Sheet 1 - 5 Sheets.

W. Mason.
Self-Acting Mule.

No. 4,779. Patented Oct. 3, 1846.

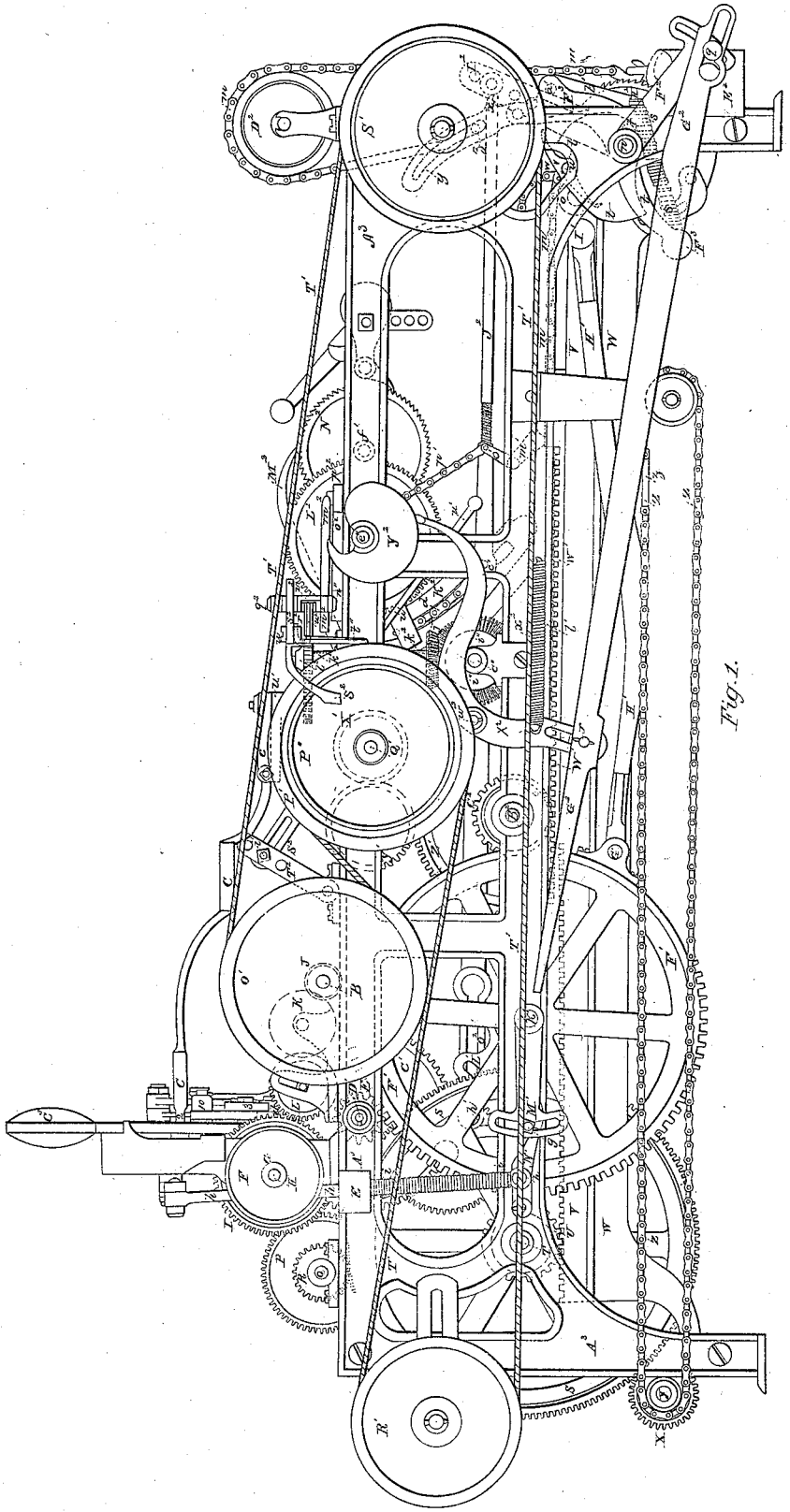

Fig. 1.

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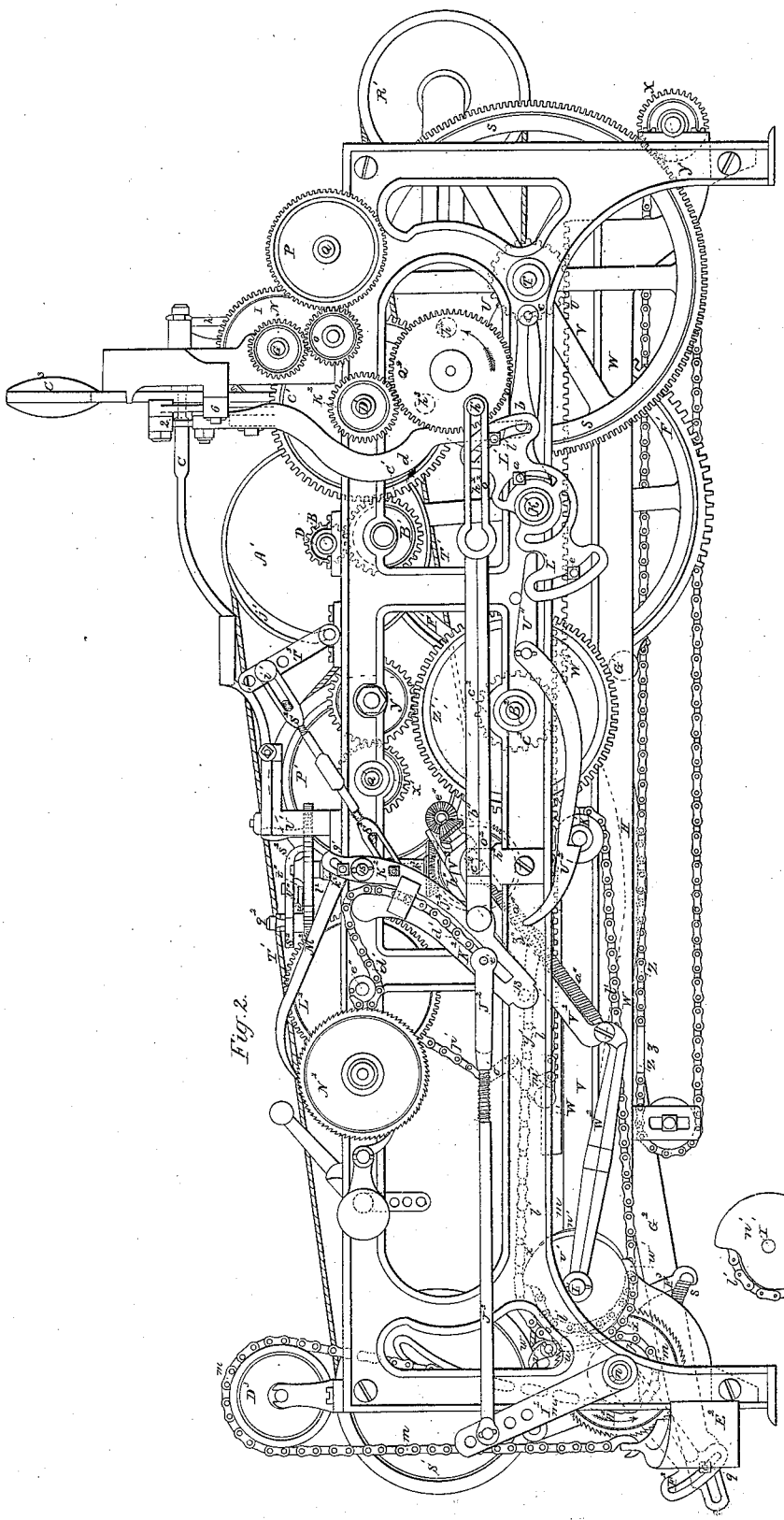

Fig. 2.

Fig. 8.

W. Mason.

Self-Acting Mule.

No. 4,779. Patented Oct. 3, 1846.

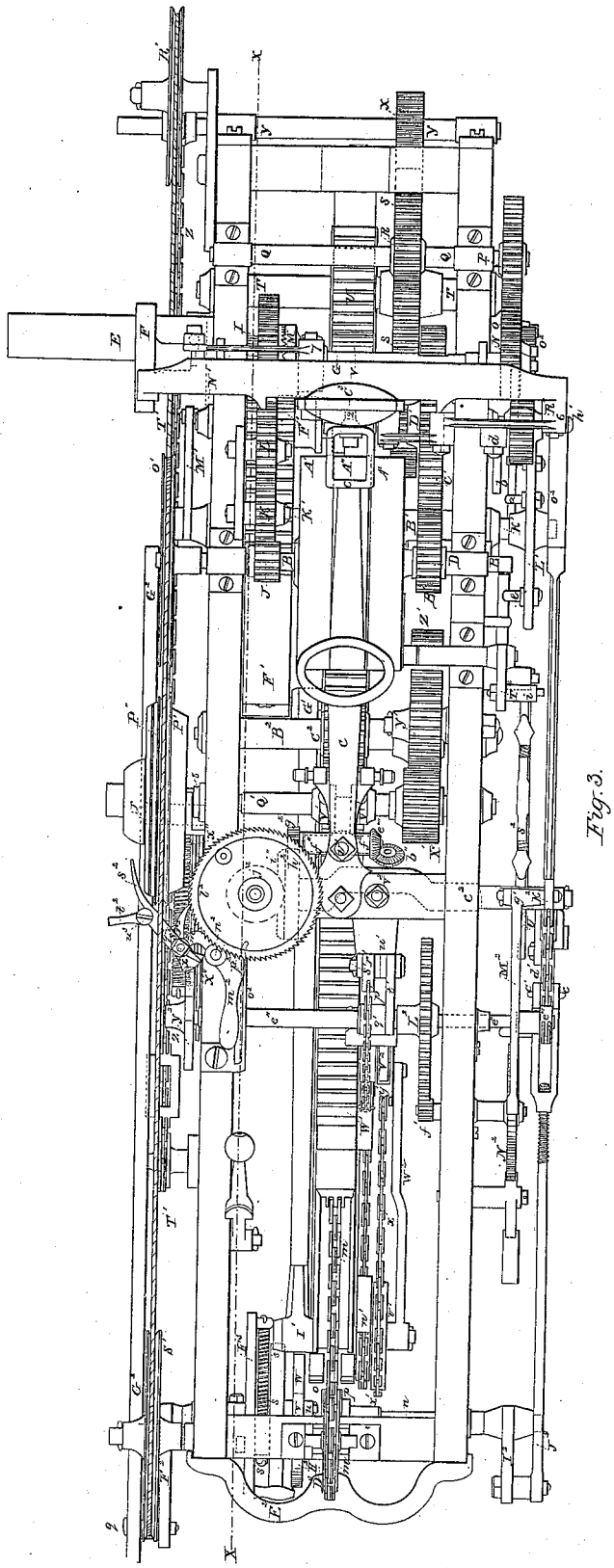

Fig. 3.

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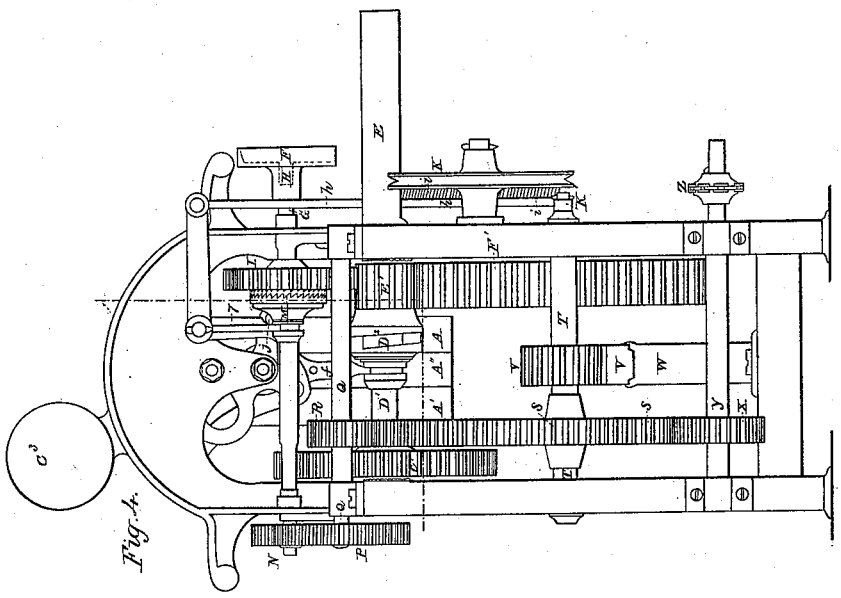

Fig. 4.

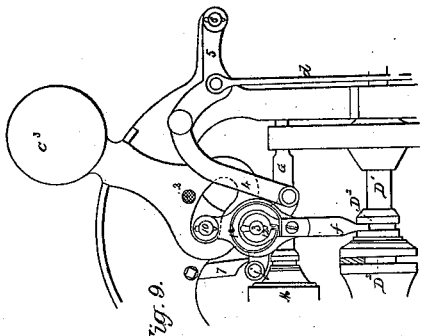

Fig. 9.

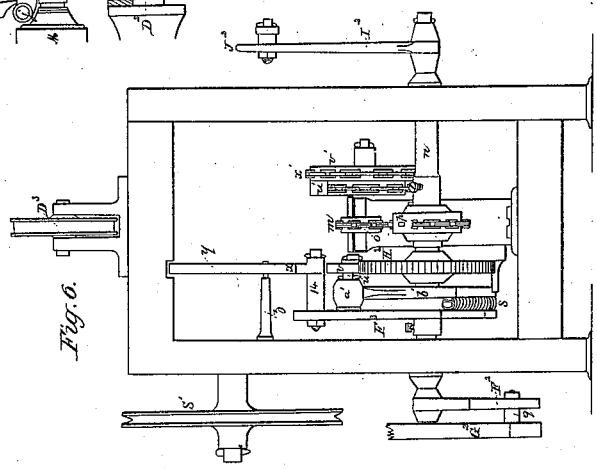

Fig. 6.

Sheet 5-5 Sheets.

W. Mason.

Self-Acting Mule.

No. 4,779. Patented Oct. 3, 1846

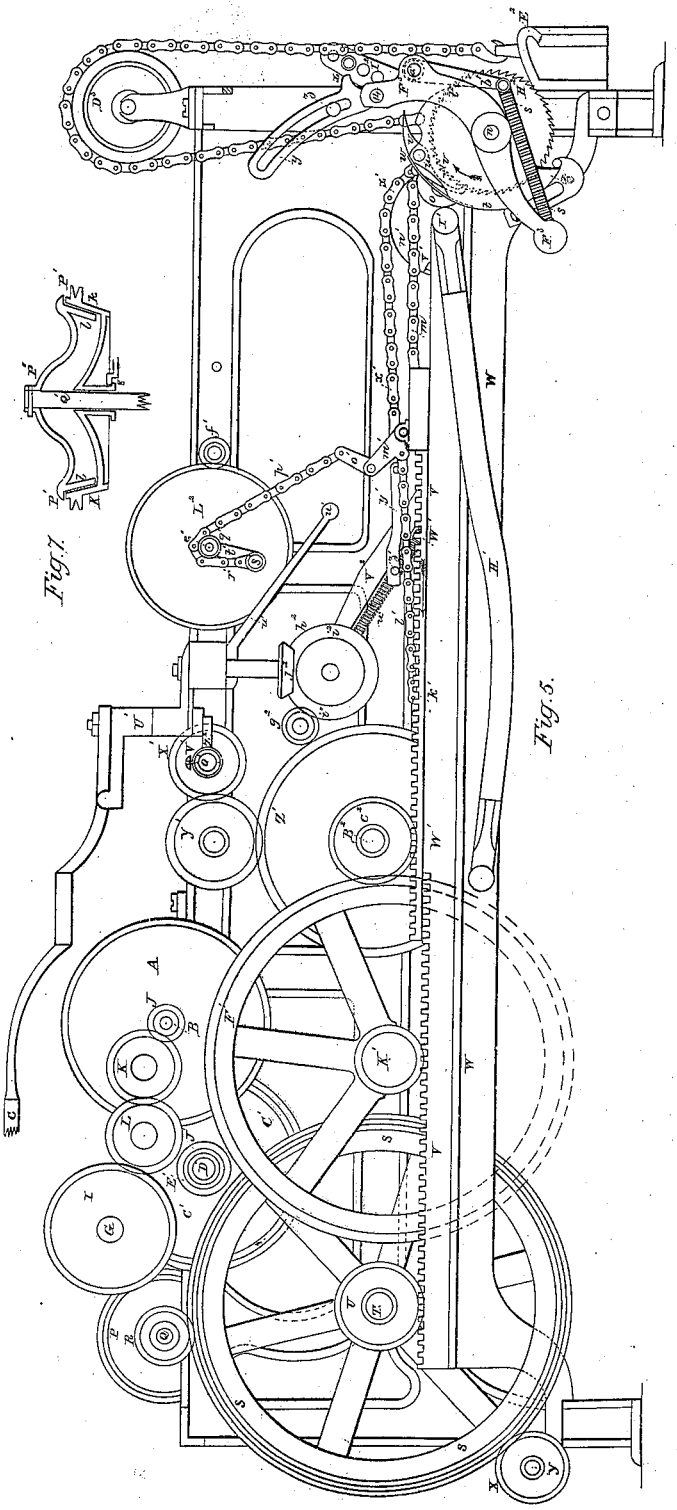

Fig. 5.

Fig. 1.

UNITED STATES PATENT OFFICE.

WILLIAM MASON, OF TAUNTON, MASSACHUSETTS.

IMPROVEMENT IN SELF-ACTING MULES.

Specification forming part of Letters Patent No. **4,779**, dated October 3, 1846.

To all whom it may concern:

Be it known that I, WILLIAM MASON, of Taunton, in the county of Bristol and State of Massachusetts, have invented a new and useful Self-Acting Mule for Spinning Cotton and other Fibrous Substances; and I hereby declare that the following is a full, clear, and exact description of the principle or character which distinguishes it from all other things before known, and of the manner of making, constructing, and using the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is an elevation of the head of the mule next the carriage; Fig. 2, an elevation of the opposite side; Fig. 3, a plan; Fig. 4, a back elevation; Fig. 5, a longitudinal vertical section taken at the line *x x* of Fig. 3, in the direction of the arrow; Fig. 6, a front elevation; Fig. 7, a section of and through the friction-clutch; Fig. 8, separate view of the scroll or volute cam, and Fig. 9 a vertical cross-section of the head, taken just in front of the shipper-lever.

The same letters indicate like parts in all the figures.

The motions of the mule may be divided into three series, which are subdivided in the action of the apparatus. The first series consists of the drawing out of the carriage, the revolving of the draw-rollers, and the whirling of the spindles, by means of which series of motions the rovings are drawn out, and the threads spun and twisted. The second series consists of "backing off," as it is termed—that is, turning the spindles the reverse direction to uncoil the threads from the points of the spindles to the cops, and turning down or depressing the front faller at the same time to place all the parts in a proper condition for the third series of motions, which consists of putting or running in the carriage, winding on the yarn or threads by giving a varying motion to the spindles corresponding to the form and size of the cops, and operating the faller to give the proper shape to the cops.

The first series of motions is regular. The carriage is drawn out by a regular motion effected by a train of wheels from the driving-pulley to a line shaft which carries endless chains connected with the carriage at different parts of its length to insure steadiness of motion. During this the draw-rollers are rotated to give out the staple as it is spun by another train of wheels deriving motion from the same source as the preceding, and in manner substantially similar to other mules; and at the same time the spindles are whirled or rotated by a band receiving motion from a pulley on the shaft of the driving-pulley, as in other mules. This completes the first series of motions, in which I claim nothing new.

At the end of the first series of motions the threads that have been spun are coiled on the spindles from the cops to their points. It is therefore necessary to uncoil them (called "backing off") preparatory to winding on, and at the same time to depress the front faller to place it in a proper position for winding on. The second series of motions effects these purposes, and the various parts of the mechanism are put in a proper condition to effect this by the momentum of the moving parts at the end of the first series of motions. This constitutes the first part of my invention.

As the carriage approaches the end of the out motion the driving-belt is shifted from the first driving-pulley to a loose pulley by the side of it to permit the momentum of the moving parts to complete the movements, and so soon as these are accomplished a balance-weight is carried beyond the vertical line and falls over, which shifts the belt from the loose pulley to a second fast pulley on the same shaft with the others, at the same time the trains of wheels that operate the carriage and the draw-rollers are liberated by the shifting of a clutch, and at the same time a friction-clutch is brought into action, thereby connecting the band that drives the spindles with a sliding rack, (called the "top sliding rack,") which, in consequence of this connection, is carried by the momentum of the spindles sufficiently far in one direction to give, by its return, the required motion to the spindles in the reverse direction to uncoil the threads from the upper part of the spindles. While the rack is thus moved, the second fast pulley sets in motion by a train of wheels a crank-pin that works in a slot in a connecting-rod, and this crank-pin when set in motion is a little below a line passing through the connecting-rod and the axis of motion so that the crank-pin moves a short distance before it begins to move the connecting-rod. This period of time is sufficient to permit the momentum

of the spindles (as above stated) to draw the sliding rack to the distance required to be in a condition, by its return movement, to give the backing-off motion to the spindles. The crank-pin then in making a semirevolution carries the connecting-rod with it, and this being in connection with the lever of a rock-shaft provided with a toothed pulley, around which passes a chain attached to the end of the sliding rack, draws it (the rack) for a short distance in a reverse direction and thus causes it to give the backing-off motion to the spindles to uncoil the threads, at the same time depressing the front faller to bring the threads in a proper position for winding on, this latter being effected by having one end of the shaper or copping-rail jointed to a lever on the rock-shaft above mentioned. The chain attached to the rack and which communicates motion to it is kept tight by being passed over a pulley and having a weight suspended to it.

When the top sliding rack is carried forward by the momentum of the spindles at the end of the first series of motions, it is gradually arrested, and with it the spindles, by means of a spring-brake of a peculiar construction—viz: On the rock-shaft there is a bent lever, to one end of which is connected a helical spring, also attached to an arm jointed to the other end of the bent lever, and by the side of and attached to the toothed wheel, around which passes the chain on the end of the sliding rack and which turns freely on the rock shaft, there is a ratchet-wheel, and by the side of it a cam-plate provided with a hand or catch by means of which the ratchet and toothed wheels are carried around when the cam plate is carried around by the action of the spring-brake on the cam form of its periphery, and when this has been carried far enough around the catch is liberated to permit the return of the parts by means of an arm or lever jointed to one end of the bent lever, which is made to lift the catch from the teeth of the ratchet-wheel. As the cops increase in diameter it is evident that the backing-off motion must be diminished, and this is effected by making the connecting-rod above mentioned in two parts—the first connected by one end (as above stated) with the crank pin which actuates it, and which works in a slot to give motion to the rod in one direction only, (the crank being then at liberty to turn without imparting any motion longitudinally to the rod), the other end being jointed to a curved arm that vibrates on a stud-pin, and the other part of the connecting-rod is jointed to the arm of the rock-shaft and to a slide that works in a curved groove in the vibrating-arm, so that as this slide is moved from or toward the axis of motion of the arm the rock-shaft will be vibrated more or less; and this slide is moved in or out by being in connection with the mechanism that operates the motions of the copping-rail, and which, therefore, will be described under the third series. At the end of the backing-off motion the vibrating arm of the connecting-rod is hooked and held by a catch until the carriage is run up, and then liberated to permit the parts to resume their appropriate positions preparatory to a repetition of the operations.

At the end of the second series of motions the third series of motions commences, and these constitute the second part of my invention. The carriage is run in by a crank motion, which has the effect to gradually start it from a state of rest and accelerate its motion to the middle of its course, and then gradually diminish its motion until it is brought to a state of rest, thus avoiding all tendency to break the threads consequent upon all sudden motions. This is effected in the following manner—viz: when the shipping-lever is operated, at the end of the first series of motions, a clutch, on a shaft carried by the second fast pulley, is shifted, and as this clutch has but one tooth the shaft is thereby permitted to make part of a revolution, during which the second series of operations take place, before it (the clutch) begins to act, and then it communicates motion to a large cog-wheel provided with a crank pin that actuates a connecting-rod jointed to a rack, (below the top sliding rack above described,) the teeth of which take into the teeth of a pinion on the shaft of one of the train of wheels that communicates motion to the carriage, thereby imparting the desired movement. The winding on of the yarn during the running in of the carriage is effected by the top sliding rack, which, for this purpose, is carried by the rack just described, by means of such connections as admit of modifying the motions of the top sliding rack which drives the spindles in winding on.

Motion is communicated from the bottom to the top rack in the following manner: On the end of the lower rack, and by the side of it, there is a stud-pin on which turns a scroll-cam, and to that part of its periphery which is nearest the axis is attached one end of a chain which passes from thence around a roller that turns on a stud-pin at the side of the lower rack, and is then carried back and attached by a short arm to the top sliding rack, so that when the lower rack slides the top rack will move with it, provided the scroll-cam remains immovable on its axis; but as the motion of the top rack during each operation must have a motion accelerated relatively to that of the lower rack to increase the rotation of the spindles as the threads are wound on a gradually-diminishing diameter of the conical form of the cops, this is effected by causing the scroll-cam to turn on its axis during the motion of the rack by having a wheel attached to and turning with it, to the periphery of which is attached one end of a chain that passes around it and is attached by the other end to another part of the machine, so that if this part of the attachment remains fixed a regular accelerated motion will be given to the

top rack relatively to the motion of the lower rack, and necessarily the spindles will have their rotation accelerated relatively to the motion of the carriage. These relative motions of the two racks, as described, are such as are required after the base of the cops has been formed, for then the threads are wound regularly on a cone; but in forming the base of the cops the first winding is on the naked spindles, at which time the motion of the spindles should correspond with that of the carriage, and from the commencement until the base is formed the accelerated motion should be gradually brought into play to give the conical form to the cops. This is effected by having the chain that winds on the wheel that turns with the scroll-cam attached to a slide that works on a screw in a vibrating arm, the outer end of which is jointed to another arm of equal length that turns on the end of the stud on which the scroll cam and wheel turn, so that when the slide is at the lower end of the arm, the two arms being of equal length, the motion of the wheel with the rack will not cause it to wind up the chain, but as the slide is drawn up toward the axis of vibration of the arm one end of the chain will necessarily move through a less space than the other, and thus cause the wheel with the scroll-cam attached thereto to turn on its axis and thus to vary the motion of the top rack, and thereby adapt the motion of the spindles to the varying diameter of the base of the cops. The screw in the vibrating arm that carries this slide is in connection, by means of appropriate cog wheels, with a horizontal ratchet-wheel which is free to move when the arm vibrates in one direction, but held by the hand or catch when the arm vibrates in the reverse direction for the purpose of turning the screw to move the slide; and this hand or catch is governed by an apparatus called a "butterfly," which is acted upon by an arm from the counter-faller, when the tension of the threads is too great, and thus throws the hand into the teeth of the wheel that the vibration of the arm shall operate the slide--the hand or catch being disengaged at each running out of the carriage. The last of the third series of motions is the operation of the copping-rail for operating the faller, which, being essentially similar to the others, needs no special notice here.

At the end of the running-in motion of the carriage, a pin on an arm projecting from the shaft of the crank that operates the under rack, liberates the catch that holds the connecting-rod by which the backing-off motion is effected, and so soon as it is liberated the weight of the machinery attached draws it back, and, to prevent any sudden jar by this operation, the crank-pin which operates the connecting-rod in one direction is so governed in its revolutions as to be nearly a semirevolution from its point of departure at the commencement of the backing-off operation, so that the force required for carrying it back to this position is sufficient to ease off the motion of the returning parts. This crank-pin is held in the position just indicated by a brake within the second fast pulley, and this brake is connected by a joint-link and lever with the arm of the connecting-rod of the backing-off apparatus, which when drawn back forces the brake in contact with the pulley and arrests the train of wheels and this crank-pin in their appropriate place.

When finishing the cops, it is important to wind the threads on tight at the point, particularly as the upper ends of the spindles are tapering. This is effected by forming the connection between the chain and the end of the top sliding rack by means of a vibrating frame, from which projects another arm that has a chain jointed to it, extending to and winding on an arbor, which arbor has a ratchet-wheel on it which is carried a part of a revolution at each operation of the mule by a hand on the arm of the connecting-rod of the backing-off motion, and this auxiliary chain is of such length that it continues to be wound upon the arbor without affecting the operations of any part of the machinery until the cops are nearly completed, and then it becomes so short as to be brought in contact with a permanent arm toward the end of the winding-on operation, and when thus brought in contact with this arm it suddenly shortens the chain that forms the connection between the two racks, and necessarily increases the rotation of the spindles, which, as a necessary consequence, draws the threads tighter on the spindles.

In the accompanying drawings, A^3 represents a frame properly adapted to the operative parts of what constitutes the head of the mule, the carriage not being represented, as it is in every particular similar to other mules. A A′ A″ are three pulleys of equal diameter, and placed side by side on the main shaft B. The one, A, is the first fast pulley attached to and turning with the shaft B. A′ is the second fast pulley carrying a pinion, D, and turning freely on the shaft B, and A″ is a loose pulley placed between the other two and turning freely on the shaft. A driving-belt from some first mover passes over these pulleys, and is guided to either of them by a shipper-lever, C, that vibrates on a stud-pin, U′, and connected with a weighted balance-lever, C^3, by which it is operated when the belt is to be shipped from one to another of these pulleys.

At the commencement of the first series of operations the belt runs on the first fast pulley, A′, to give the first series of motions. The pinion J on the shaft B communicates a positive and regular motion to the shaft G, (which is in connection with the draw-rollers in the usual manner,) by means of the first train of wheels, K L I, and from the shaft G by the second train of wheels, N O P R S X, to the line-shaft Y, that drives the carriage by means of endless chains Z, connected with the car-

riage by one of the links Z^3. There is but one of these chains represented in the drawings, and the shaft is shown as broken off, as the connections with the carriage present nothing new, and therefore need not to be represented, and at the same time the spindles are rotated or whirled by the usual band T′ driven by the pulley O′ on the same pulley-shaft B. This completes the first series of motions—viz: drawing out the carriage, rotating the draw-rollers, and whirling the spindles to draw out, spin, and twist the threads.

Toward the end of the running-out motion of the carriage the belt is shipped from the first fast pulley, A, to the loose pulley A″, which removes the driving-power from these motions. This shifting of the belt is effected in the following manner—viz: the weighted balance-lever C^3 is jointed to the shipper-lever at 2, and above the stud-pin 3, on which it vibrates, its upper end being weighted to enable it to fall over by gravity after the weight has been carried a little beyond the vertical line. The lower end of this balance-lever is T-formed, and one of its short arms is jointed by a link, 4, with a short lever, 5, that turns on a stud-pin, 6, and this lever is also connected by a link, *d*, with another lever, *b*, that turns on a stud-pin, *c*, and this last lever is depressed when the belt is to be shipped by means of a pin, *d*, on a vibrating arm, L′, on the shaft K′ of the wheel that carries the connecting-rod by which the carriage is run in. The balance-lever is by this means carried a little beyond the vertical line and then carried entirely over by the weight of the lever C^3. On this same shaft K′ and on the opposite side of the frame there is another arm, M′, provided with a pin, *g*, which at the same time depresses another lever, N′, connected by means of a jointed rod, *h*, with an elbow-lever, 7, that operates a clutch, M, on the shaft G, by means of which the cog-wheel I is clutched to its shaft or unclutched, so that when the driving-belt is removed from the fast pulley A to disconnect the parts that give the first series of motions the wheel I is unclutched, which liberates the draw-rollers and the second train of wheels that communicate motion to the carriage from the parts that drive the spindles, so that they (the spindles) are free to continue to move by their momentum independent of the draw-rollers and carriage. The clutch M is held open until the belt is again carried to the first fast pulley at the end of the third series of motions by a pin, *j*, on one arm of the balance-lever C^3, which bears against one side of the arm of the clutch-lever 7, for the lever N′ that operates the clutch-lever is provided with a helical spring, *i*, attached to it and the frame for the purpose of forcing the clutch in the moment that the pin *j* of the balance-lever c^3 liberates the clutch-lever 7. The parts being thus situated and the driving-belt on the loose pulley, the momentum of the spindles will cause them to continue to turn for some time, and this commences the second series of motions. The band T′ that carries the spindles and which, as stated above, passes around and is carried by the pulley O′, on the main shaft B, passes around a guide-pulley, R′, at one end of the frame, and another, S′, at the other end, and also around another pulley, P′, that runs freely on a shaft, Q′, except when clutched to it, which is done at the time the driving-belt is shipped from the fast first pulley, A. This pulley P′, called the "friction clutch-pulley," is a hollow cone lined with leather, into which is received a conical friction-clutch, P″, attached to the end of the shaft Q′, which slides endwise in its bearings and in the friction-pulley, which is prevented from sliding endwise with the shaft by a collar, 8, so that when this shaft Q′ is moved in one direction the pulley P′ is clutched to it by the friction of the conical surfaces, and when moved in the reverse direction it is unclutched and turns freely on the shaft. This clutching and unclutching is effected by an arm, Z^2, Fig. 5, on the spindle U′ of the shipper lever C, which embraces a collar on the shaft Q′, so that when the shipper C shifts the belt from the first fast pulley, A, it at the same time gives the requisite movement to clutch the friction-clutch that connects the spindles with the shaft Q′, which will be carried by their momentum, and as this shaft is connected by the train of wheels X′, Y′, Z′, and C″, with a horizontally-sliding rack, W′, it (the rack) will be carried for a short distance in the direction of the arrow thereon. (See Fig. 5.) When the shipper transfers the belt from the first fast to the loose pulley, a clutch, D^2, Fig. 9, on the shaft D′ is shifted by the forked lever *f*, which turns on the stud-pin 10, and is operated by a spur, 11, on the balance-lever C^3, which bears on the end of a volute spring, 12, attached to the lever *f*, the tension of which forces the sliding part of the clutch against the permanent part, which, having but one cog, causes it to clutch, when, by the rotation of the shaft, the parts coincide. The sliding part of the clutch is feathered to the shaft D′, which is carried by a train of wheels, C′ B′, and pinion D on the second fast pulley, A′, driven by the driving-belt when it is shifted by the shipper which carries it from the first fast pulley, A, to the loose pulley A″, and then to this, the time required for this transfer of the belt by the motion of the shipper being sufficient for the preparative movements.

So far it has been shown that the second fast pulley carries the shaft D′ of the clutch D^2 a part of a revolution before clutching the pinion E′, which gears into the wheel F′, that runs the carriage in, (as will be hereinafter described,) this period of time being required to enable the momentum of the spindle to run back the rack W′, preparatory to the backing-off motion. As the rack W′ is carried by the momentum of the spindle in the direction of the arrow preparatory to the backing-off motion, it is necessary gradually to arrest this motion, which is effected by a friction spring-

brake, constructed and connected with the rack in the following manner: To the end of the rack is attached a chain, *m*, which passes over a pulley, *o*, and then around a spur-wheel, *p*, attached to a ratchet-wheel, H^2, and with its turning freely on a rock-shaft, *n*, and then it passes over another loose pulley, D^3, and to the end of it is suspended a tension-weight, E^2, which takes up the slack of the chain. On the said rock-shaft *n*, and by the side of the ratchet-wheel, there is a cam-plate, *t*, that also turns freely on the shaft, and which is carried in one direction by the ratchet-wheel when the catch or hand *v*, which is jointed to the cam-plate, takes into the teeth of the ratchet, the two turning independently of each other in the reverse direction, or in the same direction when the catch or hand is lifted out of the teeth. When the rack is drawn by the momentum of the spindles in the direction of the arrow, the chain *m*, attached thereto, turns the spur and ratchet wheels in the direction of the arrow, and the cam-plate is also turned in the same direction by the catch or hand *v*. This motion is gradually arrested by the enlarged or scroll form of the cam-plate, which forces out a friction-arm, *b'*, one end of which is jointed at *a'* to one arm of a lever, F^3, attached to the rock-shaft *n*, the other arm of this lever being connected with the friction-arm *b'* by a helical spring, S. It will therefore be perceived that as the friction arm is forced out by the cam-plate the tension of the spring increases the friction of the brake on the periphery of the cam-plate, which gradually arrests the motion of all the parts in connection with the rack W', and of necessity the spindles. When these parts are arrested, the rock-shaft *n* is turned in the opposite direction, and carries with it the cam-plate, ratchet-wheel, and spur-wheel, by the pressure of the brake, and of necessity reverses the motion of the rack and spindles to uncoil the threads from the spindles. At the end of this motion the catch *v* of the cam-plate is liberated from the ratchet-wheel H^2 by a spur, *x*, of a lever *y*, jointed at 14 to the arm F^3 of the rock-shaft *n*, the spur being forced onto the back end of the catch by the rotation of the rock-shaft, the lever *y* having a slot in it which turns and slides on a permanent rod, *z*. This reversed motion of the rock-shaft *n* is effected by a crank motion in the following manner—viz: The pinion D on the second fast pulley, A', communicates motion by the train of wheels, B' C', and R^2 to the wheel Q^2 in the direction of the arrow, and this wheel carries a crank-pin, *h'*, that works in a slot, h^2, of a connecting-rod, o^2, jointed to a curved arm, K^2, that vibrates on a fixed stud-pin, 15, and this arm has a slot in it which works a slide, *e'*, for the purpose of graduating the backing-off motion, and to this slide is jointed another connecting-rod, J^2, the other end of which is jointed to the arm I^2 of the rock-shaft *n*. At the time that the driving-belt is shifted to the second fast pulley, A', which takes place while the momentum of the spindle prepares the parts for the backing-off motion, the crank-pin *h'* is at h^3, a little above a line passing from the center of the wheel to the junction of the connecting-rod o^2 and the arm k^2, so that the crank-pin on this wheel can move around to the position represented in Fig. 2 before it begins to draw the connecting-rod, to give time for completing the preparation of the parts for backing off.

In rotating from *h'* to h^4 the crank-pin carries the connecting-rod the required distance to give the required backing-off motion to the spindles to uncoil the threads, and at the same time depresses the faller to guide the threads to the cops preparatory to winding on by means of the copping rail or former G^2, one end of which is connected by a slot with a wrist, *q*, on an arm, F^2, of the rock-shaft *n*, the elevation of which, by the backing-off motion of the rock-shaft *n*, depresses the faller. So soon as the connecting-rod o^2 has been carried to the point h^4 by the crank-pin, which is the extent of the backing-off motion, the catch-lever U^2 takes hold of the pin 13 on the arm R^2 and there holds all the parts of the backing-off operation until released toward the end of the running-in motion of the carriage, the liberation of the parts being then effected by means of a pin, *l'*, on the arm L' on the shaft K' of the wheel F', which runs in the carriage. So long as the backing-off apparatus is held by the catch-lever U^2 the crank-pin *h'* can revolve freely, the slot in the connecting-rod o^2 admitting of this.

When the backing-off apparatus is liberated, it falls back to the position indicated in the drawings by the weight of the copping-rail and the other parts attached to the rock-shaft, and, to prevent jar, this return motion of the parts is eased off by the connecting-rod o^2 coming against the crank-pin *h'* at the point h^3, the power required to turn this train of wheels in the reverse direction being sufficient to ease off and gradually arrest the moving parts without jar. This return motion of the backing-off apparatus at the same time arrests the second fast pulley, A', and the train of wheels in connection with it by means of a brake, *j'*, connected by the arm T^2 and link S^2 with the arm K^2 of the backing-off apparatus, and the train of wheels and the connection of the brake are so regulated as to stop the crank-pin *h'* at the point h^3, where it is required to be when the second series of motions is commenced. The link S^2 and the connecting-rod J^2 are provided with adjusting-screws for the proper adjustment of all these parts.

As the backing-off motion must be gradually decreased as the cop is formed and increased in length, the vibrating motion of the rock-shaft is gradually shortened by means of the slide *e'* in the arm K^2, to which the connecting-rod J^2 is jointed. For this purpose the slide is attached to a chain, *d'*, which passes over the upper end of the arm and is gradually wound up on the arbor *e''* of a cog-

wheel, L^2, that gears into a pinion, f', of a ratchet-wheel, N^2, which receives motion from the vibration of the arm K^2 of the backing-off apparatus by a hand or catch, M^2, jointed thereto at g'. It will be evident that as the slide is drawn up by the chain toward the axis of motion of the arm K^2 the motion of the connecting-rod J^2 will be diminished, and with it the motion of the backing-off apparatus. This completes the second series of motions, and the mule is then in a condition to commence the third series.

When the clutch D^2 at the end of the backing-off motion clutches the pinion E' it begins to turn, which communicates motion to the cog-wheel F' on the shaft K', and to the periphery of this wheel at G' is jointed a connecting-rod, H', the other end of which at I' is jointed to a horizontal sliding rack, V, that runs on ways W, that carries, by means of the pinion U, the train of wheels that communicate motion to the carriage.

The wheel F' is carried but part of a revolution (nearly one-half) in one direction by its connection with the second driving-pulley, A', when the clutch D^2 is closed, which gives by the crank motion, in consequence of the connection above pointed out, the peculiar running-in motion to the carriage, as pointed out in the description of the general characteristics of this invention; and as the carriage approaches the end of its running-in motion the pinion E' is unclutched by the reversed action of the shipper-lever C^3, this reversed motion of the shipper and its appendages being effected by the pin e on the arm E' of the shaft K' of the wheel F', this pin e being on the side of the shaft K' opposite to the pin d, which first ships it. The unclutching of the pinion E' leaves the wheel F' free to be turned back by the reversed motion of the rack V, by the train of wheels which runs out the carriage in the first series of motions.

As the carriage is run in by the means just described the spindles must be turned to wind up the threads which have been spun during the first series of motions, and this is effected by means of the top sliding-rack, W', by which the backing-off motion is given, and which is placed on top of the main rack V. The connection of this rack W' with the spindles by means of the friction, clutch having been described, it is only necessary to describe the manner in which the winding-on motion is communicated to it by the main rack V, and the manner in which this motion is varied and regulated to correspond with the varying size of the cops as they are formed. To the upper rack, W', and near one end of it, is jointed a lever, m', to the short arm of which is attached a chain, l', which thence passes around a pulley, k'', that turns on a stud-pin projecting from the side of the main rack V, the other end of the said chain being attached to the smallest diameter of a scroll-cam, n', connected with the end of the main rack V. From this arrangement it will be obvious that if the cam n' be prevented from turning on its axis the motion of the main rack V will carry the top rack in the same direction and with the same varying velocity, which would give to the spindles a winding-on motion corresponding with the running-in motion of the carriage—such as would be required if the cops were to be formed cylindrical and did not vary in diameter; but such is not the case, as clearly pointed out in the general description.

To give the varying motions required and fully pointed out above, the scroll-cam n' is attached to and turns with a wheel, v', on the stud-pin I' on the main rack V, and to this wheel at w' is attached a chain, X', which, after passing around a portion of the circumference thereof, is attached by a link, y', to a slide, z'', that travels on a screw, a''', that turns in the arm V^2 of a rack-frame, V^3, the lower end of the said arm being jointed to another arm of equal length W^2, that vibrates on the stud-pin I' on which turn the wheel v' and the cam n', so that when the slide z'' is at the lower end of the arm V^2 that end of the chain X' which is attached to the slide, during the movements of the main rack, will not communicate motion to the wheel v' and cam n'; hence the motions of the two racks V and W' will correspond and give to the spindles the motion required for winding the threads on the naked spindles, and as the base of the cops is increased in diameter the slide z'' is drawn up toward the axis of motion of the arm V^2 to decrease the motion of that end of the chain X' attached to it, which will cause the wheel and cam to turn on their axes and thus give out the chain l', thereby giving to the top rack, W', and consequently to the spindles, a gradually-reduced motion relatively to the main rack to correspond with the increased diameter of the base of the cops. The motion required is given to the slide z'' by the vibrations of the rock-frame V^3, the screw a'' that operates the slide being connected by a train of cog-wheels, $b'' e'' g'' h'' i'' j''$, and with a horizontal ratchet-wheel, l'', which turns freely by the rocking motion of the frame V^3 in one direction, and which, therefore, does not turn the screw, but which is prevented from turning in the opposite direction, (during the running-in motion of the carriage,) by a catch or pawl, r'', to turn the said screw. Whenever the tension of the threads in winding on is too great, it bears down the counter-faller, (not represented in the drawings,) the arm of which in the running-in motion of the carriage strikes an arm, s'', of what is termed a "butterfly," that turns on a stud-pin, q'', on which the catch or hand r'' of the ratchet-wheel l^2 also turns, and with which it is connected by a spring, w^2, (see Fig. 1,) and throws it into the teeth of the ratchet-wheel, the wheel being thus held, the further vibration of the rock-frame turns the screw and carries up the slide to reduce the motion of the spindle, and on the return motion of the carriage the hand or catch r'' is thrown out of the teeth of the ratchet-wheel

by the arm of the counter-faller, which then comes in contact with another arm, t^2, of the butterfly, the end of which extends lower down than the arm S^2, and low enough to be struck by the arm of the counter-faller when it is not under the action of the tension of the threads. The catch or hand then remains out until the tension of the threads again requires the motion of the spindles to be reduced. The butterfly is connected with a hand latch-lever, m^2, that turns on a stud-pin, n^2, by which the attendant can throw the butterfly in and out of play.

So soon as the base of the cops have been formed the scroll form of the cam n' gives the regular varying motions to the spindles to wind the cone of the cops, as fully pointed out in the general description.

It has been stated that in finishing the cops the threads are wound on harder at the point of the cops. This is effected in the following manner: On the shaft e'' which regulates the backing-off motion, as described above, there is a hub, q', from which projects a crank-arm, t', to the pin S' of which is jointed by a link, r', a chain, p', the other end of which is jointed by a link, o', to the long arm of the lever m', which forms the connection between the top rack, W', and the chain l', which forms the connection between the top and main racks. This shaft, as heretofore described, is connected with the ratchet-wheel N^2, which is operated by the catch or hand M^2 of the lever K^2 of the backing-off apparatus, and the chain p' is of such length that it is wound up by the rotation of the shaft until toward the completion of the cops, at which time it is drawn sufficiently tight to strike against a permanent arm, u', toward the end of the winding on motion, which causes the lever m' to turn on its axis, and by its connection to draw up the chain l' and hence to increase the velocity of the rack W', and therefore the rotation of the spindles which winds the threads on tighter. This operation gradually increases to the completion of the cops. On this same shaft e'' is placed the copping-cam Y^2, the periphery of which acts on the lever X^2, to which the copping-rail or former G^2 is jointed at r in manner well known to those acquainted with the construction of self-acting mules, and which therefore needs not to be described.

This completes the whole series of motions, but it will be obvious that when one set of cops have been completed the parts employed in giving the progressive movements—such as the shaft e'', that rotates the copping or forming cam Y^2, winds the chain which carries the slide e' of the backing-off apparatus and the crank-arm t' that winds the chain p' to increase the tension of the threads in finishing the points of the cop, and also the ratchet-wheel l^2, which governs the motions of the slide z'' on the arm V^2, by which the winding-on motion of the spindles is regulated to form the base of the cops—are to be turned back by hand to their original positions by the attendant preparatory to commencing a new set of cops.

I have thus described the general character of my invention and the manner of constructing and using the same; but before pointing out what I claim as my invention, I wish it to be distinctly understood that I do not limit myself to the precise form and construction of the various parts employed, or to the precise arrangements described, as I consider all mechanical equivalents as within the limits of my invention.

What I claim, therefore, as my invention, and desire to secure by Letters Patent, is—

1. The disconnecting of the mechanism employed in running out the carriage and turning the draw-rollers from the mechanism which gives the whirling or spinning motion to the spindles when the driving-power is shifted from these the first series of motions to enable the spindles to continue their motion by inertia, independent of the other motions, by means of the clutch-box, or its equivalent, which forms the connection between the three movements constituting the first series of motions, whereby the momentum of the spindles can be employed for preparing the parts for the backing-off motion, substantially as described.

2. The method of preparing the parts for the backing-off motion by means of the momentum of the spindles, by connecting them with the backing-off apparatus by means of the friction-clutch, or any equivalent therefor, substantially as described.

3. The backing-off apparatus, consisting of the combination of the top sliding rack, which communicates motion to the spindles, the rocking shaft with its cam and spring-brake and other appendages, and the connecting-rod operated by the crank, all substantially as described.

4. The method of decreasing the backing-off motion to correspond with the increased length of the cops by means of the slide in the intermediate arm of the connecting-rod, (between the two sections of the connecting-rod,) by means of which the rocking motion of the rock-shaft is gradually decreased, substantially as described.

5. Combining the train of wheels which actuate the backing-off motion of the carriage, by means of a clutch, substantially as herein described, which admits of the necessary backing-off motion before the tooth of the clutch starts the carriage, whether this be effected by a clutch or by any other means, substantially the same.

6. Running in the carriage by means of a crank motion, which actuates a sliding rack that communicates the desired motion to the carriage, so as to start and arrest it gradually, substantially as described, to avoid any sudden strain or jar upon the threads.

7. The method of communicating the winding-on motion to the spindles from the main

rack which runs in the carriage by combining the said main rack with the top sliding rack by means of a chain and scroll-cam, or their equivalents, by means of which combination, in connection with the form of the cam, the motions of the spindles so corrrespond with that of the carriage as to wind the threads on the conical form of the cops, as described.

8. The method of varying the winding-on motion of the spindles to form the base of the cops by means of the slide and chain, which vary the motions of the wheel that is attached to and which rotates the scroll-cam, substantially as described, whether the slide be operated by the vibration of the arm on which it slides or by any other means, substantially as herein described.

9. The method of regulating the motion of slide that varies the motions of the scroll-cam of the winding-on motion by means of what is termed the "butterfly" and its appendages, when this is acted upon by the counter-faller operated by the tension of the threads, substantially as described.

10. The method of winding on the threads tighter at the points of the cops when finishing them by means of the apparatus which gives to the top sliding rack an increased motion toward the end of the operation, the said apparatus consisting of a chain which is connected with the chain that forms the connection between the main and top rack, and which is gradually wound up and strikes against an arm toward the end of the operations of the mule to shorten the connection between the two racks, and thus increase the winding-on motion of the spindles, as described.

WM. MASON.

Witnesses:
JESSE HARTSHORN,
WILLIAM JONES.