urged against the gear 118 by a helical compression spring 121 arranged around the shaft between the disk 120 and a collar 122 fixed upon the shaft 111 at the rear end thereof.

The collars 119 and 122, the disk 120, the spring 121 together with the gear 118 form a friction or slipping clutch which causes the shaft 111 to be rotated when the gear 118 is rotated but which permits the control shaft 111 to be rotated manually to reset the cam 110 when the gear 118 is stationary, a hand wheel 123 or other suitable means being fastened to the front end of the shaft 111 for that purpose.

Power for driving the control shaft 111 is ordinarily supplied from an independent source, such as an electric motor and reduction gear unit (Figs. 1 to 3) consisting of a constant speed motor 124 and a reduction gear 125 mounted upon a pad 126 which is shown as being formed integral with the base 1.

The motor and reduction gear unit has not been illustrated nor described in detail for the reason that it is a well known commercial article. It is deemed sufficient to state that the reduction gearing 125 has a very large ratio, for instance 900:1 and enables the motor 124 to drive at a slow speed, for instance 2 R. P. M., a pinion 127 which is fixed upon the output shaft of the reduction gearing 125.

The pinion 127 meshes with a gear 128 fixed upon the rear end of a horizontal shaft 129 which is journaled in suitable bearings arranged in a bearing bracket 130 which is fixed upon the pad 126 and extends vertically upward therefrom.

The shaft 129 has a gear 131 fixed thereon and in mesh with a gear 132 fixed upon the front end of a horizontal shaft 133 which is journaled in suitable bearings carried by the bearing bracket 130 at the upper end thereof.

The shaft 133 has a gear 134 fixed upon the rear end thereof and in mesh with a gear 135 fixed upon the rear end of a horizontal shaft 136 which has a gear 137 fixed thereon and in mesh with the gear 118 on the control shaft 111.

The shaft 136 is journaled in suitable bearings carried by an eccentric bushing 138 which is clamped in adjusted position in a split bearing 139 by means of a clamping bolt 140. By loosening the bolt 140, the bushing 138 may be rotated in the bearing 139 to change the distance between the axes of the shafts 136 and 133.

The bearing 139 is provided upon its under side with a flange 141 which is fastened by means of bolts 142 to the front face of the bearing bracket 130 at the upper end thereof and provided with an annular shoulder 143 which is fitted in a circular recess 144 formed in the front face of the bracket 130 upon the axis of the shaft 133.

The flange 141 is provided with slots for the bolts 142 each of which extends through one of the slots and is threaded into one of a series of holes formed in the front face of the bracket 130 upon an arc struck from the axis of the shaft 133. By loosening or removing the bolts 142, the bearing 139 may be swung upon the shoulder 143 to change the distance between the axis of the shaft 136 and the axis of the shaft 111, the distance between the axes of the shafts 136 and 133 remaining unchanged for the reason that the bearing 139 turns upon the axis of the shaft 133.

When the motor 124 is energized, it will drive the control shaft 111 through the reduction gearing 125, pinion 127, gear 128, shaft 129, gears 131 and 132, shaft 133, gears 134 and 135, shaft 136 and gears 137 and 118, thereby rotating the cam 110 and the pinion 108 at a speed determined by the ratios of the several pairs of intermeshing gears which are ordinarily so proportioned that the control shaft 111 is driven at a very slow speed.

The gears 128, 131, 132, 134, 135 and 137 and the pinion 127 are arranged upon the free ends of their shafts so that any pair of gears may be readily removed and replaced by gears of a different ratio, thereby permitting the mechanism to be adjusted to vary the speed of the control shaft 111 through a wide range, for instance from 1/40 R. P. M. to 1/120 R. P. M.

If all of the gears rotated upon fixed centers, the number of speed changes would be limited and the speed of the control shaft 111 would be varied by distinct steps. However, by providing the shaft 136 with the above described mounting which permits the distances between its axis and the axes of the shafts 111 and 133 to be varied, one or all of the gears 134, 135 and 137 may be replaced by gears which vary but little from the replaced gears, thereby permitting the mechanism to be so adjusted that the motor 124 will drive the control shaft 111 at substantially any speed within a wide range of speeds.

When the control shaft 111 is stationary and the pin 109 is inserted into the slot 113 or the segmental gear 107 is in mesh with the pinion 108, the left end of the lever 58 will be held stationary and the stroke of the motor 8 will remain unchanged both as to range and length, as previously explained, and a ring rail or traverse bar connected to the links 7 will be reciprocated or traversed between fixed limits.

As previously explained, the lever 64 pivots upon the roller 62 as long as the cam 67 is moving the right end of the lever 64 downward or permitting the valve spring 50 to move it upward. Therefore, the roller 62 corresponds to the fulcrum of a lever, the pin 66 corresponds to the point of application of power to the lever, and the link 65 corresponds to the load to be moved by the lever.

If the fulcrum of a lever is moved relative to the point of application of power, the load will be moved through a proportionally shorter or greater distance as graphically illustrated in Figs. 19 and 20 in which the levers 58 and 64 are represented by single lines. Since the valve 30 moves but slightly from its central or neutral position, the rollers 55 supported thereby are represented as being stationary.

Rotation of the cam 67 causes the pin 66 to be moved from its upper position at 66U to its lower position at 66L and, when the lever 58 is in the position shown in full lines, the lever 64 will pivot upon the roller 62 and the left end thereof will move from the lower position at L to its upper position at U. The distance between U and L represents the stroke of the motor 8 which will remain constant until the roller 62 is moved relative to the rollers 55.

If the lever 58 is shifted so that the roller 62 is moved laterally in a horizontal plane, the left end of the lever 64 will move through a greater

or lesser distance depending upon the direction in which the lever 58 is shifted.

Rotation of the cam 110 causes the lever 58 to be shifted to the right to lengthen the stroke of the motor or to the left to shorten the stroke of the motor depending upon the position and direction of rotation of the cam 110. As shown, the shaft 111 is adapted to rotate the cam 110 in the direction of the arrow on Fig. 10, thereby permitting the spring 116 to gradually move the lever 58 toward the left, the pin 109 moving along the slot 113 in the disk 114. However, by simply reversing the cam on the shaft or by simply rotating it in the opposite direction, the lever 58 will be gradually shifted to the right.

When the lever 58 has been shifted to the left, as indicated in dotted lines in Fig. 19, the roller 62 will be nearer the rollers 55 so that, when the right end of the lever 64 is moved through the same distance as formerly, the left end will move through a shorter distance or from L' to U' as indicated in dotted lines in Fig. 19. Consequently, the motor 8 will not have to move the left end of the lever 64 as far to shift the valve 30 as it did before the lever 58 was shifted toward the left. The stroke of the motor 8 is therefore shortened at each end thereof.

As the shaft 111 is rotated at a very low speed, the cam 110 thereon will permit the spring 116 to move the lever 58 toward the left only at a very slow speed, thereby slowly reducing the stroke of the piston 10 at each end thereof as is necessary during the production of a winding having both of its ends tapered.

If it is desired to produce a winding having only one of its ends tapered, it is necessary to shorten the stroke of the piston 10 at only one end thereof. This may be accomplished by turning the reaction block 56 and the disk 114 until the slot 113 and the bearing surfaces on the block 56 are parallel to the axis of the lever 64 when it is at that end of the stroke which is not to be shortened.

Assuming that the upper end only of the winding is to be tapered so that the stroke of the motor 8 should be shortened at its upper end only, the slot 113 and the bearing surfaces on the reaction block 56 are arranged parallel to the line L—66U as shown in Fig. 20.

When the lever 58 is in its initial position as indicated in full lines and the pin 66 is moved from 66U to 66L, the lever 64 will pivot upon the roller 62 and its left end will move from L to U which represents the initial stroke of the motor 8.

Rotation of the cam 110 will permit the spring 116 to move the lever 58 toward the left. Engagement of the pin 109 with the slot 113 and engagement of the reaction block 56 with the rollers 55 will cause the lever 58 to move downward at the same time that it moves toward the left.

When the lever 58 has been moved toward the left and downward, as indicated in dotted lines in Fig. 20, the roller 62 will be nearer the vertical axis of the rollers 55 and in a lower plane. Then, when the right end of the lever 64 is moved from 66U to 66L, the lever 64 will pivot upon the roller 62 in its new position and the left end of the lever 64 will move a shorter distance upward to U' as indicated in dotted lines in Fig. 20, the distance L—U' representing the stroke of the motor 8 after it has been shortened.

Since the roller 62 is moved along the line L—66U, the motor 8 must move the left end of the lever 64 downward to the same point each time to shift the valve 30 and, since the roller 62 is moved nearer the vertical axis of the rollers 55, the motor 8 during each succeeding reciprocation need not raise the left end of the lever 64 as far to shift the valve 30 as it did during the preceding reciprocation.

The stroke of the motor 8 is thus shortened at the top end only as is necessary to produce a winding having its upper end tapered and its lower end flat. If it is desired to shorten the stroke at the bottom end only, it is simply necessary to tilt the slot 113 and the reaction block 56 in the opposite direction.

In producing a winding in which each succeeding layer of thread is offset from or extends beyond the preceding layer, such as a filling-winding, it is necessary to progressively advance the range of reciprocation or stroke of the motor piston 10 in order to progressively advance the traverse of the ring rail or traverse bar connected to the links 7. That is, the limit of piston movement in both directions must be progressively advanced in one direction while the stroke remains the same length.

If it is desired to change the range of reciprocation, the pin 109 is disengaged from the slot 113 and the cam 110, the pinion 108 is moved into mesh with the gear 107 and the electric motor 124 is energized to thereby cause rotation of the pinion 108 which will move the gear 107 and the left end of the lever 58 upward or downward depending upon the direction of rotation.

For the purpose of illustration, the lever 58 is shown as being prevented from moving toward the left under the influence of the spring 116 by the teeth of the pinion 108 meshing full depth with the teeth on the segmental gear 107 which has its teeth arranged upon a pitch line so shaped that, when the pinion 108 moves the gear 107 upward or downward and thereby causes the lever 58 to pivot upon the rollers 55, the roller 62 will be moved vertically in a substantially straight line. However, the pinion 108 may be provided with a roller and the gear 107 provided with a cam which is urged by the spring 116 against that roller and has its contact face so shaped that upward or downward movement of the gear 107 will cause the roller 62 to be moved vertically in a substantially straight line.

If the left end of the lever 58 is moved downward, the range of reciprocation will move upward and, if the left end of the lever 58 is moved upward, the range of reciprocation will move downward.

Assuming that the rollers 55 are stationary and that the lever 64 is free to pivot upon the roller 62, as graphically illustrated in Fig. 21, the left end of the lever 64 will move from L to U when the roller 62 is in its initial position and the pin 66 is moved from 66U to 66L as indicated in full lines.

When the left end of the lever 58 is swung downward in the correct arc, the roller 62 will be moved vertically upward. Then when the pin 66 is reciprocated between 66U and 66L, the lever 64 will pivot upon the roller 62 in its new position and the left end of thhe lever 64 will reciprocate through the same distance but in a higher range or between L' and U' as indicated in dotted lines in Fig. 21. If the left end of the lever 58 were swung upward, the roller 62 would be lowered and the left end of the lever 64 would reciprocate in a lower range.

When the electric motor 124 is energized, the control shaft 111 will be rotated at a very slow

speed, as previously explained. As shown, the shaft 111 is adapted to be rotated in the direction of the arrow on Fig. 15 and to cause the pinion 108 to move the segmental gear 107 and the left end of the lever 58 downward to move the roller 62 slowly upward.

Since the piston of the motor 8 moves upward when the valve 30 is in its lower position and downward when the valve 30 is in its upper position, and since the point of contact between the roller 62 and the lever 64 is gradually moved upward, the motor 8 during each succeeding reciprocation does not have to move the left end of the lever 64 as far downward to reverse the valve 30 as it did during the preceding reciprocation and it must move the left end of the lever 64 farther upward to reverse the valve 30 than it did during the preceding reciprocation.

The range of reciprocation is thus advanced upward but the stroke remains unchanged for the reason that the distance between the pin 66 and the roller 62 remains substantially the same and the right end of the lever 64 is caused to reciprocate through a fixed distance by the cam on the shaft 75.

Since the stroke of the motor 8 remains the same length while the range of reciprocation is progressively advanced upward, it is apparent that a ring rail or traverse bar connected to the links 7 will be reciprocated through a fixed distance during each reciprocation of the motor 8 and that, during each succeeding reciprocation, the ring rail or traverse bar will not be lowered quite as far as during the preceding reciprocation and will be raised slightly farther than during the preceding reciprocation, thereby raising the range of reciprocation at the rate determined by the rate at which the control shaft 111 is rotated.

Operation

Assuming that the electric motor 23 is operating so that the cam 67 is rotating and the pump 17 is delivering liquid at a rate in excess of the rate required to operate the motor 8 at the desired speed, that the electric motor 124 is idle so that the left end of the lever 58 is held stationary, and that the several parts in the positions shown in Figs. 1 to 6, the mechanism will operate as follows:

As the cam 67 rotates, it depresses the right end of the lever 64 and thereby depresses the valve 30 to permit liquid from the pump 17 to enter the lower end of the bore 9 and raise the piston 10 which carries the crosshead 13, the links 7 and 65 and the left end of the lever 64 upward with it.

Upward movement of the left end of the lever 64 tends to permit the spring 50 to shift the valve 30 but the cam 67 is rotating continually and moving the right end of the lever 64 downward so that the valve 30 is held in its depressed position until the high point on the cam 67 passes the pin 66 and thereby permits the spring 50 to shift the valve 30 upward at which time the right end of the lever 64 is still moving upward so that the valve 30 is shifted very rapidly.

The valve 30 in its upper position permits liquid from the pump 17 to enter the upper end of the bore 9 and lower the piston 10 which carries the crosshead 13, the links 7 and 65 and the left end of the lever 64 downward with it.

Downward movement of the left end of the lever 64 tends to depress the valve 30 but the cam 67 continues to permit the right end of the lever 64 to rise until the low point on the cam passes the pin 66 and then the cam depresses the right end of the lever 64 and thereby shifts the valve 30 to its lower position to start the piston 10 on another upward stroke.

The motor 8 will continue to operate in this manner as long as the cam 67 is rotated and the pump 17 is operated. The stroke and speed of the motor 8, and consequently the stroke or length of traverse and the rate of reciprocation of a ring rail or traverse bar connected to the links 7, will be determined by the contour and speed or rotation of the cam 67.

If the mechanism were connected to the ring rail or traverse bar of a spinning machine and operated as described above, it would enable the machine to produce windings in which the thread is wound in tight spirals as in a warp-winding and the several turns are all the same length so that the finished winding would have flat ends.

Figs. 6 and 7

For the purpose of illustration, let it be assumed that the links 7 are connected to the traverse bar of a rayon spinning machine, that the bar is provided with a plurality of spinnerets through which rayon threads are fed from the machine, that each spinneret extends into a cup or winding form, and that each cup is attached to and rapidly rotated by a spindle. A fragment of spinneret is shown at 150, the cup is indicated by the reference numeral 151, the spindle by the reference numeral 152 and the spindle bearing by the reference numeral 153.

Fig. 6 shows the several parts of the reciprocating mechanism in the positions occupied at the end of a down stroke and a winding just being started. Fig. 7 shows the parts in the positions occupied at the end of an up stroke and a winding just being completed.

When the reciprocating mechanism is operated as above described and the spinning machine is in operation, the spinneret 150 will be reciprocated vertically in the cup 151. Near the end of the down stroke of the spinneret, the thread or threads 154 being fed therethrough will come into contact with the bottom of the rapidly rotating cup 151 and be thrown outward by centrifugal force against the side wall of the cup 151, as shown in Fig. 6, and the rapidly revolving wall of the cup 151 will cause the thread to be wound thereon as it is fed through the spinneret. If several threads are fed through the spinneret simultaneously, the winding thereof in the above described manner will cause them to be twisted into a single thread.

As the spinneret moves upward, the thread 154 will be wound in a uniform layer of tight spirals on the wall of the cup 151 and, when the spinneret next moves downward, a similar layer of thread will be wound upon the first layer. As the spinneret continues to reciprocate, the thread will be wound in succeeding layers until a winding 155 of the desired thickness is produced, as shown in Fig. 7.

Since the spinneret 150 is reciprocated through a fixed distance, each layer of thread will be the same length and the winding 154 will have flat ends.

Figs. 10 and 11

If it is desired to produce a winding having one flat end and one tapered end, the slot 113 and the bearing surfaces of the reaction block 56 are inclined downward toward the left at the correct angle, as previously explained and as shown graphically in Fig. 20, and the electric motor 124

is energized so that the control shaft 111 is rotating continually, the pinion 108 being out of mesh with the segmental gear 107 and the pin 109 being in contact with the cam 110 and extending into the slot 113.

Fig. 10 shows the several parts of the reciprocating mechanism in the positions occupied at the end of a down stroke and a winding shortly after being started. Fig. 11 shows the several parts in the positions occupied at the end of an up stroke and a winding just being completed.

The mechanism will operate in the same manner as when a winding having flat ends is being produced except that the stroke of the motor 8 is gradually shortened at the upper end thereof in the manner previously explained and as shown graphically in Fig. 20.

Since the stroke of the motor 8 is gradually shortened at the upper end thereof, the stroke of the spinneret 150 will be similarly shortened so that each succeeding layer of thread wound inside the cup 151 is slightly shorter than the preceding layer and the finished winding 155a will have its upper end tapered and its lower end flat as shown in Fig. 11.

After the winding is completed, the electric motor 124 is stopped and the control shaft 111 rotated manually by means of the hand wheel 123 to reset the cam 110 in its initial or starting position, the friction disk 120 permitting the shaft 111 and the cam 110 to be rotated while the gear 118 is held stationary by the train of gears connecting it to the electric motor 124. The apparatus is then in condition to start another winding.

Figs. 8 and 9

If it is desired to produce a winding having both of its ends tapered, the disk 114 and the reaction block 56 are turned until the slot 113 and the bearing surface on the block 56 are horizontal and the hand wheel 123 is operated to rotate the control shaft 111 and bring the cam thereon into its initial or starting position.

For the purpose of illustration, it is assumed that the links 7 are connected to a ring rail 160 of a spinning machine having a plurality of rapidly rotating vertical spindles 161 each of which carries a spool 162 and extends upward through an annular track or ring 163 arranged upon the ring rail and provided with a thread guide or traveler 164 which guides the thread 165 as it is being wound upon the spool 162 and which is carried by the thread around the ring 163 to cause the thread to be twisted during the winding thereof.

In order to show that windings of almost any desired shape may be produced, the spool 162 is shown as being of a special form and the cam 110 has been replaced by a cam 110a of such a shape that the stroke of the motor 8 will be both lengthened and shortened during the production of a single winding.

Fig. 8 shows the several parts of the mechanism in the positions occupied at the end of a down stroke of the motor 8 and just as a winding is being started. Fig. 9 shows the several parts of the mechanism in the positions occupied at the end of an up stroke of the motor 8 and just as a winding 166 of special form is being completed.

Assuming that the spinning machine and the reciprocating mechanism are operating, that the thread 165 is being wound upon the spool 162 and that the parts are in the positions shown in Fig. 8, the cam 110a will move the lever 58 slowly toward the right and cause the stroke of the motor 8 to be gradually lengthened, as previously explained, and each succeeding layer of thread wound upon the spool 162 will be slightly longer than the preceding layer as is necessary to produce a uniform winding on account of the fillets on the spool 162.

The cam 110a will continue to move the lever 58 toward the right and the layers of thread on the spool 162 will continue to be lengthened until the high part 167 of the cam 110a engages the pin 109.

As shown, the high part 167 extends through a few degrees and, while the pin 109 is in contact with that part, the lever 58 will be held stationary and the layers of thread wound at that time on the spool 162 will be of equal length.

When the high part of the cam passes the pin 109, the spring 116 will shift the lever 58 slowly toward the left to gradually shorten the stroke of the motor, as previously explained and as shown graphically in Fig. 19.

Shortening the stroke of the motor 8 will cause the succeeding layers of thread on the spool 162 to be shorter than the preceding layers and the rate at which they are shortened will be in accordance with the contour of the cam 110a, thereby producing a winding 166 of the desired shape.

Figs. 14 to 18

If it is desired to produce a winding in which the layers of thread are successively advanced and in which the layers are wound in open and tight spirals alternately, such as a filling-winding, the pin 109 is withdrawn from the slot 113 and moved forward out of contact with the cam 110 and the pinion 108 is moved rearward along the control shaft 111 into mesh with the segmental gear 107, as shown in Fig. 14, the cam 67a is substituted for the cam 67 and the control shaft 111 is rotated by means of the hand wheel 123 to move the segmental gear into its initial or starting position as shown in Fig. 15.

For the purpose of illustration, it is assumed that the links 7 are connected to a ring rail 170 of a spinning machine having a plurality of rapidly rotating vertical spindles 171 each of which carries a bobbin 172 and extends upward through an annular track or ring 173 arranged upon the ring rail and provided with a thread guide or traveler 174 which guides the thread 175 as it is being wound upon the bobbin 172 and which is carried by the thread around the ring 173 to cause the threads to be twisted during the winding thereof.

Figs. 15 to 18 show the several parts of the reciprocating mechanism and the ring rail in the positions occupied during four phases of the production of a filling-winding 176. In Fig. 15, the ring rail 170 is at the lower end of its lower traverse and the winding of the thread 175 upon the bobbin 172 is about to be started. In Fig. 16, the ring rail 170 is at the upper end of its lower traverse and one layer of thread has been wound upon the bobbin 172. In Fig. 17 the ring rail 170 is at the lower end of its upper traverse and the winding 176 is about to be completed. In Fig. 18, the ring rail 170 is at the upper end of its upper traverse and the winding 176 has been completed.

Assuming that the spinning machine and the reciprocating mechanism are operating and that the several parts are in the positions shown in Fig. 15, the cam 67a will depress the right end

of the lever 64 and thereby depress the valve 30 to start the motor 8 on its up stroke.

The motor 8 will raise the ring rail 170 at a rate determined by the contour of the cam 67a and will continue to move it upward as long as the pin 66 is in contact with the cam track 100 the pitch of which is such that the ring rail is raised at the rate required to cause the thread 175 to be wound in tight spirals on the bobbin 172.

When the end of the cam track 100 reaches the pin 66, the ring rail 170 will be at the upper end of its lower traverse as shown in Fig. 16, and a short layer of thread will have been wound in tight spirals upon the bobbin 172.

Continued rotation of the cam 67a will cause the high point thereon to pass the pin 66 which may then move upward along the cam track 101 and permit the spring 50 to shift the valve 30 to reverse the motor 8 which will move the ring rail downward during the time that the pin 66 is in contact with the cam track 101 the pitch of which is such that the ring rail is lowered at the rate required to cause a second layer of thread to be wound in open spirals on top of the first layer.

As the end of the cam track 101 passes the pin 66, the following cam track 100 will come into contact therewith and start a second reciprocation of the motor 8 and the ring rail 170.

During continued rotation of the cam 67a, the ring rail 170 will be continually reciprocated or traversed as above described. At the same time, the pinion 108 is being rotated by the electric motor 124 and is slowly moving the segmental gear 107 and the left end of the lever 58 downward, thereby raising the range of reciprocation as previously explained and as shown graphically in Fig. 21.

Since the distance through which the ring rail 170 is reciprocated remains unchanged and since the range of reciprocation is slowly moved upward, each succeeding layer of thread is offset slightly upward from the preceding layer, that is, it does not extend quite as far downward as the preceding layer and extends slightly farther upward than the preceding layer so that, if the thread is wound upon a bobbin of the type shown, the body of the winding will be cylindrical and the upper end thereof will be conical as indicated by the winding 176 shown in Figs. 17 and 18.

While the reciprocating mechanism has been illustrated and described as employed in the production of particular types of windings, it is obvious that it may as readily be employed in the production of other types of winding and to reciprocate members or parts of machines other than textile machines, and that it is susceptible of various modifications and adaptations without departing from the scope of the invention as hereafter claimed.

The invention is hereby claimed as follows:

1. The combination, with a reciprocating fluid motor and means for supplying motive fluid to said motor to drive the same, of a valve for directing said fluid to opposite ends of said motor alternately and for controlling the rate of fluid delivery, a control element continuously driven at a speed proportional to the desired speed of said motor, means actuated by said element and said motor jointly for effecting operation of said valve to thereby control the speed and length of stroke of said motor, and means operable during operation of said motor for adjusting said last named means to vary the length of motor stroke.

2. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor to operate the same, a controller driven at a substantially constant speed, means actuated by said motor and said controller jointly for controlling the delivery of fluid to said motor to thereby control the speed and the length of stroke of said motor, and means driven independently of said motor for modifying the action of said delivery controlling means to thereby progressively vary the length of stroke of said motor.

3. A hydraulic reciprocator, comprising a reciprocating hydraulic motor, a valve hydraulically connected to said motor for controlling the delivery of liquid thereto, means for supplying motive liquid to said valve at a substantially constant pressure and at a rate in excess of motor requirements, a controller driven at a substantially constant speed, means actuated by said motor and said controller jointly for operating said valve to thereby control the speed and length of stroke of said motor, and means driven independently of said motor for modifying the effect of said valve operating means to thereby progressively vary the length of stroke of said motor.

4. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor to operate the same, a controller driven at a substantially constant speed, means actuated by said motor and said controller jointly for controlling the delivery of fluid to said motor to thereby control the speed and the length of stroke of said motor, and means driven independently of said motor for modifying the action of said delivery controlling means to thereby progressively vary the length of stroke of said motor and adjustable to vary said stroke at either or both ends thereof.

5. A reciprocator, comprising a motor cylinder, a piston fitted in said cylinder to reciprocate therein, means for supplying motive fluid to said cylinder including a valve for directing fluid to opposite ends of said cylinder alternately to effect reciprocation of said piston and for controlling the rate of fluid delivery thereto, a control element continuously driven at a speed proportional to the desired speed of said piston, means actuated by said element and said piston jointly for operating said valve to thereby cause said piston to reciprocate within a given range and at a predetermined speed, and means selectively operable for adjusting said valve operating means to either change the length of stroke of said piston or to change the range in which said piston reciprocates.

6. A hydraulic reciprocator, comprising a reciprocating hydraulic motor, a valve hydraulically connected to said motor for controlling the delivery of liquid thereto, means for supplying motive liquid to said valve at a substantially constant pressure and at a rate in excess of motor requirements, a controller driven at a substantially constant speed, means actuated by said motor and said controller jointly for operating said valve to thereby control the speed and length of stroke of said motor, and means driven independently of said motor for modifying the effect of said valve operating means to thereby progressively vary the length of stroke of said motor and adjustable to vary said stroke at either or both ends thereof.

7. A hydraulic reciprocator, comprising a reciprocating hydraulic motor, a valve hydraulical-

ly connected to said motor for controlling the delivery of liquid thereto, a pump for supplying motive liquid to said valve at a substantially constant pressure and at a rate in excess of motor requirements, a controller driven at a substantially constant speed, means for changing the speed of said controller, means actuated by said motor and said controller jointly for operating said valve to thereby control the speed and length of stroke of said motor, means driven independently of said motor for modifying the effect of said valve operating means to thereby progressively vary the length of stroke of said motor, and means for changing the speed of said last named means.

8. A reciprocator, comprising a motor cylinder, a piston fitted in said cylinder to reciprocate therein, means for supplying motive fluid to said cylinder including a valve for directing said fluid to opposite ends of said cylinder alternately to effect reciprocation of said piston and for controlling the rate of fluid delivery thereto, a control element continuously driven at a speed proportional to the desired speed of said piston, means actuated by said element and said piston jointly for operating said valve to thereby cause said piston to reciprocate within a given range and at a predetermined speed, and means operable during operation of said motor for adjusting said valve operating means to change the range of reciprocation of said piston.

9. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor, a valve for reversing said motor, a power driven actuator, a lever having one of its ends reciprocated by said motor and its other end reciprocated in response to actuation of said actuator, means for operating said valve in response to movement of a point on said lever, and means for shifting said point along said lever to thereby vary the length of the stroke of said motor.

10. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor, a valve for reversing said motor, a power driven actuator, a lever having one of its ends reciprocated by said motor and its other end reciprocated in response to actuation of said actuator, means for operating said valve in response to movement of a point on said lever, and means for shifting said point along said lever to thereby vary the length of the stroke of said motor and adjustable to shift said point in a direction to cause said stroke to be varied at each end or in a direction to cause said stroke to be varied at one end only.

11. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor, a valve for reversing said motor, a power driven actuator, a lever having one of its ends reciprocated by said motor and its other end reciprocated in response to actuation of said actuator, means for operating said valve in response to movement of a point on said lever, and means for shifting said point in a direction to change the range of reciprocation of said motor.

12. A reciprocator, comprising a reciprocating fluid motor, means for supplying motive fluid to said motor, a valve for reversing said motor, a power driven actuator, a lever having one of its ends reciprocated by said motor and its other end reciprocated in response to actuation of said actuator, means for operating said valve in response to movement of a point on said lever, and mechanism for shifting said point to thereby change the operating characteristics of said motor and including a control shaft, a gear arranged upon said shaft and driven independently of said motor, point shifting means arranged upon said shaft, and a slipping clutch through which rotation is imparted to said point shifting means from said gear and which permits said point shifting means to be reset without rotating said gear.

13. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operative the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, and means for preventing said spring from moving the other end of said second lever.

14. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, means for preventing said spring from moving the other end of said second lever, and means for moving said second lever bodily at a predetermined slow rate to thereby progressively change the operating characteristics of said motor.

15. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, means for preventing said spring from moving the other end of said second lever, and means operating independently of said motor for moving said second lever bodily at a predetermined slow rate to thereby progressively change the operating characteristics of said motor.

16. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage

said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, means for preventing said spring from moving the other end of said second lever, and means for shifting said second lever at a predetermined rate transverse to the axis of said motor to thereby progressively vary the length of stroke of said motor.

17. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, and stroke control mechanism driven independently of said motor and connected to the other end of said second lever for gradually moving it in a given direction to thereby progressively vary the length of stroke of said motor.

18. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, stroke control mechanism driven independently of said motor and connected to the other end of said second lever for gradually moving it in a given direction to thereby progressively vary the length of stroke of said motor, and means adjustable to enable said stroke control mechanism to move said second lever in a direction to cause the length of stroke of said motor to be varied at one end of the stroke only.

19. A reciprocator, comprising a fluid motor, means for supplying motive fluid to said motor to operate the same, a valve for controlling said motor, a cam driven independently of said motor, a lever having one of its ends reciprocated by said motor, a contact carried by the other end of said lever to engage said cam, a second lever having a pivot at one end thereof to engage said first lever intermediate the ends thereof, means arranged intermediate the ends of said second lever for transmitting motion to and from said valve, a spring urging said valve toward said second lever and thereby keeping said pivot in contact with said first lever and said contact in engagement with said cam, and stroke control mechanism connected to the other end of said second lever and driven independently of said motor for operating said second lever to gradually move said pivot in a direction substantially parallel to the axis of said motor to thereby progressively advance the range of reciprocation of said motor.

WALTER FERRIS.