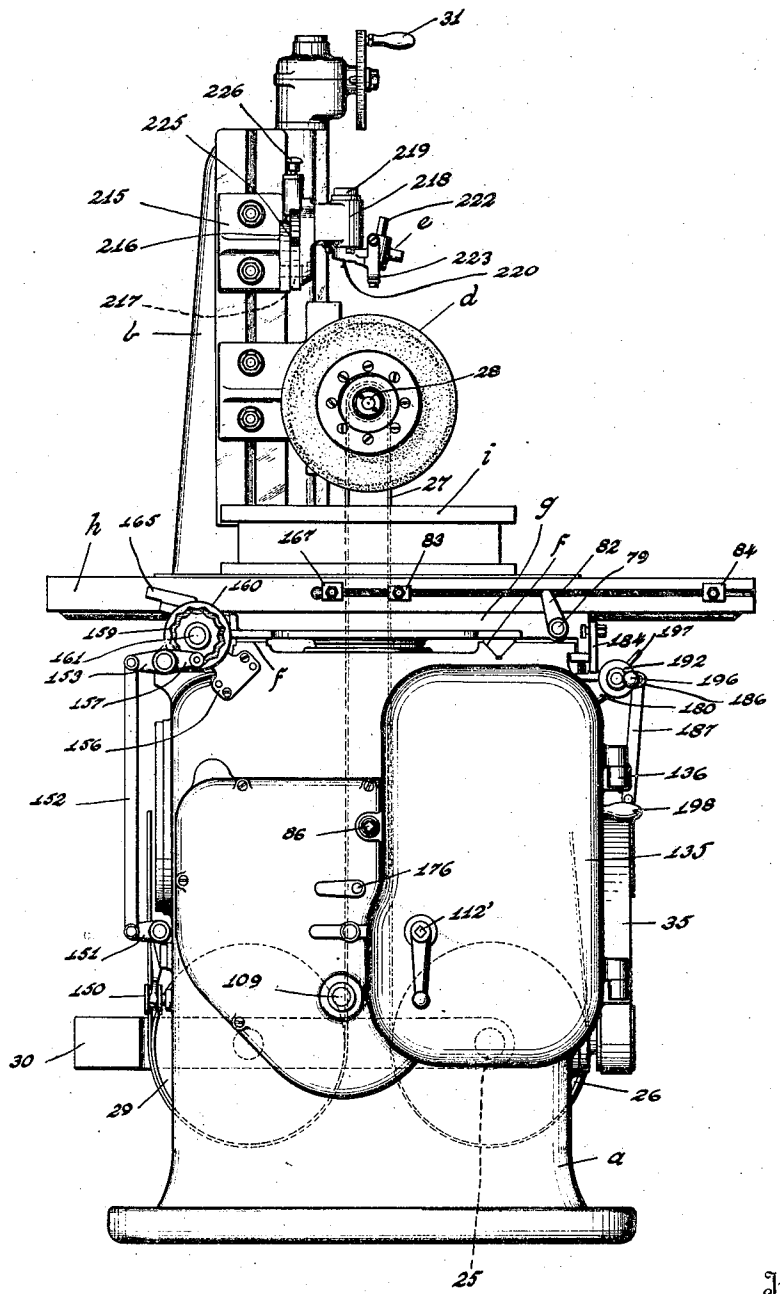
Nov. 11, 1924. 1,515,039

B. M. W. HANSON

METAL WORKING MACHINE

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Fig. 1.




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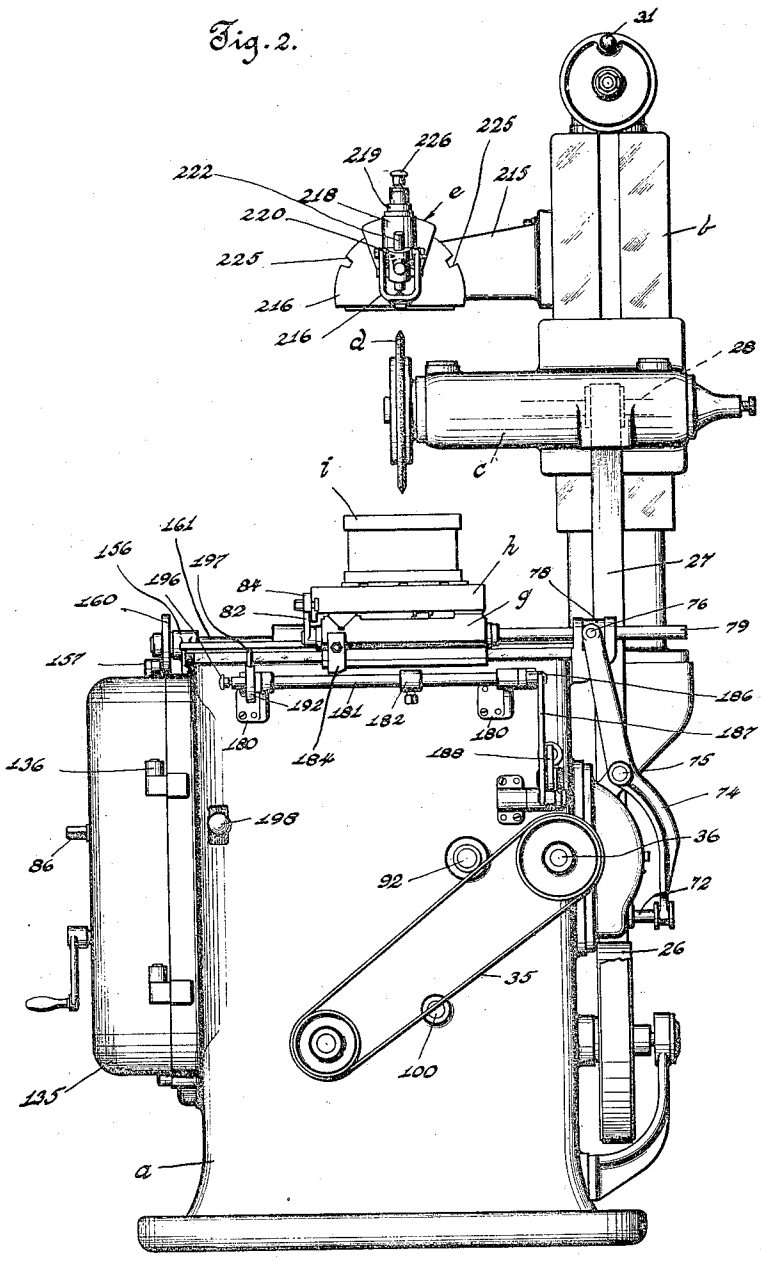
Nov. 11, 1924. 1,515,039

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METAL WORKING MACHINE

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Fig. 2.




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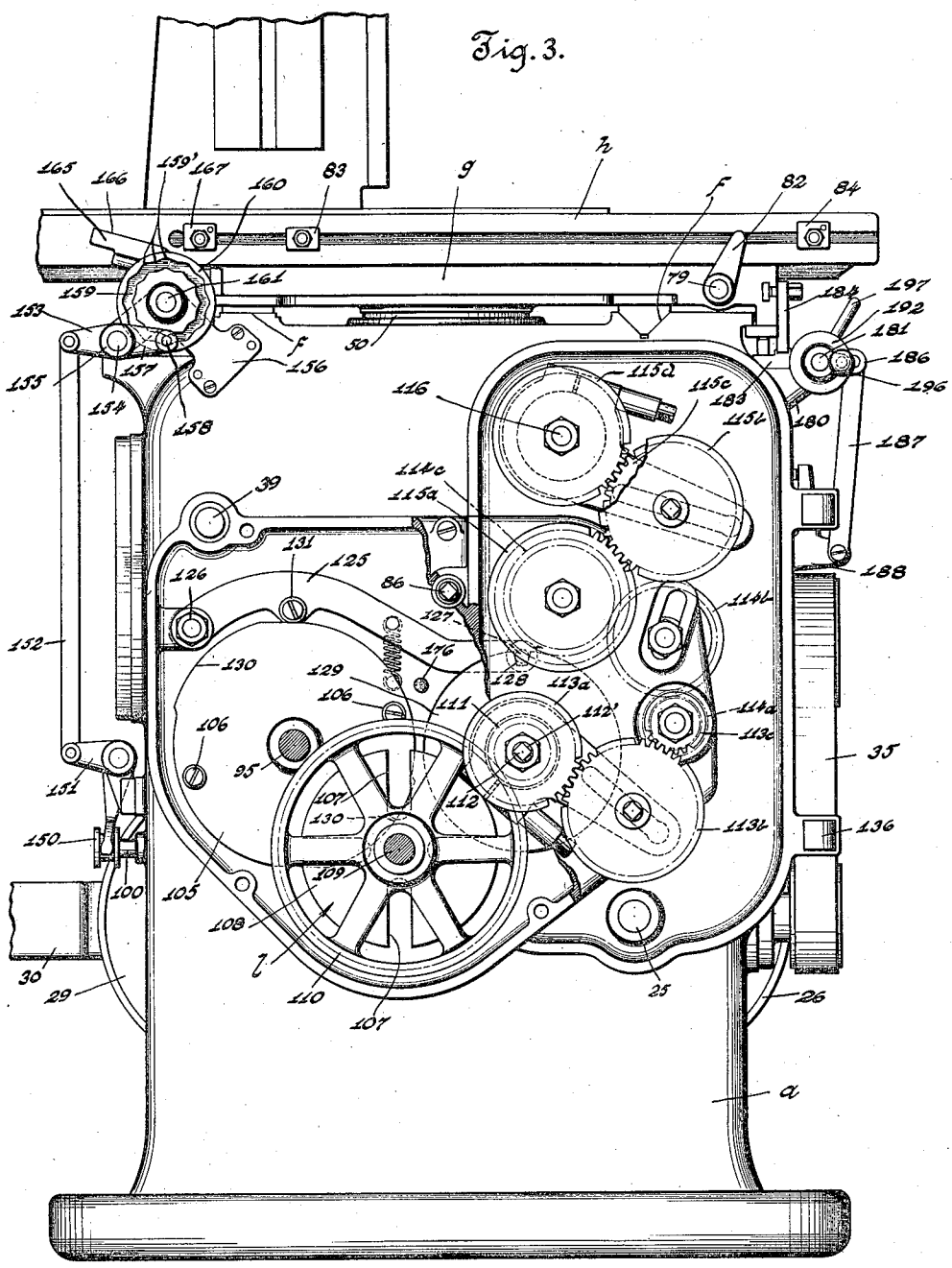
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METAL WORKING MACHINE

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Fig. 3.




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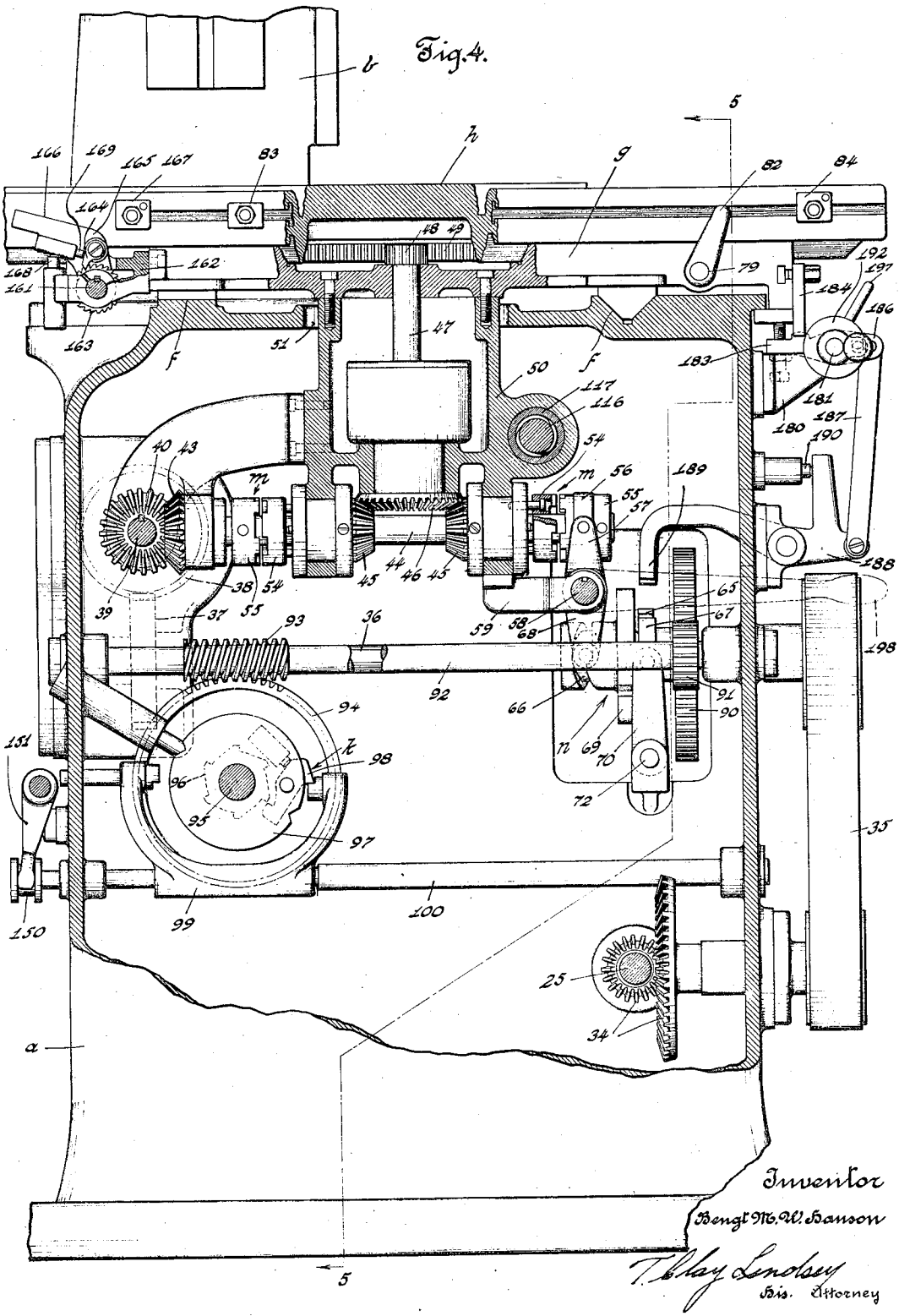
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METAL WORKING MACHINE

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Fig. 4.



Nov. 11, 1924. 1,515,039

B. M. W. HANSON

METAL WORKING MACHINE

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Fig. 5a.

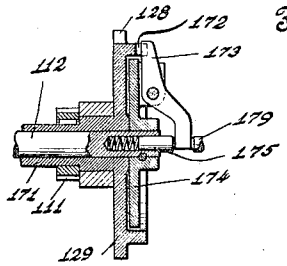



Fig. 5.




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METAL WORKING MACHINE

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Fig. 6.

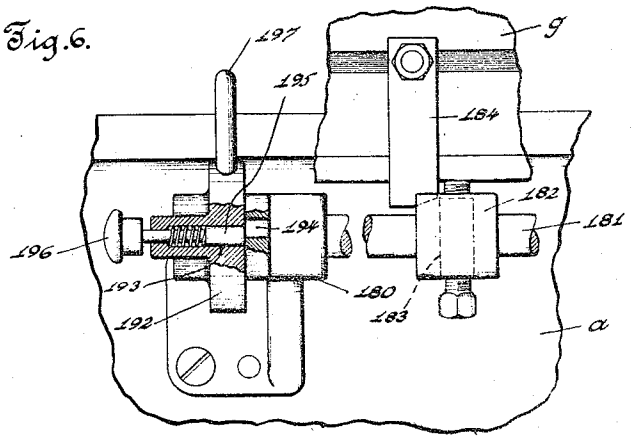
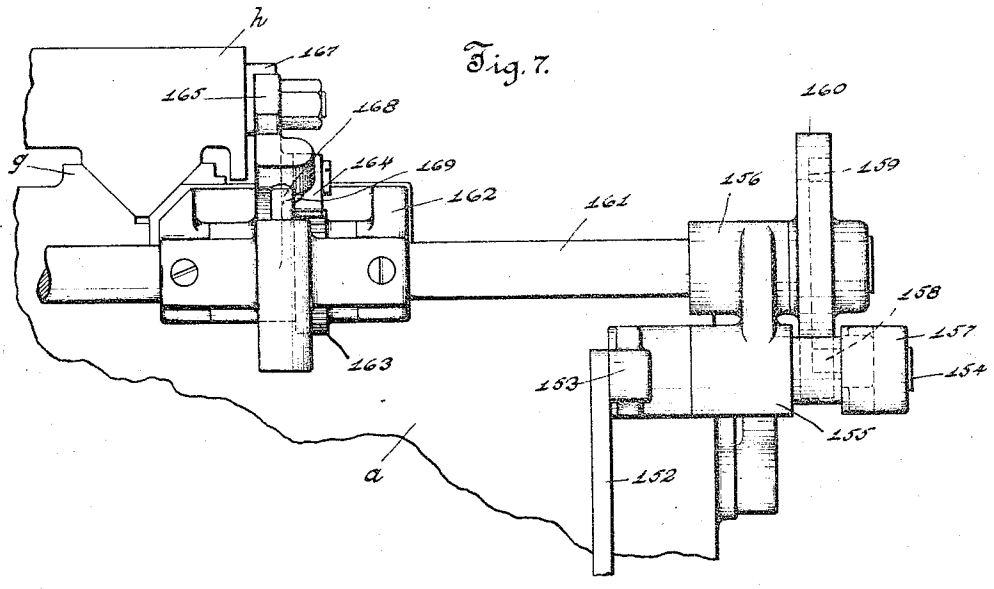



Fig. 7.




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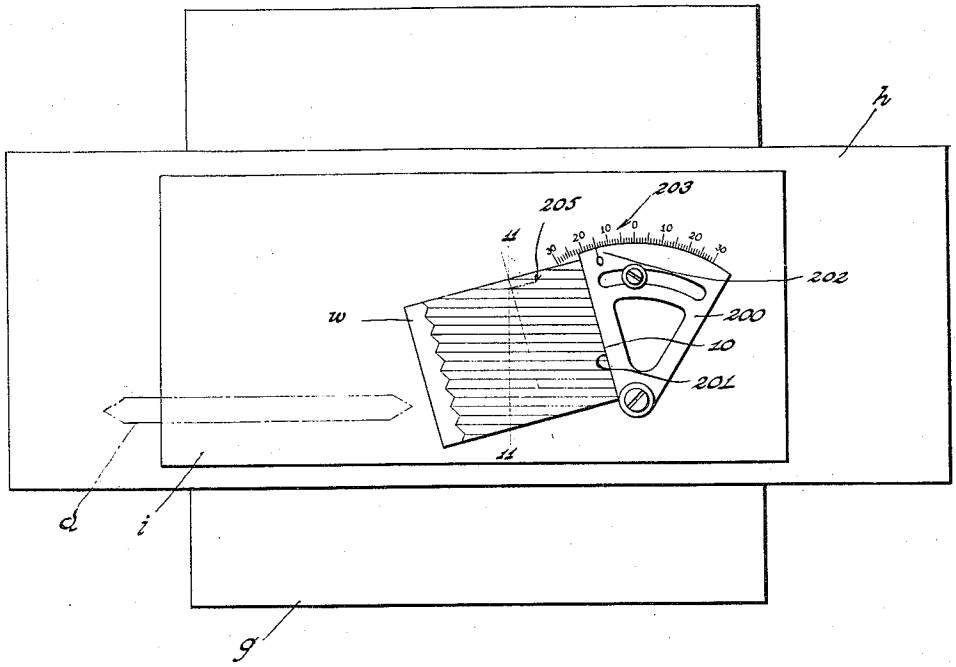
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METAL WORKING MACHINE

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Fig. 8.




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Patented Nov. 11, 1924. 1,515,039

# UNITED STATES PATENT OFFICE.

BENGT M. W. HANSON, OF HARTFORD, CONNECTICUT.

## METAL-WORKING MACHINE.

Application filed December 8, 1921. Serial No. 520,856.

*To all whom it may concern:*

Be it known that I, BENGT M. W. HANSON, a citizen of the United States, and resident of Hartford, county of Hartford, State of Connecticut, have invented certain new and useful Improvements in Metal-Working Machines, of which the following is a specification.

The present invention relates to metal working machines, and has particular reference to a machine for generating or operating upon serrated or toothed members.

As an instance of a use to which the machine forming the subject matter of the present invention may be applied, reference may be had to the final finishing operation on the serrations or teeth of a jaw or block for gauging threaded members, such a jaw being illustrated and described in my co-pending application S. No. 461,956, filed April 16th, 1921. I desire it, however, to be clearly understood that the present disclosure is by way of exemplification only; that the invention is susceptible of various embodiments and modification, and that the terms here used are merely terms of description and not terms of limitation. It will further be obvious that many features of construction are susceptible of modification to suit different requirements without departing from the spirit of the invention.

It is the aim of the invention to provide a machine of the character described having various features of novelty and advantage and more particularly to provide a machine which will operate with uniformity and accuracy and with a saving of time. Also, to provide a machine which may be easily, quickly and accurately set up and adjusted without the necessity of the operator first making mathematical calculations which are so likely to result in errors and which ordinarily require experience and time.

In the accompanying drawings:

Fig. 1 is a front elevational view of the entire machine,

Fig. 2 is an elevational view of the right hand end thereof,

Fig. 3 is a front view of the bed of the machine with the front cover removed and a portion of the front wall of the bed broken away so as to show the driving connections,

Fig. 4 is a sectional view taken substantially on line 4—4 of Figs 2 and 5,

Fig. 5 is a sectional view taken substantially on line 5—5 of Fig. 4,

Fig. 5ª is a detail view showing the manually operable means for disconnecting the work carrier from the automatically operated indexing means,

Fig. 6 is an enlarged view showing the means by which the work carrier is automatically stopped,

Fig. 7 is a detail view of the controlling mechanism for the means for moving the work support step by step, and

Fig. 8 is a diagrammatic view illustrating the manner in which a piece to be operated upon is positioned on the work carrier.

In order that the detailed description of the construction of the machine and its mode of operation which are to follow may be better understood, a very brief statement of the general construction and operation of the machine will here be given. The machine is provided with a base *a* from the rear edge of which arises a standard *b* on which is mounted, for vertical adjustment, a housing or mounting *c* for the tool which is here shown as being in the form of a grinding wheel *d*. *e* is a truing device carried by the standard *b* and so arranged that it may be employed for sharpening or resurfacing the grinding wheel without disturbing the relation of the wheel to the work. Mounted on ways *f* on the top of the bed *a* is a work carrier or support including a slide or carriage *g* which is adapted to be indexed or moved step by step in accordance with the normal distance between the successive serrations or teeth on the gauge block to be operated upon. The work support also includes a table *h* mounted upon the carriage *g* and reciprocable at right angles to the indexing movement thereof. The work to be operated upon is secured on the table *h* in any suitable manner; in the present instance, a magnetic chuck *i* being shown for this purpose. The carriage *g* is indexed through the driving connections which include the escapement ratchet clutch mechanism *k*, the Geneva motion device *l* and the train of gearing shown in Fig. 3. The table *h* is reciprocated through the

driving connections which include the reversing clutch mechanism indicated generally by the letter $m$ and the escapement ratchet clutch mechanism $n$ which controls the reversing clutch $m$. The escapement ratchet clutch mechanisms $k$ and $n$, as hereinafter described more in detail, are controlled by the movement of the table $h$.

In Fig. 8, I have shown, for illustrative purpose, a thread gauge block $w$ such as the present machine is adapted to operate upon so as to bring the serrations of the block in exact conformity to the groove of a thread of given pitch and diameter. The linear pitch of a thread is measured along a line parallel to the axis of the screw, and the shortest distance (that is the normal pitch) between successive threads of the screw is less than the linear pitch; that is to say, if the screw thread is "8" pitch, the normal pitch between successive threads is slightly less than one-eighth of an inch. The lead of the thread of a screw and, therefore, its normal pitch, will vary with the linear pitch and the diameter of the thread. This means that when the normal pitch is to be determined, both the linear pitch and the diameter of the screw must be considered. In the jaw block shown in Fig. 8, the edge 10 at the end of the serrations corresponds to a line parallel to the axis of a threaded member and the serrations are spaced along this line in accordance with the linear pitch of the threaded member to be gauged. The normal pitch is measured along the line 11—11 which is at right angles to the length of the serrations. The gauge block, as shown, is positioned on the work table with its serrations parallel to the edge of the grinding wheel and the line of movement of the work table. The carriage $g$ with the work table and the work thereon is indexed on a line at right angles to the length of the serrations so as to bring the successive grooves into proper alinement with the grinding wheel. In order to relieve the operator setting up the machine from making calculations to determine the extent to which the carriage $g$ should be moved to properly index it (and which calculations, as stated, would have to take into account the lead of the serration as well as the linear pitch thereof), I provide in series one set or train of interchangeable gears for taking care of the linear pitch of the serrations and a second set or train of interchangeable gears for compensating for the difference between the linear and normal pitches, all as hereinafter described more in detail.

In operation, the table is advanced and returned on a straight line while the tool is operating on the work, and after the work has cleared the tool and while the table is finishing its return stroke and starting on its next forward stroke, the carriage $g$ is indexed so that by the time the work is again brought up to the tool it is moving in a straight line with the next groove in alinement with the tool. Thus it will be seen that the work is indexed while it is being moved away from and up to the tool. The indexing movement of the work is brought about with a smooth movement, free from jars or vibrations, and with every assurance of uniformity and accuracy.

Referring now more in detail to the construction of the machine, 25 designates a drive shaft journaled in the rear wall of the bed $a$ and having a pulley 26 for a belt 27 which also passes about a pulley on the grinding wheel spindle 28 and a pulley 29 journaled in the free end of a lever 30 pivoted at its other end on a shaft 25. With this arrangement, it will be seen that the housing $c$ carrying the grinding wheel spindle may be vertically adjusted on the standard $b$ as by means of a handle 31 operatively connected to the housing in any suitable manner. The power is transmitted from the shaft 25 through the gearing 34 and belt 35 to a main shaft 36 extending longitudinally of and through the bed of the machine. The shaft 36 is constantly driven.

The table $h$ is reciprocated through the following driving connection. Secured to the left hand end of the main shaft 36 is a spiral gear 37 meshing with a gear 38 on a shaft 39 on which is splined a bevel gear 40 meshing with a like gear 43 splined on a longitudinally shiftable shaft 44 on which the reversing mechanism $m$ is mounted. This mechanism includes a pair of opposed bevel gears 45 loose on the shaft 44 and meshing with a common bevel gear 46 operatively connected to a shaft 47 having a pinion 48 meshing with a longitudinally extending rack 49 on the under surface of the table $h$. The gears 40, 43, 45, 46 and the shaft 47 are journaled, against endwise movement, in bearings provided in a part 50 fixed to, so as to move, with the carriage $g$, the top wall of the bed $a$ being slotted as at 51 to accommodate this part 50. Secured to each gear 45 is a clutch member 54 and fixed to the shaft 44 are clutch members 55, one for cooperation with each clutch member 54. One of the clutch members 55 is provided with a ring 56 secured to a fork 57 keyed on a rod 58 extending longitudinally of the machine. The arm 57 is mounted between the arms of a bracket 59 secured to the part 50 so that when the carriage $g$ is indexed, the arm 57 will move therewith. It will be seen that when the arm 57 is rocked in one direction, one pair of clutch members 54, 55 are engaged to move the table forwardly, and when the arm 57 is swung in the other direction, the other pair of clutch members 54, 55 are engaged

to withdraw the table. In Fig. 4 the clutch members 55 are shown in neutral position.

The reversing clutch mechanism is controlled through the escapement ratchet clutch mechanism *n*. This latter mechanism includes a ratchet wheel 65 fixed to the shaft 36 so that it is constantly driven, a cam 66 loose on the shaft 36, and a spring pressed pawl 67 carried by the cam. Fixed to the rod 58 is an arm 68 having a roller which engages in the groove of the cam 66. Periodic engagement of the pawl 67 with the constantly rotating ratchet wheel 65 is controlled by an escapement yoke 70 having a pair of diametrically opposite stops 71 adapted to be alternately brought into the path of travel of the pawl so that the cam 66 is intermittently rotated through an angle of 180°. The escapement yoke 70 is fixed to so as to move with a longitudinally movable rod 72 slidably supported in suitable bearings. For the purpose of insuring that the shaft 36 will stop in a predetermined position when the pawl 67 is tripped, a spring pressed plunger 73 is provided for engagement with notches in the periphery of a disk 69 to which the pawl is pivoted.

Movement of the escapement yoke 70 is controlled by the reciprocating movement of the table as follows:—The outer end of the rod 72 is connected to a lever 74 pivoted intermediate its ends as at 75. The upper end of the lever 74 carries a pin 76 which engages in a cam groove 77 of a collar 78 splined on a rock shaft 79 and positioned between abutments 80 at the rear of the bed. The rod 79 is journaled in and fixed against longitudinal movement relative to the carriage *g* and at its forward end carries a finger 82 positioned between dogs 83, 84 secured to the side of the table *h*, one of these dogs, 83, being adjustable so as to vary the extent of throw of the table in its reciprocating movement.

When the automatically operated mechanism for reciprocating the table *h* is thrown out, in which case the reversing clutch *m* is in neutral position, the table may be manually moved through the following arrangement: 85 is a shaft (see Fig. 5) extending transversely of the machine at right angles to the shaft 44, and having its forward end squared as at 86 for the reception of a handle. Splined on this shaft and journaled in a bracket 87 depending from the part 50 of the carriage, is a gear 88 meshing with a gear 89 also journaled in the bracket 87 and carrying a bevel gear 89′ meshing with the gear 46.

The means for moving, step by step, the carriage *g* with the table and work thereon will now be described. Fixed on the constantly rotating main shaft 36 is a gear 90 meshing with a smaller gear 91 on a countershaft 92 provided with a worm 93 meshing with a worm wheel 94 loose on a shaft 95. Associated with this worm wheel 94 is the escapement ratchet clutch mechanism *k* which is similar to the mechanism *n* above described. The mechanism *k* has a constantly rotating ratchet wheel 96 fixed to the hub of the worm wheel 94; a disk 97 fixed to the shaft 95 and carrying a spring pressed pawl 98, the automatic engagement of which with the constantly rotating ratchet wheel 96 is controlled by an escapement yoke 99 fixed so as to move with a shiftable rod 100, movement of which is controlled, as hereinafter described, by the reciprocating movement of the work table *h*. On the forward end of the shaft 95 (see Fig. 3) is fixed a driver or cam disk 105 of the Geneva motion device *l*. On the face of the cam disk 105 are a pair of diametrically spaced rollers 106 which are adapted to engage in the radial slots 107 of a driven member or wheel 108 fixed on a stub shaft 109. The slots 107 are four in number so that upon each half revolution of the disk 105 the shaft 109 with the parts thereon will make one-quarter of a revolution. Fixed on the shaft 109 is a large gear 110 meshing with a gear 111 fixed on a shaft 112. Power is transmitted from the shaft 112 through the gears $113^a$, $113^b$, $113^c$, $114^a$, $114^b$, $114^c$, $115^a$, $115^b$, $115^c$, $115^d$, to a lead screw 116 journaled in and extending transversely of the bed and passing through a nut 117 in the part 50 of the carriage *g*. It will be seen with the arrangement so far described when the escapement ratchet clutch yoke 99 is shifted, the cam disk 105 will make a half revolution and drive the wheel 108 and the gear 110 a fourth of a revolution. The gears 110, 111 are in the ratio of one to four so that for each half revolution of the cam disk 105 the shaft 112 is driven one complete revolution. The Geneva motion device provides means for indexing the carriage during the reciprocation of the table with a smooth movement free of jars and vibrations. To insure that the carriage *g* and the parts carried thereby are uniformly and accurately indexed, means are provided for stopping and positioning the shaft 112 in the same angular position each time it is operated. This means includes a lever 125 pivoted as at 126 and having on its free end a pin or roller 127 of such diameter as to have wedging fit in an inwardly tapering notch 128 in a disk 129 fixed to the shaft 112. This disk has but one such notch. The cam disk 105 is provided with a pair of lands 130 diametrically disposed and spaced slightly forward of the respective rollers 106. Upon each half revolution of the disk 105 one of the lands 130 will ride under a roller 131 on the lever 125 thereby lifting the lever and withdrawing the pin 127 from the notch 128 so that the shaft 112 may be driven through the Geneva

motion device. After the disk 129 has started its rotary movement, a land 130 will ride from beneath the roller 131 so that the pin 127 will ride on the periphery of the disk 129, and when this disk has made one complete revolution, the pin 127 will drop back into the notch 128 insuring that the disk 129 together with the shaft 112 and the parts driven therethrough will always stop in the same position which means that the carriage *g* and the work thereon will be moved exactly the same extent each time they are indexed.

As has been previously stated, the gauge block is so positioned on the table that it is indexed at right angles to the length of serrations, that is along the line of normal pitch. The normal pitch is less than the linear pitch of the serrations, the difference depending upon the angle of lead. In order to make the setting up of the machine as simple as possible, to avoid the necessity of making calculations, and so as to eliminate any chance of error, the present machine is provided between the shaft 112 and the lead screw 116 with two sets of interchangeable gears; one set (comprising the gears 113ª, b, etc.) being arranged to take care of the linear pitch and the other set (comprising the gears 115ª, b, etc.) which is in series with the first set, being arranged to compensate for the difference between the linear pitch and the normal pitch. In actual practice, a plurality of interchangeable gears for each set or train will be provided, and these gears will bear suitable indicia or numbers to indicate in what combinations they should be used to effect the desired indexing movement of the work. The gears 113ª, b, etc. and 115ª, b, etc. are positioned at the front of the base and enclosed in a swinging cover 135 hinged as at 136 so these gears may be readily changed. The two sets of gears 113ª, b, etc. and 115ª, b, etc. are connected by the gears 114ª, b, etc. which may be interchangeable if desired.

The escapement ratchet clutch mechanism *k* of the means for moving the carriage step by step, as just described, is controlled by the reciprocating movement of the table *h* through the following mechanism: On the outer end of the longitudinally movable rod 100 carrying the escapement yoke 99, is a collar 150 with which cooperates one arm of a bell crank 151, the other arm of this bell crank being connected by a link 152 to an arm 153 fixed to a stud 154 journaled in a bearing 155 provided in a bracket 156 secured to the front of the base. Fixed to the stud 154 is a second arm 157 carrying in its free end a follower pin 158 which engages in a cam groove 159 of a cam plate 160 fixed to a shaft 161 journaled against longitudinal movement in the bracket 156. In the present instance the cam groove 159 is in the form of a multi-pointed star, each point, designated by the numeral 159′, being of like configuration and having its opposite sides or portions of like length and inclination relative to the radii of the cam plate 160. The shaft 161 extends along the side edge of the carriage *g* and is supported by a bracket 162 fixed to the carriage *g* and having sliding relation to the shaft 161. Supported in the bracket 162 so as to move with the carriage *g*, and keyed to the shaft 161, is a ratchet wheel 163 with which cooperates a pawl 164 pivoted to an arm 165 journaled on the shaft 161. The number of teeth on this ratchet wheel corresponds to the number of rises and falls of the cam groove 159. The arm 165 is normally held in raised position by a spring pressed plunger 168 so that an inclined surface 166 on this arm normally lies in the path of a dog 167 secured to the table *h*. The pawl 164 is held in engagement with the ratchet 163 by a spring pressed plunger 169 carried by the arm 165. It will be seen that each time the table *h* reaches the end of its return stroke, the dog 167 will depress the arm 165 and through the ratchet rotate the shaft 161 and the cam wheel 169 thereon a distance equal to one half of a star point 159′, whereupon the yoke 99 is shifted permitting the shaft 95 to make a half revolution. It will be seen that by manually depressing the arm 165 the correct number of times the carriage may be indexed to any desired position although the table is not being reciprocated.

For the purpose of permitting of manual movement of the carriage, either while the table is at rest or in motion, means is provided (see Fig. 5ª) for disconnecting the Geneva motion device from the train of gears between this device and the lead screw 116 for the carriage *g*. In the present instance the gear 113ª is fixed to the shaft 112, the outer end of which is squared as at 112′ for the reception of a handle. The gear 111 which meshes with the large gear 110 of the Geneva motion device is fixed to a sleeve 171 loose on the shaft 112. This sleeve carries the disk 129 having a flange provided with a single notch or recess 172 in which is adapted to engage a finger 173 pivoted intermediate its ends to a plate 174 fixed to the shaft 112. The finger is normally urged into the notch 172 by a spring pressed plunger 175. The finger 173 is swung out of the notch 172 by manually pulling out a rod 176 connected to a lever 177 pivoted as at 178 and carrying a projection 179 abutting against the tail end of the finger 173 and opposed to the spring pressed plunger 175. It will be seen that when the finger 173 is thus disengaged from the notch in the disk 129 the shaft 112 is disengaged from the Geneva motion device and may be manually

turned to bring the carriage to any desired position. It will also be noted that, since the disk 129 has a single recess in which the finger 173 is adapted to closely fit, the rotatable member or disk 129 and the driven member or plate 174 are always connected in the same relation.

For the purpose of automatically stopping the machine when the operation upon the work is completed, that is, after all serrations on the gauge block operated upon have been successively ground, the following arrangement is provided: Journaled in suitable brackets 180 on the right hand end of the base (referring to Figs. 2, 4, and 6, for instance) is a shaft 181 carrying an adjustable collar 182 provided with a radially extending finger 183 with which a dog 184 adjustably secured to the right hand end of the table $g$ is adapted to cooperate when the grinding operation on the work is completed. Rocking movement of the shaft 181 is transmitted by an arm 186 fixed thereto and a link 187 to a lever 188, the free end 189 of which when lowered into the path of movement of the pawl 67 of the ratchet clutch mechanism $m$ is adapted to trip the same. When the pawl is thus tripped the ratchet clutch mechanism stops in such position that the reversing mechanism $m$ is in neutral position. For the purpose of holding the lever 188 in engagement with the pawl 67 the shaft 181 carries a disk 192 provided with an eccentrically disposed bore 193, in which is mounted a spring pressed plunger 195 adapted to engage in a bore 194 in the bracket 180 when the shaft 181 is rocked by the engagement of the dog 184 with the finger of the collar 182. When it is desired to throw the machine into operation the plunger 195 is withdrawn from the bore 194 by pulling out on a knob 196 secured to the plunger 195, whereupon the spring pressed plunger 190 will raise the lever 189 out of engagement with the pawl 67. Furthermore, the power may be thrown off the machine at any time during the operation upon the work by rotating the shaft 181 as by means of a handle 197 secured to the disk 192. Also, the reversing clutch $m$ may be thrown into neutral position by means of a handle 198 secured to the shaft 58 which carries the clutch fork 57.

In setting up the machine, a piece of work is positioned upon the chuck $i$ with the serrations of the chuck parallel to the edge of the grinding wheel and the line of reciprocation of the table $h$. To this end, a work positioning device such as shown in Fig. 8 may be provided. This device is in the form of a pivoted member 200 having a straight edge 201 against which the edge of the work is adapted to engage and a scale mark 202 cooperating with a scale 203 on the top of the chuck. For the convenience of the operator of the machine a table of calculations (not shown) may be provided to indicate what the setting of the work positioning device 200 should be for gauge blocks having serrations of different pitches and leads. Also, in setting up the machine the operator, for the reasons heretofore stated, will select and insert such interchangeable gears of the set of gears $113^a$, $113^b$, $113^c$ as would index the carriage $g$ in accordance with the linear pitch of the serrations of the work. The operator will then select for the set of gears $115^a$, $115^b$, $115^c$, those gears which will compensate for the difference between the linear pitch and the normal pitch of the serrations. The two sets of interchangeable gears will then be thrown into engagement with the intermediate set $114^a$, $114^b$, $114^c$, so that in effect these three trains of gears are a single train leading from the Geneva motion device to the lead screw 116 for the carriage. The difference between the normal pitch and the linear pitch of the serrations, and which difference the set of gears $115^a$, $115^b$, $115^c$, compensates for, is indicated as at 205 of Fig. 8. The operator will now properly set the dogs on the table and carriage, and in doing this may manually move the carriage and table by turning the shafts 112 and 86, respectively.

In operation, the table will advance on its forward stroke moving the first serration of the gauge block into engagement with the grinding wheel, and at the end of the forward stroke of the table the dog 83 will engage the finger or trip 82, and through the rod 79 and lever 74 the escapement yoke 70 will be shifted whereupon the cam 66 is rotated through an angle of 180°, the result being that one set of clutch members 54, 55 of the reversing clutch mechanism will be engaged and the other set will be disengaged, thus changing the direction of movement of the table. The table, on its return movement, and while the tool is in engagement with the work, will move in the same line as on its forward movement. After the work has cleared the tool, the dog 167 will engage the arm 165 causing the cam plate 160 to rotate through a distance equal to one side of a star point thereof, and through the connections described, shift the yoke 99 of the escapement clutch mechanism through which the carriage $g$ is indexed. When this yoke is shifted the cam disk 105 will make a half revolution and through the Geneva motion device and the train of gears which this device drives, rotate the lead screw through an angle which will index the carriage so as to bring the second serration of the gauge block into alinement with the grinding wheel. At about the same time the dog 167 engages the arm 165 of the mechanism for con-

trolling the indexing means for the carriage, the dog 84 will engage the finger 82 whereupon the escapement clutch mechanism *n* is again actuated to reverse the direction of movement of the table. It will be seen that the indexing movement of the carriage takes place during the time that the table is completing its return stroke and starting on its forward stroke, this indexing movement being brought about in a smooth and easy manner and with a saving of time. The table is advanced, returned, indexed, and so on, until the table has been advanced and returned with the last serration in alinement with the grinding wheel, and while the table is finishing its last return movement the carriage is taking an indexing movement, and at this time the dog 184 engages the finger 183 of the mechanism for automatically stopping the machine and which mechanism includes, as stated, the lever 188.

The truing device *e* and the manner in which it operates will now be described. As previously stated, this truing device is so arranged that it may be employed for sharpening or resurfacing the grinding wheel without disturbing the relation of the wheel to the work. Referring to Figs. 1 and 2, where the truing device is most clearly shown, 215 designates a bracket mounted for vertical adjustment on the standard *b* and having a segmental plate 216 to which is pivoted, by means of a pivot pin 217, a carriage 218. The axis of the carriage, namely the pin 217, is at right angles to the axis of the grinding wheel and lies in a plane including the edge of the grinding wheel. 219 is a vertical shaft journaled in the carriage 218 and with its axis at right angles to that of the pivot pin 217 about which the carriage turns. Mounted in the arm 220 of the shaft 219 is a sharpening tool 222, shown as a diamond point which is well adapted for resurfacing the grinding wheel. For the purpose of properly adjusting the diamond point, a gauge 223 may be provided, this gauge, in the present instance, being in the form of a yoke pivoted to the arm 220 so that it may be thrown up out of the position shown when the grinding wheel is to be resurfaced. For the purpose of indexing the diamond point to the proper position relative to any one of the faces of the grinding wheel, the segmental plate 216 is notched as at 225 to receive a spring pressed plunger 226 mounted on the carriage. The position of the notches 225 will, of course, vary in accordance with the angle of the thread to be cut. It will be noted that the grinding wheel, when it is adapted to resurface the same, is moved in the plane in which it rotates and the truing device, though adjustable, is for practical purposes fixed to the bed of the machine and, therefore, has a predetermined relation to the work carried by the table. Since the grinding wheel is movable only in one direction to and from the truing device, the alinement of the truing device and the wheel is never changed, thus the wheel may be resurfaced as many times as may be necessary and it is always certain that when it is brought back into contact with the work its shape and relationship thereto is unchanged from the original setting.

I claim as my invention:—

1. In a machine of the character described, a tool, an indexible carriage, a slide mounted for reciprocation thereon at an angle to the direction in which said carriage is indexed, means for indexing said carriage and slide, and means for reciprocating said slide, both of said means being controlled by the movement of said slide.

2. In a machine of the character described, a tool, a bed, a carriage adapted to be indexed thereon to bring successive portions of the work into alinement with the tool, a table on said carriage and reciprocal at right angles to the direction of movement thereof, means for reciprocating said table, means for indexing said carriage with the table thereon, means on said table controlling said reciprocating means and other means on said table controlling said indexing means.

3. In a machine of the character described, a rotary grinding wheel having its edge shaped correspondingly to a screw thread, a carriage adapted to be moved step by step to bring successive portions of the work into alinement with the grinding wheel, a table mounted on said carriage for reciprocating movement at right angles to the direction in which said carriage is indexed, means for reciprocating said table, and means for indexing said carriage with the table thereon.

4. In a machine of the character described, a tool, a work support including a pair of slides one mounted upon the other, means for reciprocating one of said slides, means for indexing the other of said slides at an angle to the direction in which the first slide is reciprocated, and dogs on said reciprocating slide for controlling both of said means, one at least of said dogs being adjustable.

5. In a machine of the character described, a tool, a work support, means for reciprocating said support including a power operated clutch controlling the direction of travel of said support, means for indexing said support at an angle to its reciprocating movement and including an intermittently actuated power operated clutch, and means movable in unison with said support for controlling both of said clutches.

6. In a machine of the character described,

a tool, a support, means for reciprocating said support including an escapement ratchet clutch mechanism, means for indexing said support at an angle to its reciprocating movement and including an escapement ratchet clutch mechanism, and automatically operated means controlling both of said mechanisms.

7. In a machine of the character described, a tool, a work support including a pair of slides one mounted upon the other, means for reciprocating one of said slides including a power operated clutch, means for indexing the other of said slides at an angle to the direction in which the first slide is reciprocated and including an automatically operated clutch, and means movable in unison with the first mentioned slide for controlling said clutches.

8. In a machine of the character described, a tool, an indexible carriage, a slide mounted for reciprocation thereon at an angle to the direction in which said carriage is indexed, means for moving said slide including an escapement ratchet clutch mechanism controlling the direction of travel thereof, means for indexing said carriage and including an intermittently actuated escapement ratchet clutch mechanism, a pair of dogs on said table controlling the first mentioned clutch, and a dog on said table controlling the second mentioned clutch, one, at least, of said dogs being adjustable.

9. In a machine of the character described, a grinding wheel, a carriage indexible axially thereof, a table mounted on said carriage for reciprocation at right angles to the direction in which said carriage is indexed, automatically operated means for indexing said carriage, and automatically operated means for reciprocating said table.

10. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation on said carriage, means for reciprocating said table including a clutch controlling the direction of movement thereof and an escapement ratchet clutch controlling said first mentioned clutch, and means for indexing said carriage and including a Geneva motion device and an escapement ratchet clutch mechanism controlling the same.

11. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation on said carriage, means for reciprocating said table including a clutch controlling the direction of movement thereof and an escapement ratchet clutch controlling said first mentioned clutch, and means for indexing said carriage and including a Geneva motion device and an escapement ratchet clutch mechanism controlling the same, both of said escapement ratchet clutches being controlled by the movement of said table.

12. In a machine of the character described, a tool, a work support, means for reciprocating said support, and means for indexing said support during the latter part of its reciprocating movement in one direction and the first part of its movement in the other direction.

13. In a machine of the character described, a tool, a work support, means for reciprocating said support, and means for indexing said support each time the support is completing one reciprocating cycle and starting on the next cycle.

14. In a machine of the character described, a tool, a work support, means for reciprocating said support, means for indexing said support including a Geneva motion device and a power operated clutch controlling said device, and means movable in unison with said support for intermittently actuating said clutch as said support approaches the end of its return stroke.

15. In a machine of the character described, a tool, a work support, means for reciprocating said support and controlled by the movement thereof, and means for indexing said support including a Geneva motion device, and an escapement ratchet clutch mechanism controlling said device and in turn controlled by the reciprocating movement of said support.

16. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table on said carriage, and means for indexing said carriage while said table is completing one stroke and starting on the next one.

17. In a machine of the character described, a tool, an indexible carriage, a reciprocating table thereon, and means for indexing said carriage with the table thereon including a Geneva motion device, an escapement ratchet clutch mechanism controlling said device, and a dog on said table controlling said clutch.

18. In a machine of the character described, a tool, a work support, means for reciprocating said support, means for indexing said support equal distances and including an intermittently actuated mechanical train positively connected to said support, and means for positioning said train in like position each time it is actuated.

19. In a machine of the character described, a tool, a work support, means for indexing said support equal distances and including a rotatable member adapted to rotate one complete revolution each time said indexing means is actuated, and means cooperating with the same portion of said member each time it is actuated for positively positioning the same in the same angular position.

20. In a machine of the character described, a tool, a work support, means for indexing the same equal distances and including a mechanical train positively connected to said support, a rotatable member connected to said train and adapted to be rotated one complete revolution each time said train is actuated and having a recess, and means adapted to engage in said recess to position said member in the same angular position each time it is actuated.

21. In a machine of the character described, a tool, a work support, means for indexing the same including a mechanical train positively connected to said work support and mechanism for intermittently driving said train, a rotatable member positively connected to said train and rotated one complete revolution each time said train is actuated, a tapering notch in the periphery of said member, and a pin adapted to wedgedly engage in said notch to position said member in the same position each time it is actuated.

22. In a machine of the character described, a tool, a work support, means for indexing said support equal distances including an intermittently rotary cam and a mechanical train positively connected to said support, a rotatable member positively connected to said train and adapted to rotate one complete revolution each time the train is driven, and means associated with said last mentioned member and controlled by said cam for positioning said member in the same angular position each time said work support is indexed.

23. In a machine of the character described, a tool, a work support, means for indexing said support including a mechanical train positively connected to said support and a Geneva motion device through which said train is driven and including an intermittently actuated driver and a driven member, a cam adapted to rotate in unison with said driver, a member positively connected to said train and adapted to rotate one complete revolution each time the train is driven, and means controlled by said cam and cooperating with said member for positioning the same in the same angular position each time said train is operated.

24. In a machine of the character described, a tool, a work support; means for indexing said support including a mechanical train positively connected to said support, and a Geneva motion device through which said train is driven and including a driver and a driven member; a rotatable member positively connected to said train and adapted to rotate one complete revolution each time the same is driven, said rotatable member having a notch in its periphery, a pin adapted to automatically fit in said notch each time said member is brought to the same position, and a cam associated with said driver for lifting said pin out of said notch to permit said train to be driven.

25. In a machine of the character described, a tool, a work support, and means for indexing the same including a Geneva motion device having a driver provided with a pair of diametrically spaced pins and a driven member having four radial slots in which said pins are adapted to engage, a shaft connected to said driven member in the ratio of one to four, means for intermittently rotating said driver 180°, and a mechanical train between said shaft and support.

26. In a machine of the character described, a tool, a work support, means for indexing the same including a Geneva motion device having a driver provided with a cam surface and with a pair of diametrically spaced pins and a driven member having four radial slots in which said pins are adapted to engage, a shaft connected to said driven member in the ratio of one to four, means for intermittently rotating said driver 180°, a mechanical train between said shaft and support, a disk fixed to said shaft and having a single tapering notch in its periphery, and a lever cooperating with said cam surface and having a pin adapted to engage in said notch.

27. In a machine of the character described, a tool, a work holder, and means for indexing the latter including interchangeable driving members adapted to be arranged to step said holder a distance in accordance with given measurements of the work, and other interchangeable driving members in series with the first ones and arranged to modify the action thereof.

28. In a machine of the character described, a tool, a work holder, and means for indexing the latter including two sets of interchangeable gears arranged in series, one set being arranged to step said holder in accordance with given measurements of the work and the other set being adapted to be arranged to modify the action of the first set.

29. In a machine of the character described, a tool, a work support adapted to receive serrated members to be operated upon having serrations corresponding to screws of given pitches and diameters, means for reciprocating said support lengthwise of said serrations, and means for indexing said support at right angles to the serrations, said indexing means including two sets of interchangeable driving members arranged in series, one set of members being arranged to step said support in accordance with the linear pitch of the serrations, and the other set being arranged to modify the action of

the first set whereby said support is stepped in accordance with the normal pitch of the serrations.

30. In a machine of the character described, a tool, a work support adapted to receive serrated members having serrations corresponding to screws of given pitches and diameters, means for reciprocating said support lengthwise of said serrations, and means for indexing said support at right angles to the serrations, said indexing means including two sets of interchangeable gears in series, one set being arranged in accordance with the linear pitch of the serrations and the other set being arranged to compensate for the difference between the linear pitch and the normal pitch of the serrations.

31. In a machine of the character described, a tool, a work support adapted to receive serrated members to be operated upon having serrations corresponding to screws of given pitches and diameters, means for reciprocating said support lengthwise of said serrations, and means for indexing said support at right angles to the serrations and including an intermittently driven member, a lead screw connected to said support, and a mechanical train between said member and said support and including one set of interchangeable gears arranged to step said support in accordance with the linear pitch of the serrations, a second set of interchangeable gears arranged to modify the action of the first set whereby the support is stepped in accordance with the normal pitch of the serrations, and a third set of gears connecting the other two sets in series.

32. In a machine of the character described, a rotary grinding wheel, a carriage indexible axially thereof, a table mounted on said carriage for reciprocation at right angles to the direction in which said carriage is indexed, means for reciprocating said table, and means for indexing said carriage including interchangeable driving members adapted to be arranged to step said carriage a distance in accordance with given measurements of the work and other interchangeable driving members in series with the first ones and arranged to modify the action thereof.

33. In a machine of the character described, a tool, a work support, means for reciprocating said work support, means for indexing said support to successively bring different portions of the work into cooperative relation to the tool, both of said means being controlled by the reciprocating movement of said support, and means controlled by the indexing movement of said support for automatically stopping said reciprocating means.

34. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, means for indexing said carriage with the table thereon, both of said means being controlled by the movement of said table, and means controlled by the movement of said carriage for automatically stopping the machine when the work is completed.

35. In a machine of the character described, a tool, a bed, a carriage mounted for index movement thereon to bring successive portions of the work into alinement with the tool, a table on said carriage and reciprocal at right angles to the direction of movement thereof, means for indexing said carriage, means for reciprocating said table including an automatically controlled escapement ratchet clutch mechanism, and means controlled by the index movement of said carriage for throwing said clutch into neutral position and thus stop the reciprocating movement of the table at a predetermined point.

36. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon at an angle to the direction in which said carriage is indexed, means for indexing said carriage, means for reciprocating said table including a power operated clutch controlling the direction of movement thereof and an escapement ratchet clutch mechanism controlling said power operated clutch, both of said means controlled by the reciprocating movement of said table, and means controlled by the indexing movement of said carriage for automatically disengaging said ratchet clutch mechanism in a position where said power operated clutch is inoperative, thus stopping the movement of said table.

37. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for indexing said carriage, means for reciprocating said table including a clutch, and means controlled by the indexing movement of the carriage for disconnecting said clutch to stop the reciprocating movement of the table when the carriage has been indexed to a predetermind position, said last mentioned means including a member adapted to cooperate with said clutch to throw the same into neutral position, a rock shaft, a connection between said rock shaft and member, a trip on said carriage adapted to rock said shaft and through said connection move said member into operative position, and normally active means for holding said rock shaft in rocked position.

38. In a machine of the character described, a tool, an indexible carriage, a reciprocating table thereon, means for reciprocating said table including a clutch, means for indexing said carriage, both of said means being controlled by the movement of said table, and means for automatically stopping the machine including a member adapt-

ed to cooperate with said clutch to throw the same in neutral position, means for normally holding said member in inoperative position, a rock shaft, a connection between said rock shaft and member, an adjustable trip on said carriage adapted to rock said shaft when said carriage is indexed to a predetermined position, and a spring pressed plunger for holding said shaft in the position into which it is rocked by said trip.

39. In a machine of the character described, a tool, a work holder, means for intermittently moving the same including a clutch, a shaft, a cam member fixed thereto and having alternate rises and falls of like length, an operative connection between said cam and clutch, a ratchet wheel fixed to said shaft and having teeth corresponding in number to the aggregate rises and falls of said cam, a pivoted arm, a pawl on said arm cooperating with said ratchet wheel, and a dog on said work holder adapted to move said arm the angular distance of one tooth.

40. In a machine of the character described, a tool, an indexible carriage, a table, a trip thereon, means for reciprocating said table, means for moving said carriage step by step and including a clutch, a cam having a plurality of successive rise and fall portions, a connection between said cam and clutch, and means actuated by said trip each time said table reaches the end of one of its strokes for moving said cam a distance of one of said portions.

41. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, a trip on said table, means for reciprocating said table, means for moving said carriage step by step and including a clutch having a part adapted to be shifted in one direction and then in the other direction, a rotary cam having a groove in the form of a multi-point star, a follower in said groove, a connection between said follower and part, and means actuated by said trip each time said table reaches the end of one of its strokes for rotating said cam a distance of one-half of a star point.

42. In a machine of the character described, a tool, an indexible carriage, a reciprocal table thereon, a trip on said table, means for reciprocating said table, means for moving said carriage step by step and including a clutch, a cam operatively connected to said clutch and having a plurality of successive rise and fall portions of like lengths, and a device operatively connected to said cam and actuated by said trip each time said table reaches the end of one of its strokes, said device each time it is actuated being adapted to rotate said cam the distance of one of said portions.

43. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, means for moving said table step by step and including a clutch, a cam having a plurality of successive rise and fall portions, a connection between said cam and clutch, a ratchet wheel connected to so as to rotate in unison with said cam, a pivoted arm, a pawl thereon cooperating with said ratchet wheel, and a trip on said table adapted to periodically engage said arm.

44. In a machine of the character described, a tool, a bed, an indexible carriage on said bed, a table mounted for reciprocation on said carriage, means for reciprocating said table, means for moving said table step by step and including a clutch having a part adapted to be shifted in one direction and then in the other direction, a shaft journaled in said bed, a cam on said shaft having a groove in the form of a multi-point star, a connection between said groove and part, a ratchet wheel keyed on said shaft and indexible with said carriage and having twice as many teeth as points on said cam, an arm loose on said shaft, a pawl thereon cooperating with said ratchet wheel, and a trip on said table adapted to engage said arm to move said ratchet wheel a distance of one tooth each time the table reaches the end of one of its strokes.

45. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, and means for indexing said carriage step by step, both of said means being controlled by the movement of said table, said indexing means being manually operable while said table is at rest on said carriage.

46. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table controlled by the movement thereof, means for indexing said table, controlling means therefor including a member having a limited rocking movement, and a trip on said table adapted to engage said member and rock the same each time the table approaches the end of one of its strokes, said member being adapted to be manually rocked to actuate said indexing means while the table is at rest on said carriage.

47. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, means for moving said carriage step by step and including a clutch, a cam having a plurality of successive rise and fall portions, a connection between said cam and clutch, a trip on said table, and means actuated by said trip each time said table reaches the end of

one of its strokes for moving said cam a distance of one of said portions, said last mentioned means being manually operable to actuate said clutch.

48. In a machine of the character described, a tool, a work holder, means for intermittently moving the same including a clutch, a shaft, a cam member fixed thereto and having alternate rises and falls of like length, an operative connection between said cam and clutch, a ratchet wheel fixed to said shaft and having teeth corresponding in number to the aggregate rises and falls of said cam, a pivoted arm, a pawl on said arm cooperating with said ratchet wheel, and a dog on said work holder adapted to move said arm the angular distance of one tooth, said arm being manually operable to actuate said clutch when the table is at rest relative to said carriage.

49. In a machine of the character described, a tool, an indexible carriage, a reciprocating table thereon, means for reciprocating said table, and automatic means for indexing said carriage including a periodically rotatable member, a member driven therethrough, means for detachably connecting said members always in the same relation, and means for manually traversing said carriage when said members are disconnected.

50. In a machine of the character described, a tool, an indexible carriage, a reciprocating table thereon, means for reciprocating said table, means for indexing said carriage including a periodically rotatable member, a member driven therethrough and having a single recess, a part carried by said rotatable member and adapted to engage in said recess, means for disengaging said part from said recess, and means for manually traversing said carriage when said member is disconnected.

51. In a machine of the character described, a tool, a work support, means for indexing said support equal distances and including an intermittently rotatable member adapted to rotate one complete revolution each time said indexing mechanism is actuated, means cooperating with said member for positively positioning the same in the same angular position, a member driven by said rotatable member, means for detachably connecting said members always in the same relation, and means for manually traversing said carriage when said members are disconnected.

52. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, means for indexing said carriage including an automatically operated clutch, mechanism interposed between said clutch and carriage for throwing said carriage out of the control of said clutch, and means for manually traversing said carriage when said mechanism is disengaged.

53. In a machine of the character described, a tool, an indexible carriage, a table mounted for reciprocation thereon, means for reciprocating said table, means for indexing said carriage including a periodically actuated clutch controlled by the movement of said table, a Geneva motion device having a driven member, a mechanical train between said device and carriage, means for detachably connecting said train to said driven member, and means for manually traversing said carriage when said train is disconnected from said driven member.

54. In a machine of the character described, a tool, an indexible carriage, a reciprocating tool thereon, means for indexing said carriage including an escapement clutch controlled by the movement of said table, means for reciprocating said table including a reversing clutch and an escapement clutch controlling said reversing clutch and in turn controlled by the movement of said table, means for throwing said reversing clutch into neutral position, and means for manually reciprocating said table when said reversing clutch is in neutral position.

55. In a machine of the character described, a tool, a bed, an indexible carriage thereon having a part depending into said bed, a table mounted for reciprocation on said carriage, a reversing clutch mechanism carried by said part, a driving connection between said clutch and table, means for driving said clutch mechanism, and a lead screw connected to said part for traversing said carriage.

56. In a machine of the character described, a tool, a bed, an indexible carriage thereon having a part depending into said bed, a table mounted for reciprocation on said carriage, a pair of opposed gears journaled in said part, a driving connection between said gears and table, a longitudinally shiftable shaft journaled in said gears, means for driving said shaft, clutch members between each gear and shaft, and means for shifting said shaft to engage one pair of clutch members and disengage the other.

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