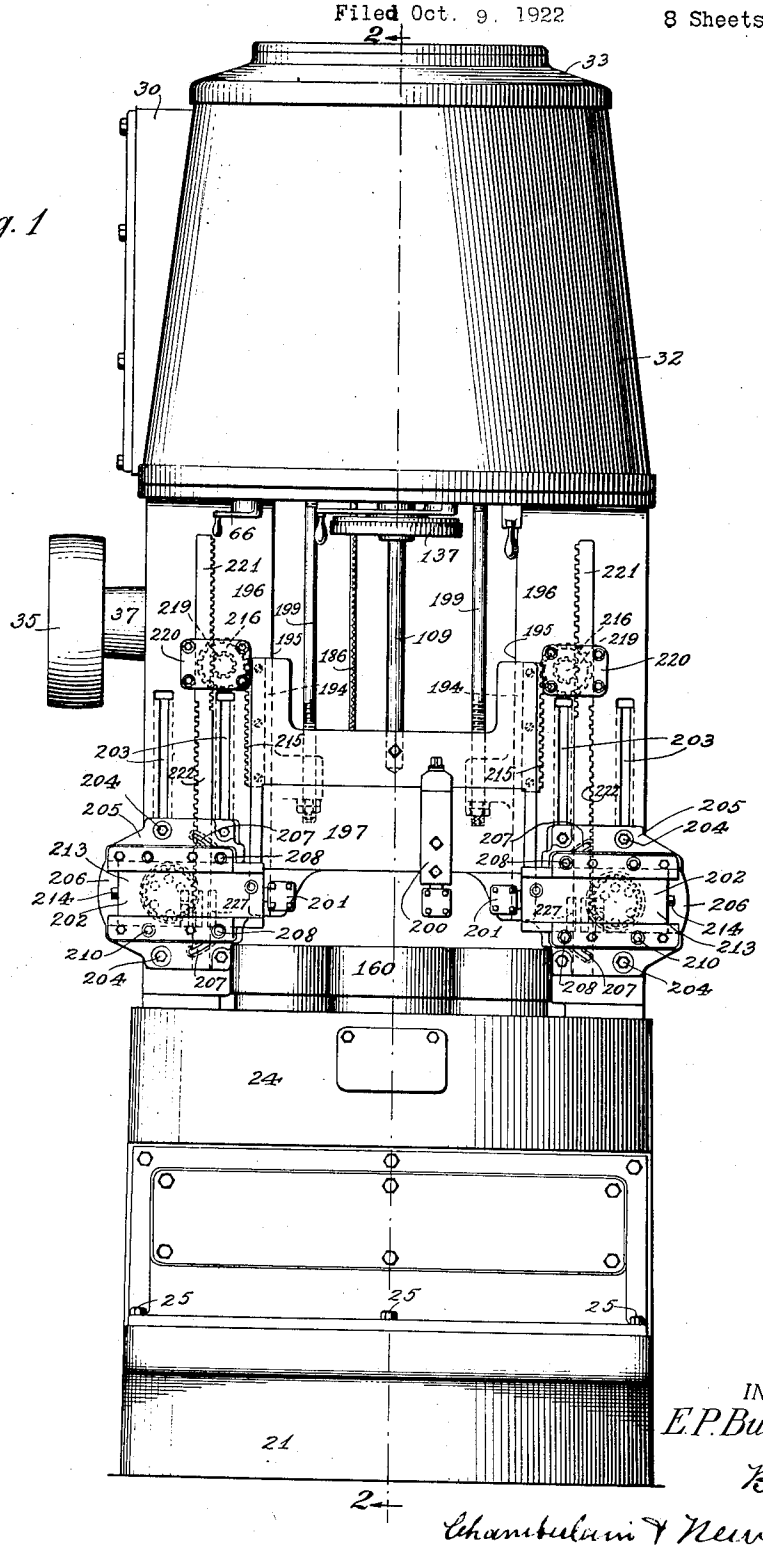
May 25, 1926. 1,586,066

E. P. BULLARD, JR

MULTIPLE SPINDLE MACHINE

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Fig. 1



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May 25, 1926. 1,586,066

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MULTIPLE SPINDLE MACHINE

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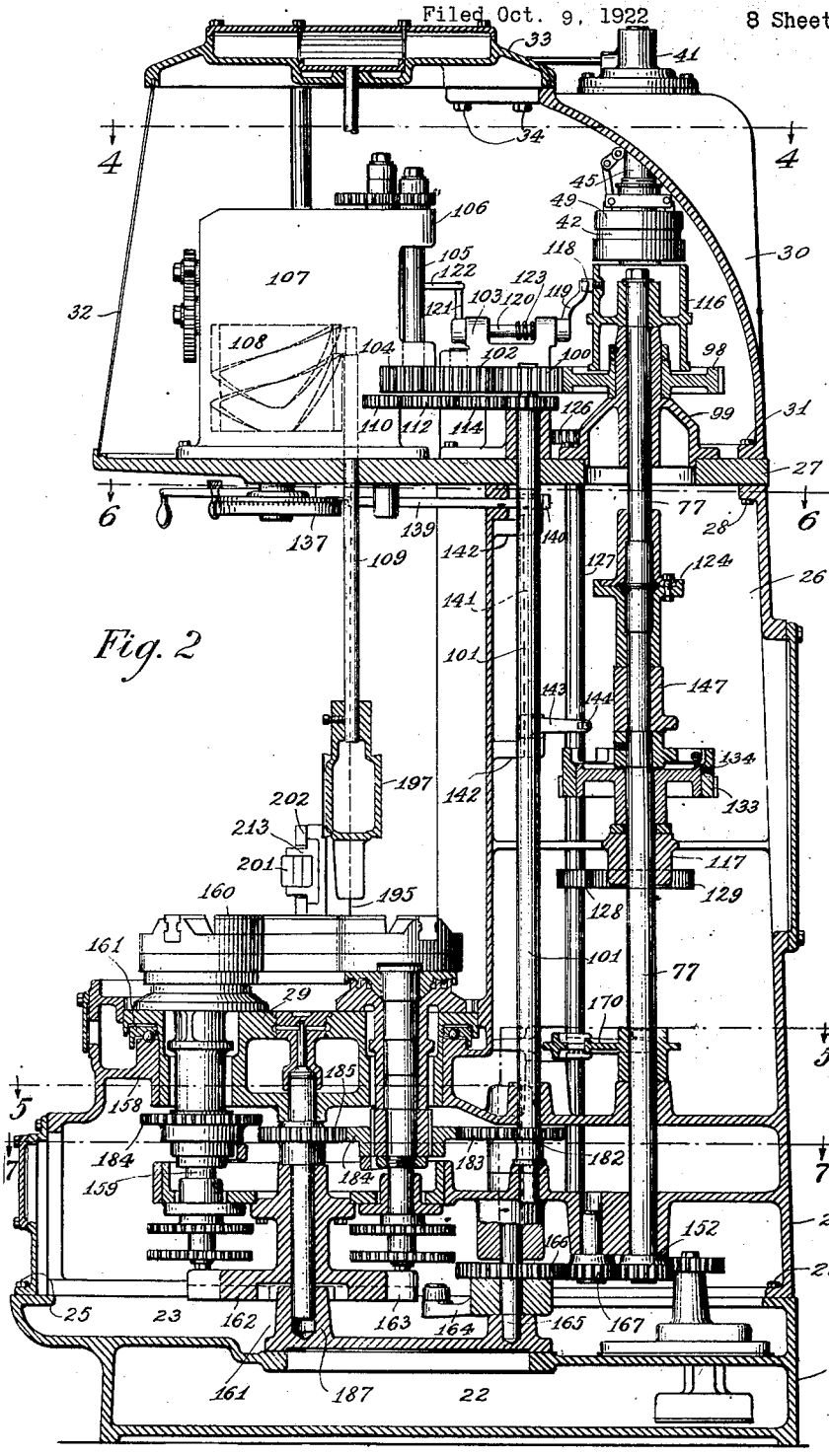


Fig. 2

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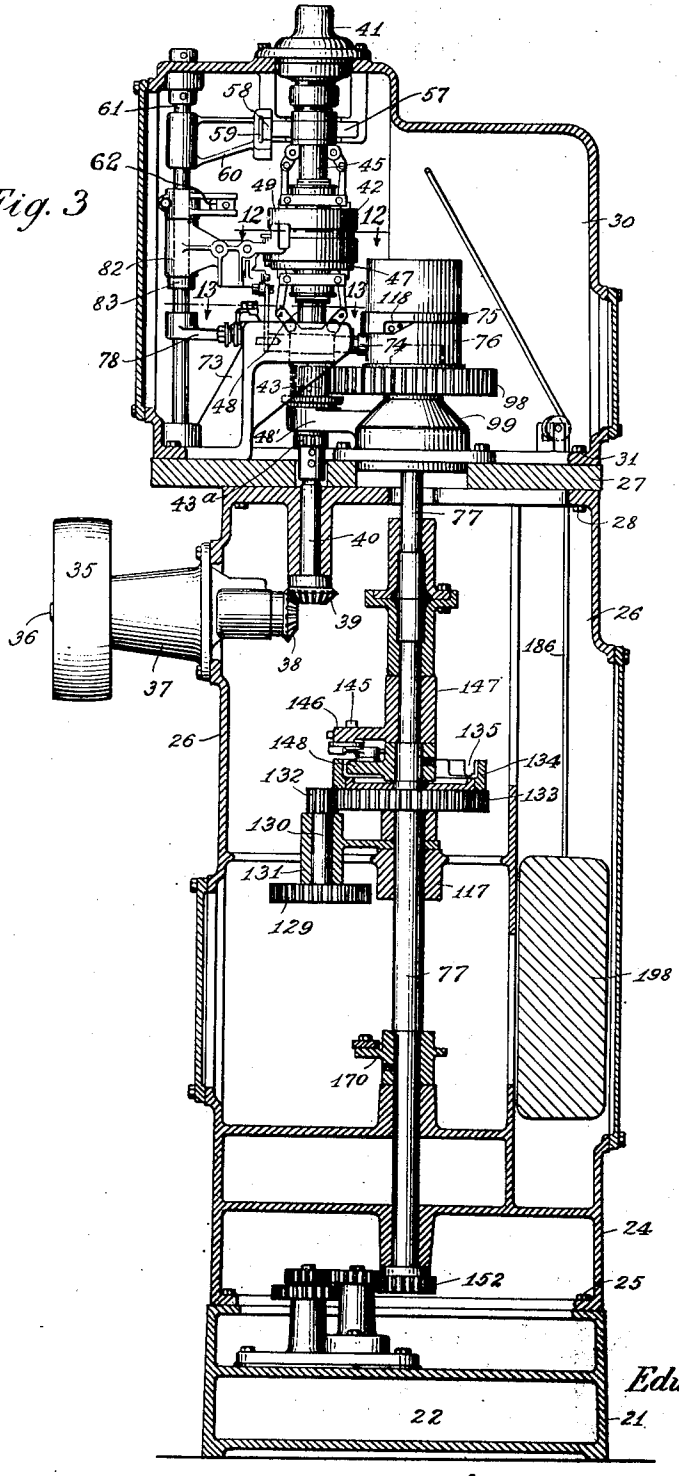
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MULTIPLE SPINDLE MACHINE

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Fig. 3



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MULTIPLE SPINDLE MACHINE

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Fig. 4

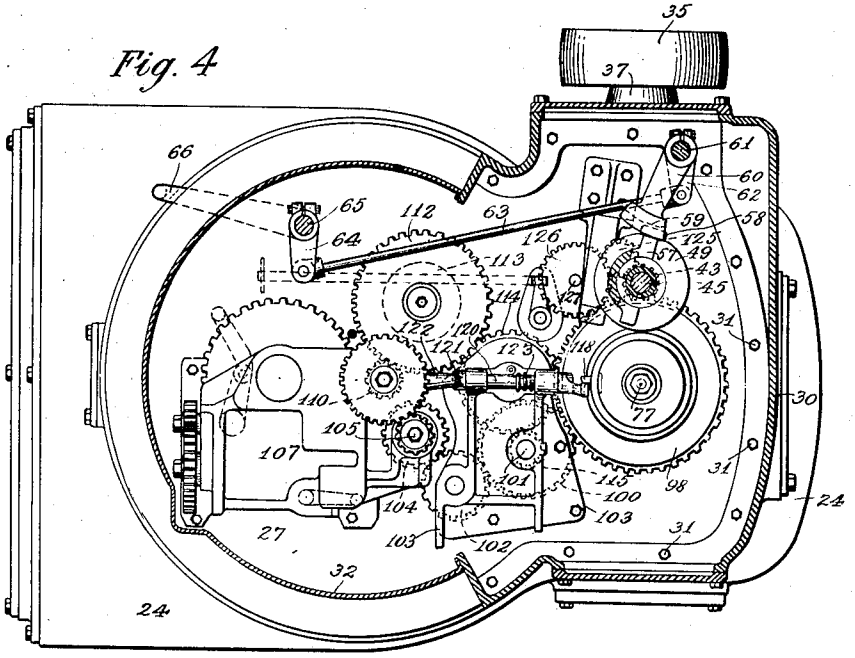
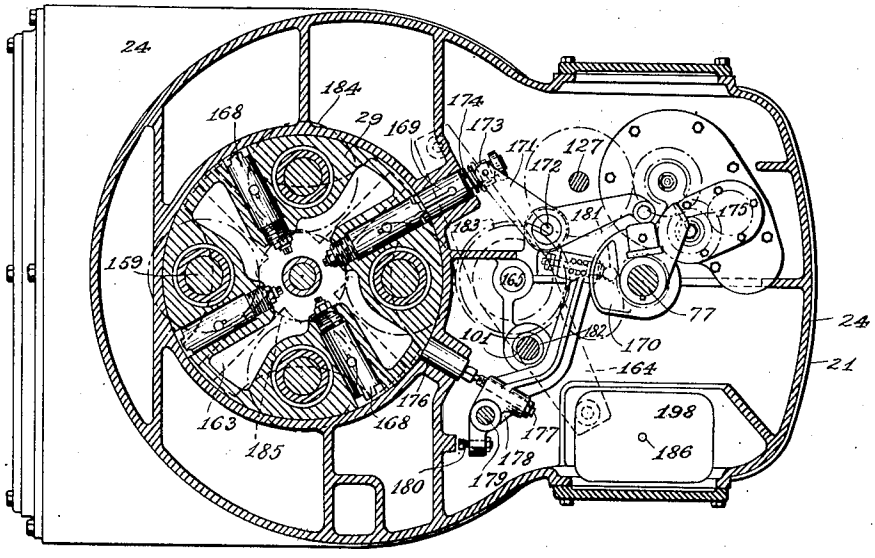


Fig. 5



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MULTIPLE SPINDLE MACHINE

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Fig. 6

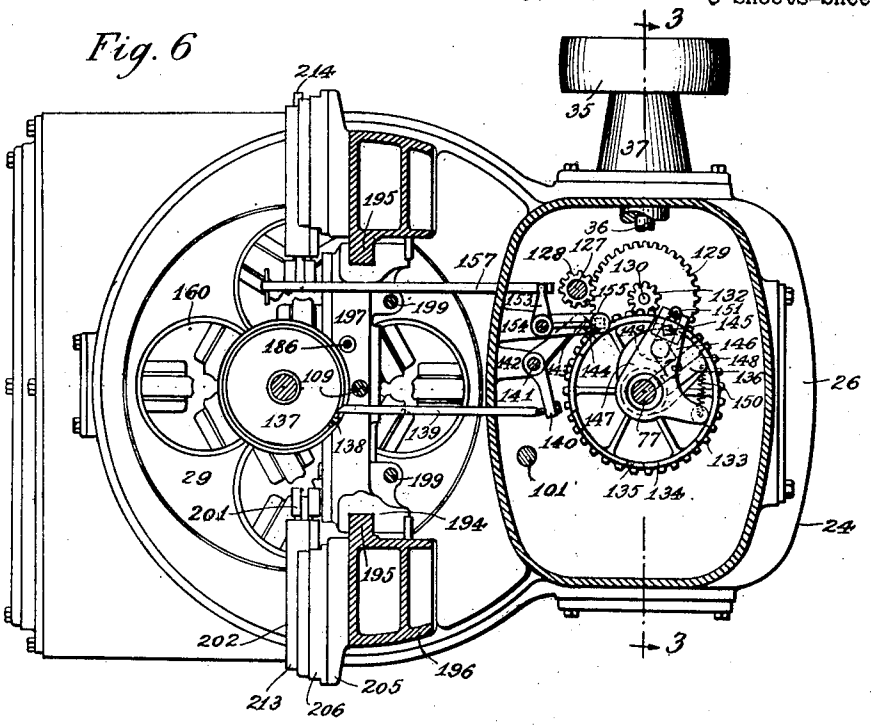


Fig. 7

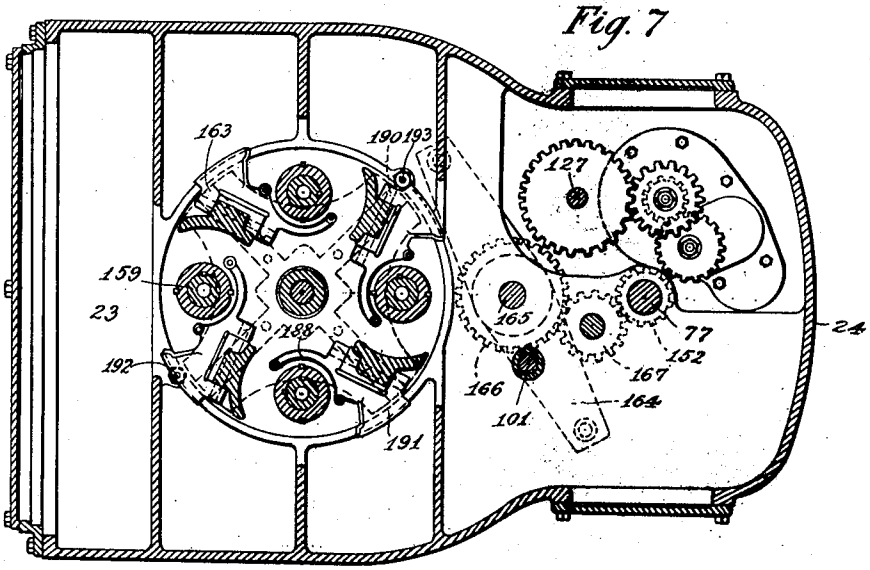
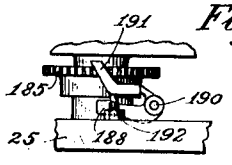


Fig. 8



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MULTIPLE SPINDLE MACHINE

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Fig. 10

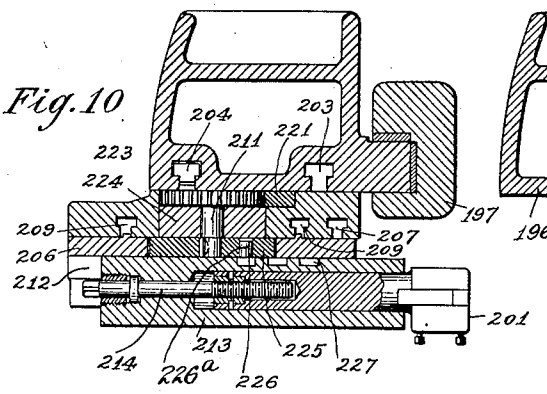


Fig. 11

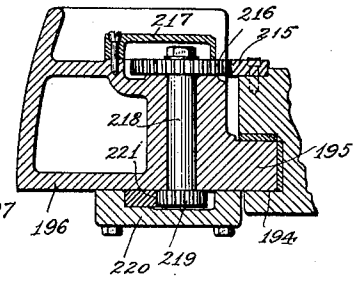
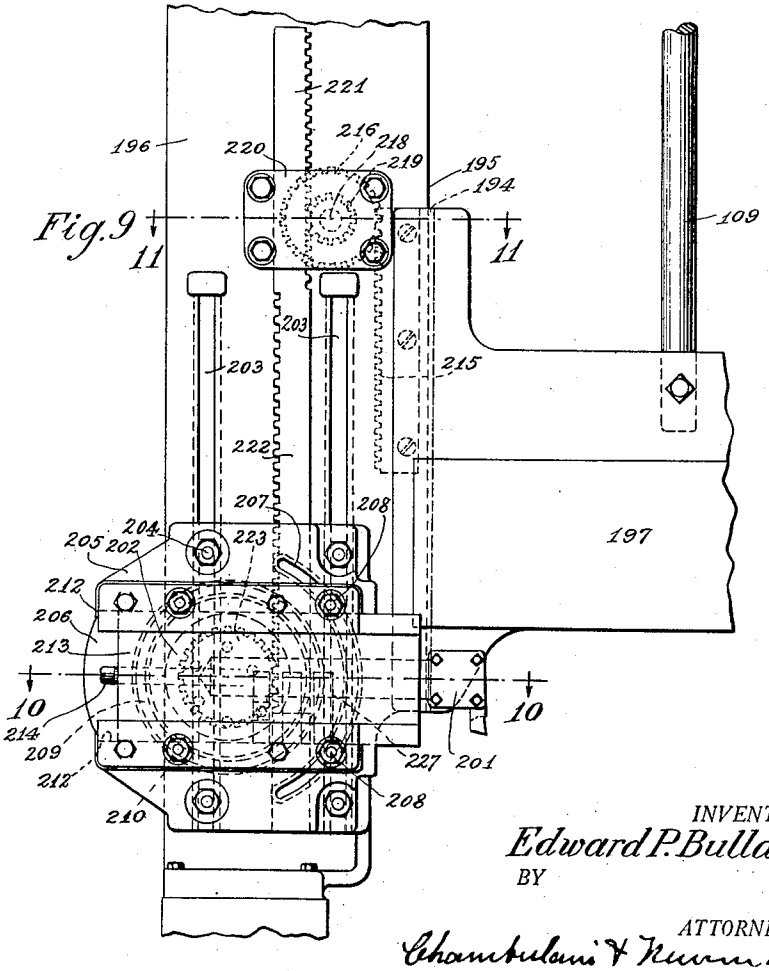


Fig. 9



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MULTIPLE SPINDLE MACHINE

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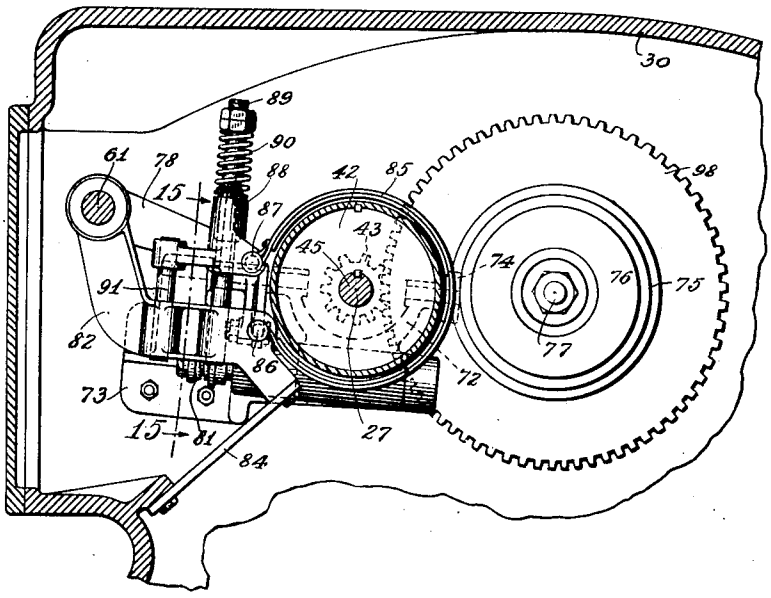


Fig. 12

Fig. 13

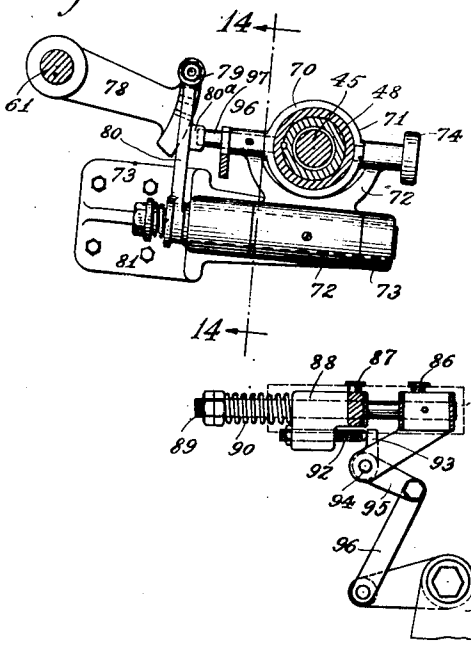


Fig. 14

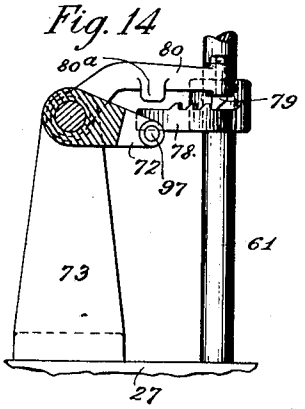


Fig. 15

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MULTIPLE SPINDLE MACHINE

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Fig. 16

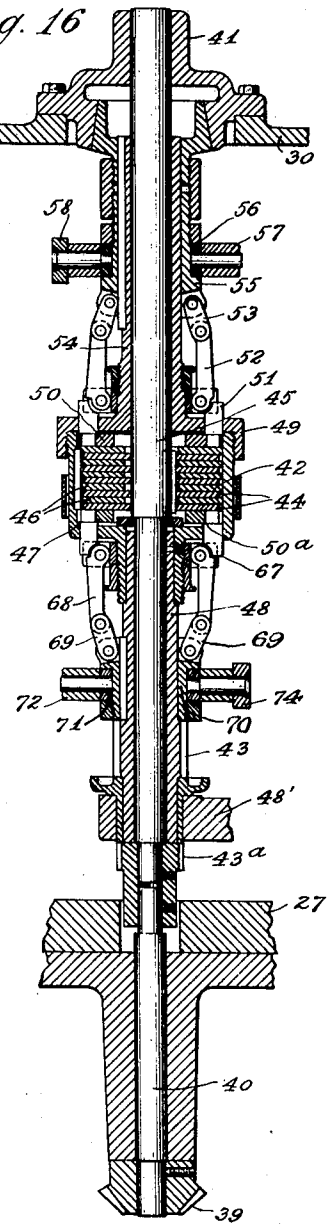
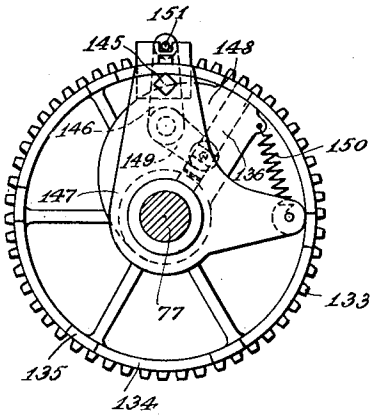


Fig. 17



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UNITED STATES PATENT OFFICE.

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MULTIPLE-SPINDLE MACHINE.

Application filed October 9, 1922. Serial No. 593,198.

This invention relates to vertical automatic multiple spindle machine tools such as are used for turning and boring operations for duplicating different kinds or pieces of work.

The object of the invention is to generally improve upon machines of this type and particularly to simplify and lessen the construction. Further to reduce the size and weight of the machine and to design it so as to require less floor space and power.

To provide a machine of the above type, having a rotatable carrier, a series of rotary tables, and tool heads, with a single feed works for directing the travel of the cutting tools carried by the tool slide and likewise for controlling the speed with which the work carrying tables are rotated. Further to provide a series of rotatable tables, one of which is designed to remain idle while the others are operated and to provide a single reciprocatory cross rail adapted to be vertically operated through the medium of the feed-works, and to provide one or more cutting tools for each of the rotating tables so that all required operations upon the several pieces of work will be simultaneously performed.

Finally to particularly provide, in a machine of the above class, including a rotary carrier and a series of rotary tables, a vertical reciprocatable cross-rail connected to operate vertically, horizontally and angularly movable tool holders. Also to construct and position the cross-rail so as to carry cutting tools at intermediate points and adapted to operate upon one or more of the rotary work carrying tables mounted in the carrier.

Other objects of the invention will be apparent from the further description and claims together with the accompanying drawings forming a part of this specification and in which,

Fig. 1 shows a front elevation of my improved form of vertical multiple spindle machine, commercially known as a "vert-aumatic";

Fig. 2 is a central vertical longitudinal section through the complete machine, taken on line 2—2 of Fig. 1 and looking in the direction of the arrow;

Fig. 3 is a further vertical sectional view taken on line 3—3 of Fig. 6;

Fig. 4 is a sectional plan view through the machine, on line 4—4 of Fig. 2 and looking down;

Fig. 5 is a further cross section through the machine looking down and taken on line 5—5 of Fig. 2;

Fig. 6 is a sectional plan view on line 6—6 of Fig. 2;

Fig. 7 is a still further sectional plan view taken on line 7—7 of Fig. 2;

Fig. 8 is an elevational detail of the mechanism for raising the table spindle gear, as seen from the arrow *a* in Fig. 7;

Fig. 9 is an enlarged front elevation of the side-rail and side-head and a portion of the cross-rail as seen at the left in Fig. 1;

Fig. 10 shows a sectional plan view through one of the side heads taken on line 10—10 of Fig. 9;

Fig. 11 is a further detail cross sectional view taken on line 11—11 of Fig. 9;

Fig. 12 is an enlarged sectional plan view of the clutch mechanism taken on line 12—12 of Fig. 3, looking down in the direction of arrow;

Fig. 13 is a further enlarged sectional plan view of the same mechanism taken on line 13 of Fig. 3;

Fig. 14 is also an enlarged sectional elevation taken on line 14—14 of Fig. 13;

Fig. 15 is a sectional elevation further illustrating the mechanism shown in Fig. 12 and taken on line 15—15 of Fig. 13;

Fig. 16 is an enlarged vertical sectional view through the feed works on line of the cam drum and spindle drive shaft; and

Fig. 17 shows a further sectional elevation through the feed-works on line of the clutches included therein forward so to speak of the cam drum.

It will be noted that the frame work of the machine is made up of several large castings which may be more specifically designated as a base designated as 21, and upon which the remainder of the machine is supported. This base includes two reservoirs 22 and 23, the former to contain a cutting compound and the latter to contain oil for lubricating the machine. The bed represented by 24 is supported upon and secured to the base by means of screw bolts 25. The bed member 24 includes an upwardly disposed hollow column designated as 26 through which certain shafts extend for

driving the lower mechanism of the machine from the upper.

27 represents the feed works base which as will be noted is secured to the top of the column 26 by means of screws 28 and not only covers the upper portion of the column, but also extends forward over the carrier 29 rotatably mounted in the bed, as will later be again referred to. The base 27 serves to support the feed works and driving mechanism, the latter being enclosed by the drive housing 30 shown in the form of a cast metal member secured to the feed works base by means of screws 31. This housing as shown in Fig. 4 directly encloses the clutch and driving mechanism and further serves as a support for the slidable sheet metal closure members 32 which enclose the feed works supported upon the base 27. 33 represents the drive base that is secured to the top of the drive housing 30 by means of screws 34 and serves to form a top for the enclosure for the feed works and drive mechanism and is also of such design and construction as to support a driving motor not shown, should it be desired to operate the machine by a direct motor drive.

As shown, I have designed this particular machine to be belt driven, from a motor or line shaft as preferred. The driving pulley being designated as 35 and secured on a shaft 36 journalled in the bracket 37 secured to the column 26.

The power is further transmitted from the shaft 36 through gear 38 mounted thereon and gear 39 secured upon the lower end of a main driving shaft 40. The lower end portion of the driving shaft is journalled in the top of the column 26 and its upper end portion is similarly mounted in a bracket 41, secured on the drive housing.

The several driven parts of the machine are operated from the main driving shaft 40, some being continuously driven while others are operated through a clutch 42. That portion of the driven parts which require to be continuously operated, as for instance the pumps for the cutting compound, and the oil, as well as the controller unit which operatively connects the indexing mechanism with the drive and feed works, are continuously operated from the main driving shaft 40 through the gears 43 and 43a and as will later be more fully described. The operation of all other parts of the machine is effected through a clutch mechanism 42 carried on the shaft. This clutch is of the disc type wherein one set of discs 44 (Fig. 16) are keyed to the upper driving shaft section 45 and the other set 46 are keyed to the driven clutch case 47. This clutch case together with its discs forms the driven member of the clutch and is mounted upon a hollow shaft 48, mounted on the driving shaft and having a bearing in arm 48' of the controller drive bracket 99. One end of the clutch case is enclosed by a cap 49 threadably secured thereto and includes a hub through which the shaft 45 extends. A slidable clamping plate 50 is positioned against the outer disk 46 of the clutch case 47 and is connected through a series of pins 51 with toggle levers 52 and links 53 carried upon the hub 54 of the cap 49. One end of the link is pivotally connected to a sleeve 55 slidably keyed on the hub 54 of the cap so as to be moved longitudinally upon the hub to operate the toggle levers and clutch. This line of operative connections is to provide hand operating means for the clutch, which I will next describe, see Figs. 4 and 16.

The sleeve 55 includes an annular groove in which a ring 56 is operatively mounted. A fork 57 is hinged to the housing in a way to straddle the ring 56 and sleeve and is provided with pins to pivotally connect the arms of the fork with the ring so as to slide the sleeve by the tilting of the fork. This fork carries a roller 58 that engages a cam groove 59 (Fig. 3) in an arm 60 secured to a vertical rocker shaft 61 journaled in the top and bottom portions of the drive housing 30 so that the arm will be thrown backward and forward, to raise and lower the fork and ring by the turning of the shaft. This shaft 61 in turn is manually operated through the arm 62 beneath the arm 60, a link 63 connecting said arm with a similar arm 64 upon a rocker shaft 65 and upon which an operating handle 66 is secured, said handle disposed forward beneath the drive housing so as to be readily manipulated by the operator.

In addition to the hand operating means above described for operating the clutch 42 I also provide an automatic power operating means whereby the feeding and spindle drive mechanism is disconnected while the machine is indexing as will be explained. In this connection I also provide a brake which is automatically applied to the clutch case when the clutch is released from power operation. Still another feature employed in connection with the clutch mechanism is an interlocking device which prevents the clutch from being operated by hand while the machine is indexing.

The power operating mechanism for the clutch is connected to the underside of the clutch, see Fig. 16, and below the hand operating device. It also includes a plate 50a which in function serves the same as plate 50 and is provided with pins 67 to which toggles 68 and links 69 are connected. The links are also pivoted to a sleeve 70 slidably keyed upon the hollow shaft 48. A ring 71 encircles the sleeve, see Fig. 13, and is pivotedly connected through pins, with the two arms of a fork 72 hinged in a bracket 73

secured to the feed works base. This fork 72 carries a roller 74 on one side that is engaged by a rotary cam 75 (Fig. 3 and 12) formed upon the cam drive 76 mounted on the controller shaft 77 which provides the power for the automatic operation of the clutch.

The interlocking means which prevents hand operation of the clutch while the machine is indexing, will be best understood from Figs. 13 and 14 and includes means carried by the power operated fork 72 to engage the hand operated device at certain intervals to prevent the latter from being operated. As will be remembered, the hand operation device referred to includes in part a rock shaft 61 which in addition to its other features bears an arm 78 having a series of teeth upon its outer end to be engaged by a pawl 79 carried by an arm 80 loosely mounted on one of the trunnions of the fork 72. A spring 81 is mounted on this trunnion and has one end connected to the trunnion and the other end to the arm in a way to yieldably hold the arm down so that its pawl 79 will engage the teeth when the clutch is disengaged and the machine is indexing. At all other times the arm is normally raised and its pawl free from the teeth to allow the rack arm 78 and shaft 61 to be operated by the engagement of the pin 97 on the yoke 72, with the lug 80^a on the said arm.

The brake, heretofore referred to as being automatically applied to the clutch to more quickly stop the work spindles from rotating after the clutch is thrown out, includes the following described mechanism and may best be understood from Figs. 3, 12 and 16. A bracket 82 is loosely mounted on the before mentioned shaft 61, and is held up in position by the collar 83 upon the shaft and a tie plate 84 secured to the drive housing as shown in Fig. 12. One end of a brake band 85 is fastened to a fixed stud 86 secured to the inner end of the bracket while the other end of the band is similarly connected to a stud 87 carried by a member 88 slidably mounted on a headed rod 89 of the bracket. A spring 90 is positioned on this rod between the head and slidable member so that the latter will be normally forced inward to draw the brake-band around the clutch. The slidable member is provided with a guide pin 91 that slidably operates in a hole of the bracket, see Fig. 12, to better guide and support the member 88. The brake is released by moving the member 88 against the action of the spring 90, through the operation of the fork 72 when the same is operated to open the clutch. An adjustable contact screw 92 is mounted in the slide 88 and is engaged for the operation of the slide by the short arm 93 of a bell crank lever, pivoted at 94 to an arm of bracket 82, and whose longer arm 95 is connected by a link 96 with one of the trunions of the fork 72, see Figs. 13 and 15.

The feed works shown in Figs. 2, 3 and 4 and 11 is operated from the driven shaft 48 before mentioned, through a train or gear connections as follows. The small gear 43 carried upon the shaft 48 meshes with and drives a large idler gear 98—journalled upon the hub of the controller drum bracket 99 secured upon the feed works base 27. This idler gear meshes with and drives the idler gear 100 loosely mounted upon the top end of spindle drive shaft 101 later to be referred to. The gear 100 in turn drives the idler gear 102 mounted in a stud secured in bracket 103 secured to the feed works base. Idler gear 102 transmits movement to the gear 104 secured on the lower end of a shaft 105 journalled in bearings 106 of the feed works bracket 107. This feed works serves to reciprocate the vertically operatable cross rail 197 upon which some of the cutting tools are mounted and which particularly serves to feed the side heads cutting tools later to be explained. The feed works further serve to rotate the four table spindles in the carrier at a uniform but variable speed.

The construction and operation of this feed works is for the most part similar to that shown and described in my prior patent dated October 23, 1920, #1,360,175 and it is thought will not here require a full detailed description and that it will be sufficient to state that the feed works mechanism as disclosed in the drawings serves in part to operate the cam drum 108 provided with a peripheral cam groove in which the roller upon the end of the vertical reciprocating rod 109 is mounted, for the purpose of supporting and reciprocating the cross rail 197 before mentioned. The feed works serve the further purpose of operating the spindle drive shaft 101 through the train of gears shown in Figs. 2 and 4, and including a pinion 110 mounted upon driven shaft 111 of the feed works and which pinion meshes with and drives the larger idler 112 mounted upon a bracket 113 secured to the feed works base. This gear in turn drives the idler gear 114 mounted upon bracket 103 and connected to drive the gear 115 upon the before mentioned spindle drive shaft 101.

This feed works includes clutches and clutch operating mechanism whereby the feed works may be made to operate the cross rail and cutting tools in either their rapid traverse or feeding movement. The clutch operating mechanism will probably best be understood from Fig. 2 wherein I have provided a controller drum 116 secured upon the upper end of controller shaft 77, journalled in the before mentioned bracket 99.

This controller is provided with a lug 118 which with each rotation of the drum serves to engage the arm 119 upon the end of rocker shaft 120 journalled in the before mentioned bracket 103. An arm 121 is mounted on the other end of this rocker shaft and is positioned to engage trip lever 122 (see Figs. 2 and 4). A spring 123 serves to normally retain the rocker shaft and arms in position to be operated by the lug and to in turn operate the trip lever which connects the clutch mechanism to give quick downward movement to the cross rail.

The controller shaft 77 is preferably made up of two sections coupled together at 124. This shaft is of different diameters and in addition to its upper and lower bearings is provided with intermediate bearings 117 as shown and is operated from the small gear 43^a upon the driving shaft 40 through the idler gear 125, see Fig. 4, mounted upon a stud of the feed works base, and meshes with and drives a larger gear 126 secured to the upper end of the pump shaft 127 located in the column of the bed. 128 represents a second gear carried upon the pump shaft and meshes with and drives a larger gear 129 mounted upon a short shaft 130 (Fig. 3) journalled in bracket 131 and bearing a pinion 132 upon its upper end. This pinion in turn meshes with and drives a large gear 133, see Figs. 3, 6, 7 and 17, loosely mounted upon the controller shaft 77. A clutch ring 134 is secured to the above mentioned gear and includes a series of notches 135 in its upper peripheral side edge to be engaged by a radially movable clutch pin 136 mounted to slide in the bracket 148 secured to the shaft 77, as will now be further explained. This clutch pin is thrown into operative position by trip mechanism actuated by a disk 137 carried upon the underside of the feed-works bracket, see Figs. 1, 2 and 6. This disk includes upon its periphery a cam 138 that serves to engage one end of a trip rod 139, the other end of which is connected to an arm 140 on a short rocker shaft 141 mounted in bearings 142 of the column. A second arm 143 is also mounted on said shaft 141 and carries an inwardly disposed pin 144 for engagement with a stud 145 on one arm 146 of a rocker member 147 loosely mounted on the shaft 77 above the clutch ring 134. A clutch pin bracket 148 is secured to the controller shaft and carries the before mentioned clutch pin 136 in the clutch ring 134. This clutch pin 136 is operated by connection with one arm of a bell crank 149, pivotedly mounted on the clutch pin bracket 148, against the action of spring 150, one end of said spring being fastened to the rocker member and the other to said clutch pin bracket 148. The other end of the bell crank is provided with a pin 151 that is at all times in engagement with a slot on underside of arm of rocker member 147.

From the foregoing it will be understood that the pump shaft 101 is continuously driven whether clutch on driving shaft be engaged or disengaged, whereas the controller shaft 77 is engaged and disengaged to make one complete rotation to effect a cycle of operations of the machine including a single rotation of the controller drum 116, and the gear 152 on the lower end of the same shaft. This engagement of the shaft 77 is made from the pump shaft 101 through the line of mechanism before described, including gear 128, gear 129 and its shaft, large gear 133 and its clutch ring 134, which elements like the pump shaft are continuously operated. The clutch pin 136 being operatively mounted in the bracket 148 secured to the shaft 77 and operated from the timing disk 137 through the operating connections including trip rod 139, rocker shaft 147 and arm 143 which as before described disengages the pin of the rocker member, loosely mounted upon the controller shaft, and allows said rocker member to be partially rotated by the action of its spring. This movement of rocker member through the slot on under side and its connection with bell crank 149 serves to operate the pin to engage the clutch ring, thus completing the drive connection as between the pump shaft and controller shaft. In this connection it should be borne in mind that the controller shaft is thus given but a single rotation which in functions of the machine, represent a single cycle of operations and that with the completion of such rotation of the shaft and cycle of operations the clutch is automatically disengaged through the same medium, namely disk, trip rod, etc. by which the engagement is made.

The further purpose of this controller unit and its relative bearings upon the several operations of the machine will be again referred to and more fully described after the mechanisms for operating the carrier and work spindles have been described. In this connection I have provided a hand operating device which in case of emergency may be manipulated to immediately prevent the functioning of the controller shaft and likewise the further operation of the machine. This device is clearly shown in Fig. 6 of the drawing, wherein it will be noted that a bell crank lever 153 is pivotedly mounted upon a bracket 154 of the column. The inner end 155 of this bell crank is positioned in horizontal alignment with stop 145 upon the rocker member 147 of the controller shaft whereby the said rocker member is prevented from functioning when the said end 155 of the bell crank is swung around into the path of travel of the said pin 145. This bell crank is connected to be

operated as just suggested through a slide rod 157, one end of which is connected to the shorter end 153 of the bell crank and the other end extended out through the forward portion of the machine in position for engagement by the operator, it being obvious that an inward thrust of the slide rod would serve to stop the indexing of the machine, whereas an opposite manipulation of the slide rod would leave the machine free to index continuously and automatically.

The carrier which is designated as 29 serves to carry the work spindles 159 of which four are shown in this particular design. These work spindles are provided with suitably attached heads 160 upon which the work to be machined is rotatably mounted so that with each indexing operation of the machine the said work will be carried forward from one set of cutting tools to the next. This carrier is rotated or indexed from time to time, which in this instance, there being four spindles, is moved exactly one-quarter of a rotation. The carrier 29 includes a cylindrical tapered hub portion 158 that fits into a correspondingly tapered bearing of the base and is further supported in a ball bearing 161, the upper race member of which is adjustably mounted upon the annular hub portion of the carrier while the lower race member of the bearing is formed in the top portion of the tapered bearing in bed.

A spider 162 is secured to the central portion of the carrier 158, which spider in all respects so far as operation of the machine is concerned forms an integral part of the carrier and serves as the particular medium or portion thereof through which engagement is made for indexing the carrier. This spider (see dotted lines in Figs. 5 and 7) includes four radially disposed arms each provided with a slot 163 that radiates from the center of the spider and serves to be engaged by a roll on the outer end of the indexing arms 164 loosely mounted on a short shaft 165 journalled in the base and bed respectively of the machine. The hub portion of the two indexing arms 164 is secured to the under side of the gear 166 also loosely journalled upon the said shaft 165 for the purpose of operating the indexing arm through the medium of the said gear. This gear is operated from the before mentioned controller shaft 77 through the idler gear 167 positioned between said gear 166 and the before mentioned gear 152 on the said shaft 77. The ratio of this train of gears is such as to impart a one-half rotation to the gear 166 causing one of the two indexing arms to be swung into and out of engagement with the slot in one of the arms of the spider, and whereby a one-quarter turn of the same and the carrier is effected with each complete rotation of the controller shaft 77. This relative operation further shows that but a one-quarter turn of the carrier is included in each complete cycle of operations of the machine and that this one-quarter turn is for the purpose of moving the work spindles from one of the four spindle stations to another.

The carrier just referred to is provided with a locking device which is perhaps best shown in Fig. 5, and whereby the carrier is securely locked and its work spindles accurately positioned with the completion of each indexing operation. This locking device as shown includes a series of locking pins 168 which are radially positioned and adjustably secured within pockets of the carrier between the spindles, and provided with a tapered end portion to be engaged by the slidable locking pin 169 operatively mounted in the bed in position for alignment with the outer end of each of the several fixed pins 168 of the carrier when the same are brought forward to a position of rest, and so that an inward longitudinal movement of the slidable pin 169 will engage the tapered end of the aligned fixed pin and insure an accurate positioning of the spindles. This slidable pin is provided with means for shoving it forward for engagement as above suggested and likewise for withdrawing it to release the carrier which operation is brought about by connections with the cam 170 upon the controller shaft 77.

One end of a bell crank lever 171 which is pivotally mounted upon a stud 172 in the bed engages a slidable collar 173 upon the outer reduced end of the movable locking pin 169 and is provided with a spring 174 that is positioned upon the locking pin between a shoulder of the same and the collar so as to yieldably connect the said arm of the bell crank lever with the movable pin in its locking operation. The other end of the bell crank lever is provided with a roller which is engaged by the peripheral surface of the cam 170, as for the locking operation of the pin and is engaged by the cam face 175 upon the under side of the cam.

In order to further insure a more accurate positioning of the carrier and its work spindles during the operation of the latter I provide a binding mechanism which is arranged to engage the annular peripheral tapered bearing surface of the carrier, and like the movable pin of the locking device is mounted in the bed of the machine and in substantially the same horizontal plane. This binding device is clearly shown in Fig. 5 and consists of the following mechanism. A plug 176 is slidably mounted in a bearing of the bed, and is engaged by an adjustable contact pin 177 carried by a

lever 178 which is pivotally mounted at 179 to the bed. The short end of this lever is provided with an adjustable stop pin 180 and the forward end is in position to be engaged by a lug 181 on the under side of the before mentioned cam 170, thus insuring the operating of the lever and the binding plug when the cam is positioned as shown in Fig. 5 to hold the carrier during the working operations of the table spindles.

The spindles 159 heretofore referred to as being mounted in the carrier and operating the work carrying tables 160 are of like construction and are directly operated from one common central drive which in turn is driven from the before mentioned spindle drive shaft 101 through gear 182 upon the lower end of said shaft which meshes with and drives the idler gear 183 loosely mounted on the before mentioned short shaft 165 and which is positioned to engage and operate either of the spindle gears 184 as they are brought into mesh therewith, with the rotation of the carrier.

A central gear 185 that is mounted on a fixed central shaft 161 meshes with and serves to operate the several spindle gears. The shaft 161 is secured in and turns with the carrier, its lower end turning in a bearing 187 of the base. This central gear as before described is brought into operation when the carrier is in a position of rest, which means that one of these spindle gears mesh with the driving idler 183 and that the gears of the adjacent spindles are driven from the central gear.

These spindle gears are each slidably mounted upon their spindles and are adapted to be raised and lowered for their disengagement and engagement with the central gear 185 and idler driving gear 183 for two purposes. Each spindle gear 184 is provided with a separate raising device that is mounted upon the carrier adjacent to the respective spindles and is adapted to be operated at two opposite points in the rotation of the carrier so that when the carrier comes to a stop and the front spindle is positioned at what is called the loading station its gear will have been raised out of mesh from the central driving gear 185 and that on the other hand when the carrier is indexing the particular spindle gear which is approaching the idler gear 183, will be likewise raised out of engagement with said gear so that there can be no driving connection with the spindle gears until the carrier has come to a position of rest and the work spindles are positioned for their working operations. This engaging and disengaging mechanism will be best understood with reference to Figs. 7 and 8, wherein it will be noted that these gear operating devices as shown adjacent to the four spindles 159 are duplicates of each other and therefore a detail description of one should be sufficient for a proper understanding of them all.

It will be seen that a forked arm 188 which straddles the hub portion of each spindle gear is pivotally mounted at 190 to the carrier and that each of said fork members is provided with an outwardly disposed cam arm 191 designed to be engaged by the adjustable cam pins 192 and 193 mounted on the bed 25. These pins are so distanced from the center of the axis of the machine and with relation to the operating stations of the machine as to insure engagement of the said cam arms 191 as they pass over the top of the cam pins as the spindle gears approach the loading station in the one instance, and as they approach the rear station on the other hand. In this respect while the mechanism just referred to serves to raise the spindle gears as the same approach the rear station, yet said gears are immediately dropped upon the idler driving gear the moment the carrier stops so that the said spindle gear may promptly be brought into operative engagement with said driving gear and the central driving gear.

The cross rail 197 as before mentioned and as is clearly shown in Figs. 1, 2, 9, 10 and 11 is provided with a vertical guide slot 194 in each end to engage the ways 195 in the side rails 196 which extends from the top of the bed to the under side of the feed works. This cross rail, as before stated, is operatively connected with the feed works by the reciprocating rod 109, by means of which it is raised and lowered. 186 represents a cable, one end of which is connected to the said cross rail and the other end to the counterweight 198 hung in the rear side of the column of the machine and serves to counter-balance the cross rail. 199 represents two stop rods secured in the under side of the feed works base and extending down through the lugs of the cross rail, with nuts positioned thereon to be engaged by the lugs on the back of the cross rail in a manner to limit the downward movement of the cross rail.

The purpose of this cross rail and reciprocatory movement imparted thereby are obviously for the feeding operations of the cutting tools which operate upon the work carried upon the work tables, said operations being confined to the work upon three of the tables while the fourth only is positioned at the loading station. The cutting tool for the rear work station, namely that positioned directly back and opposite from the loading station, is directly mounted in a tool holder and tool holder support 200 which is directly mounted upon the intermediate portion of the cross rail and may

be positioned to carry either an internal or external cutting tool. Whereas the holder 201 for the cutting tools for the other two work tables are positioned directly opposite each other and carried by the side heads 202 which in turn are mounted upon the vertical side rails.

These two side heads designated as 202, together with their operative connections with the cross rail, are alike in construction and therefore a detail description of one only will be necessary for a proper understanding of each. In this respect it may be further stated that the feeding operations of the tools carried by these heads are effected through the movement of the cross rail 197 and are simultaneous with each other and as arranged are afforded similar feeding movements.

These side heads are adapted to move vertically and are angularly adjustable so that the tool carrying holder may be fed horizontally toward and from each other in independent angular directions. The vertical guideways 196 include guide slots 203 in which T-head bolts 204 are movably supported, the threaded end portion of said bolts being passed through the saddle 205 forming a part of the head and secured in said adjusted position by means of nuts secured to the threaded ends of said T-bolts.

A swivel plate 206 (Figs. 9 and 10) is mounted to turn upon the face of the saddle, the saddle being provided with a semi-circular slot 207, T-bolts 208, and circular slots 209 and T-bolts 210 whereby the guide plate may be turned upon an axis designated by the center of the short shaft 211. This swivel plate 206 includes a transverse guide way 212 in which a slide 213 is operatively mounted. The tool holder 201 is provided with an elongated shank which is adjustably mounted in the slide 213 and is adapted to be positioned longitudinally of the said slide by means of the adjusting screw 214 which is clearly shown in Fig. 10. This horizontal feeding movement is imparted to the cutter, mounted in the tool holder 201 through vertical movement of the before mentioned cross rail 197 through the operation of gear and ring connections as will next be referred to.

Referring particularly to Figs. 9 and 11 it will be seen that the vertical end portions of the rail 197 are each provided with a rack 215 that engage and operate a gear 216 housed within a bracket 217 and mounted upon a short shaft 218 journalled within the vertical guide way. This short shaft is further provided with smaller pinions 219 upon its forward end which is covered by a closure plate 220 that also forms a guide for the vertical movable rack 221 which is engaged and operated by the said pinion 219 as will be apparent from the drawing. This rack includes a series of teeth upon one of its upper edge portions and a similar series of teeth upon its opposite lower edge portion. The lower series of teeth which I will designate as 222 engage and mesh with a gear 223 upon the short shaft 211 journalled in a bock 224 mounted in the saddle and upon the forward end of the said short shaft is carried a disk 225 which bears a series of holes 226 arranged upon a spiral line at different distances from the axis of the gear, and in one of which a pin 226^a is adapted to be selectively engaged, one end portion of which is positioned to engage one of the several cross slots 227 upon the inner side of the slide 213 so that a vertical movement of the rack 221 will rotate the gear 223 and its disk 225 carrying its pin around so that the projected end engaging one of the said slots moves the slide, its tool holder and cutter transversely in its cutting operation the distance of the particular pin from the axis determining the effective throw of the carrier. The carrier may be adjusted longitudinally by engaging one or the other of the slot 227 with the pin 226^a. The rack 221 is obviously operated through gear 216 and 219 mounted upon the short shaft 218 as a result of the engagement therewith by the rack 215 of the slide 197.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying member adapted to engage work upon another table, means actuated by said first tool carrying member at a different lineal speed from the speed of said first tool carrying member and adapted to impart movement to said second tool carrying member.

2. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a vertically movable tool carrying member, a tool carried thereby adapted to engage work upon one of said tables, and a second tool carrying member normally fixed against vertical movement adapted to engage work upon another table, means adapted to receive movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in a direction at an angle to said vertical movement and means for changing said angle of movement.

3. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying mem-

ber, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying member mounted for vertical adjustment and normally fixed against vertical operative movement adapted to engage work upon another table, means adapted to receive movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in a direction at an angle to the direction of movement thereof and means for changing said angle of movement.

4. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying member mounted for angular adjustment relative to a line at right angles to the first tool carrying member and adapted to engage work upon another table, means adapted to receive movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in a direction at an angle to the direction of movement thereof, said member being normally fixed against movement in the direction of movement of said first tool carrying member.

5. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a pair of tool carrying members normally fixed against movement in the direction of movement of said first tool carrying member adapted to respectively engage work upon other tables, means adapted to receive movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in directions at an angle to the direction of movement thereof and means for independently changing said angles of movement.

6. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a vertically movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a pair of tool carrying members mounted for independent vertical adjustment and normally fixed against vertical movement adapted to respectively engage work upon other tables, means adapted to receive movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in directions at an angle to the direction of movement thereof and means for independently changing said angles of movement.

7. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a vertically movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a pair of tool carrying members normally fixed against vertical movement mounted for independent angular adjustment relative to a horizontal line and adapted to respectively engage work upon other tables, means adapted to receive reciprocatory movement from said first tool carrying member at a variable speed with respect thereto, said last means adapted to impart movement to said second tool slide in directions at an angle to the direction of movement thereof.

8. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying means comprising a rotatably mounted member normally fixed against movement in the direction of movement of said first tool carrying member adapted to be adjusted angularly to change the direction of feed of said tool, and a reciprocating tool carrier mounted thereon adapted to engage work upon another table, and means actuated through the movement of the first tool carrier at a variable speed to the speed of said first tool slide adapted to impart reciprocatory movement to said second tool carrier.

9. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying member comprising a member mounted for linear adjustment parallel to the line of movement of said first tool carrying member relatively to a line at right angles to said linear adjustment, and normally fixed against operative movement in said direction, a member mounted thereon and adapted to be adjusted angularly, and a reciprocating tool carrier mounted on said second member, and means actuated through the movement of the first tool carrier at a variable speed to the speed of said first tool slide adapted to impart reciprocatory movement to said second tool carrier.

10. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrier, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carry-

ing means normally fixed against movement in the direction of movement of said first tool and comprising a reciprocating tool carrier, and a gear adapted to impart reciprocatory movement to said reciprocating tool carrier, a rack engaging said gear, and means actuated through the movement of said first tool carrier adapted to reciprocate said rack at a variable speed to the speed of said first tool carrier and in opposed direction to the direction of movement of said first tool carrier to impart reciprocatory movement to said second tool carrier.

11. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying means comprising a member mounted for linear adjustment, a reciprocating tool carrier, and a gear adapted to impart reciprocatory movement to said tool carrier, a rack engaging said gear adapted to be reciprocated in a direction parallel to the direction of lineal adjustment of said member, and means actuating through the movement of said first tool carrier adapted to reciprocate said rack in opposed direction to the direction of movement of said first tool carrier to impart reciprocatory movement to said second tool carrier.

12. In a machine of the character described, a rotary carrier, a plurality of work tables mounted thereon, means for indexing the tables, a movable tool carrying member, a tool carried thereby adapted to engage work upon one of the tables, and a second tool carrying means comprising a reciprocating tool carrier, a gear adapted to impart reciprocatory movement to said tool carrier, a rack engaging said gear, a second gear engaging said rack, a gear fixed to and coaxial with said second gear, and a rack mounted on said first tool carrier engaging said last mentioned gear and adapted through the movement of said first tool carrier to impart reciprocatory movement to said second tool carrier.

13. In a machine of the character described, a work carrier, and a tool carrying means comprising a member mounted for linear adjustment, a member mounted on said first member and adapted to be adjusted angularly, and a reciprocating tool carrier mounted on said second member, rotary means adapted to impart reciprocatory movement to said tool carrier and selective means arranged upon a spiral line adapted to adjust the effective throw of said tool carrier.

14. In a machine of the character described, a work carrier, and a tool carrying means comprising a reciprocating tool carrier, a gear, and selective means variably spaced from the axis of said gear adapted to cooperatively relate said tool carrier and gear whereby the effective throw of said tool carrier may be adjusted, and means adapted to rotate said gear to impart reciprocatory movement to said tool carrier.

15. In a machine of the character described, a work carrier, and tool carrying means comprising a reciprocating tool carrier, a gear, and a plurality of spaced means on said carrier variably spaced from the axis of said gear and adapted to be selectively related to said gear to vary the effective throw of the carrier, and means adapted to rotate said gear to impart reciprocatory movement to said tool carrier.

16. In a machine of the character described, a work carrier, and tool carrying means comprising a reciprocating tool carrier provided with a transverse slot, a gear and means engaging said slot adapted to be connected to said gear at different distances from its center, to vary the effective throw of said tool carrier, and means adapted to rotate said gear to impart reciprocatory movement to said tool carrier.

17. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted thereon, spindles therefor, and driving means for said spindles comprising gears on the respective spindles, an idler gear mounted coaxially of the carrier and engaging said spindle gears, and a driving gear adapted to mesh with one of said spindle gears.

18. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted thereon, spindles therefor, and driving means for said spindles comprising gears slidably mounted on the respective spindles, an idler gear mounted coaxially of the carrier and adapted to be engaged by said spindle gears, and a driving gear adapted to mesh with one of said spindle gears, said spindle gears adapted to be slidably moved to engage and disengage said idler and driving gears.

19. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted thereon, spindles therefor, indexing means for said carrier, driving means for said spindles comprising gears slidably mounted on the respective spindles, an idler gear mounted coaxially of the carrier and adapted to be engaged by said spindle gears, and a driving gear adapted to mesh with one of said spindle gears, and means adapted to disengage one of said spindle gears from said idler gear while another of said spindle gears is in mesh with said driving gear, and the other spindles rotating.

20. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted

thereon, spindles therefor, indexing means for said carrier, driving means for said spindles comprising gears slidably mounted on the respective spindles, an idler gear mounted coaxially of the carrier and adapted to be engaged by said spindle gears, and a driving gear adapted to mesh with one of said spindle gears, and means adapted to disengage said spindle gear from said driving gear during indexing of said carrier.

21. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted thereon, spindles therefor, driving means for said spindles comprising gears slidably mounted on the respective spindles, individual gear shifting means for said respective gears mounted on said carrier, an idler gear mounted coaxially of the carrier and adapted to be engaged by said spindle gears, and a driving gear adapted to mesh with one of said spindle gears, and means adapted to cooperate with said gear shifting means to disengage said spindle gears from said idler and driving gears at a predetermined point during the travel of said carrier.

22. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted thereon, spindles therefor, indexing means for said carrier, driving means for said spindles comprising gears slidably mounted on the respective spindles, an idler gear mounted coaxially of the carrier and adapted to be engaged by the spindle gears, and a driving gear adapted to mesh with one of said spindle gears, and means operative at predetermined points in the travel of said carrier adapted to disengage said spindle gear from said driving gear during the indexing of the carrier, and to disengage one of said spindle gears from said idler gear while said carrier is stationary and during the rotation of the other spindles.

23. In a machine of the character described, a base having a cylindrical bearing portion having an inner cylindrical bearing surface, a work carrier rotatably mounted in said base and having a cylindrical bearing portion disposed within said other bearing portion, a plurality of circumferentially spaced work tables mounted on said carrier, means adapted to index the carrier, a plurality of circumferentially spaced locking pins carried by said carrier and having locking ends at their outer ends, and a locking pin carried by said base adapted to be interlockingly engaged automatically with one of said spaced locking pins at the completion of each indexing operation, and to be disengaged automatically at the beginning of each indexing operation.

24. In a machine of the character described, a base having a cylindrical bearing portion having an inner cylindrical bearing surface, a work carrier rotatably mounted in said base and having a cylindrical bearing portion disposed within said other bearing portion, a plurality of circumferentially spaced work tables mounted on said carrier, means adapted to index the carrier, a plurality of circumferentially spaced locking means carried by the carrier, a locking member adapted to be interlockingly engaged automatically with one of said spaced locking means at the completion and to be disengaged automatically at the beginning of each indexing operation, and a friction member movably mounted in said base adapted to be engaged and disengaged with the periphery of said bearing portion of the carrier at the completion and beginning of the indexing operations.

25. In a machine of the character described, a rotatable work carrier, a plurality of circumferentially spaced work tables mounted on said carrier, means adapted to be intermittently operated to index the carrier, a cam member disposed at one side of said carrier operated by said indexing means and locking means operated by said cam to lock said carrier against movement between said indexing operations.

26. In a machine of the character described, a rotatable work carrier, a plurality of circumferentially spaced work tables mounted on said carrier, means adapted to be intermittently operated to index the carrier, locking means disposed at one side of the carrier cooperatively related to said indexing means adapted to lock said carrier against movement between said indexing operations and other means disposed at one side of the carrier cooperatively related to said indexing means and adapted to be frictionally engaged with said carrier between said indexing operations.

27. In a machine of the character described, a rotatable work carrier, a plurality of work tables carried thereby, feed works, a continuously driven shaft, a controller shaft, means adapted to be periodically operated by said feed works to cooperatively relate said continuously driven shaft and said controller shaft to periodically drive the latter, and indexing means for said carrier adapted to be operated by said controller shaft.

28. In a machine of the character described, a rotatable work carrier, a plurality of work tables carried thereby, feed works, a continuously driven shaft, a controller shaft, means adapted to be periodically operated by said feed works to cooperatively relate said continuously driven shaft and said controller shaft to periodically drive the latter, drive means for said feed works, a clutch for driving the same from said continuously driven shaft, and means operated by said controller shaft adapted to disconnect and connect said clutch periodically.

29. In a machine of the character described, a support including a base and a head, a rotatable work carrier mounted in said base, a plurality of work tables carried thereby, feed works mounted in said head, a continuously driven shaft, a controller shaft extending from said base to said head, means adapted to be periodically operated by said feed works to cooperatively relate said continuously driven shaft and said controller shaft to periodically drive the latter, indexing means for said carrier at the lower end of said controller shaft adapted to be operated thereby to periodically index the carrier, drive means for said feed works, a clutch for driving the same from said continuously driven shaft, and means at the upper end of said controller shaft adapted to be operated thereby to connect and disconnect said clutch periodically.

30. In a machine of the character described, a work carrier, feed works, a continuously driven shaft, a controller shaft for controlling the relative operations of said work carriers and feed works, driving means for said controller shaft operated by said continuously driven shaft, a clutch adapted to operatively relate said driving means to said controller shaft, and means adapted to be periodically operated to connect and disconnect said clutch.

31. The invention as in claim 30, further characterized by means adapted to be manually operated to prevent operation of said clutch means.

32. In a machine of the character described, a work carrier, feed works, a continuously driven shaft, a controller shaft for controlling the relative operations of said work carrier and feed works, a gear rotatably mounted on said controller shaft and adapted to be continuously driven by said continuously driven shaft, a clutch carried by said controller shaft adapted to connect and disconnect said gear thereto, and means adapted to be periodically operated to connect and disconnect said clutch.

33. In a machine of the character described, a work carrier, feed works, a continuously driven shaft, a controller shaft for controlling the relative operations of said work carrier and feed works, a gear rotatably mounted on said controller shaft and adapted to be continuously driven by said continuously driven shaft, a clutch rotatable with said controller shaft adapted to connect and disconnect said gear thereto, and means disposed in the path of said clutch adapted to be periodically operated to release said clutch to connect said gear and the controller shaft, said means adapted to be engaged by said clutch at the completion of a revolution of the controller shaft to disconnect said gear and the controller shaft.

34. In a machine of the character described, a work carrier, feed works, a continuously driven shaft, a controller shaft for controlling the relative operations of said work carrier and feed works, a gear rotatably mounted on said controller shaft and adapted to be continuously driven by said continuously driven shaft, a spring controlled clutch rotatably mounted on said controller shaft and adapted to connect and disconnect said gear thereto, a member rotatably mounted on said controller shaft and having angular movement relative to said clutch to connect and disconnect the same, and means disposed in the path of said member adapted to be periodically operated to release said member to permit connection of said clutch under the action of its spring, said means adapted to engage said member at the completion of a revolution of said controller shaft to disconnect said clutch against the action of said spring.

35. In a machine of the character described, a work carrier, feed works, a continuously driven shaft, a controller shaft for controlling the relative operations of said work carrier and feed works, a gear rotatably mounted on said controller shaft and adapted to be continuously driven by said continuously driven shaft, a clutch rotatable with said controller shaft adapted to connect and disconnect said gear thereto, stop means disposed in the path of said clutch, trip means for said stop means adapted to be periodically operated by said feed works to release said stop means to connect said gear and said clutch, said stop means adapted to be engaged by said clutch at the completion of a revolution of said controller shaft to disconnect said clutch and said gear.

36. The invention as in claim 35, further characterized by auxiliary stop means adapted to be manually operated into and out of the path of said clutch to prevent and permit operation of said controller shaft.

37. In a machine of the character described, a rotatable work carrier, a plurality of work tables carried thereby, feed works, a continuously driven drive shaft, a shaft for operating said work tables operatively related to said drive shaft to be driven thereby, a controller shaft for controlling the relative operations of said work carrier and feed works, and means adapted to be periodically operated to cooperatively relate said continuously driven drive shaft and said controller shaft to periodically drive the latter.

38. In a machine of the character described, a rotatable work carrier, a plurality of work tables carried thereby, feed works, a continuously driven drive shaft, a lubricant pump, an operating shaft therefor operatively related to said drive shaft to be continuously driven thereby, a controller

shaft for controlling the relative operations of said work carrier and feed works, and means adapted to be periodically operated to cooperatively relate said continuously driven drive shaft and said controller shaft to periodically drive the latter.

39. In a machine of the character described, a rotatable work carrier, a plurality of work tables carried thereby, indexing means for said work carrier, feed works, a continuously driven drive shaft and a two-piece controller shaft comprising disconnectable sections, one of said sections carrying means adapted to operate said indexing means, and the other section carrying means adapted to control said feed works, and means adapted to be periodically operated to cooperatively relate said continuously driven drive shaft and said controller shaft to periodically drive the latter.

40. In a machine of the character described, a work carrier, feed works, a continuously driven drive shaft, drive means for said feed works, clutch means adapted to connect said drive means to said drive shaft, automatic means adapted to periodically disconnect said clutch, and manual means for disconnecting said clutch.

41. In a machine of the character described, a rotatable work carrier, feed works, a continuously driven drive shaft, means for indexing the work carrier periodically, drive means for said feed works, clutch means adapted to connect said drive means to said drive shaft and automatic means adapted to periodically disconnect said clutch during said indexing operation.

42. In a machine of the character described, a rotatable work carrier, feed works, a continuously driven drive shaft, means for indexing the work carrier periodically, drive means for said feed works, clutch means adapted to connect said drive means to said drive shaft, automatic means adapted to periodically disconnect said clutch during said indexing operation, manual means for operating said clutch means, and means adapted to prevent operation of said manual means during said indexing operation.

43. In a machine of the character described, a work carrier, feed works, a starting device for said feed works, a continuously driven drive shaft, drive means for said feed works, clutch means adapted to connect said drive means to said drive shaft, automatic means adapted to periodically connect and disconnect said clutch, and means adapted to operate said starting device upon connection of said clutch means.

44. In a machine of the character described, a rotatable work carrier, feed works, means for driving said feed works, means for periodically indexing said carrier, means adapted to render said feed works driving means inoperative during said indexing operation, manual means adapted to render said feed works driving means operative, and means adapted to prevent operation of said manual means during said indexing operation.

45. In a machine of the character described, a work carrier, a rotatable work table mounted on said carrier, a spindle for said carrier, feed works, a continuously driven drive shaft, driving means for said spindle and said feed works, and clutch means adapted to be operated to connect and disconnect said drive shaft to said driving means.

46. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted on said work carrier, spindles for said tables, means for driving said spindles, feed works, indexing means adapted to periodically index said work carrier, a continuously driven drive shaft, means for connecting said drive shaft to said spindle driving means to drive the latter, and means adapted to automatically disconnect said drive shaft from said spindle driving means during said indexing operation.

47. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted on said work carrier, spindles for said tables, means for driving said spindles, feed works, indexing means adapted to periodically index said work carrier, a continuously driven drive shaft, clutch means adapted to connect said spindle driving means and said drive shaft, automatic means adapted to periodically disconnect said clutch means during said indexing operation, manual means for operating said clutch means, and means adapted to prevent operation of said manual means during said indexing operation.

48. In a machine of the character described, a rotatable work carrier, feed works, a continuously driven drive shaft, means for indexing the work carrier periodically, drive means for said feed works, clutch means adapted to connect said drive means to said drive shaft, automatic means adapted to periodically disconnect said clutch during said indexing operation, and brake means adapted to be automatically applied to said feed works driving means upon disconnection of said clutch means.

49. In a machine of the character described, a rotatable work carrier, a plurality of rotatable work tables mounted on said work carrier, spindles for said tables, means for driving said spindles, feed works, indexing means adapted to periodically index said work carrier, a continuously driven drive shaft, clutch means adapted to connect said spindle driving means and said drive shaft, automatic means adapted to periodically disconnect said clutch means during said index-

ing operation and brake means adapted to be automatically applied to said spindle driving means upon disconnection of said clutch means.

50. In a machine of the character described, a work carrier, feed works, a continuously driven drive shaft, a multiple disc clutch mounted coaxially with said drive shaft, means operating said work carrier and feed works from said clutch, and automatic means adapted to periodically connect and disconnect said clutch to control the operations of said work carrier and feed works.

51. In a machine of the character described, a work carrier, feed works, a continuously driven drive shaft, a multiple disc clutch mounted coaxially with said drive shaft, means operating said work carrier and feed works from said clutch, automatic means operatively connected to one end of said clutch adapted to periodically connect and disconnect said clutch to control the operation of said work carrier and feed works, and manually operated means operatively connected to the other end of said clutch adapted to operate it independently of said automatic means.

52. In a machine of the character described, a rotatable work carrier, feed works, a continuously driven drive shaft, a clutch adapted to be connected and disconnected to said drive shaft, means operating said work carrier and said feed works from said clutch, means adapted to be periodically connected to said drive shaft to index said carrier, a controller shaft adapted to be rotated through a complete revolution during each indexing operation, and a cam rotated by said controller shaft and adapted to disconnect said clutch during said indexing operation, and to connect the same at the completion of such operation.

53. In a machine of the character described, a rotatable work carrier, feed works, a starting device for said feed works, a continuously driven drive shaft, a clutch adapted to be connected and disconnected to said drive shaft, means operating said work carrier and feed works from said clutch, means adapted to be periodically connected to said drive shaft to index said carrier, a controller shaft adapted to be rotated through a complete revolution during each indexing operation, a cam rotated by said controller shaft and adapted to disconnect said clutch during said indexing operation, and to connect the same at the completion of such operation, and means operated by said controller shaft for actuating said starting device.

Signed at Bridgeport, in the county of Fairfield and State of Connecticut, this sixth day of October, A. D., 1922.

EDWARD P. BULLARD, JR.