No. 644,310. Patented Feb. 27, 1900.

L. C. WOERNER & F. HARRINGTON.

MULTIPLE SPINDLE SCREW MACHINE.

(Application filed Sept. 2, 1898.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 12.

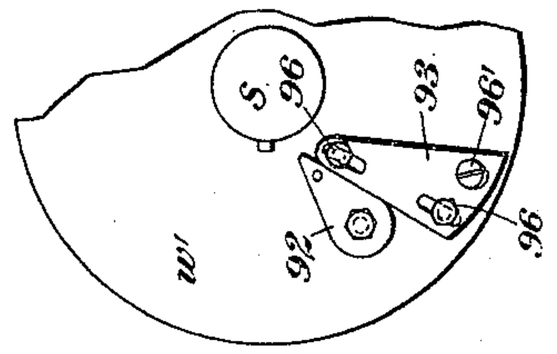

Fig. 1.

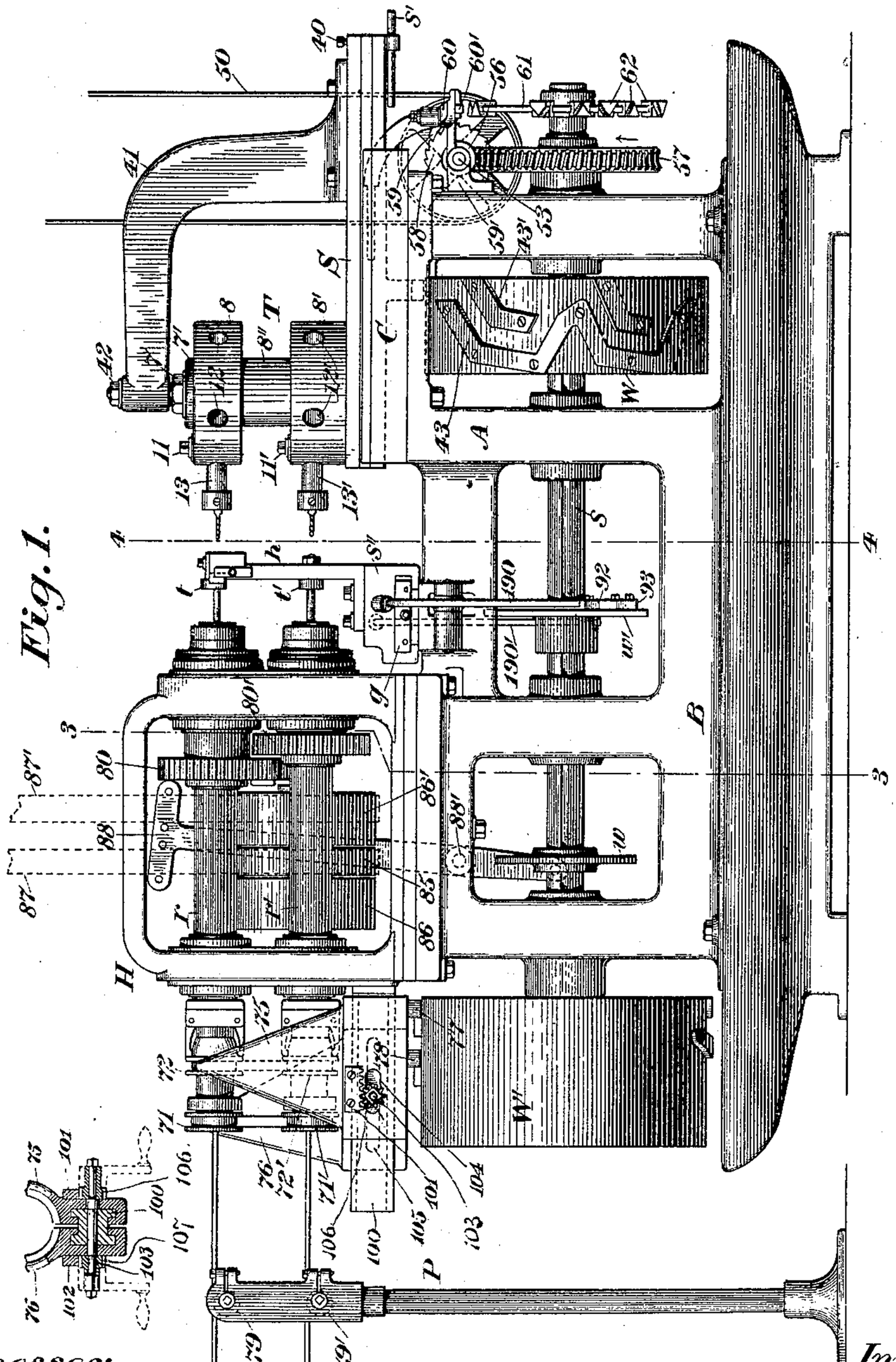

Fig. 13.

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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

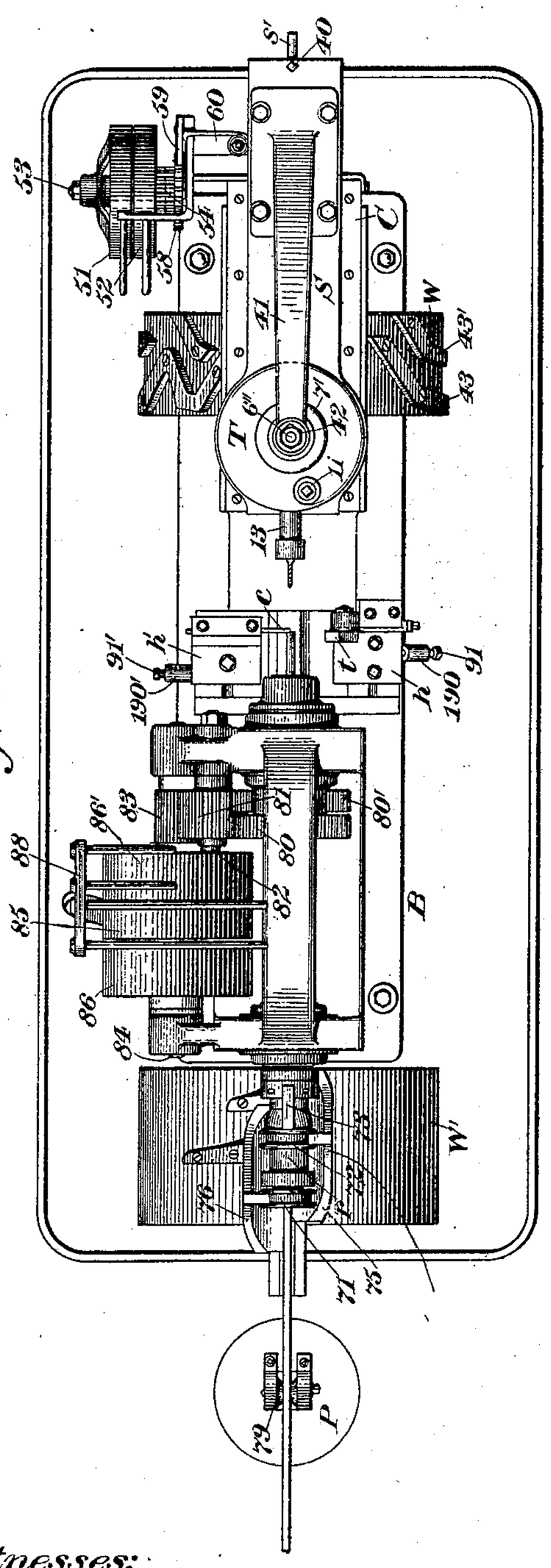
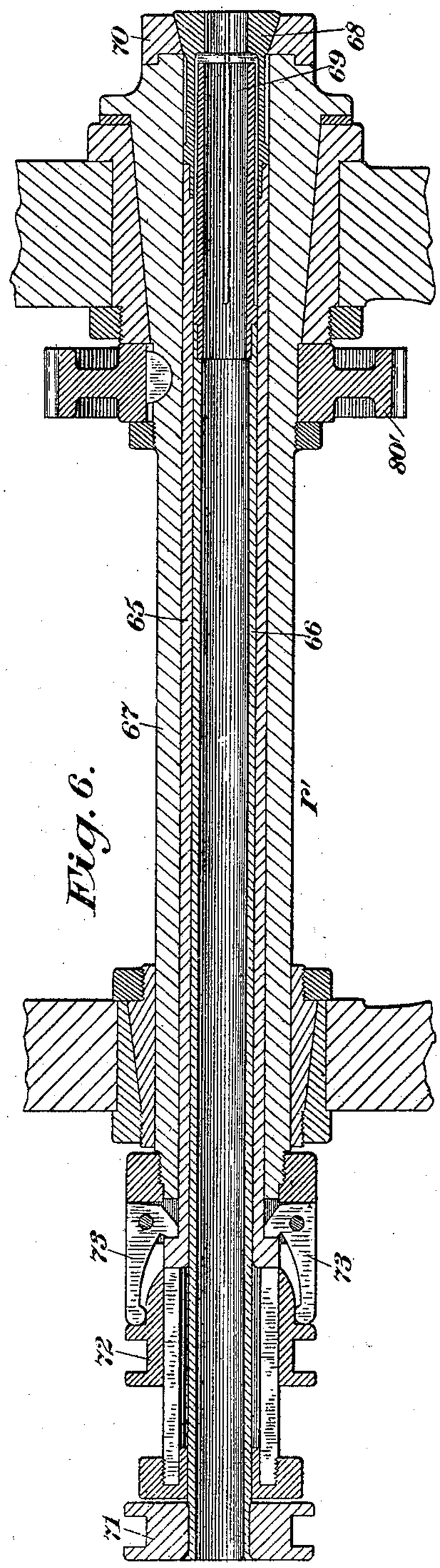


Fig. 6.



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(No Model.) 4 Sheets—Sheet 3.

Fig. 5.

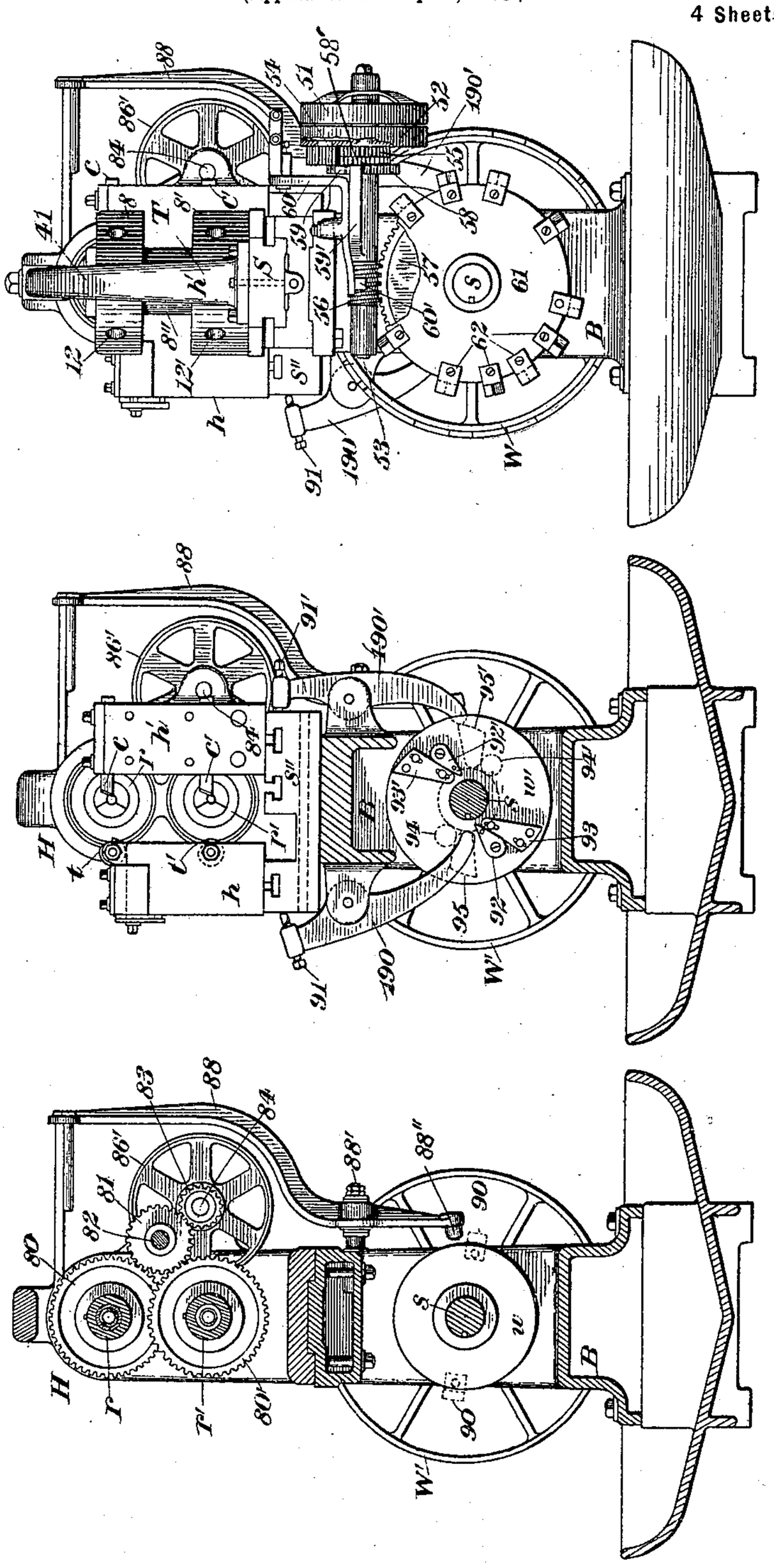

Fig. 4.

Fig. 3.

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(Application filed Sept. 2, 1898.)

(No Model.) 4 Sheets—Sheet 4.

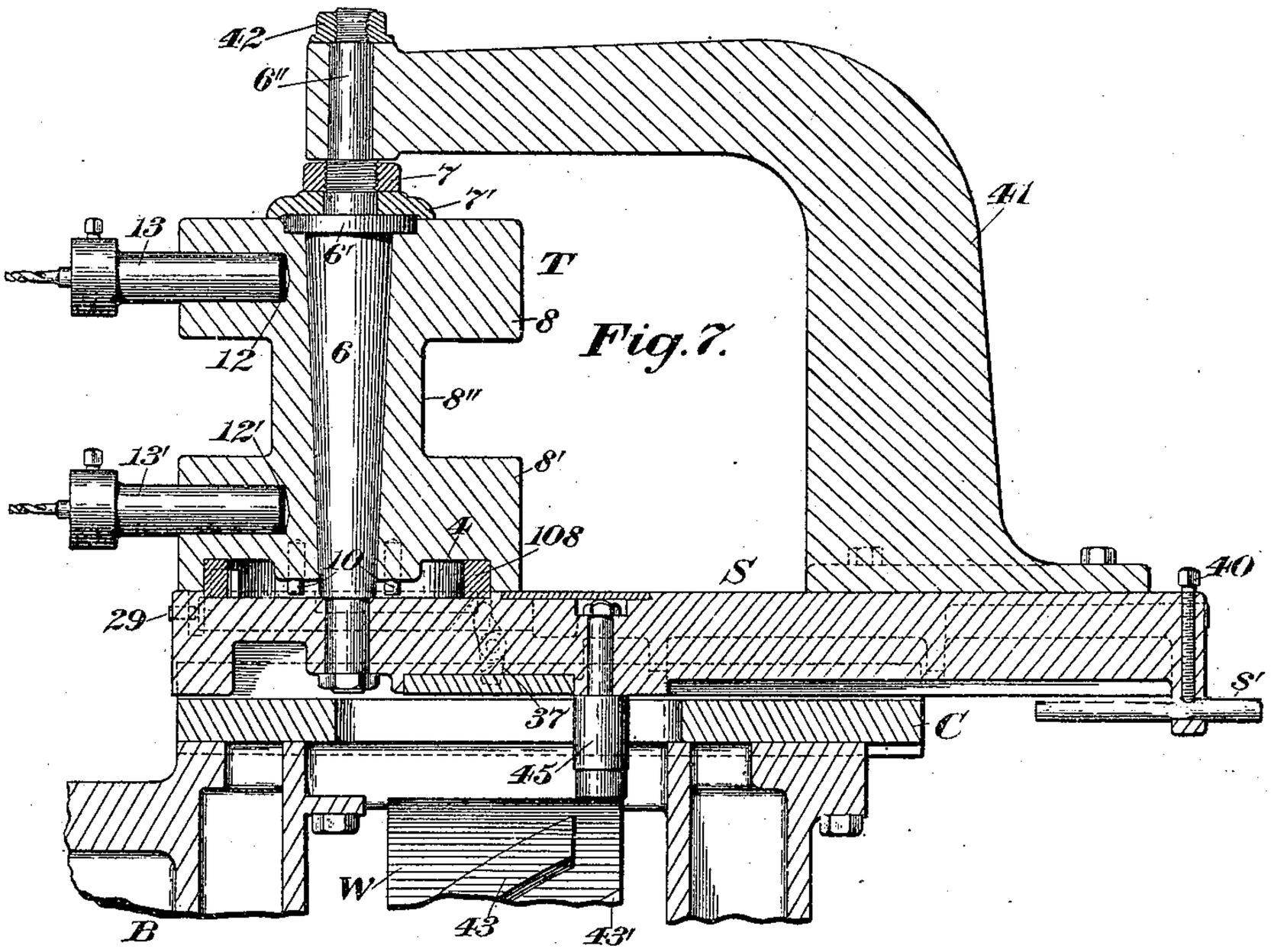

Fig. 7.

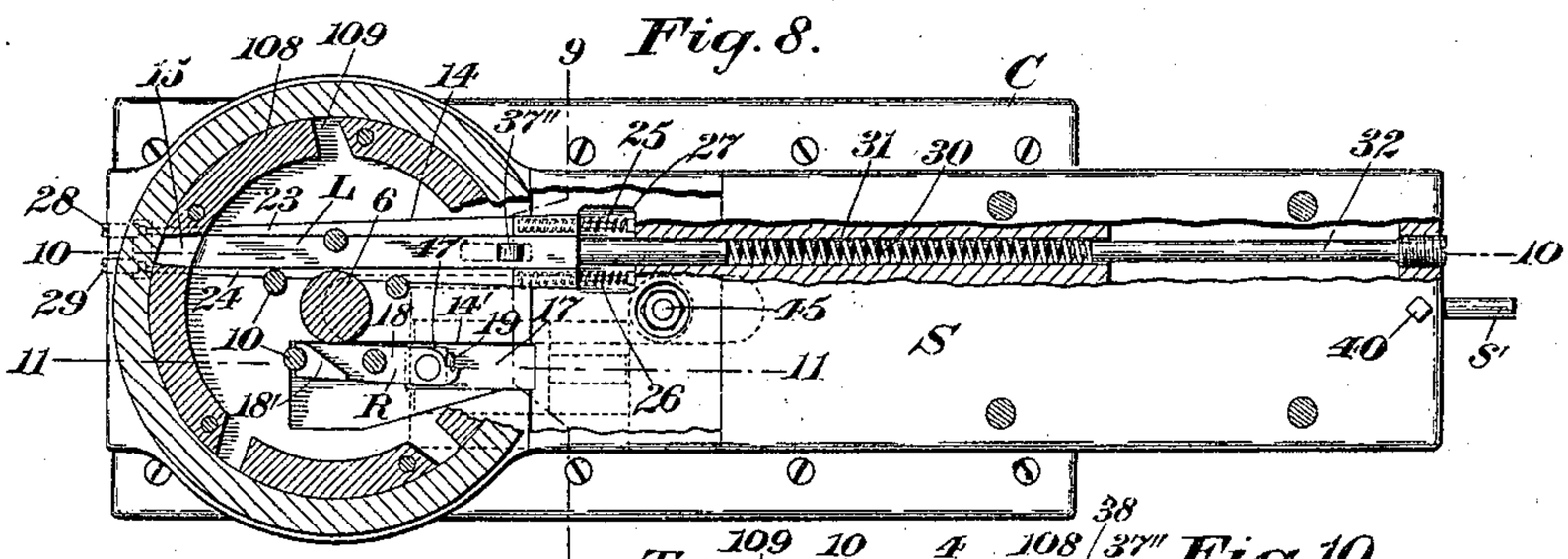

Fig. 8.

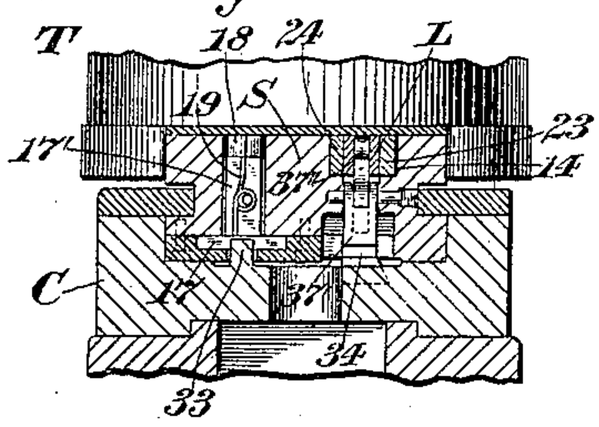

Fig. 9.

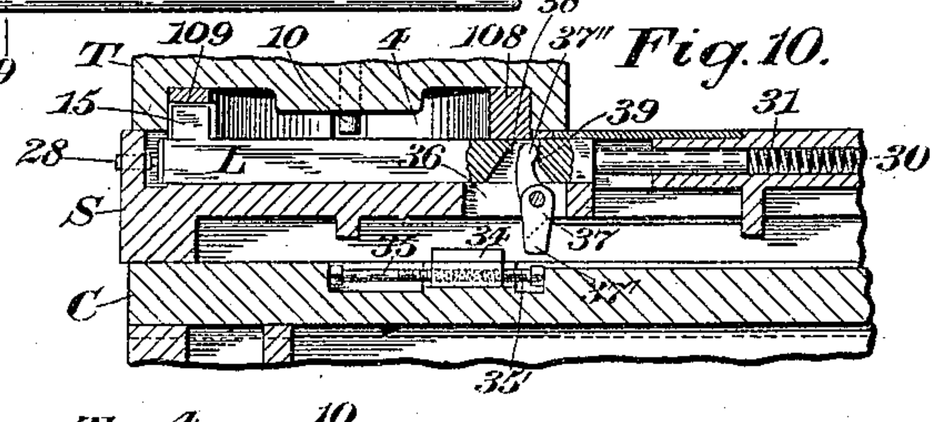

Fig. 10.

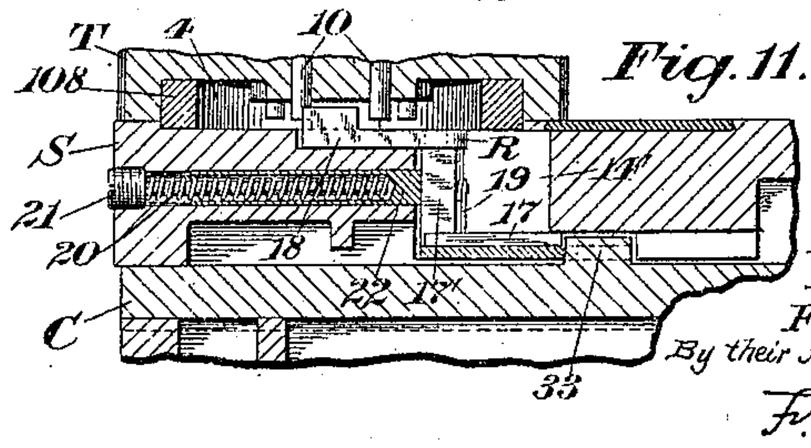

Fig. 11.

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UNITED STATES PATENT OFFICE.

LOUIS C. WOERNER AND FRANK HARRINGTON, OF HARTFORD, CONNECTICUT, ASSIGNORS TO THE PRATT & WHITNEY COMPANY, OF SAME PLACE.

MULTIPLE-SPINDLE SCREW-MACHINE.

SPECIFICATION forming part of Letters Patent No. 644,310, dated February 27, 1900.

Application filed September 2, 1898. Serial No. 690,086. (No model.)

To all whom it may concern:

Be it known that we, LOUIS C. WOERNER and FRANK HARRINGTON, citizens of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Multiple-Spindle Screw-Machines, of which the following is a specification.

This invention relates to metal-working machines, and it is embodied especially in an automatic multiple-spindle machine or lathe for forming screws and other similar articles from rods of the usual type.

One of the main features of this invention is the provision of improved turret mechanism for holding and advancing to and withdrawing from a working position the tools usually carried by the turret in a machine of this kind. One of the essential features of this part of the invention is the employment in connection with a turret of a reciprocatory actuating device for rotating the same, this actuating device being operated in turn by automatic actuating means—such, for example, as the usual cam-shaft of a machine of this type. In addition to the turret-rotating device and in connection therewith a locking device for the turret is also employed, which coacts with such rotating device and may also be operated automatically in a manner similar to the operation just described with respect to the reciprocatory turret-rotating member.

One of the principal features which distinguishes the construction shown in the present application is the automatic operation of the turret rotating and locking devices, which action will be described more fully hereinafter in detail.

Another important feature of this invention is the provision of a turret-rotating device supported and operable independently of the locking device, separate actuators being provided, preferably, for the purpose of shifting these parts into and out of action. Hence in the preferred construction each of these devices is reactive in one direction, a spring being employed in this case for normally holding the locking device in or forcing it toward its locking position, while another spring tends normally to return the turret-rotating device toward the beginning of its range of movement, which in this case will be in a direction the opposite of the normal movement of the locking device. The usual construction will be one in which the turret will be supported for rotation on a reciprocatory turret-slide mounted in the ordinary manner upon suitable ways, and the turret rotating and locking devices will be carried by this turret-slide and will be reciprocated relatively thereto, preferably by fixed actuators or stops carried on the ways or support proper and in the paths of movement of the locking and turret-rotating devices, respectively. The turret itself may advantageously be one having a substantially-central peripherally-reduced portion forming two tool-receiving members at the upper and lower ends, respectively, of the turret, these two members or portions of the turret having the usual tool-sockets for receiving tool-holders of suitable construction, separate securing or fastening devices being provided for the tool-holders carried by each of these members of the turret. It will be evident that by providing tool-holders and fastening devices of this type the holders of one series may be adjusted in place or removed independently of those of the other series.

In a machine of the class in which the present improvements are embodied it is customary to operate the several tools and other parts from a rotary cam-shaft, and for the purpose of varying the rate of rotation of this cam and for correspondingly regulating the operation of the tools and other parts controlled thereby we have provided in this case a driving-shaft carrying two pulleys so connected with the cam-shaft as to be capable of rotating the latter at different rates of speed at different stages in the operation. The preferred construction is one in which these two pulleys are rotated alternately by means of a belt, which will be shifted from one to the other automatically at the proper points by the action of a cam-wheel secured to the cam-shaft and controlling the movements of a belt-shipper of the usual type. The transmitting means between the pulleys and the cam-shaft may be of any suitable type to pro-

duce the requisite variation in the speed of the latter, although we prefer to employ the epicyclic gearing illustrated herein. The movements of this cam-shaft will be transmitted to the tools by mechanism which will be described fully in detail hereinafter. One of the mechanisms—that for operating the turning-down, cutting-off, or similar tools—embodies in its construction an adjustable cam carried by the cam-shaft and shiftable toward and from the latter, this cam coöperating with suitable intermediate means or devices for regulating the extent to which the tool slide or slides are shifted. Preferably at least two of these adjustable cams will be located on the cam-shaft, at opposite sides of the latter, and will determine the distance through which the tool-slide moves in each direction. Another feature of this mechanism is a cam-wheel having a cam-groove controlling the movements of the turret-slide, said slide having a depending arm carrying a shoe which completely fills the space between the walls of the cam-grooves, and thus positively locates the turret-slide at any point in its advancing or retracting movement.

The foregoing and other features of novelty in the construction and organization of the several mechanisms and devices of the improved automatic machine illustrated in the drawings of this application and forming the subject-matter of our present invention are fully set forth in the accompanying description.

In the drawings accompanying and forming part of this specification, Figure 1 is a side elevation of an automatic machine embodying our present invention. Fig. 2 is a plan of the same. Fig. 3 is a transverse section of the same, the section being taken substantially in line 3 3, Fig. 1. Fig. 4 is a transverse section of the same, the section being taken in line 4 4, Fig. 1. Fig. 5 is an end elevation of the same as seen from the right in Fig. 1, parts being broken away to illustrate the construction more clearly. Fig. 6 is an enlarged longitudinal section of one of the live-spindles of the machine and its connected parts. Fig. 7 is an enlarged longitudinal section of the turret mechanism and coacting parts. Fig. 8 is a sectional plan of the turret, the turret-slide, and the turret rotating and locking devices. Fig. 9 is a transverse section of the same, the section being taken in line 9 9, Fig. 8. Fig. 10 is a partial longitudinal section of the same, taken in line 10 10, Fig. 8. Fig. 11 is a corresponding section taken in line 11 11, Fig. 8. Fig. 12 is a detail view, partly broken away, of one of the cam-wheels; and Fig. 13 is a detail in section of manual means for actuating the rod feeding and holding devices.

Similar characters designate like parts in all the figures of the drawings.

In a general way the construction and operation of the machine illustrated herein are in many respects similar to those of automatic multiple-spindle screw-machines now in use. It embodies the usual cam-shaft, continuously rotative, for operating the different tools and other parts of the machine, a head-stock carrying two or more composite live-spindles carrying the usual rod feeding, chucking, and rotating devices, a suitable tool slide or slides carrying the turning-down and cutting-off tools controlled in their movements by the cam-shaft, and a turret-slide, the latter of which carries the usual tools for drilling, tapping, countersinking, or otherwise operating in accordance with the character of the parts to be made by the machine.

The several operative parts of the machine may be mounted substantially in the usual manner upon a framework, such as B, of the ordinary construction. At one end thereof the turret-support and the turret will be mounted for operation, while at the other end the live-spindles or work-spindles will be mounted on the head-stock of the machine, and between such head-stock and the turret will be supported the transverse slide carrying the turning-down and cutting-off tools, while below all of these parts will extend through the framework, from end to end thereof, the usual cam-shaft, controlling the operations of the several parts.

In the preferred construction, which is illustrated herein, the turret mechanism embodies a turret slide or support (designated in a general way by S (which may be supported in any suitable manner on a carriage, such as C, mounted on the bed B or framework proper, a turret (designated in a general way by T) supported for rotation on the turret-slide S and having a circuit of lock-notches or stop-faces concentric with the axis of rotation of the turret, a turret-locking device, such as L, supported for reciprocation on the turret-slide at one side of the axis of rotation of the turret and in position to engage successively the stop-faces of the latter, a reciprocatory turret-rotating device, such as R, and actuating means for reciprocating the slide and for also reciprocating the turret rotating and locking devices relatively to such slide.

The turret-slide will be of the usual type, supported and guided between ways on the carriage C, and need not be described in detail. The turret T, except as to certain features hereinafter more fully specified, may also be of any desired construction. In the present case it has in the under side thereof a recess, such as 4, of a suitable depth and diameter for permitting the operation of the several turret rotating and locking parts. This turret may be pivotally or rotatively supported on the turret-slide on a tapered or conical stud, such as 6, passing through a corresponding tapered longitudinal bore in the turret and bolted at its lower end to the turret-slide, the turret and the slide being held together substantially in the usual manner by means of a nut 7, carried on a threaded portion of the upper end of the stud 6, a suit-

able washer, such as 7′, being interposed between the nut 7 and the turret and engaging the upper face of a notched or flanged portion 6′ of the stud. All of these parts are substantially of the usual type.

The turret itself, by which the different tools are carried for operating upon the stock, is of novel construction, and instead of being of substantially the same diameter from the upper to the lower end thereof it has a central peripherally-reduced portion, such as 8″, supporting two tool-receiving portions 8 and 8′ of relatively large diameter, each of these tool-receiving portions having the usual radial sockets 12 and 12′, carrying tool-holders, such as 13 and 13′. For the purpose of fastening these tool-holders securely in place, as illustrated herein, (see Figs. 1 and 2,) separate clamping means or holding devices, such as 11 and 11′, are employed, the clamping members for each circuit of tool-holders being separate from and adjustable independently of those for the tool-holders of the other circuit. By means of this construction it will be apparent that the clamping members may be passed into the tool-receiving portions substantially in a vertical direction and transversely to the plane of each circuit of tool-holders and that any tool-holder of one series may be adjusted in position or removed without affecting the adjustment of any other tool of either circuit. The space between the two receiving portions should of course be of sufficient height to permit the clamping members 11′ to be operated readily and should also be of sufficient radial depth to provide ample space for the holding members.

In the construction illustrated there is secured to the turret, within the recess 4 thereof a stop-ring 108, having a series or circuit of, stop-notches, such as 109, located at suitable intervals, these notches being undercut or formed in the lower face of said ring 108, they being in the present case five in number and concentric with the axis of the turret.

For the purpose of effecting the intermittent rotary movements of the turret there is shown, in connection with the reciprocatory turret-rotating device hereinafter referred to, a circuit of members or pins coöperative with such actuating devices and forming therewith a pawl-and-ratchet mechanism controlling the rotation of the turret. In this construction there are five of these pins, each of which may be of the type shown at 10, they being disposed concentrically about the axis of the turret and depending into the recess 4, with their lower faces in a horizontal plane below the plane of the upper walls of the stop-notches 109.

As before stated, the turret-slide carries turret rotating and locking devices which may be of the type indicated at R and L. The turret-rotating device coacts with the pins 10 and forms therewith the pawl-and-ratchet mechanism just referred to, while the locking device is in the nature of a lock-bolt adapted to be received by any one of the notches 109, according to the position of the turret. The turret-locking device or bolt is preferably oblong and has a substantially wedge-shaped locking end, such as 15, which projects transversely therefrom above the upper face of the main portion of the locking device. (See Fig. 10.) This bolt may be supported in a longitudinal guideway in the upper face of the slide S and at one side of the axis of rotation of the turret T, this guideway being preferably a groove or channel in the upper face of the slide.

For the purpose of guiding the turret-locking bolt L and for retarding the unlocking movement of said bolt the guideway or groove 14 in the turret-slide is preferably tapered, the forward end being of less width than the rear end thereof, and the bolt L may be disposed between two elongated tapered jaws or guides, such as 23 and 24, interposed between the outer faces of said bolt and the outer tapered walls of the guideway, said jaws or guides being held in frictional engagement with the opposite faces of the bolt, preferably by means of spiral springs 25 and 26, lying between the inner ends of said jaws and a portion of the turret-slide S, the slide being recessed at 27 to receive said springs, as shown clearly in Fig. 8 of the drawings. These springs force the jaws 23 and 24 forward and cause them to grip the opposite faces of the locking-bolt L, the advancing and transverse movements of the jaws being limited, preferably, by stops, such as the screws 28 and 29, extending through the forward end of the slide S and bearing at their inner ends against the forward ends of said respective jaws.

In connection with the bolt L there is provided a spring, such as 30, seated in a horizontal groove 31 in the slide S and bearing at its forward end against the rear end of the bolt and at its opposite end against an adjustable tension device, such as the adjusting screw-bolt 32, extending into the groove 31 at the end of the slide S.

The reciprocatory turret-rotating device R is supported in this case in a longitudinal channel or recess in the turret-slide at the opposite side of the axis of the turret from that at which the locking-bolt is carried. In this case said actuating device embodies a turret-rotating slide 17, suitably held in a guideway at the bottom of the opening 14′, and this slide has rising therefrom a fixed projection or stud, such as 17′, the upper end of which may be rounded to form a pivot for the actuating member or pawl proper, (indicated by 18.) At the forward end thereof the actuating member or pawl 18 is recessed to form a feed-pin-engaging face corresponding in contour to the periphery of each pin 10, this pawl also having a cam-face projecting above the main portion of the pawl and so shaped as to permit the pawl to return to its normal position after having actuated a pin 10 to the position shown in Fig. 8. In

the present case this pawl is normally spring-pressed into engagement with one of the pins 10, a suitable spring for this purpose being shown at 19.

The slide 17, like the bolt L, is intended to be reactive in one direction and will also have a suitable spring for effecting such movement. The reactive movements of these two devices are in opposite directions, however, for whereas the lock-bolt is intended to be normally pressed to the left by means of its spring, as seen in Fig. 8, the slide 17 will be shifted to the right by its spring. This will be apparent by referring more particularly to Fig. 11, in which there is illustrated at 20 a spring surrounding an adjusting screw-bolt 21 and working against the inner back wall of a tubular member or guide, such as 22, resting against the stud 17′. The movement of slide 17 to the left during a part of the reciprocation of the slide S in the same direction will be caused by the contact of the wall of the recess 14′ with the stud or projection 17′. When the slide S returns to the right, the movement of slide 17 therewith will be arrested by the stop or abutment 33, and the pawl 18 being then held stationary will rotate the turret by engaging with one of the pins 10 thereof during the last period of the return movement of the turret-slide S″.

For unlocking the turret the pawl L is operated in substantially the same manner as has just been described with reference to the member 17. The reciprocatory turret-rotating device is arrested by a resistance block or stop, the stop 33 being employed in connection with the slide 17, as above mentioned, while a corresponding stop, such as 34, on the carriage constitutes the resistance-block for the locking device. This stop 34 may be an adjustable one having a wedge-shaped base working in a corresponding guideway in the carriage and will be adjustable in position in some suitable manner, as by means of the adjusting screw-bolts 35 and 35′. This stop 34 is disposed in the path of movement of an intermediate supported on the turret-slide S, this intermediate being in the present case a two-part or by-pass lever or pawl pivoted in an opening, such as 36, in the slide S and having its lower end depending into the path of the stop 34. This by-pass lever is designated by 37, and the upper end thereof projects into an opening 38 in the locking-bolt L and is intended to engage the stop-wall 39 to actuate said locking-bolt to release the same. When the turret-slide moves to the left, the lower part 37′ of the by-pass 37 will swing freely and will pass over the face of the stop 34 without actuating the upper part 37″ of said lever; but when the turret-slide returns to the position shown in Fig. 10 the arm 37′ will become effective as soon as it strikes the left-hand end of the stop 34, and the movement of the slide continuing the upper end 37″ of said lever 37 will swing to the right and will actuate the locking-bolt L in the same direction and will release the same from the locking-notch in the ring 108, this movement being effected, of course, in opposition to the thrust of the spring 30.

The movement of the turret-slide toward its advanced position may be limited in any suitable manner—as, for instance, by an adjustable rod *s*′, which may be held in place by a clamp-bolt 40.

For bracing the turret rigidly an overhanging arm, such as 41, may be used, it being clamped to the turret-slide and having at its free end a bearing for the upper journal portion 6″ of the stud 6, a nut, such as 42, being employed for maintaining the parts in position.

Any suitable means may be employed for automatically actuating the turret-slide to advance and retract the same; but in this case a cam-wheel, such as W, is carried by the usual cam-shaft *s*, said cam-wheel having thereon suitable cams, such as 43 and 43′, forming between them a cam groove or channel adapted to receive a suitable member carried by the turret-slide. In this instance there depends from said slide a stud, such as 45, the lower end of which constitutes a shoe and is of such a size as to exactly fill the cam-groove in the wheel W, and thereby be positioned positively in its reciprocation, and with it, of course, the turret-slide itself. The shape of these cams will of course determine the rate and extent of advance and withdrawal of the turret-slide, while the stops 33 and 34 will determine the points at which the turret will be rotated and the locking-bolt withdrawn from the notch 109. Obviously as the turret-slide advances toward the work the spring 30 will maintain the locking-bolt in locked engagement with the ring 108 and the by-pass 37 will ride over the stop 34 and will not be effective, while during a part of this movement the slide 17 will be held against the stop 33 by the expansion of the spring 20, and that pin 10 which will next serve to transmit a rotary movement to the turret will ride over the cam-face 18′ and will drop into the conical recess at the end of the pawl 18. When the turret-slide is retracted, however, the arm 37′ of the by-pass 37 immediately comes into engagement with the stop 34, and as the pivot of the lever is shifted to the right, as seen in Fig. 10, by the continued retractive movement of the turret-slide the upper end of the arm 37″ will withdraw the locking-bolt quickly from the notch 109, owing to the fact that the movement of the end of the arm 37″ is substantially twice that of its pivot. As soon as the locking-bolt withdraws the pawl 18 will become effective to rotate the turret, owing to the fact that the slide 17 is then in engagement with the stop 33, and hence by its resistance to movement in the direction of the return of the turret-slide will cause the partial rotation of the turret by engagement with

a pin 10. At the end of this movement the parts will be left in the positions shown in Figs. 8, 10, and 11.

The rate at which the turret and its slide advance and withdraw is determined in this case not only by the shape of the cam-faces of the cam-wheel W, but also by the rate of rotation of the shaft *s*, which, as before stated, is intended to be operated either at a high or a low rate of speed. For this purpose I have illustrated at 50 a driving-belt which may be rotated continuously from the usual countershaft (not shown) and is intended to drive either one of a pair of pulleys 51 and 52 as it is shifted from one to the other. The pulley 51 in this case is fast on a worm-shaft 53, journaled at one end of the main frame A, while the pulley 52 is loose on said shaft and carries a planet gear or pinion, such as 54, adapted to mesh with the sun-gear 55, fixed on the shaft 53, and also with another gear 58′, which, although of the same diameter as the sun-gear 55, has one tooth less than the same. The gear 58′ is rigidly secured to a ratchet-wheel 58, which is loose on the shaft 53, and a stop-pawl, such as 59, may be employed for preventing a retrograde movement on the part of the gear 58′, the pawl being mounted in this case on a bracket 59′, projecting from the framework, this mechanism forming an epicyclic train for imparting either a high-speed or low-speed movement to the worm-shaft 53, and hence to the cam-shaft *s*, which carries thereon a worm-gear 57, in mesh with a worm 56 on said shaft 53. This mechanism is not by itself considered a part of our invention.

As it is intended that all of the operations of the machine shall be automatic, there is provided a belt-shipper, such as 60, pivoted on the bracket-arm 59 and having the usual fingers for shifting the belt 50 from one to the other of the pulleys 51 and 52 alternately. In order to operate this belt-shipper, there is provided on the cam-shaft *s* a cam-wheel 61, having a circuit of peripheral cam-faces, formed in this case on cam segments or wipers 62, preferably removably secured to the cam-wheel 61 at different intervals. As the cam-shaft rotates these cam-faces will alternately shift the belt-shipper first in the one direction and then in the other and correspondingly operate the belt, and thus vary the rate of operation of the driving mechanism, the speed of rotation of the cam-shaft, and the feed movements of the several tools and driven parts. These cams 62 coact with a stud or pin 60′ on the belt-shipper. It will be seen also that the cam-faces of the cams 62 are so arranged in two sets as to automatically shift the belt-shipper whether the cam-shaft be rotating in the one or the other direction. Near the opposite end thereof this cam-shaft carries in this case another cam-wheel, such as W′, for controlling the operation of the rod gripping and feeding spindle supported on the head-stock of the machine. This head-stock is indicated by H and is substantially of the usual construction. It supports also substantially in the usual manner a plurality of composite live spindles or rod feeding and rotating spindles, preferably two in number and each preferably of the construction illustrated in detail in Fig. 6. The two spindles are designated, respectively, by *r* and *r*′, and each is made up, as is usual, of two spindles, the intermediate of which is designated by 65 and is journaled substantially in the usual manner in an outer spindle, such as 67, while the inner spindle, which engages the rod directly, is designated by 66. The spindle 65 carries at its working end the usual chuck-jaws 68 for holding and clamping the rod when the latter is to be rotated, and the corresponding end of the spindle 66 is also split to form spring arms or jaws 69 of the usual type. At the chucking end of the spindle 65 the sleeve 67 carries a conically-bored collar, such as 70, to form an inclined resistance-surface for operating the members of the chuck 68. At the rod-receiving ends thereof each of the spindles 65 and 66 carries the usual grooved collar, the inner spindle having its collar 71 secured to the extreme end thereof, while the outer spindle has its collar 72 splined thereon in substantially the usual manner for sliding movement, the conical or cam faces of the collar coacting with the usual levers 73 for clamping the spindles together.

For the purpose of operating the two collars of each composite spindle back and forth we make use in this case of a pair of slides, one of which (that shown herein at 75) controlling the movements of the two collars 72 and 72′, while the other is indicated at 76 and is adapted to operate simultaneously the collars 71 and 71′ in the usual manner. The two slides 75 and 76 are mounted in suitable guides on the framework at the receiving end of the machine and will have depending members or studs, such as 77 and 78, coacting with suitable cams on the cam-wheel W′, which cams of course will operate the slides at the proper points.

A manually-operated actuator is provided for each of the slides 75 and 76, whereby said slides may be independently adjusted during the "setting up" of the machine for making any particular kind of work. Although any suitable device may be employed for this purpose, we prefer to provide each of the slides with a short rack or section of teeth, (designated, respectively, by 101 and 102.)

As will be observed by reference to Fig. 13, each of the slides 75 and 76 has a base portion shaped to fit one-half of the channel-shaped sustaining-bar 100, projecting from the frame of the machine, whereby when the slides are placed in position they substantially inclose said bar. Fixedly mounted in the bar 100 is a stud or spindle 103, having reduced ends which project through slots 104 and 105, re-

spectively, in the slides, and loosely journaled on said stud, one at each reduced end thereof, is a pinion 106 107, respectively, said pinions intermeshing with the racks 101 and 102 and each having a hub equipped with a suitable crank or handle (shown by dotted lines) for manipulating the same when it is desired to adjust either or both of the slides by hand. It will therefore be seen that mechanism is provided which includes a power-operated actuator for the slides 75 and 76 and a hand-actuated actuator for the same slides, whereby during the successive operations involved in running the machine and in setting up the same for any particular kind of work both of these devices may be brought into use and jointly coöperate to enable the operator or machinist to manage the machine conveniently and effectively.

In connection with the composite spindles of the machine we have also illustrated at P a standard or post having thereon a pair of rod-guides of any usual type, (indicated by 79 and 79'.) The spindles r and r' may be rotated in any suitable manner; but in this case the outer spindle of each of these composite spindles has keyed thereto a gear-wheel which is intended to be rotated by a gear or pinion supported on a shaft separate from these spindles. The two gears on the spindles may be spur-gears, such as those shown at 80 and 80', and these two gears may be rotated in the same direction by an idler, such as 81, supported on a stud 82 and driven by a pinion 83, secured to a driving-shaft 84, carrying a fast pulley 85 and a pair of loose pulleys 86 and 86', controlled by two oppositely-running belts 87 and 87', the movements of which will be governed in the usual manner by means of a belt-shipper, such as 88.

It will be apparent that the direction of rotation of the spindles may be reversed quickly by shifting the belt-shipper. This belt-shipper will usually be pivoted on the framework at some suitable point—as, for example, at 88', (see Fig. 1)—and may be controlled in its movements automatically by a suitable power-operated part—such, for example, as the cam-wheel w on the cam-shaft s, said cam-wheel having two cam-segments 90 thereon coöperative with a pin or finger 88'' on the belt-shipper. (See Figs. 1 and 3.)

By operating the spindles from a driving-shaft at one side of such spindles practically all of the strain of the belt is removed from the work, and the rods as they are fed through the machine and up to the tools will be located in position with much greater precision than as is the case when the feed-spindle is subjected directly to the pulls and strains of a driving-belt passing therearound. Moreover, by this improved construction the work-feeding spindles may be brought closer together than is ordinarily the case and a more compact organization of the parts thereby secured.

For the purpose of turning down the stock and cutting off the partially-finished articles we may employ the usual turning-down or cutting-off tools, such as t and t' and c and c', supported in the ordinary manner by tool-holders, such as h and h', preferably mounted adjustably in ways on a transverse tool-slide, such as s'', supported in a well-known manner by a transverse guide, such as g, on the main framework between the head-stock and the turret. All of these parts are of well-known construction.

For the purpose of imparting the proper transverse movements to the tool-slide s'' we prefer to employ a pair of levers, such as 190 and 190', pivoted on the framework and having at their upper ends actuating members for engaging and shifting said tool-slide. These actuating parts may be adjustable and will preferably be screw-bolts, such as 91 and 91'. At their lower ends the levers 190 and 190' coöperate with a cam-wheel, such as w', carried by the cam-shaft s and having thereon suitable cams governing the movement of these two levers, and hence the operation of the tools. In this instance this cam-wheel has cams on both sides thereof, the cams on one side coacting with the lever 190 and those of the other side with the lever 190'. The different cam members are designated herein by 92 92', 93 93', 94 94', and 95 95'. For the purpose of regulating the movements of the tool-slide, and hence the throw of the tools, certain of these cams may be made adjustable, in this case the two cams 93 and 93' being so shown. Preferably these cam-segments, which of course will have the usual peripheral cam-faces, will coact with the levers 190 and 190' and will be adjustable toward and from the axis of the cam-shaft s. The adjustment may be effected in any suitable manner—as, for instance, by passing clamping-screws through substantially-radial slots in these cam-segments, the points of the screws or bolts, such as shown at 96, Fig. 12, passing into the face of the cam-wheel w'. It will be apparent that by loosening these bolts and the screw 96' the cam-segments may be adjusted to any desired position and the throw of the levers 190 and 190' correspondingly varied.

Obviously the cam-wheel w need not necessarily be provided with cams for automatically shifting the belt-shipper 88 when working on stock to form articles in making which the reversal of the rotation of the spindle is not necessary. As it is desirable, however, to reverse the rotation of these spindles when forming screws and similar articles, cams 90 have been illustrated in connection with the cam-wheel w, but these cams, it should be understood, should be removable ones, as illustrated in Fig. 3.

By providing for variable throws of either one or both of the tool-slide-actuating levers the machine is adapted to have a wide range of usefulness in connection with stock of different sizes, and this is increased by the pro-

vision of the means hereinbefore described for automatically varying the rate of rotation of the cam-shaft *s* at different points in a single cycle of rotation of the latter, whereby of course the rate at which the turning-down and cutting-off tools may be operated will be governed by the speed at which the cam-shaft turns. Hence the operation of all of the tools and parts being dependent upon the action of this cam-shaft the manner in which the different tools will cut the stock and the degree of speed of operation will be varied automatically at the proper times, in accordance with the shape of the cams carried by the shaft *s* and the speed with which the latter is operated by the worm-shaft.

As the automatic machine illustrated in the drawings of this application may be used for a great variety of different purposes, it is believed that a more detailed description of the operations of the several parts will be unnecessary, as the action of the several mechanisms not referred to more particularly herein is substantially similar to that of corresponding mechanisms heretofore used.

Having described our invention, we claim—

1. The combination, with a turret, of a reciprocatory turret-supporting device; automatic means for operating said turret-supporting device; a reciprocatory slide having a stud or projection; a pawl carried by said stud or projection, said pawl serving to rotate the turret on the retractive movement of the turret-support; and a stop for holding said reciprocatory slide stationary at a predetermined point in the retractive movement of the turret-supporting device.

2. In a machine of the class specified, the combination, with multiple spindles for holding the work, of means for automatically actuating said spindles; a turret-support; a cam-shaft having a cam for automatically operating said turret-support; means for automatically actuating said cam-shaft and for driving the same at different speeds; a turret having two separated tool-receiving portions mounted for rotation on the turret-support; a slide having a stud or projection movable with said turret-support; a pawl pivoted to said stud or projection; a stop for restraining the movement of said slide at the proper time; a turret-locking device also movable with the turret-support; a device for positively actuating said turret-locking device in one direction; a spring for actuating said locking device in the opposite direction; and a stop with which said positively-actuating device engages.

3. The combination, with a turret, of a turret-support having a chambered base; means for reciprocating the turret-support; a reciprocatory slide having a stud or projection carrying a pawl; and a stop for arresting the movement of the slide at a predetermined point in the retractive movement of the turret-support.

4. The combination, with a turret, of a turret-support; a reactive slide carrying a stud having a turret-rotating device movable with said turret-support; automatic means for operating the turret-support; and a stop coöperating with the slide carrying the turret-rotating device.

5. The combination, with a turret, of a turret-support; a slide having a stud carrying a turret-rotating device; a turret-locking device; automatic means for operating the turret-support; means for actuating the locking device; and means for operating the slide carrying the turret-rotating device by and upon the retractive movement of said turret-support.

6. The combination, with a turret, of a turret-support; a slide carrying a stud on which is mounted a turret-rotating device, said slide being movable with the turret-support; a stop on the frame with which said slide engages during the retractive movement of the turret-support; a turret-locking device movable with the turret-support; a lever for actuating said turret-locking device; a stop with which said lever engages; and automatic means for operating the turret-support.

7. The combination, with a turret, of a turret-support; a slide having a stud carrying a turret-rotating device; a turret-locking device carried by said turret-support, the turret rotating and locking devices being disposed at opposite sides of the axis of rotation of the turret; and means for automatically operating the turret-support, the turret-rotating device and the turret-locking device.

8. The combination, with a turret, of a recessed turret-support; a slide having a vertical stud or projection located in the recess of said turret-support; a pawl carried by the stud or projection of said slide; a stop on the frame, for arresting the movement of said slide; and automatic means for operating the turret-support.

9. The combination, with a turret, of a turret-support; a reciprocatory slide carrying a projection having a turret-rotating device movable with said support; a turret-locking device carried by said support and movable relatively thereto; automatic actuating means for operating the turret-support; and separately-operable actuators for the turret rotating and locking devices.

10. The combination, with a turret, of a turret-support; a reciprocatory locking device carried by said support and movable relatively thereto; a slide reciprocatory on and relatively to the turret-support; a vertical stud on said slide; a turret-rotating pawl supported for oscillation on said stud; and automatic actuating means for operating the turret-support, the turret-locking device, and the reciprocatory slide.

11. The combination, with a turret, of a recessed turret-support; a reciprocatory turret-locking device carried by said support and

movable relatively thereto; a spring-retracted turret-rotating slide having a stud or projection reciprocatory on and relatively to the turret-support; a turret-rotating pawl supported for oscillation on the stud or projection of the turret-rotating slide; and automatic actuating means for operating the turret-slide, the turret-locking device, and the turret-rotating slide.

12. The combination, with a turret having recesses, of a turret-support; a spring-advanced reciprocatory turret-locking device carried by said support and movable relatively thereto; a spring-retracted turret-rotating slide reciprocatory on and relatively to the turret-support, said slide having a stud or projection; a turret-rotating pawl supported for oscillation on the stud or projection of the turret-rotating slide; and automatic actuating means for operating the turret-support, the turret-locking device, and the turret-rotating slide.

13. The combination, with a turret, of a turret-support; a reciprocatory turret-locking device carried by said support; a by-pass device carried by the support for operating said turret-locking-device; an actuator for said by-pass; a movable turret-rotating device having a stud or projection; a pawl carried by said stud or projection; and means for arresting the movement of said turret-rotating device upon the retractive movement of the turret-slide.

14. The combination, with a turret, of a turret-support; a reciprocatory turret-locking device carried by said support; a by-pass device carried by said support for operating said turret-locking device; a stop in the path of movement of the by-pass and operative for actuating the latter; a movable turret-rotating device having a stud; a pawl pivoted to said stud; and a stop for arresting the movement of said turret-rotating device at a predetermined point in the retractive movement of the turret-support.

15. The combination, with a turret having tool-receiving portions of large diameter and an intermediate recessed portion of small diameter, the portions of large diameter having sockets, of adjustable tool-clamping devices located in the tops of said tool-receiving portions, the lower tool-clamping devices projecting into the recessed portion of the turret whereby they are readily accessible when it is desired to remove or adjust the tools.

16. The combination, with a turret, of a recessed turret-support; a turret-rotating pawl carried by a projection on a slide disposed in the recess of the turret-support; a spring cooperating with said projection; a stop with which said slide engages; a cam having a groove; a shoe on the turret-support working in said groove and adapted thereby to locate the turret-support positively in its several positions during the reciprocation of said support; and means for actuating the cam.

17. The combination, with a support, of a cam-shaft and means for actuating the same; a rotary spindle; a chuck; a rod-feeding device coöperating with the spindle and chuck; means for automatically actuating said rod-feeding device and said chuck; manually-operated means separate from but in engagement with said rod-feeding device for independently actuating the rod-feeding device; a tool-slide mounted on said support for reciprocation transversely to the axis of rotation of the cam-shaft and the spindle; an actuating-lever for shifting said tool-slide; and a cam on said cam-shaft and adjustable toward and from the axis of the latter and cooperative with said actuating-lever.

18. In a screw-machine, the combination, with a blank-carrying spindle, a chuck, and rod-feeding devices mounted therein, of means for automatically actuating said devices, and independent means separate from said rod-feeding devices for manually operating said devices when desired.

19. In a screw-machine, the combination, with a blank-carrying spindle, a chuck, and rod-feeding devices mounted therein, of means for automatically actuating said chuck and rod-feeding devices, said means including slides, and a manually-actuated device separate from the rod-feeding devices for independently operating said slides when desired.

20. In a screw-machine, the combination, with a spindle and rod chucking and feeding devices carried thereby, of slides connected with said devices; means for automatically actuating the slides; and means separate from but in engagement with the slides for manually actuating the slides when it is desired to impart a movement thereto independent of the automatic action of the machine.

21. In a screw-machine, the combination, with multiple spindles and rod chucking and feeding devices carried thereby, of a slide connected with the rod-chucking devices; a second slide connected with the rod-feeding devices; means for automatically actuating said slides at the proper times; and means separate from but in engagement with the slides for manually actuating either of said slides when it is desired to effect an independent adjustment thereof.

22. In a screw-machine, the combination, with multiple spindles arranged in parallelism and rod chucking and feeding devices carried by said spindles, of two slides; a channeled guide-bar projecting from the frame on which said slides are fitted; a stud or spindle mounted in said guide-bar; and manually-operated means carried by said stud or spindle for effecting an independent adjustment of the slides when desired.

23. In a screw-machine, the combination,

with multiple spindles arranged in parallelism and rod chucking and feeding devices carried by said spindles, of a channeled guide-bar projecting from the frame; two slides connected, respectively, with the rod chucking and feeding devices and movable upon said channeled bar, said slides being provided with teeth; a stud or spindle fixedly mounted in the guide-bar; toothed wheels carried on the ends of said stud or spindle for engaging with the teeth of the slides; and means for manually actuating said wheels.

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