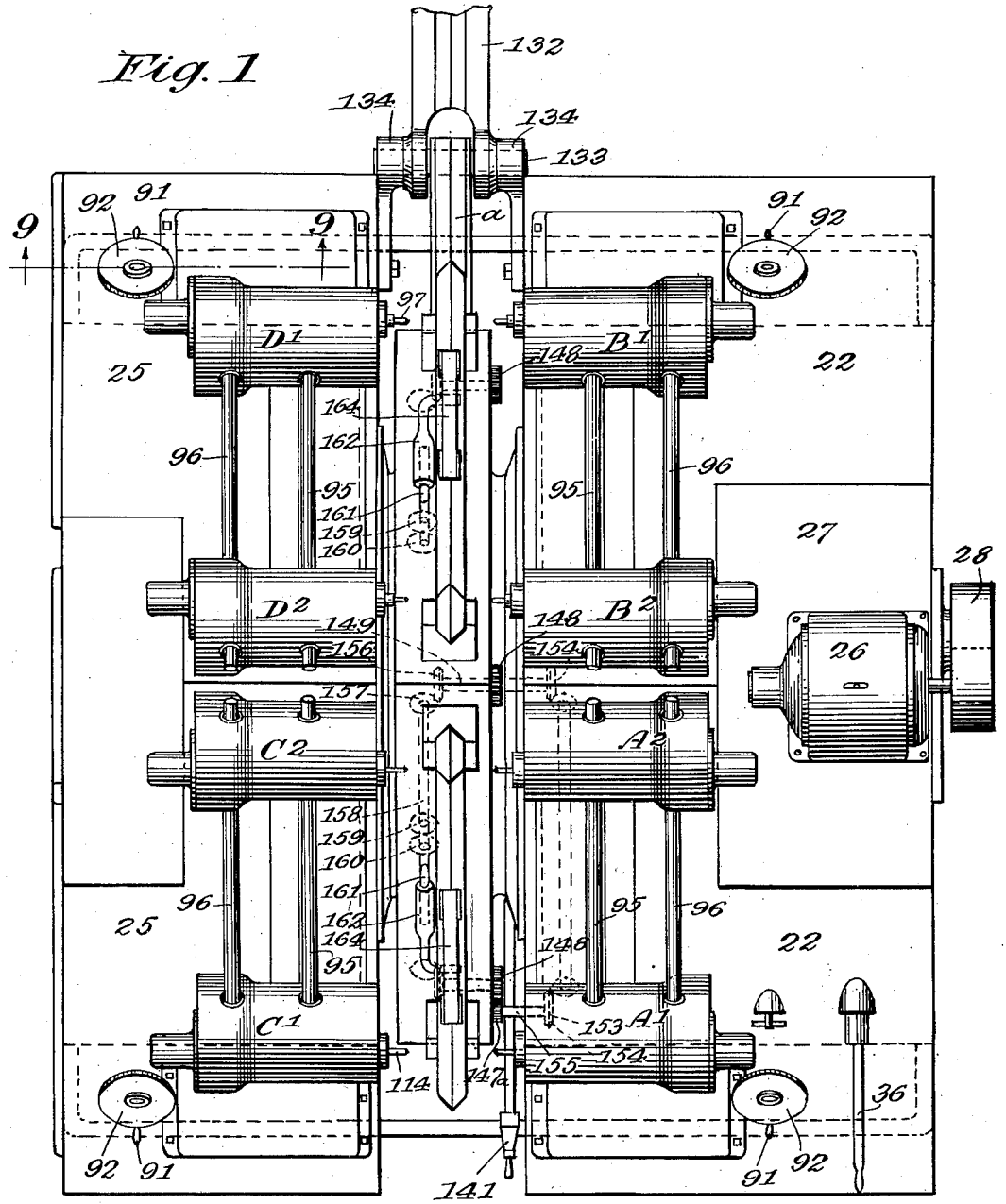
Dec. 23, 1930. E. P. BULLARD, JR 1,786,148

STATION TYPE DRILLING AND TAPPING MACHINE

Filed Dec. 22, 1928 10 Sheets-Sheet 1

Fig. 1



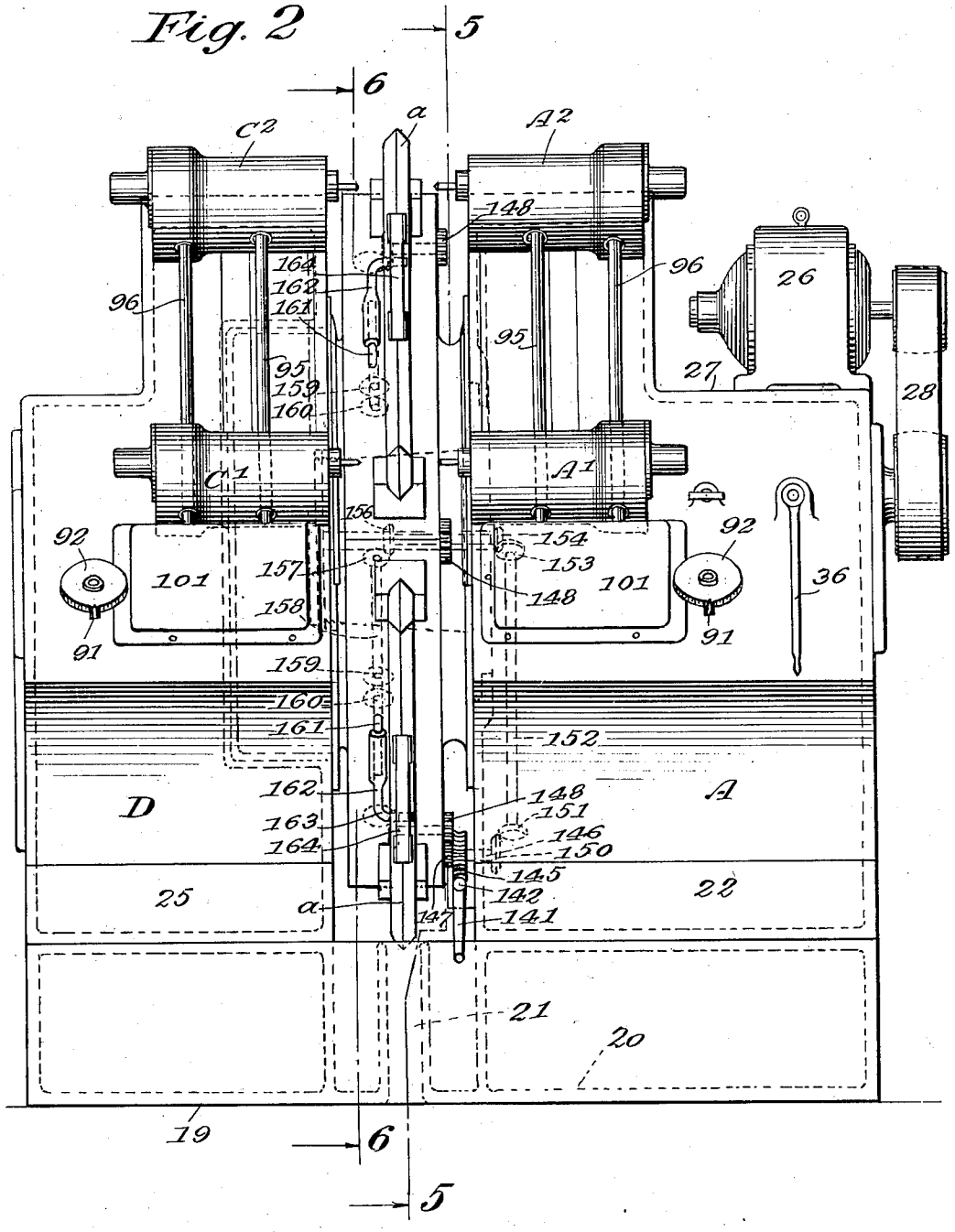
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STATION TYPE DRILLING AND TAPPING MACHINE

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Fig. 2



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STATION TYPE DRILLING AND TAPPING MACHINE

Filed Dec. 22, 1928 10 Sheets-Sheet 3

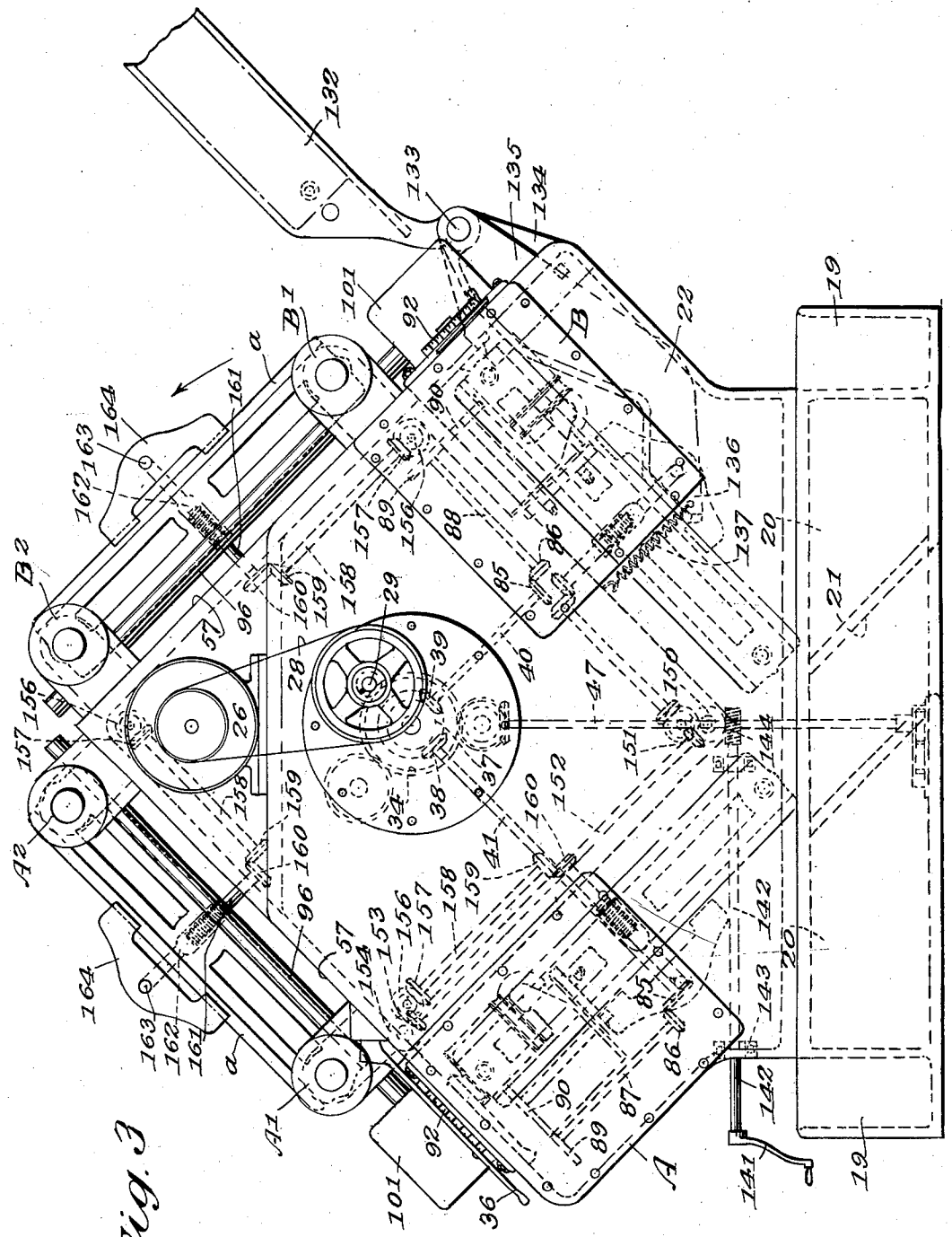


Fig. 3

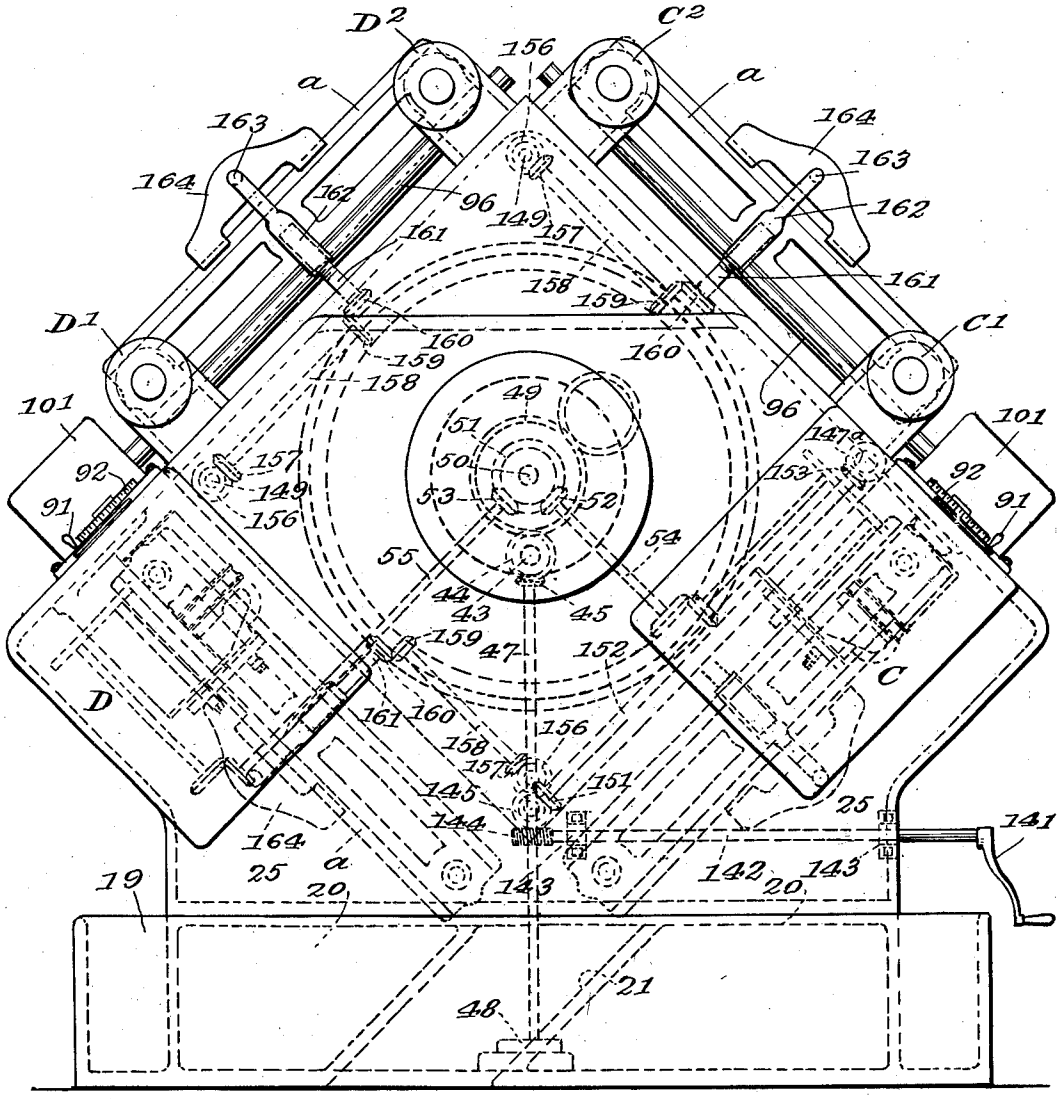
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STATION TYPE DRILLING AND TAPPING MACHINE

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Fig. 4



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STATION TYPE DRILLING AND TAPPING MACHINE

Filed Dec. 22, 1928 10 Sheets-Sheet 5

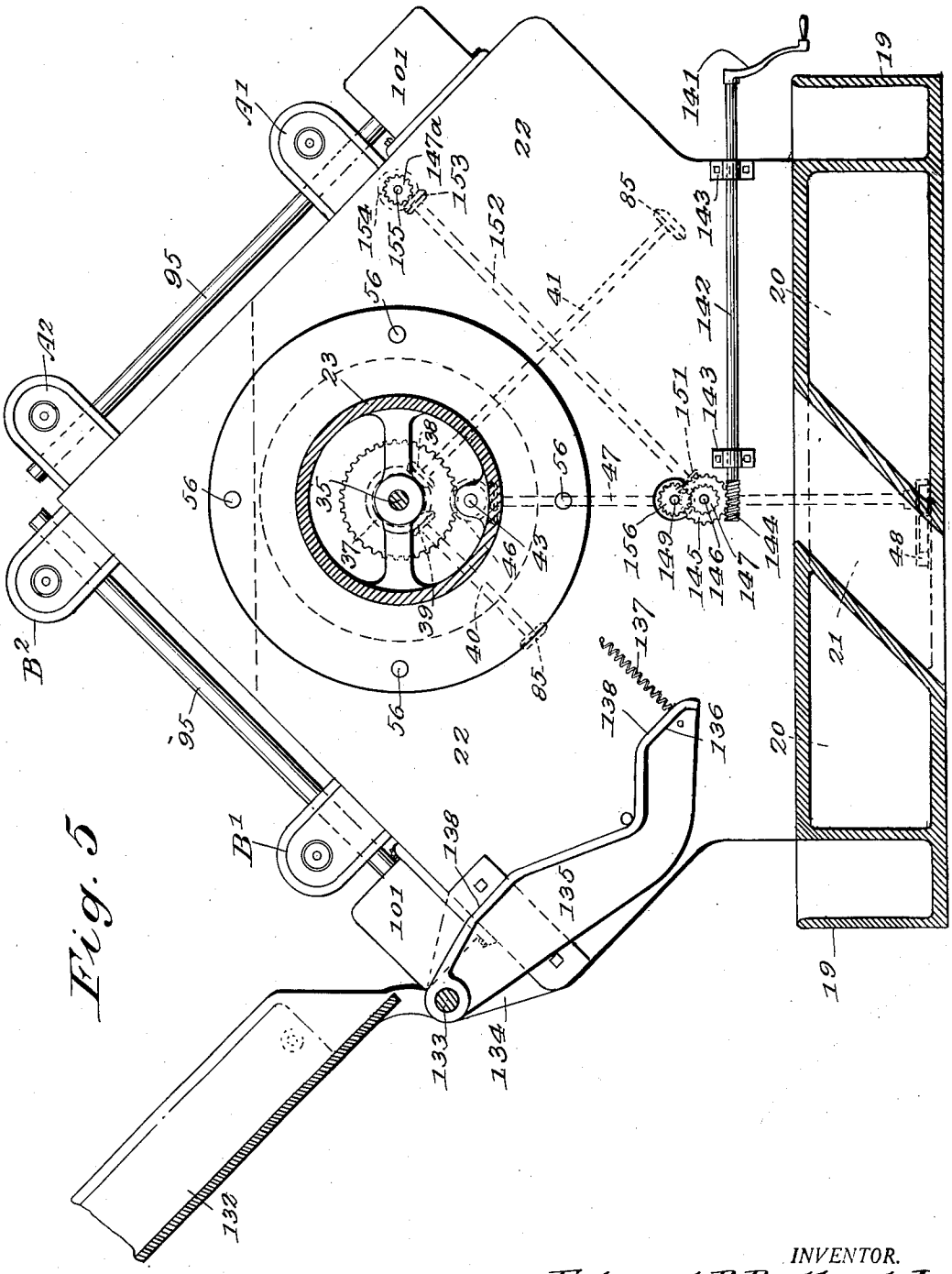


Fig. 5

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STATION TYPE DRILLING AND TAPPING MACHINE

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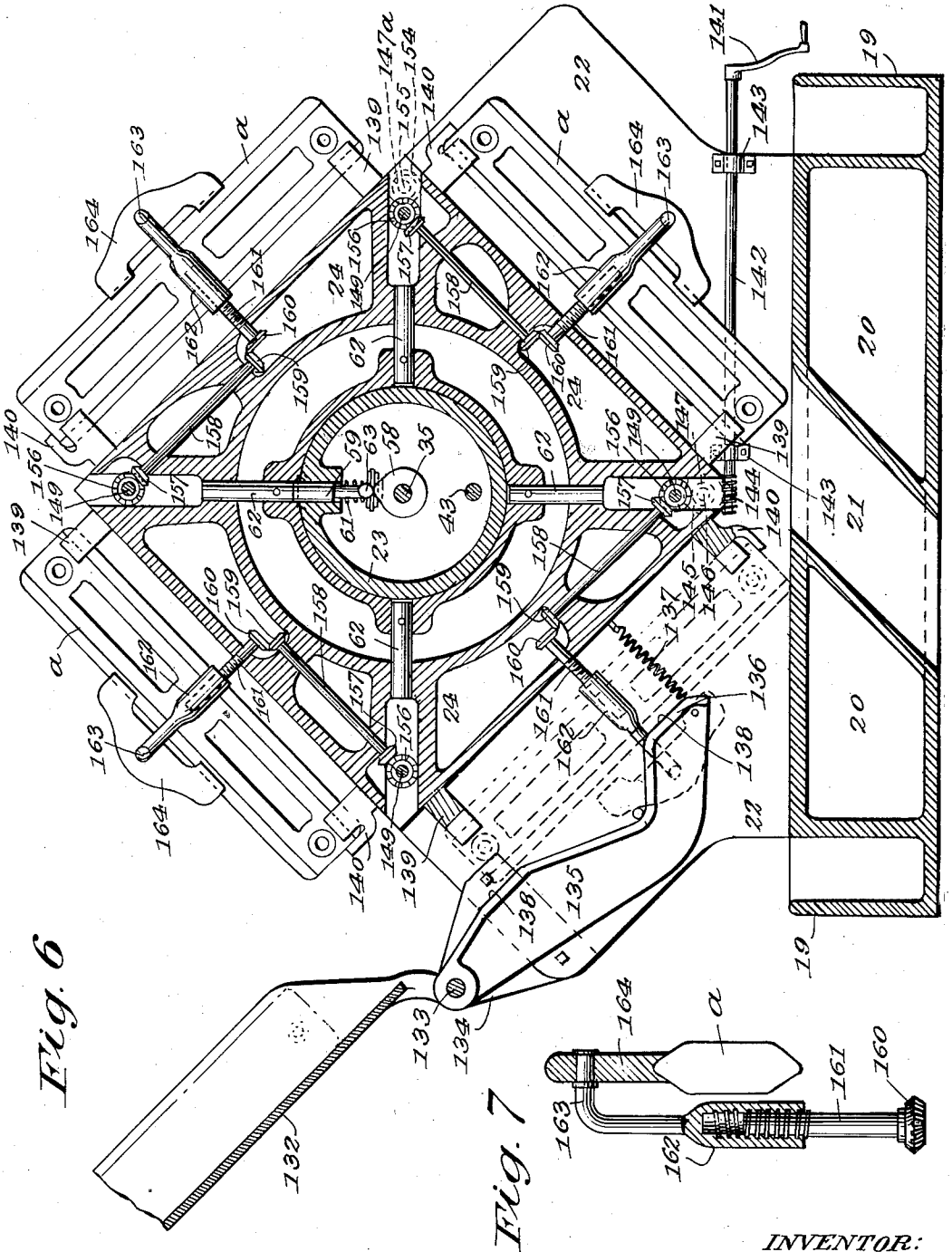


Fig. 6

Fig. 7

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STATION TYPE DRILLING AND TAPPING MACHINE

Filed Dec. 22, 1928 10 Sheets-Sheet 7

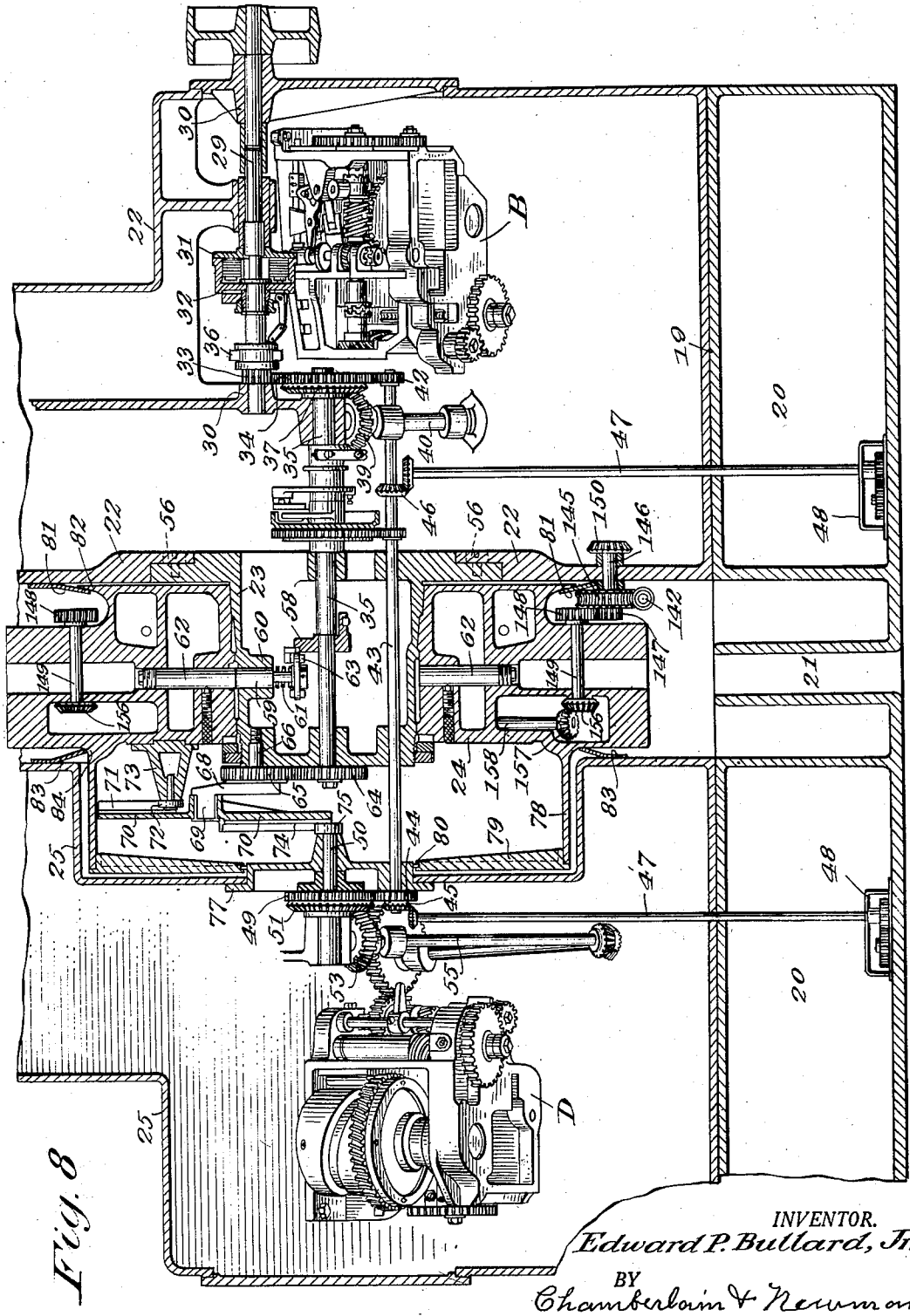


Fig. 8

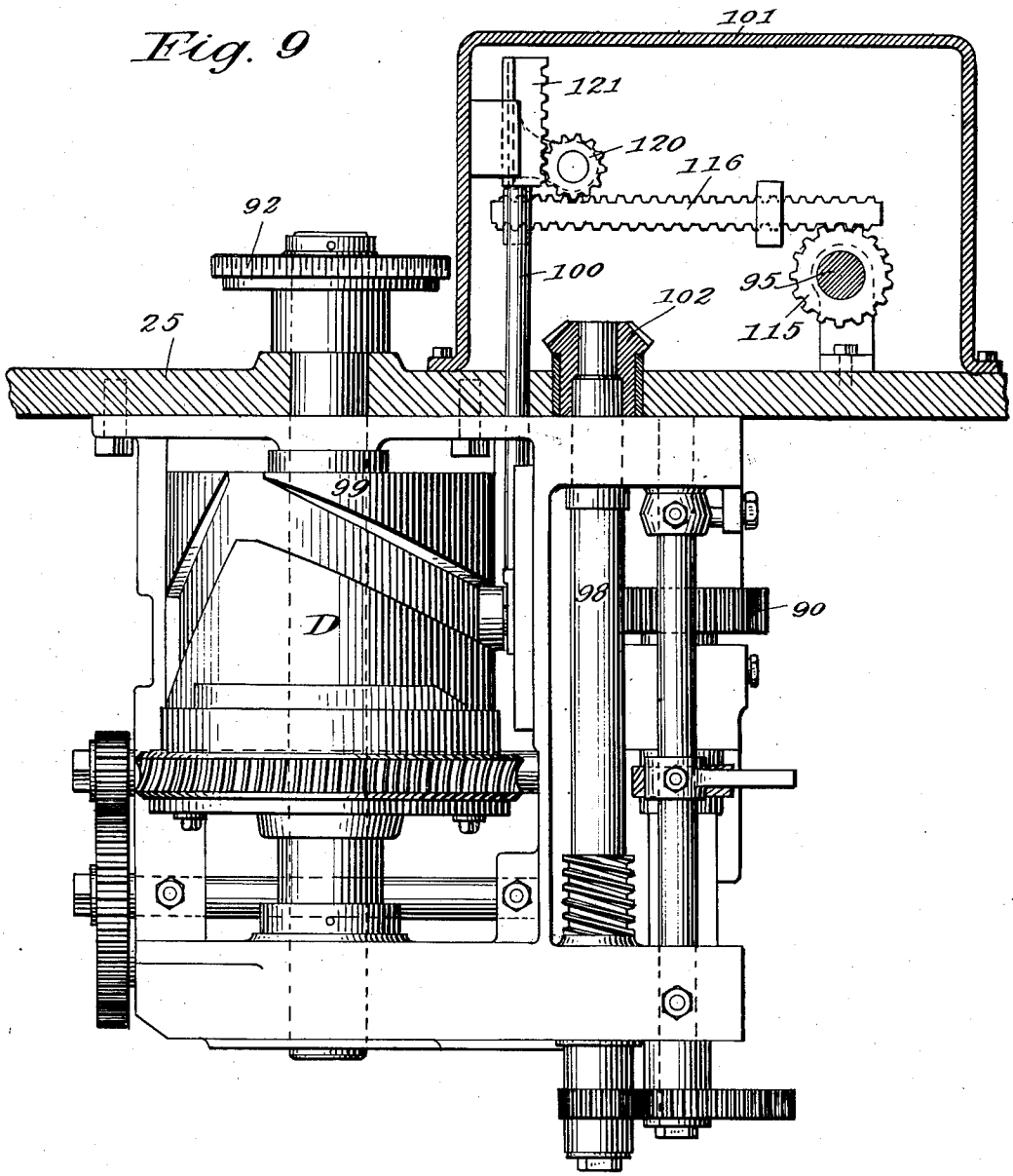
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STATION TYPE DRILLING AND TAPPING MACHINE

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Fig. 9



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STATION TYPE DRILLING AND TAPPING MACHINE

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Fig. 10

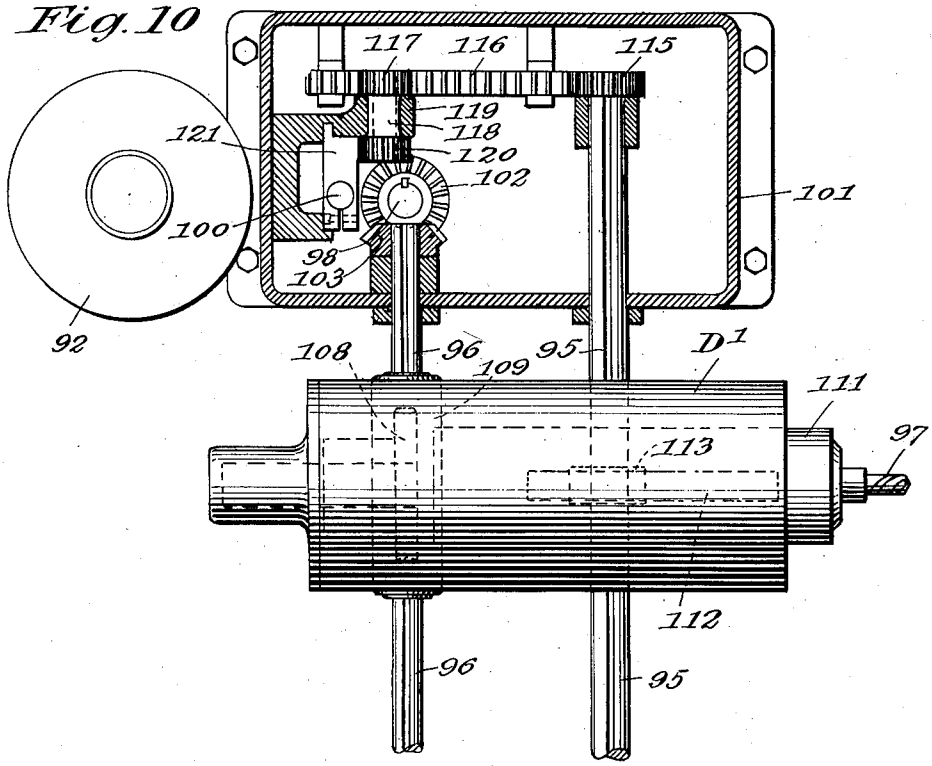
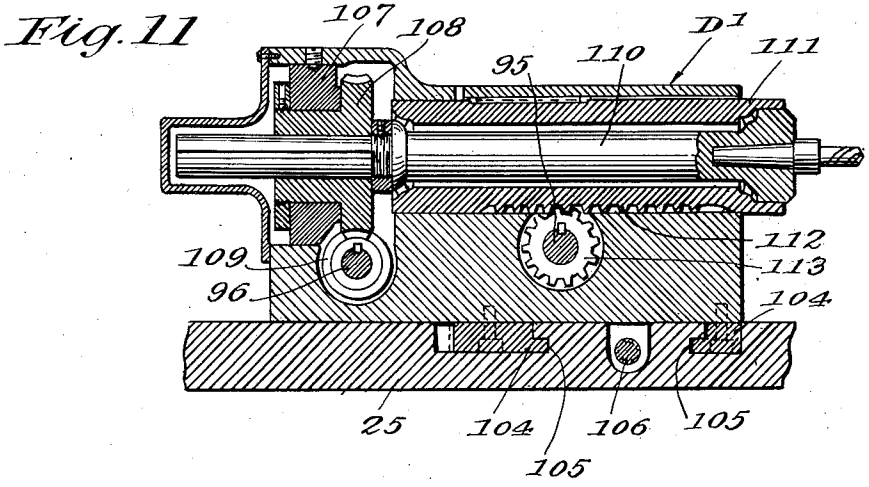


Fig. 11



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STATION TYPE DRILLING AND TAPPING MACHINE

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Fig. 12

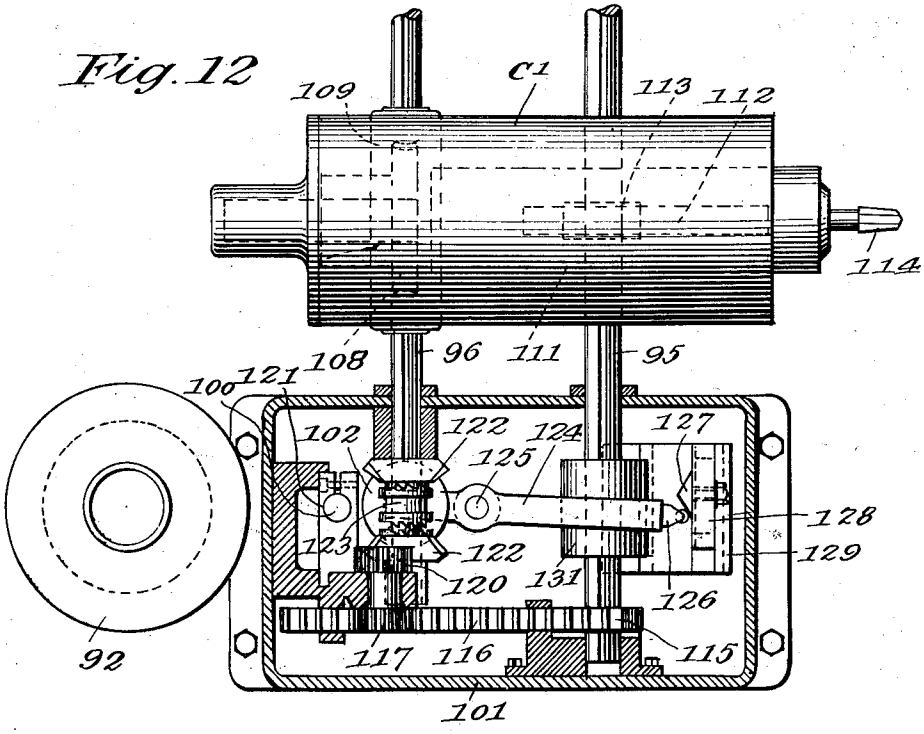
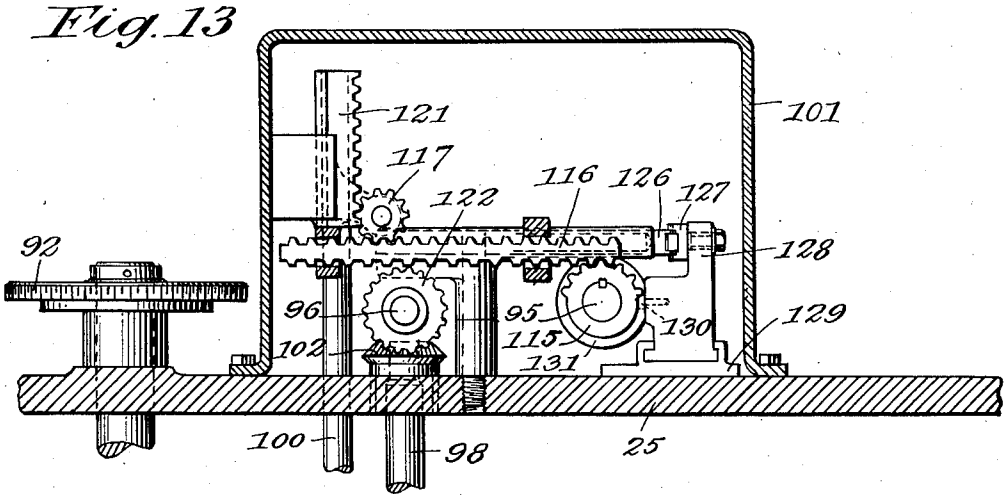


Fig. 13



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Patented Dec. 23, 1930 1,786,148

UNITED STATES PATENT OFFICE

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STATION-TYPE DRILLING AND TAPPING MACHINE

Application filed December 22, 1928. Serial No. 327,914.

This invention relates to improvements in automatic drilling, counterboring and tapping machines of the station type, and is designed more particularly for finishing radiator sections for steam and hot water radiators.

The machine is a station type of machine including a suitable drive, feed works, indexing mechanisms and a rotatable carrier for supporting and conveying the work to be finished from one work station to another. It further includes a multiplicity of holding means for retaining the work in operative position, with respect to the cutting tools, and for holding the blanks during the cutting and indexing operations.

The tools act simultaneously, though in two groups for different operations, one group for preliminary drilling operations and the other group for tapping so that by different treatment of the two different types of tools the articles are successively completed.

The purpose of the invention is to provide a machine whereby the required work upon such sections preparatory to assembling may be quickly, uniformly and accurately performed by a single operator who simply feeds the sections, one at a time, into one side of the machine. Further to utilize the cutting time of the machine for removing a finished piece of work and substituting a blank, and whereby the two said last named operations are performed simultaneously.

Other objects of the invention are to provide a machine for accomplishing the work specified, in a shorter length of time than has heretofore been possible and to insure uniform operations so that each piece or section will be an exact duplicate of the other and whereby little or no trouble will be experienced in the assembling of the sections, to form a complete radiator.

The machine is nearly automatic, requiring only an attendant who places the work in a hopper, feeds it to the carrier, secures it in position and simultaneously releases the finished piece. It is adapted for operating on several pieces of work at the same time and performing a plurality of different tooling operations, such as drilling, counterboring, tapping and the like, according to requirements and without change of position of the work upon the carrier.

The machine is a four station type, including first, a loading station where the work pieces are received and chucked, whereupon the machine indexes and carries the piece to the second station where the drilling and counterboring operations are performed simultaneously with the receiving and chucking of a second piece at the loading station. The further indexing of the machine carries the first mentioned piece to the third station where it is tapped. The fourth rotation of the carrier brings the first mentioned piece to the unloading position where it is released and ejected from the machine, leaving the machine free to move forward bringing this empty chuck forward in position to be again reloaded at the first mentioned station. The chucking of the new piece to be operated upon and the releasing of the finished piece are simultaneously performed by the operation of a single crank manipulated by the single operator.

With these and other objects in view, the invention resides and consists in the construction and novel combination and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawings, and pointed out in the claims hereto appended, it being understood that various changes in the form, proportion, size, and minor details of construction within the scope of the claims may be resorted to without departure from the spirit, or sacrificing any of the advantages of the invention.

Similar characters of reference denote like or corresponding parts throughout the several figures of the accompanying drawing forming a part of this specification and upon which

Fig. 1 shows a plan view of my improved drilling, counterboring and tapping machine;

Fig. 2 is a side elevation of the machine;

Fig. 3 is an end elevation as seen from the right of Figs. 1 and 2;

Fig. 4 is an opposite end elevation of the machine as seen from the left of Fig. 2;

Fig. 5 is a vertical cross section through the machine, on line 5—5 of Fig. 2, looking in the direction of the arrow;

Fig. 6 is a vertical cross section through the machine taken on line 6—6 of Fig. 2, looking in the direction of the arrow;

Fig. 7 is an enlarged detail cross sectional view of one of the clamping devices and a radiator section for securing the same to the carrier of the machine;

Fig. 8 is an enlarged central vertical longitudinal section through the machine including the base, casings and carrier, mounted upon and between the casings, and showing, in perspective, two sets of feed works employed in the machine;

Fig. 9 is a side elevation of one of the four feed works employed in the machine, and the connected tool operating mechanism taken on line 9—9 of Fig. 1;

Fig. 10 shows an enlarged sectional plan view of the left hand rear tool head D^1 also shown in Figs. 1 and 11, for carrying the boring and reaming tool together with the drive mechanism therefor;

Fig. 11 is a central vertical longitudinal sectional view through the tool head shown in Fig. 10;

Fig. 12 is a sectional plan view of the left hand front tool head shown in Fig. 1 for carrying a top, together with the drive mechanism therefor; and

Fig. 13 is a vertical sectional elevation of the drive and reverse drive mechanism for the tool heads C^1 and C^2, shown in Figs. 1 and 12.

Referring in detail to the characters of reference marked upon the drawings, 19 indicates a base of suitable size and proportions which includes an oil reservoir 20 from which the lubricant is pumped and supplied to the operative parts of the machine. This base also includes a central declined opening 21 through which the finished radiator sections *a* are discharged when finished and released from the machine. 22 represents a casing that is mounted on one end portion of the base 19 and is provided with an attached cylindrical bearing 23 which supports a rotatable carrier 24 mounted thereon.

This carrier is connected to be alternately rotated a quarter turn with each movement and requires four operations to make a complete rotation. This obviously constitutes what is commercially termed a four station type of machine, one position of which is the loading station, two and three work stations and four the unloading station. A second casing 25 is secured to the opposite end portion of the base and on the opposite side of the carrier from the before mentioned casing 22. These casings serve to partially enclose and to entirely support the carrier heretofore mentioned, as well as the operating mechanism next to be described.

The machine is equipped to be operated by a single motor 26 mounted upon a shelf 27 of the casing 22. This motor is connected by a belt 28 to drive a pulley secured upon a drive shaft 29 journaled in bearings 30 of the said casing 22. One section 31 of a friction clutch is mounted to be driven with this shaft while the other section 32 is detachably connected to be driven when engaged by the said section 31. A gear 33 on the driven end of this shaft meshes with and drives a larger gear 34 secured upon a central shaft 35 journaled in the casing 22 and its cylindrical extension 23.

The clutch is operated by a handle 36 exposed on the outside of the casing 22 and whereby the machine is started and stopped at will. A beveled bull gear 37 is positioned beside and secured to the large gear 34 and the two are journaled upon the central shaft 35. This bull gear meshes with two smaller beveled gears 38 and 39 on radial shafts 40 and 41 and through which the two sets of feed works A and B, contained within the right hand end of the machine, see Fig. 3, are operated as will later be described. In this connection it might be here stated that there are also two similar feed works C and D positioned in the opposite end of the machine enclosed within the casing 25, and which are also operated from the before mentioned large gear 34, through a smaller gear 42. This gear 42 is mounted on a constant speed shaft 43 journaled in the cylindrical bearing 23, and bears a small gear 44 and a bevel gear 45 upon its opposite end. The bevel gear 45 like a similar bevel gear 46 upon the same shaft are operatively connected through shafts 47—47 to operate oil pumps 48—48 positioned in the reservoir 20. The gear 44 meshes with a larger gear 49 mounted upon a short shaft 50 also journaled in the casing 25 and carrying a bull gear 51. This bull gear, like the before mentioned bull gear 37, meshes with and drives two beveled gears 52 and 53 on radial shafts 54 and 55 journaled in the casing 25, that serve to connect and drive the feed works C and D in the left end of the machine.

The machine being an indexing type of machine, is timed so that the several required operations will be consecutively performed, and so as to permit for separate loadings of a piece of work, four rotations of the carrier and like number of unloading or discharges of a piece of work, with each complete cycle of the machine. These operations are accomplished through several sets of mechanisms, first and perhaps the more important of which is the means for operating the carrier, which I will next describe.

The casing 22 before mentioned includes a central cylindrical bearing 23, which is

preferably formed separate from the casing but secured to it by means of screws 56. This bearing is positioned central of and projects from the side of said casing in a manner to form a bearing between it and the adjacent casing 25, for the rotatable carrier 24, see Fig. 8, upon which the radiator sections *a* are mounted for operation. The carrier herein employed is provided with four tables or work carrying places 57, each of which is provided with clamping means for gripping and releasing the sections.

The before mentioned central shaft 35 extends longitudinally through the center of the bearing 23 and carries a cam 58 for operating the lock pin 59 slidably mounted in a boss 60 upon the inside of the cylindrical bearing and is provided with a spring 61 that normally holds it in engagement with one of four stationary pins 62 mounted in the carrier. A lever 63 carried upon the inner end of the lock pin 59 is mounted to engage the cam 58 for the purpose of operating the pin to engage it with the sockets of the stationary pins 62 when desired to lock the carrier in its several station operation positions.

A gear 64 is mounted upon the outer end of the central shaft 35 to mesh with and turn a gear 65 on a stud 66 secured in bearing 23. This gear 65 carries a crank arm 68 whose outer end includes a bearing 69 upon which an indexing arm 70 is pivotally mounted, said indexing arm is provided with a longitudinal slot 71 in which a roll 72 is operatively positioned, the said roll being rotatably mounted upon a stud carried in a bracket 73 attached to the side of the carrier. There are four of these brackets and rolls to be successively engaged for the indexing movement of the carrier.

The indexing arm 70 is provided with an elongated slot 74 upon the outer side of the inner end portion that is in slidable engagement with a roll 75 on a central fixed stud 50 mounted in a central plate 77 and in alignment with the shaft 35.

From the foregoing it will be seen that with the alternate rotations of the central shaft and its gear connection with the crank arm 68 the latter is operated in a way to provide in part, an eccentric reciprocatory movement to the indexing arm. The slotted inner end portion of this arm is at all times in engagement with the centrally positioned roll 75 and whereby the outer slotted end portion will, as a result, with each complete turn of the crank, cause the upper slotted end 71 to alternately engage the respective rolls 72 mounted on brackets 73 of the carrier, thereby insuring a one quarter turn of the latter with each turn of the central shaft. The central cam 58 is obviously timed to cause the operation of the lock pin 59 to engage a pin 62 of the carrier to insure the holding of the carrier in a fixed position during the disengagement of the said crank arm therewith. This disengagement period is the working time of the tools upon the two pieces of work mounted upon the tables of the carrier.

The carrier includes an annular cylindrical flange portion 78 which is mounted to turn within the before mentioned casing 25 and is further enclosed by an annular plate 79 whose outer peripheral surface is secured to the said flange so as to be carried thereby and whose inner edge portion carries a bushing ring 80 of suitable material which bears upon the annular surface of the plate 77 so as to form a dust proof closure bearing of the parts within the carrier. A flexible strip of sheet material 81 is secured to the side of the casing 22 and has its free edge portion overhanging an annular flange 82 on one edge portion of the carrier. A similar strip 83 is attached to the inner face of the opposite casing 25 and has its inner annular edge portion seated against an annular shoulder 84 of the carrier. The purpose of these strips is to enclose the openings between the carrier and casing and prevent oil and chips from getting into the bearings of the carrier, and to better discharge the chips from the carrier when rotated.

The four feed works A, B, C and D are alike in construction and are similar to those employed in our Mult-Au-Matic machine, see Patent No. 1,360,175. Therefore, for the purpose of this application it is thought sufficient herein to say that all four of these feeds are driven from the shafts 35, 43 and 50 through the bull gears 37 and 51.

The feed works A and B in the drive end of the machine are operated from the first mentioned bull gear 37 through the before mentioned beveled gears 38 and 39 mounted upon shafts 40 and 41, the former of these shafts leads to the feed works B while the latter and somewhat longer shaft leads to the feed works A. These two shafts are each provided with a beveled gear 85 upon their outer ends that mesh with a like gear 86 upon angularly disposed shafts 87 and 88 for driving the two feed works. Each of these last named shafts are provided with a gear 89 that meshes with and drives a gear 90 of the feed works A and B and whereby the latter are operated. The purpose of these feed works is to first provide a proper speed of rotation for the tools and second a proper feed, per revolution of the spindles and tools. In this connection provis on is made for changing these speeds or feeds in relation to each other by the employment of a lever 91 and timing disk 92 for setting the feed works, such as is also employed in connection with the feed works of the Mult-Au-Matic.

The relative required feeds and speeds as provided by these four feed works are obviously necessary for the operation of the four pairs of tool heads A^1—A^2, B^1—B^2,

C^1—C^2, D^1—D^2, which like the feed works are substantially alike in construction and each pair is operatively connected by similar feed shafts 95 and 96. The two pairs of front tool heads, see Fig. 1, designated as A^1—A^2 and C^1—C^2, operate simultaneously on the same piece and in direct opposed relation and serve to perform drilling and counterboring operations by the use of combined drilling and counterboring tools 97 and thus comprise the tools for performing the first of the two operations necessary for each hole of the section. As shown, four of these tools are thus provided and serve to simultaneously drill and counterbore four holes, two in each side of the radiator section.

What I have said with reference to the two pair of feed works on the front side of the machine is in a measure true of the two pairs on the rear side designated as B^1—B^2 and D^1—D^2, that carry taps for tapping the holes after being drilled by the tools of the front heads, and when carried over to the back in alignment with the taps by a quarter rotation of the carrier. Each of the eight tool heads are alike in construction though the drive connections for each pair is necessarily slightly different, with the several feed works, due obviously to the fact that a clockwise drive only is necessary for some of the heads, while both a forward and reverse drive is required for the taps.

In this connection I have shown in Figs. 9, 10 and 11, the drive connections intermediate of the feed works D and the tool heads D^1—D^2 as well as the shafts 95 and 96 for operating this pair of heads, which I will next describe.

The drives and feeds for the tools carried by the tool heads are through the several feed works before referred to, and as shown in Figs. 9 and 10 are directly connected with a shaft 98 and the cam 99 respectively, of said feed works. A vertically reciprocatory rod 100 carries a roll for engagement with the cam and extends out through the casings of the machine and into a housing 101 for further operative connections as will again be referred to.

The shaft 98 carries a beveled pinion 102 that meshes with a similar beveled pinion 103 on the drive shaft 96 journaled in the two heads D^1 and D^2. The said beveled pinions are enclosed within the housing 101 as is also the operative drive connections from the feed rod 100 to the feed shaft 95. The four tool heads heretofore referred to are alike in construction and each comprise a body portion having ways 104 secured to its under side for engagement with corresponding ways 105 in the face of the casing 25. These heads are thus adapted for adjustment to and from each other upon the surface of the casing as by a screw 106. A bearing 107 is mounted in the enlarged end portion of the head and serves to support a worm gear 108 that meshes with and is driven by a worm 109 upon the before mentioned shaft 96.

A tool spindle 110 is rotatably mounted in a tubular bearing 111 that is slidably mounted in the heads. The end of the spindle being keyed to slide in a worm gear 108 whereby it is driven. The bearing is provided with a rack 112 upon its underside to be engaged and operated by a gear 113 upon the before mentioned feed shaft 95. The tool spindles 110 may be provided with any suitable form of chuck to carry the before mentioned drill 97, or a tap 114 as shown in the other heads, see Fig. 12.

On the end of the feed shaft 95, see Figs. 9, 10 and 11, is a gear 115 which meshes with the underside of a slidable rack 116 and whose opposite toothed face is engaged by a pinion 117 carried upon a short shaft 118 journaled in bearing 119. This short shaft 118 carries a second pinion 120 that meshes with a vertically operable rack 121 secured upon the upper end of feed rod 100. By this line of connection it will be clearly apparent that with the vertical reciprocations of the feed rod 100 and the consequent operation of the gear and rack connections therewith, the feed shaft 95 will be given alternate forward and backward rotations in a manner to impart longitudinal movements to the drill spindles simultaneous with the constant drive of said spindles as imparted from the shaft 98 of the feed works through its bevel gear connections before described. This line of drive is for the feed of tool heads D^1—D^2, B^1 and B^2 while a forward and reverse drive is necessary for driving the tap spindles.

This forward and reverse drive mechanism for the tap spindles is shown in Figs. 12 and 13, which shows enlarged views of the tool head C^1 shown in Figs. 1 and 2, together with its drive connections. This mechanism is somewhat similar to that shown in Figs. 9 and 10, so far as the means for feeding the tool into and out of the work is concerned, therefore similar reference characters will be employed to designate these like parts.

In order to obtain a reversal of the drive of the tap spindle for this head C^1, as well as the other tap heads, C^2, A^1 and A^2, I have provided mechanism illustrated in these Figs. 12 and 13 for automatically reversing the drive of the tap spindles at a predetermined time, so as to insure a forward cutting operation of all the taps to a uniform distance, and quickly and automatically reversed, to run the tap out. In this respect it will be seen that a pair of spaced apart beveled face clutch gears 122 are loosely mounted upon the drive shaft 96, both being in mesh with and driven by the beveled gear 102 on the feed work shaft 98. A slidable clutch member 123 is keyed to slide upon the drive shaft 96 to engage with the clutch face of one or the other of the

before mentioned clutch gears 122 and is connected to be operated by lever 124 pivoted to a stud 125.

The free end of this lever is provided with a roll 126 for engagement with an arrow point 127 adjustably secured to a slide 128 mounted for slidable movement in a bracket 129, the said slide carrying a pin 130 that is engaged by a cam 131 mounted upon the feed shaft 95. It will therefore be seen that with the constant drive of the shaft 98 the gears 122 are both driven and the drive shaft upon which they are mounted is similarly driven according to the engagement of the clutch, slidably mounted upon the shaft, the one serving to drive the spindle in a forward position and the other in a reverse. The time of the reverse movement is determined by the movement of the cam on the feed shaft 95 through the action of the lever and arrow point.

The work to be finished, which as shown in the drawings, comprises radiator sections designated as *a* placed upon and carried on the four tables of the carrier, one at a time. These sections are loaded upon these tables while the particular table to be loaded is in a lower inclined position, see Fig. 3. These sections are first placed in a chute 132 which is supported upon a cross rod 133 secured in brackets 134 fastened to the sides of casings 22 and 25. This rod also hingedly supports a bracket arm 135, the lower free end 136 of which is connected by springs 137 to the sides of the before mentioned casings in a way to normally hold the free end of the bracket in substantially the position shown in dotted lines in said Fig. 3, and whereby the aligned surfaces 138 of this bracket are supported in proper position to receive the edge portion of the sections as they slide down from the chute 132 and to guide them into and against the guides 139 and 140, the latter being provided with a stop to limit said movement and properly position the piece, see Fig. 6.

In this connection it will be observed that I have also provided manually operable means for clamping and holding these sections upon the carrier during its movements from one station to another and while the sections are being operated upon. This clamping means is in part mounted upon the carrier and in part upon the casing 22 and will next be described.

Referring to Figs. 5, 6 and 8, 141 represents a crank handle mounted upon the outer end of the shaft 142 journaled in bearings 143 and carrying a worm 144 upon its inner end. This worm drives a gear 145 mounted upon a short shaft 146 journaled in the side of casing 22. This shaft carries a small gear 147 which is positioned in the path of travel and for meshing engagement with four larger gears 148 carried upon shafts 149 journaled crosswise in each corner portion of the carrier and in equal spaced relation one to the other.

The short shaft 146 also carries a bevel gear 150 within the casing 22 that meshes with and drives a similar bevel gear 151 upon a long shaft 152 journaled within the casing 22. This shaft also carries a bevel gear 153 upon its upper end that meshes with and drives a like gear 154 upon a short shaft 155 also journaled in the casing 22 and projecting therefrom and carrying a small gear 147ª which like the gear 147 is positioned in the path of travel and adapted to be engaged by one of the four larger gears 148 of the carrier.

Each of the short shafts 149 journaled in the corner portions of the carrier are provided with a beveled gear 156 upon its inner end which meshes with a corresponding beveled gear 157 upon shafts 158 journaled in the carrier, and having a beveled gear 159 upon its inner end that meshes with a corresponding gear 160 upon a screw shaft 161 also mounted in the carrier, though having its threaded end projected to engage a correspondingly threaded sleeve 162 carrying a right angularly disposed arm 163 upon which a clamping block 164 is hingedly supported. This hinge would be so constructed as to provide but a limited hinged movement of the block and would be so proportioned as to position the recessed under face of the block in alignment for receiving the outer longitudinal edge portion of the section when positioned upon the before mentioned guides 139 and 140.

From this it will readily be seen that the turning of the crank 141 and its shaft in one direction will obviously serve to draw the clamps down upon the radiator section whereas the turning of it in the opposite direction will release the sections. This construction insures the simultaneous engagement of one of the larger gears 148 with the small gears 147 and 147ª with each rotation of the carrier. The purpose of this is not only to provide operative connections for the clamping means for the radiators being loaded, but also to simultaneously release the clamping means for the finished radiator, which release is connected to be operated from the same handle 141 and shaft used for the clamping operation. When the finished radiator is released as suggested it is free to slide out of its holding means through the slot 21 of the base and thus be discharged from the machine.

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

1. In a machine of the class described, spaced apart frames, a rotatable work carrier mounted between the frames and having a series of work tables, means for indexing the carrier to move the work from one station to

another for their respective operations, a series of tool heads arranged upon the front side of the machine on opposite sides of the carrier adapted for aligned drilling operations in opposite faces of the work, a series of tool heads arranged upon the rear side of the machine on opposite sides of the carrier adapted for aligned tapping operations in opposite sides of the work when the latter has been moved from the front station to the rear, a drive shaft for each series of tool heads, a feed shaft for each series of tool heads, and a variable speed feed works for each series of tool heads for providing variable speeds and feeds therefor.

2. A drilling and tapping machine, including a frame, a work carrier rotatably mounted therein to operate upon a horizontal axis, said carrier including four peripheral work tables, means for securing work pieces thereon, a series of tool heads mounted in operative alignment on both the front and rear sides of the frame and upon opposite sides of the work secured to the carrier, means for loading one of the tables of the carrier while in its lower position, and means for securing the said work piece to the carrier preparatory to the indexing, drilling and tapping operations, a drive shaft for each series of tool heads, a feed shaft for each series of tool heads, and a variable speed feed works for each series of tool heads for providing variable speeds and feeds therefor.

3. A station type of drilling and tapping machine including a loading station, two work stations and an unloading station, a horizontally rotatable carrier having four peripheral work tables, work receiving and clamping means for each of said tables, work loading means for one of said stations, a releasing means for another of said stations, oppositely positioned a series of drilling and boring heads arranged to operate coaxial with the carrier and upon opposite sides of the work piece held upon the carrier, and a like arrangement of a series of tapping heads arranged upon another side of the machine for aligning tapping operations in the holes of the work produced by the said drilling operation, a drive shaft for each series of tool heads, a feed shaft for each series of tool heads, and a variable speed feed works for each series of tool heads for providing variable speeds and feeds therefor.

4. A station type of drilling and tapping machine, including a frame, a carrier having a series of work tables, means for indexing the same, means within the carrier for clamping work pieces thereon, means mounted in the frame for operating one of the said clamping means while the carrier is at rest and for simultaneously operating another of said clamping means to release and discharge the piece of work.

5. A station type of drilling and tapping machine, including a frame, a carrier having a series of work tables, means for indexing the carrier, separate clamping means for each work table, a single operating means mounted in the frame for simultaneously operating two of said clamping means, one to clamp a piece of work on a table and the other to release a finished piece of work from a table.

6. A station type of drilling and tapping machine, including a frame, a rotary carrier having a series of work tables, means for indexing the carrier, a work clamp operating means mounted in the frame, a work clamp provided for each of the said work tables and adapted to register with said operating means with each indexing operation of the table for the clamping and releasing of a piece of work.

7. A station type of drilling and tapping machine, including a frame, a carrier having several work tables, clamping means for each table, clamp operating means including gearing for connecting with one of said clamping means for clamping a piece of work, and further gear connections for operating another of said clamping means to release a finished piece of work, and means for operating said clamp.

8. A drilling and tapping machine, including a frame, a station type of rotatable work carrier, means for indexing the same from station to station, a pair of tool heads mounted on the frame at opposite sides of the carrier, a rotatable cutting tool carried in each of said heads, a single drive shaft for each two of said cutting tools, and reversing mechanism for said driving connections whereby the tool may be run out of the work.

9. A drilling and tapping machine, including a frame, a station type of rotatable carrier having work tables, means for indexing the carrier from station to station, aligned tool heads positioned on opposite sides of the carrier, rotatable cutting tools mounted in the heads for aligned operations on opposite sides of a piece of work, a single drive shaft for each two of said cutting tools and reverse mechanism for said driving connections whereby two of said tools may be run out of the work simultaneously.

10. In a machine of the class described, a frame, a rotatable carrier mounted therebetween having a series of work tables, means for indexing the carrier, clamping means for securing the work on the several tables, a chute for supporting and directing the work to one of the tables, a yieldable arm pivotally hung from and between said spaced apart frames for guiding the pieces of work to the tables when positioned at the loading station, a series of tool heads for drilling holes in said work pieces at one station, and a series of tool heads for tapping said holes at another station.

11. In a machine of the class described,

spaced apart frames, a rotatable carrier mounted therebetween having a series of work tables, means for indexing the carrier, clamping means for securing the work on the several tables, a chute for supporting and directing the work to one of the tables, a yieldable arm positioned between said frames and adjacent the said chute for guiding the pieces of work to the tables when positioned at the loading station, a series of tool heads for drilling holes in said work pieces at one station, a series of tool heads for tapping said holes at another station, and means for releasing the finished work pieces from the machine.

12. In a machine of the class described, a base, spaced apart frames, a horizontally rotatable carrier mounted on the frame and having a series of work tables, means for securing work to the several tables of the carrier while in the loading station, means for releasing said holding means when in the unloading position, the said base having an inclined opening through its central portion to receive and guide the finished work from the machine when released, a yieldable guide arm, hung between said frames, to guide the work to the tables when positioned therebetween.

13. In a machine of the class described, a base, spaced apart frames, a rotatable carrier mounted upon one of said frames, means for indexing the carrier, means for locking the carrier in its several work positions, pairs of tool heads arranged upon the two said spaced apart frames on opposite sides of the carrier, and rotatable work spindles mounted in the tool heads, a single drive shaft for each pair of spindles, those on the one side being in alignment with those on the other.

14. In a machine of the class described, a base, a frame member mounted thereon having a horizontally extended cylindrical bearing, a carrier mounted thereon, a second frame also mounted upon the base and adapted to receive a portion of the said bearing, a central horizontal shaft journaled in said bearing, indexing means connected with and operated from the shaft for alternately indexing the carrier, tool heads mounted upon the two said frames in position to operate on opposite sides of the piece of work carried by the carrier, changeable feed works for said tool heads whereby the proper relative feeds and speeds are provided.

15. In a machine of the class described, a base, a frame member mounted thereon having a horizontally extended cylindrical bearing, a carrier mounted thereon, a second frame also mounted upon the base and adapted to receive a portion of the said bearing, means mounted at one end of the bearing for indexing the carrier, means for locking the carrier, work holder upon the carrier and tool heads on opposite sides of the carrier.

16. In a station type of machine of the class described, the combination with a rotatable carrier, two series of tool heads, one each side of the carrier, a drive shaft and a feed shaft connecting each series of heads, a change speed feed works for each series of shafts and heads, and a drive shaft in common for all of said feed works.

17. In a station type of machine of the class described, the combination with a rotatable carrier having two work stations, two pair of tool heads on each side of the carrier, a rotatable and longitudinally movable spindle for each head, a changeable feed works for each pair of heads providing an independent variable speed and feed for each pair of tool heads, an automatic reversing means intermediate of said feed works, and tool heads for reversing the said feed at predetermined times.

18. In a station type of machine of the class described, the combination with a rotatable carrier having two work stations, two pair of tool heads on each side of the carrier, a rotatable and longitudinally movable spindle for each head, a changeable feed works for each pair of heads providing an independent variable speed and feed for each pair of tool heads and automatic means for reversing the drive at predetermined times.

19. In a station type of machine of the class described, the combination with a rotatable carrier having two work stations, two pair of tool heads on each side of the carrier, a rotatable and longitudinally movable spindle for each head, a changeable feed works for each pair of heads providing an independent variable speed and feed for each pair of tool heads, an automatic reversing means intermediate of said feed works, tool heads for reversing the said feed at predetermined times, an automatic means for reversing the drive at predetermined times.

20. In a station type of drilling and tapping machine, a frame, a rotatable carrier, a pair of tool heads mounted upon the frame adjacent to one side of the carrier, drive and feed shafts connected to operate the two said heads in like manner, a feed works connected to operate the two said shafts and heads simultaneously and connected to drive the spindle of said heads simultaneously at variable speeds.

21. In a station type of drilling and tapping machine, a frame, a rotatable carrier, a pair of tool heads mounted upon the frame adjacent to one side of the carrier, drive shafts connected to operate the two said heads in like manner, means for adjusting said heads to and from each other upon the said frame and drive shafts, feed works connected to feed the two said heads simultaneously and connected to drive the spindles of said heads simultaneously at variable speeds.

22. In a machine of the class described, a

frame, a pair of tool heads mounted thereon, means for adjusting the same to and from each other, each of said heads including a rotatable spindle adapted to carry a cutting tool, a pair of driving shafts connecting the two said tool heads, one for driving the spindle and the other for feeding the same forward and backward, means for driving the spindle in a forward direction, reverse drive means for said shaft and spindle connected for automatic operation by the feed shaft, and means for reversing the said feed.

23. In a machine of the class described, the combination of a rotary carrier, non-rotatable work holding means mounted upon the carrier, a driving shaft, a clutch on said shaft, indexing means connected with and operated by the shaft for alternately rotating the carrier, pairs of oppositely positioned tool heads aligned for operations on opposite sides of the work carried by the work holders, means for rotating the tools of the tool heads, and means for forwardly feeding said tools.

24. The combination with a frame, of a carrier rotatably mounted therein, means for successively turning the carrier predetermined distances, means for locking the said carrier to the frame against rotation at the completion of each movement, work holders upon the carrier, oppositely positioned aligned tool heads for operations on opposite sides of the work carried by the carrier, and means for operating the tool heads.

25. The combination of a series of pairs of aligned and oppositely positioned tool holders, rotatable tools mounted therein, means for rotating the tools, means for feeding the tools of each pair toward each other, a rotatable work carrier mounted to operate between the several pairs of tool holders to carry work mounted upon the carrier from one set of tool heads to another.

26. The combination of a series of pairs of aligned and oppositely positioned tool holders, rotatable tools mounted therein, means for rotating the tools, means for changing the speeds of the drive and feed for the rotatable tools, means for feeding the tools of each pair toward each other, a rotatable work carrier mounted to operate between the serals pairs of tool holders to carry work mounted upon the carrier from one tool head to another.

27. The combination of a series of pairs of aligned and oppositely positioned tool holders, rotatable tools mounted therein, means for driving the tools in both a forward and reverse direction, means for feeding the tools of each pair toward and from each other, a rotatable work carrier mounted to operate between the several pairs of tools, and non-rotatable work holders secured to the carrier holders.

28. The combination of a series of pairs of aligned and oppositely positioned tool holders, rotatable tools mounted therein, means for rotating the tools in both a forward and reverse direction, means for feeding the tools of each pair toward and from each other, a rotatable work carrier mounted to operate between the several pairs of tools, non-rotatable work holders secured to the carrier holders, and variable change speed means for driving and feeding for tools.

29. In a machine of the class described, the combination of a rotary carrier, non-rotatable work holding means mounted upon the carrier, a driving shaft, a clutch on said shaft, a central shaft, carrier indexing means connected with the central shaft, means for locking the carrier, pairs of oppositely positioned tool heads aligned for operations on opposite sides of the work carried by the work holders, means for rotating the tools of the tool heads, and means for feeding said tools.

30. In a machine of the class described, the combination of a rotary carrier, non-rotatable work holding means mounted upon the carrier, a driving shaft, a clutch on said shaft, a central shaft, carrier indexing means connected with the central shaft, means for locking the carrier, pairs of oppositely positioned tool heads aligned for operations on opposite sides of the work carried on the work holders, and variable speed feed works for the tool heads connected with and driven by the central shaft.

31. The combination with a frame, of a carrier rotatably mounted therein, an indexing shaft carrying a gear, a second gear meshing therewith and carrying an indexing arm, means upon the carrier to be engaged by the arm for successively turning the carrier predetermined distances, means for locking the said carrier to the frame against rotation at the completion of each movement, work holders upon the carrier, oppositely positioned aligned tool heads for operations on opposite sides of the work carried by the carrier, and means for operating the tool heads at variable feeds and speeds.

32. In a machine of the class described, the combination of a frame, a rotatable carrier mounted therein, a drive shaft, a clutch on the shaft, a central shaft driven thereby, a constant speed shaft, indexing means operated by the central shaft, tool heads mounted on the frame on opposite sides of the carrier, and change speed feed works driven from the constant speed shaft, for operating each tool head.

Signed at Bridgeport, in the county of Fairfield and State of Connecticut, this 20th day of December, A. D. 1928.

EDWARD P. BULLARD, JR.