

April 2, 1929.

E. H. WILSON ET AL

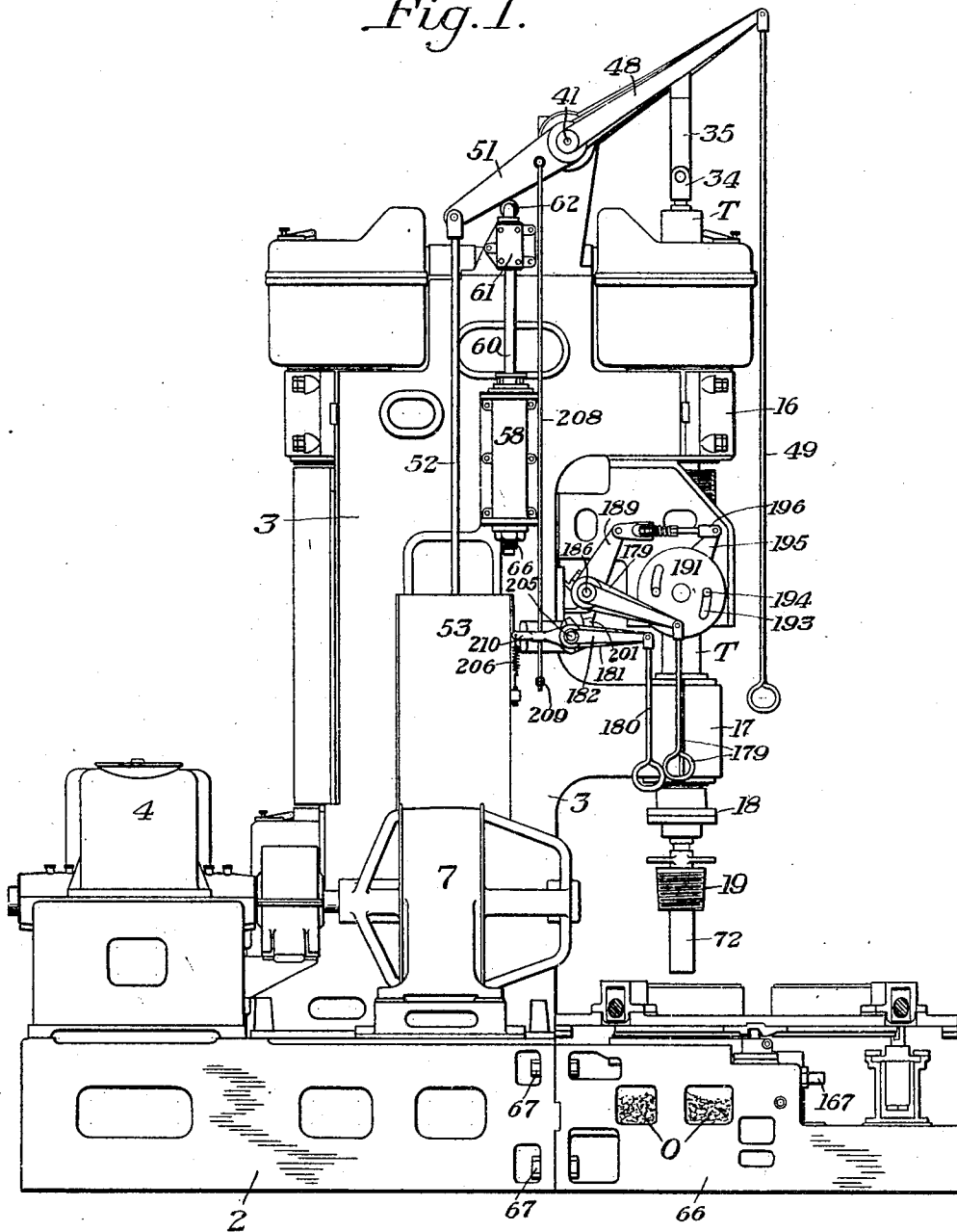
1,707,421

METAL WORKING MACHINE

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11 Sheets-Sheet 1

Fig.1.



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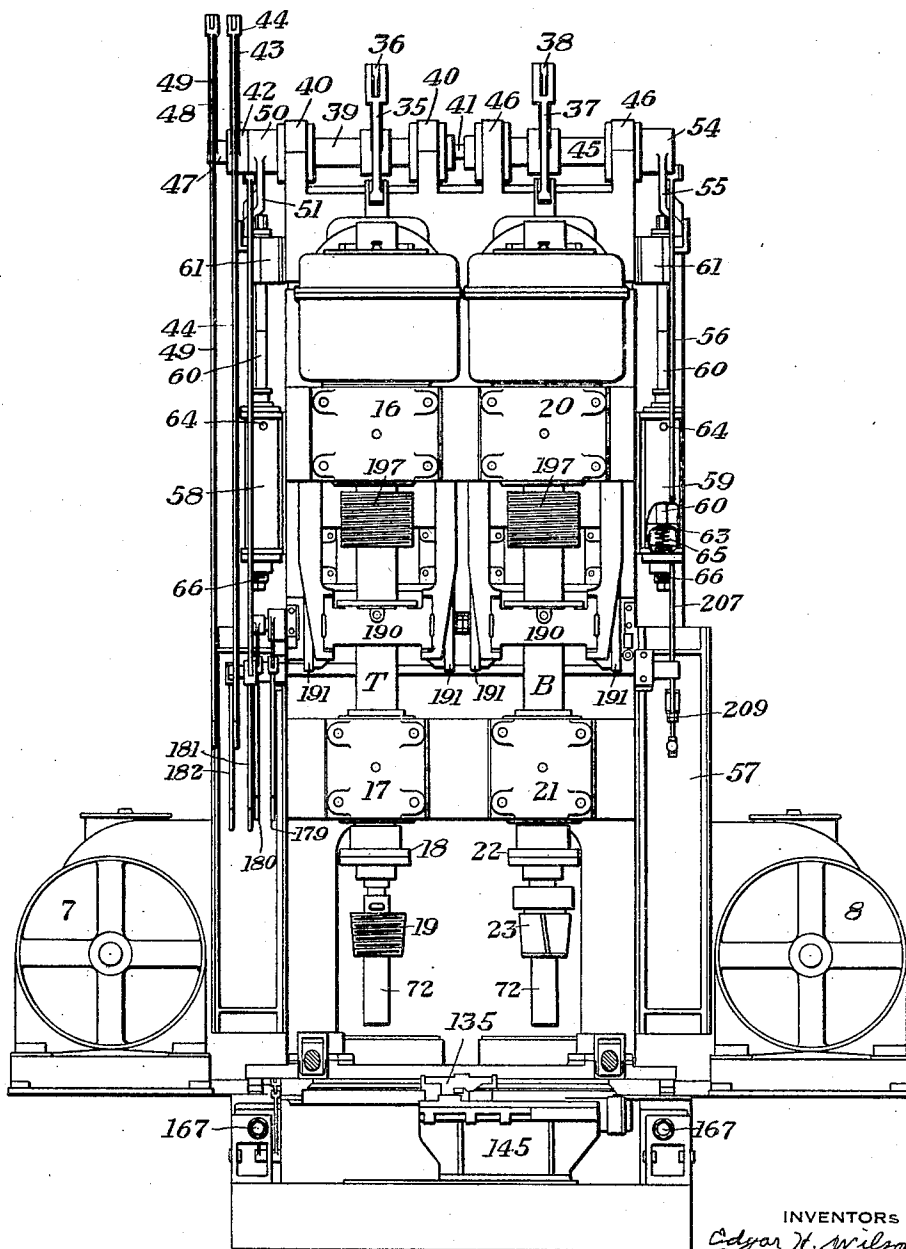
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METAL WORKING MACHINE

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Fig. 2.



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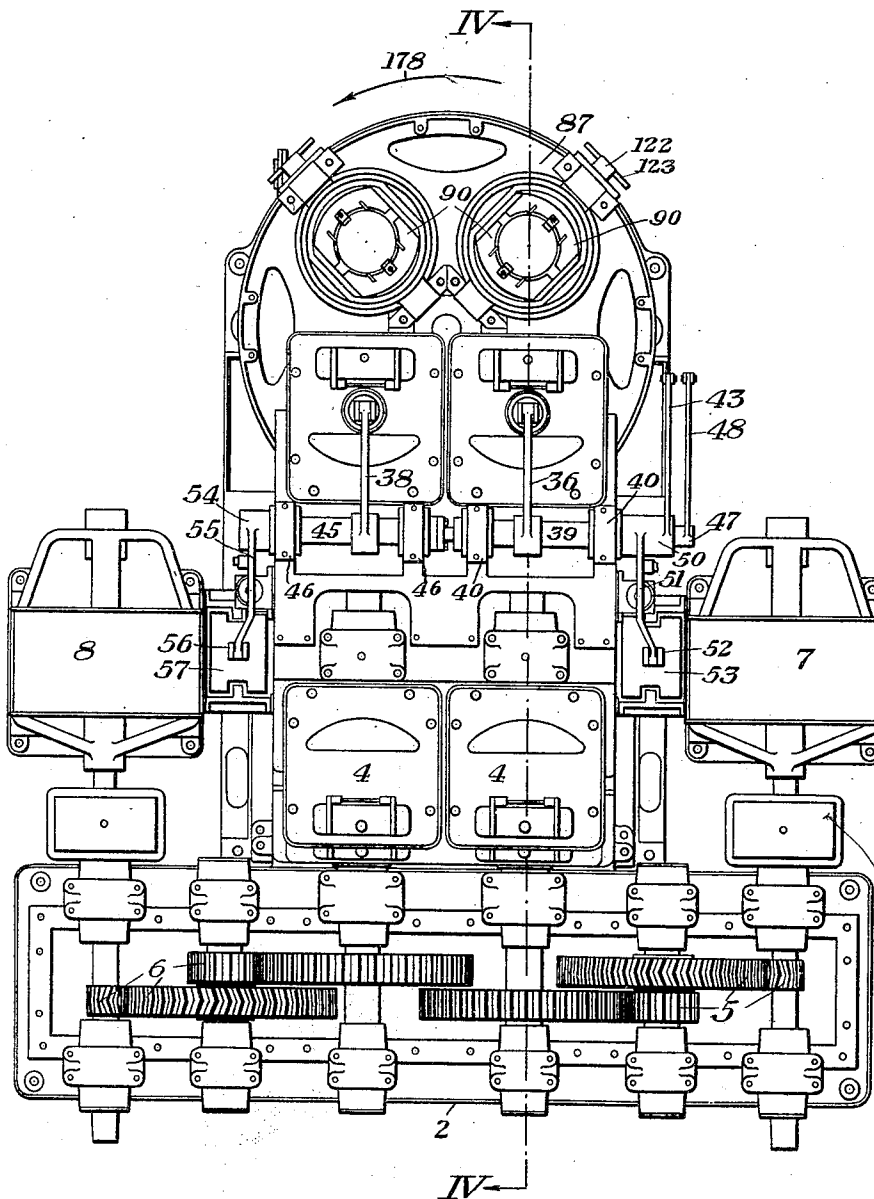
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METAL WORKING MACHINE

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Fig.3.



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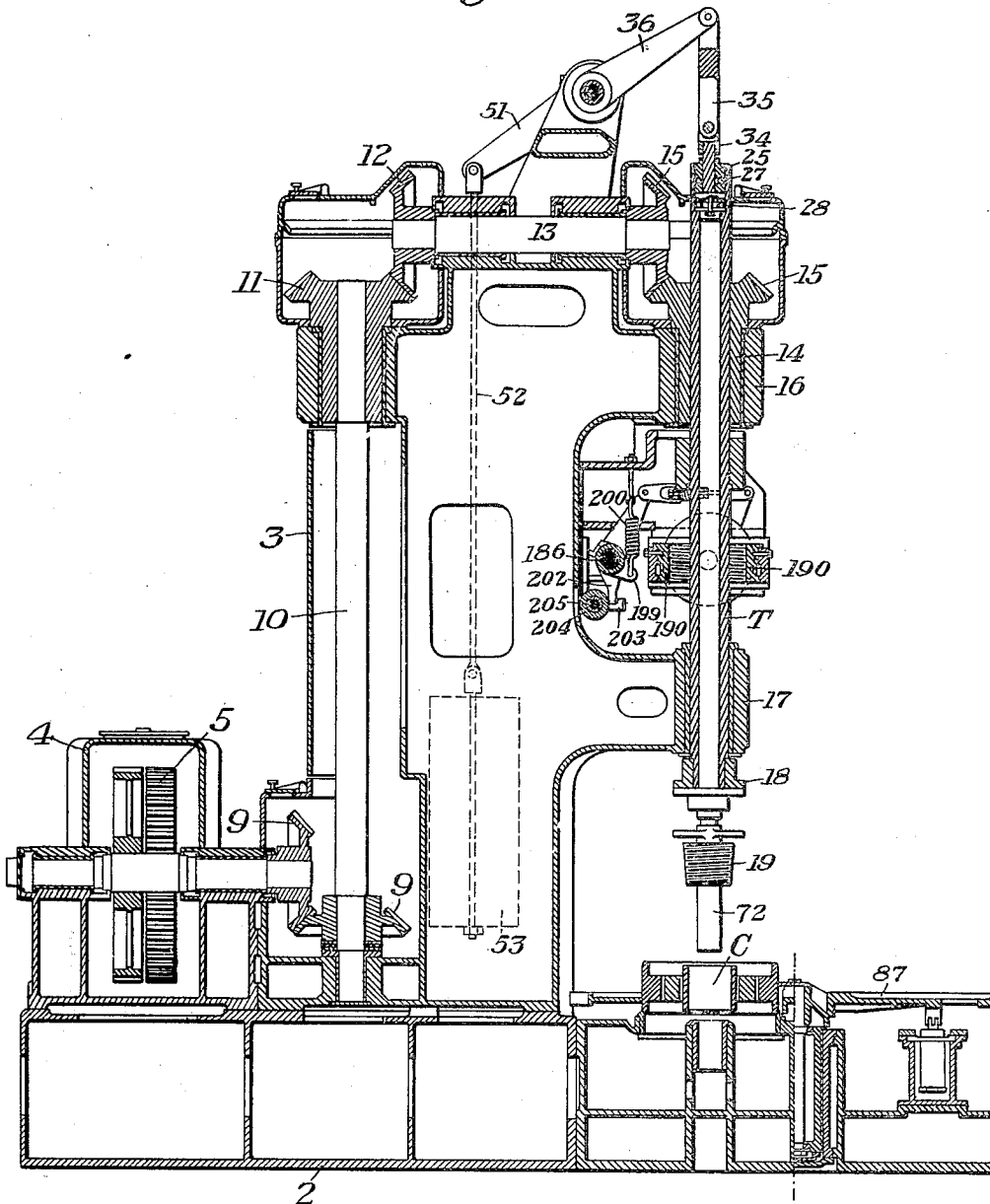
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METAL WORKING MACHINE

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11 Sheets-Sheet 4

Fig.4.



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METAL WORKING MACHINE

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Fig. 5.

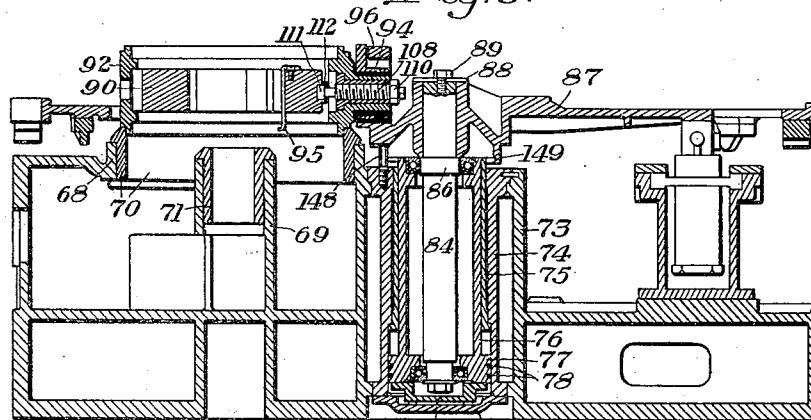
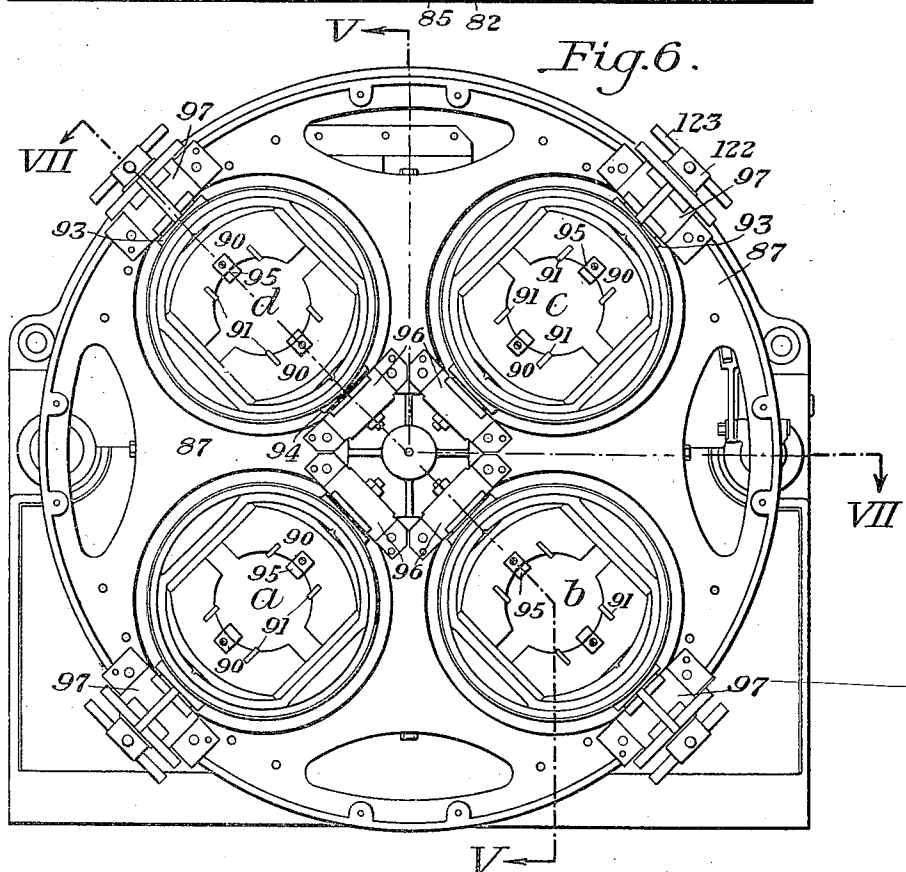


Fig. 6.



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METAL WORKING MACHINE

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Fig. 7.

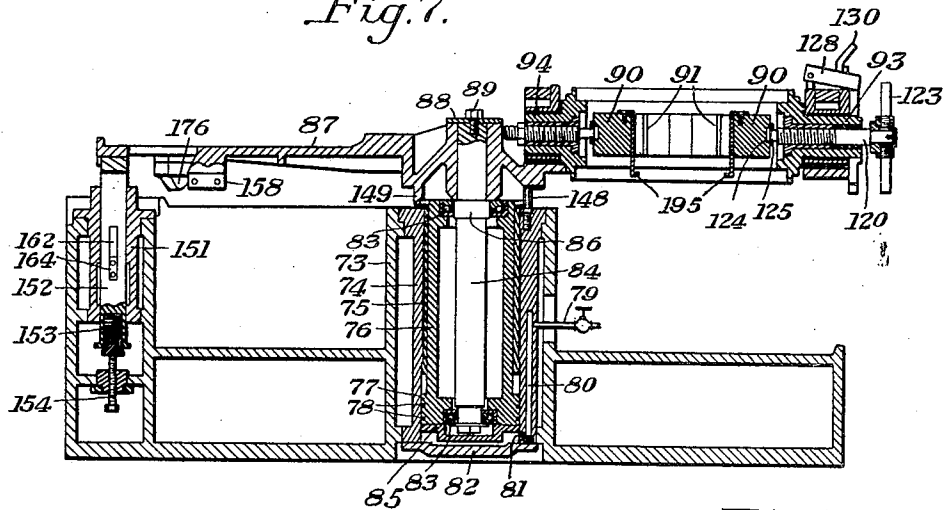


Fig. 8.

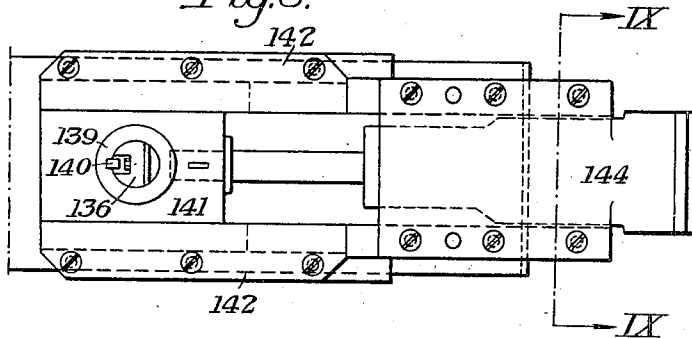


Fig.9.

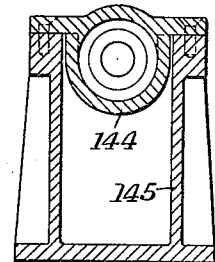


Fig. 11.

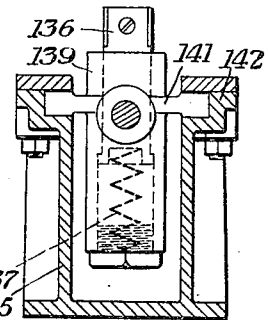
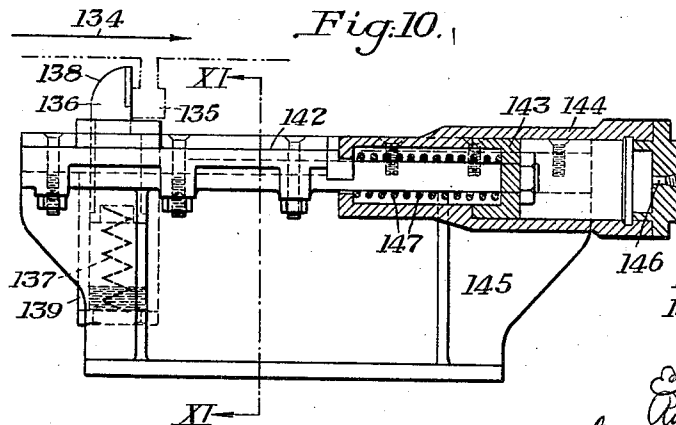


Fig:10.



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METAL WORKING MACHINE

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Fig. 12.

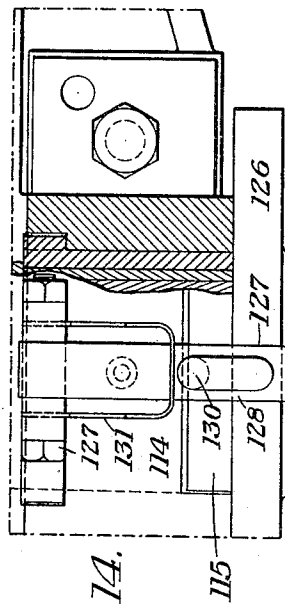
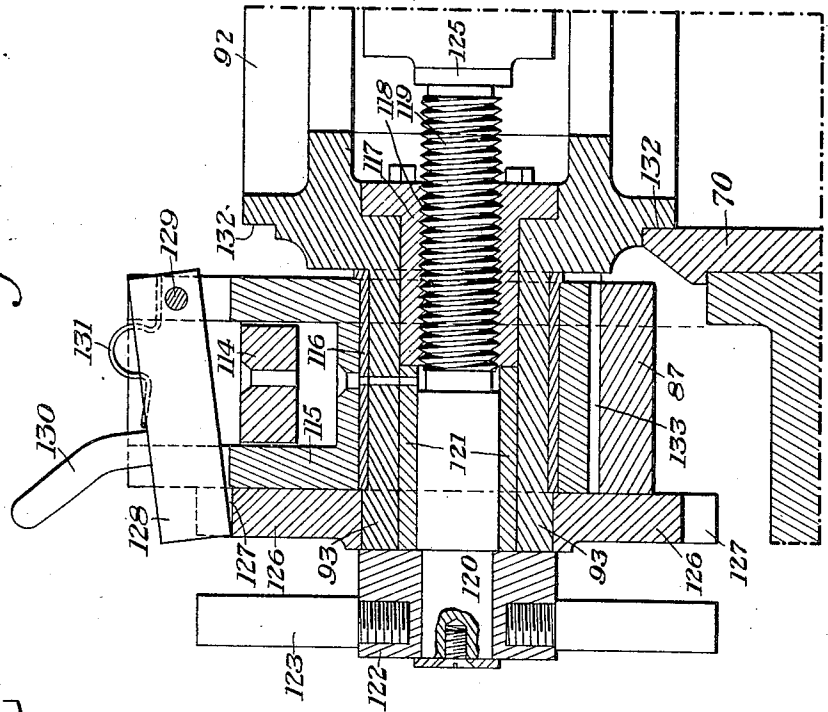
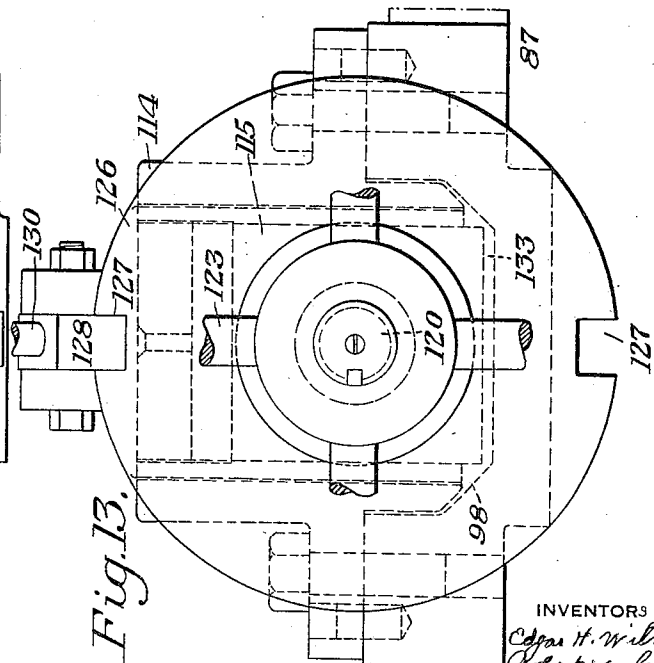


Fig. 14.

Fig. 13.



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METAL WORKING MACHINE

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Fig. 17.

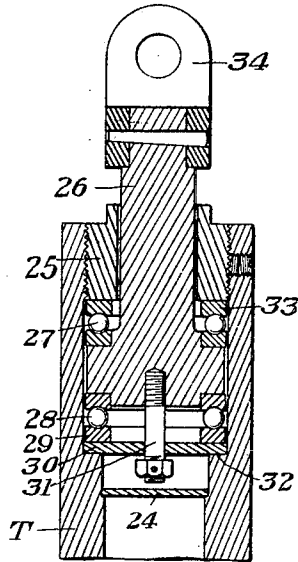


Fig. 15.

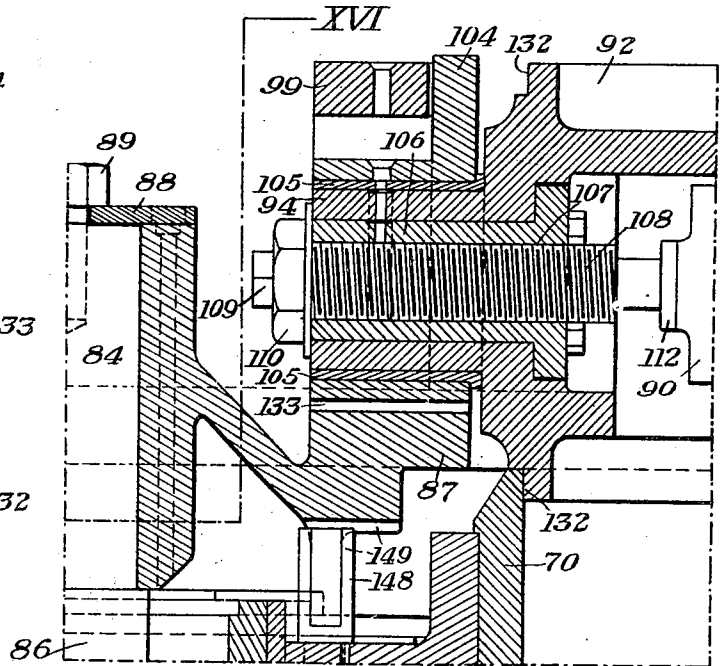
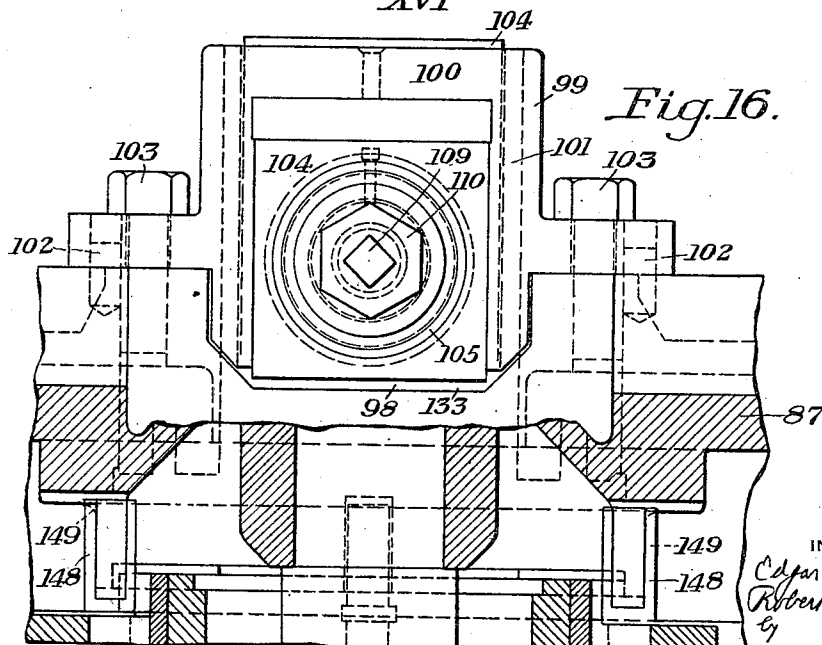


Fig. 16.



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METAL WORKING MACHINE

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Fig.20.

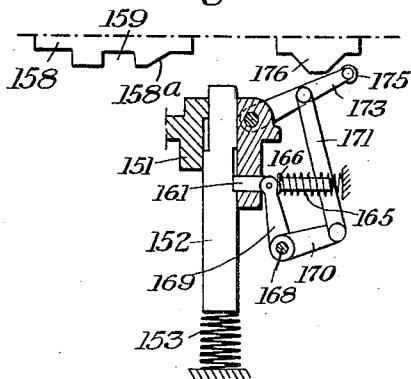


Fig.21.

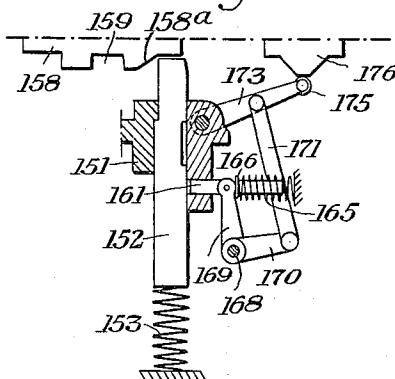


Fig.18.

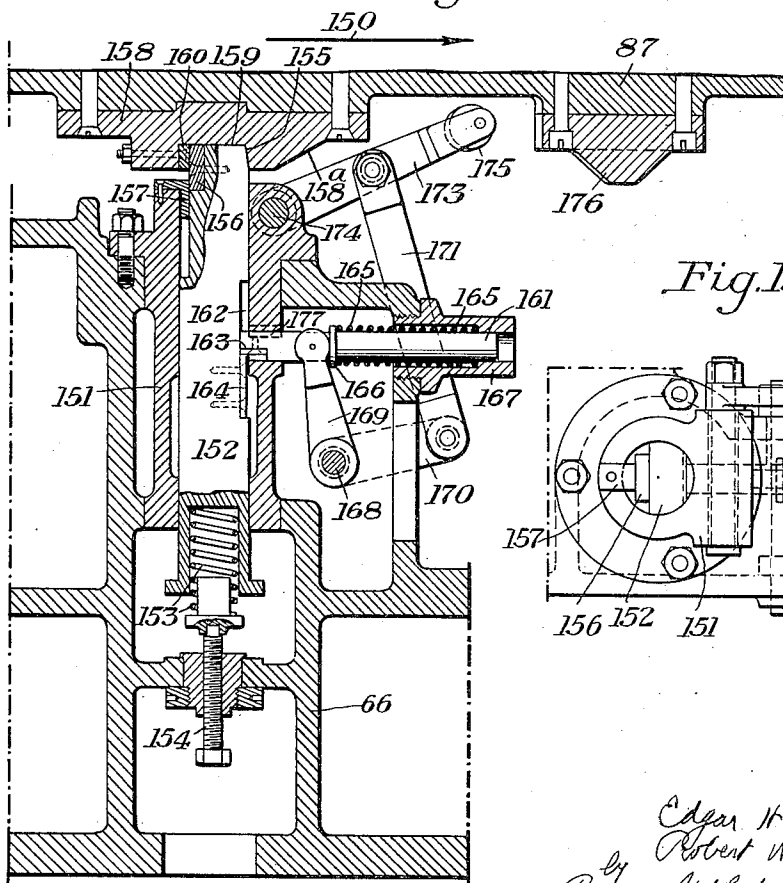
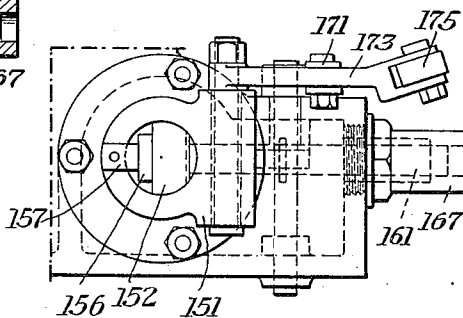


Fig.19.



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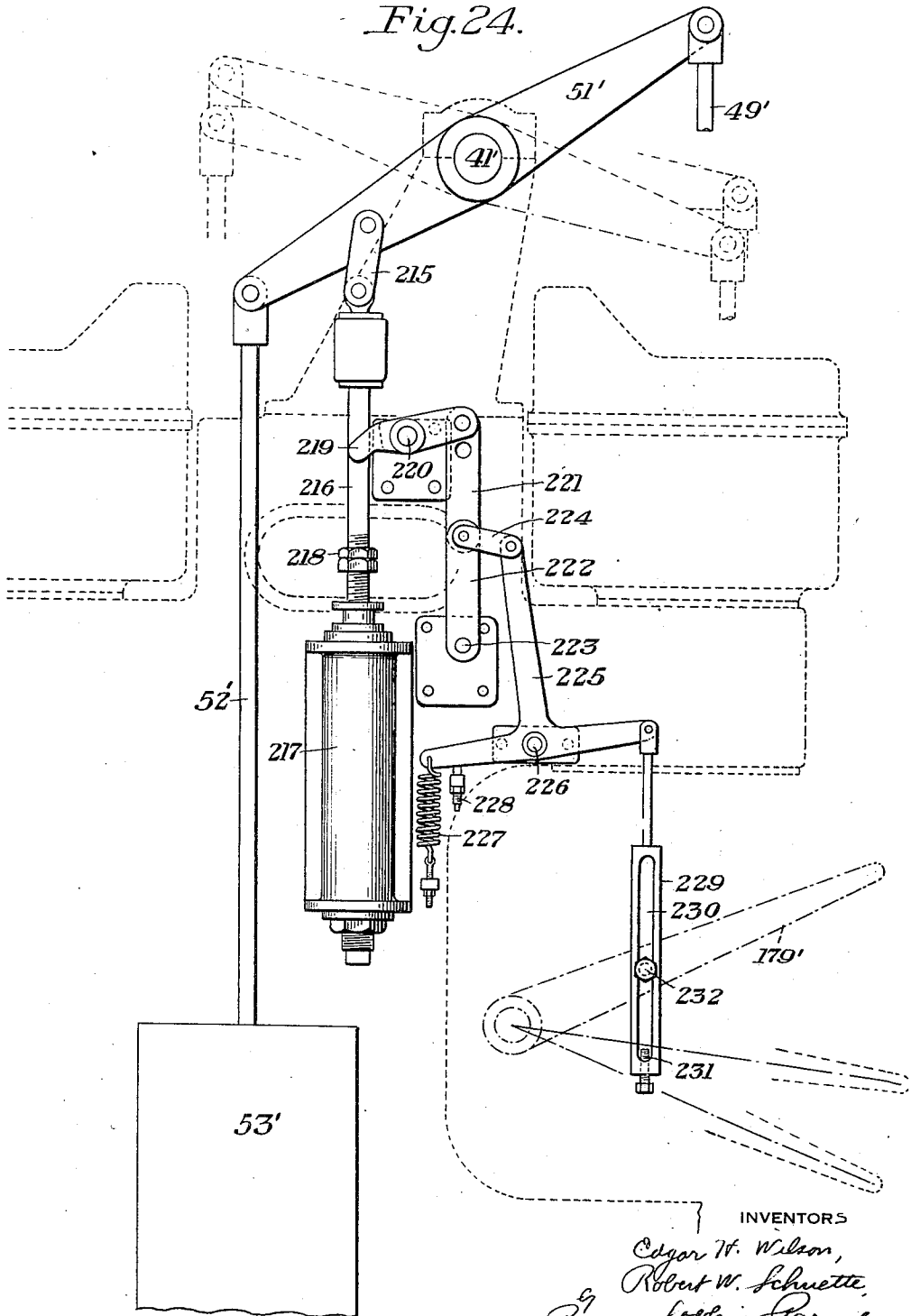
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METAL WORKING MACHINE

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Fig.24.



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UNITED STATES PATENT OFFICE.

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METAL-WORKING MACHINE.

Application filed March 1, 1926. Serial No. 91,386.

The present invention relates broadly to the art of metal working and more particularly to an apparatus and method for the production of accurate threads on couplings, although the utility of the invention is not limited entirely to this field of operation.

In the development of the art of manufacturing couplings, the change from the use of wrought iron, lap welded, or butt welded couplings and the introduction of couplings formed from seamless tubes has been accompanied by a corresponding change in the requirements with respect to the accuracy of threads produced in the couplings. It is well known that considerable difficulty is experienced, particularly with the seamless tube method of operation, in the production of tubular articles having either a uniform wall thickness, or a truly circular bore or exterior. The irregularities present in different articles have heretofore made it almost impossible to produce accurate threads in the opposite ends of couplings of such nature as to insure proper alignment of adjacent lengths of pipe, tube or casing threaded into the coupling. Where the couplings are intended for use in the oil fields or the like, it will be apparent that accuracy is of extreme importance as in a casing length of several thousand feet a small variation becomes considerably multiplied.

Heretofore, where seamless couplings have been used it has been necessary to carefully inspect the couplings before attempting to thread the same, in an effort to reject blanks having too great a variation in different portions of the wall thickness. Not infrequently this variation is as much as $12\frac{1}{2}\%$ + or - of the nominal wall thickness in large sized blanks. In such cases, the blanks have been scrapped as it has been considered impossible with known apparatus to produce accurate threads thereon.

Another difficulty encountered has arisen by reason of the comparatively high carbon content in such blanks, whereby local conditions of hardness are frequently set up either by reason of air currents or the local application of water, thereby tending to deflect either the boring bar or the threading die out of its true course.

The present invention has for one of its objects the production of an improved apparatus capable of operating on blanks having a wide variation either in wall thickness

or structural characteristics, and producing accurate threads thereon.

In the accompanying drawings there is shown for purposes of illustration only a preferred embodiment of the present invention, it being understood that the drawings do not define the limits of our invention as changes in the construction and operation disclosed therein may be made without departing either from the spirit of the invention or scope of our broader claims.

In the drawings:

Figure 1 is a side elevation of a machine embodying the present invention;

Figure 2 is a front view of the machine shown in Figure 1;

Figure 3 is a top plan view of the construction of Figures 1 and 2, the cover for the gear housing being omitted;

Figure 4 is a vertical sectional view, with certain of the parts being shown in elevation, on the line IV—IV of Figure 3 looking in the direction of the arrows;

Figure 5 is a vertical sectional view on the line V—V of Figure 6 looking in the direction of the arrows;

Figure 6 is a top plan view of the chuck table;

Figure 7 is a vertical sectional view similar to Figure 5 but taken on the line VII—VII of Figure 6 and looking in the direction of the arrows;

Figure 8 is a top plan view illustrating one form of mechanism for effecting mechanical movement of the chuck table;

Figure 9 is a vertical sectional view on the line IX—IX of Figure 8 looking in the direction of the arrows;

Figure 10 is a side elevation, partially broken away and partially in section, of the construction shown in Figure 8;

Figure 11 is a vertical sectional view on the line XI—XI of Figure 10 looking in the direction of the arrows;

Figure 12 is a sectional view, partially in elevation and partially broken away, the view being on an enlarged scale through one of the chuck trunnions and illustrating the construction thereof;

Figure 13 is an end elevation of the construction shown in Figure 12;

Figure 14 is a top plan view partly broken away and partly in section of the construction of Figures 12 and 13;

Figure 15 is a view similar to Figure 12

illustrating, however, the other trunnion of the chuck;

Figure 16 is a vertical sectional view on the line XVI—XVI of Figure 15 looking in the direction of the arrows;

Figure 17 is a detail sectional view, partly in elevation, illustrating in detail a preferred form of construction for the upper end of either the boring spindle of the tapping spindle;

Figure 18 is a vertical sectional view partly broken away and partly in elevation for the purpose of illustrating one form of indexing mechanism for the chuck table;

Figure 19 is a top plan view of the indexing mechanism of Figure 18;

Figure 20 is a diagrammatic view of the indexing mechanism illustrating the position of the indexing pin at the commencement of movement of the chuck table;

Figure 21 is a view similar to Figure 20 illustrating the position of the indexing pin at the time the chuck table approaches the limit of its movement;

Figure 22 is a detail view partly in section and partly in elevation illustrating the arrangement of control shafts, levers and sleeves in accordance with the machine shown in the drawings;

Figure 23 is a view similar to Figure 22 showing the reversibility of the control mechanism whereby the operating handles may be located at the opposite side of the machine from that shown in the drawings; and

Figure 24 is a diagrammatic view illustrating a slightly modified embodiment of the invention.

In producing a boring and tapping machine of the general character contemplated herein it is of the utmost importance to so construct the machine that a predetermined accurate relationship exists at all times between the holding chucks and the operating spindles. In accordance with the present invention this is preferably accomplished by providing chucks of a semi-floating nature adapted to be supported by seats accurately machined relatively to the axis of rotation of the respective spindles with which they cooperate. In this manner, a predetermined relationship between the axis of the spindles and the chucks is insured. This may be accomplished broadly by supporting the chucks in a rotatable table of such construction that the table may be bodily raised to remove the chucks from their supporting seats, rotated to a position to bring the chucks into cooperative relation with new seats, and then lowered to bring the chucks into engagement with such seats.

In carrying out the present invention there may be provided a machine of suitable construction having a base plate 2 car-

rying a supporting framework 3 projecting upwardly therefrom. Carried by the base 2 is a gear housing 4 containing a gear train 5 and a gear train 6. For driving the gear train 5 there may be provided a motor 7, while a similar motor 8 may be utilized for driving the gear train 6. As illustrated more particularly in Figure 4, the gear train 5 is operative, as for example, by means of bevel gears 9 for driving a vertically extending shaft 10 extending upwardly through the frame 3 and carrying at its upper end a bevel gear 11 meshing with a similar gear 12 on a horizontally extending shaft 13 in the upper portion of the frame. The shaft 13 is in turn adapted to drive a sleeve 14 by means of bevel gears 15. The sleeve 14 constitutes the immediate driving means for the tapping spindle T, this spindle being shown as journaled by means of the sleeve 14 within an upper bearing 16 and mounted at its lower end in a bearing 17. The spindle is illustrated as being of tubular construction having a coupling flange 18 at its lower end for the attachment of a suitable tap 19 although any other form of construction may be utilized as desired.

The gear train 6 is in turn adapted through mechanism similar to that hereinbefore described in detail for the tapping spindle T, to drive a boring spindle B similarly mounted within an upper bearing 20 and a lower bearing 21. At its lower end the boring spindle B is provided with a coupling flange 22 adapted to have secured thereto a suitable tool 23 effective for initially boring or cutting the coupling blanks to the desired size preparatory to the performance of the threading operation thereon.

With the exception of the particular construction of the operating tools carried by the two spindles, their construction and operation may be similar. Where the spindles are of tubular construction, as is preferably the case with large installations, the upper ends thereof may conveniently be constructed as illustrated in detail in Figure 17. In this figure a portion of the upper ends of the cavity within the tapping spindle T is shown as separated from the main body by means of an insertable division plate 24. Above this division plate the spindle may be filled to the desired extent with a suitable lubricant and is provided with an operating and suspending mechanism removable and insertable as a unit and held in position by means of a bushing 25. This unit mechanism may comprise an eye bolt body 26 shaped to cooperate with an upper anti-friction bearing 27 and a lower anti-friction bearing 28. The lower race 29 for the bearing 28 may be supported on a plate 30 loosely carried by the body 26 as by means of a bolt 31 adapted when the unit mecha-

nism is inserted in position within the upper end of the spindle to rest against a shoulder 32 formed therein. The upper race 33 of the bearing 27 in turn cooperates with the bushing 25. Each of these eye bolts for the respective spindles carries an attaching eye 34 adapted in the case of the tapping spindle to be connected by means of a link 35 to a lever 36 and in the case of the boring spindle to be connected by means of a link 37 with the lever 38.

The lever 36 for the tapping spindle is secured to a sleeve 39 mounted in bearings 40 in the frame of the machine and loosely surrounding a transversely extending shaft 41. At one end, illustrated as being the left hand end as viewed in Figure 2, the sleeve 39 has secured thereto a collar 42 carrying a lever 43, the lever 43 projecting forwardly and having depending therefrom an operating rod 44.

In like manner, the lever 38 for the boring spindle is secured to a sleeve 45 secured to the shaft 41 and mounted in bearings 46 in the frame of the machine. The shaft 41 at its outer end carries a collar 47 from which there projects a lever 48 from the outer end of which depends an operating rod 49. By reason of this construction, it will be apparent that by pulling downwardly on the operating rod 44 the tapping spindle T may be lowered, while pulling downwardly on the operating rod 49 the boring spindle B may be lowered.

As a matter of operating convenience it is desirable to have a construction of such nature that the spindles normally tend to assume a position as illustrated in Figures 1, 2 and 4 of the drawings, which corresponds to their inoperative position. For accomplishing this result, the sleeve 39 may have secured thereto a second collar 50 from which projects a lever 51 connected by means of a link 52 to a counterweight 53 slidable in suitable guides in the frame of the machine as clearly apparent from an inspection of Figure 3 of the drawings. In like manner, the shaft 41 may have secured to its outer end a collar 54 carrying a lever 55 having its outer end secured to a link 56 supporting a counterweight 57 similar to the counterweight 53. The counterweights 53 and 57 are preferably heavy enough to slightly more than counterbalance the weight of the respective spindles, whereby the spindles are normally drawn upwardly in the manner referred to.

In view of the massiveness of the mechanism adapted to be moved by the rods 44 and 49, and in view of the characteristics of the counterweights, it is desirable in many cases to provide mechanical means for assisting an operator in the lowering of the respective spindles, such means conveniently comprising mechanism effective for over-

coming the inertia of the parts and setting the same in motion. Such means may conveniently comprise a cylinder 58 for the tapping spindle and a similar cylinder 59 for the boring spindle. Each of these cylinders has a piston rod 60 projecting upwardly therefrom through a bearing 61 and is provided at its upper end with a roller 62 adapted respectively to underlie the levers 51 and 55 in such manner as to tend to move the same upwardly in a clockwise direction as viewed in Figure 1.

It will be apparent that the cylinders 58 and 59 may be of any desired construction for operation either by a gaseous medium or a liquid medium in accordance with the requirements. Ordinarily, however, in plants in which apparatus of this general nature is used air pressure is available, and the cylinders are therefore conveniently constructed to be operated at least in one direction by air under pressure. In actual operation, it has been found that it is almost impossible to maintain uniform pressure conditions in an air line, and if the air is utilized for producing the upward movement of the piston rods 60, the speed of movement will vary in accordance with the air pressure available at that particular instant. In order to obviate this objection, the cylinders may each conveniently comprise a hollow piston 63 carried by the rods 60 and adapted to be moved downwardly by air under pressure admitted through a suitable inlet as indicated at 64 in Figure 2. This downward movement is opposed by the action of a pressure spring 65, the initial pressure of which may be controlled by an adjustment 66. Under normal operation, air under pressure is constantly admitted to both the cylinder 58 and 59 for maintaining the pistons 63 in lower position. When it is desired to bring either of the spindles into operative position, this is accomplished by so operating a controlling valve in the air pressure line as to permit the pressure within the respective cylinder controlled thereby to be released, whereupon the spring 65 is effective for raising the piston and overcoming the inertia of the parts operatively connected to the spindle which it is desired to operate. In this manner the speed of movement of a given spindle can always be accurately predetermined irrespective of any variations which may exist in the pressure of the air supply available.

It will be apparent that the parts of the machine heretofore described may be accurately assembled and the bearings for the spindles so machined, and the spindles so constructed, that they will rotate about true centers. Having obtained such a condition a chuck table base 66 is rigidly secured to the base 2 in any desired manner, as by means of bolts 67 whereby to all purposes the base 66 constitutes an integral part of

the main machine construction. The chuck table base 66 is conveniently constituted by a casting hollow throughout the main portion of its body in order to reduce the weight, and with suitable openings O to permit of chip and cutting lubricant disposal.

Formed at the top of the base 66, and adjacent the base 2 in such position that their centers are in substantial alignment with the axes of rotation of the spindles are bearing flanges 68. Concentrically disposed with respect to each of the bearing flanges is an upwardly projecting bushing support 69, the top of the bushing support terminating in a plane below the top of the cooperating supporting flange 68. After the two bases are rigidly secured together, the respective spindles T and B are equipped with suitable cutting tools adapted to accurately machine the supporting flanges 68 and the bushing supports 69 whereby the desired accurate relationship will exist with respect to the rotation of the spindles, the supporting flanges and the bushing supports. This feature of machining the parts referred to in the chuck table base by means of the tapping and boring spindles respectively constitutes an important feature of the present invention, as by reason thereof much greater uniformity is obtainable than has heretofore been considered possible.

After the parts 68 and 69 in the base 66 have been machined as referred to, they are ready to receive hardened bushings. A bushing 70 is accordingly fitted in each of the supporting flanges 68 while a bushing 71 is fitted within each of the bushing supports 69. It will be noted that each of the spindles is illustrated as being provided with a pilot 72. The bushings 71 constitute pilot bushings, and are accurately machined to receive and support the respective pilots during the operations of boring or tapping.

Centrally carried by the chuck table base is a cylinder support 73 adapted to receive and support a cylindrical member 74 constituting a portion of a table elevating mechanism. Fitted within the upper portion of the member 74 is a sleeve 75 adapted to cooperate with the upper reduced portion of a piston 76. Within the lower end of the member there is located the piston head 77 preferably carrying suitable packing rings 78 as understood in the art. The piston is adapted to have a limited stroke as determined by the position of the lower end of the sleeve 75, and this stroke may be obtained by supplying any desired fluid under pressure, this fluid conveniently being conducted through an inlet 79 into a passage 80 in the lower end of the member 74 and from this passage in turn through a port 81 into the bottom of the cylinder, the cylinder being closed by a suitable plate 82.

Rotatably mounted within the piston 76

preferably on anti-friction bearings 83 is a piston rod 84, the piston rod being constructed for vertical movement with the piston and rotational movement independently thereof. For preventing a leakage of the actuating fluid around the piston rod, the piston may be provided with a sealing plate 85 on its lower end. Adjacent its upper end, the piston rod may be provided with a shoulder 86, with which one of the bearings 83 may conveniently cooperate, and serving to support a chuck table 87 mounted on the piston rod. After the chuck table has been positioned on the piston rod, it may be clamped thereon by means of a suitable washer 88 and screw 89, the piston rod and table being secured against relative rotational movement in any desired manner as well understood in the art.

By reason of the construction described, it will be apparent that an operator at will may supply fluid under pressure to the chuck table raising cylinder and thereby elevate the entire chuck table. The present machine is designed in such manner that the table will be elevated upon completion of each operation upon a coupling carried thereby and rotated while elevated to bring a new coupling into position. Upon completion of the rotation, the table will be lowered to again permit the performance of the desired operation on the coupling or couplings carried thereby. By means of this table movement, an accurate centering of the chucks is obtained as will be more fully pointed out hereinafter.

Referring more particularly to Figure 6 of the drawings, the chuck table 87 is illustrated as being provided with four chucks *a*, *b*, *c* and *d* respectively. Each of these chucks comprises a plurality of jaws carrying coupling gripping means 91. These jaws 90 are mounted for movement in known manner within a chuck ring 92 carrying diametrically opposed trunnions 93 and 94 about which each of the chucks is bodily rotatable. Each of the jaws 90 is also preferably provided with stops 95 limiting the insertion of a coupling between the jaws, thereby accurately centering the same and maintaining the two ends in such position that they will effectively cooperate with respective spindles upon operation of the machine.

A separate bearing 96 is provided for each of the trunnions 94 on the chuck rings and another bearing 97 for each of the trunnions 93, these bearings being arranged in pairs in radial alignment as clearly apparent from Figure 6 of the drawings. The construction of the bearings constitutes a very desirable feature of the present invention in that they cooperate with the table movement referred to and the accurately machined bushings 70 and 71 to insure the formation of accurate

threads in the couplings. Referring more particularly to Figures 15 and 16 in which one of the bearings 96 is illustrated in detail, it will be noted that the chuck table 87 is shaped to provide a series of depressions 98 equidistantly spaced and adapted each to cooperate with a cap 99 to form a bearing. Each of the caps 99 embodies a transversely extending upper portion 100 and vertically extending sides 101 constituting slides or guides for each of the chucks. As apparent from Figure 16, the overall width of the lower portion of the sides 101 is less than the width of the corresponding recess 98, whereby a cap 99 may be placed in position and accurately adjusted back and forth to secure true centering of the chuck. Thereafter dowel pins 102 may be utilized for tying each of the caps accurately in place, the holding being assisted by cap bolts 103.

Vertically slidable within the side guides 101 are sliding bearings 104 each carrying a bushing 105 within which the trunnions 94 rotate. These trunnions, as clearly apparent from Figure 15, are in turn hollow and carry sleeves 106 having internal threads 107 which cooperate with adjusting screws 108 provided for the adjustment of the inner jaws 90 of each chuck. The outer ends of the screws 108 may be squared as indicated at 109 to facilitate the application of a wrench thereto for adjusting the same and they may be held in adjusted position by lock nuts 110. The inner ends in turn may be provided with heads 111 adapted to fit within suitable recesses within the jaws, there being provided brackets 112 for maintaining the heads in cooperative relation with the jaws and for insuring movement of the jaws in unison with the screws.

In Figures 12 to 14 both inclusive there is illustrated in detail one of the bearings 97 cooperating with one of the trunnions 93. The table 87 adjacent its periphery is provided with recesses 113 similar to the recesses 98 and adapted to cooperate with caps 114 similar in construction and mounting to the caps 99. Slidable within each of the caps 114 is a slidable bearing 115 carrying a bushing 116 within which rotates a trunnion 93. Each of these trunnions 93 is in turn hollow and is provided with a sleeve 117 having internal threads 118 adapted to cooperate with a screw 119 formed on the hand wheel shaft 120. Within each of the trunnions 93 there is also provided a second sleeve 121 having an internal diameter preferably substantially equal to the outside diameter of the screw threads 119 whereby the screw shaft may be bodily slipped into position. Carried on the outer end of each screw shaft 120 and movable outwardly and inwardly therewith is a hub 122 carrying levers 123 by means of which the screw

shafts may be rotated to move the corresponding jaw inwardly or outwardly. Each of the screw shafts 120 has an inner head 124 similar in construction to the heads 111 on the screws 108, before described and held in position by means of brackets 125.

Also carried by the outer end of each of the trunnions 93 is an indexing disk 126, each of these indexing disks having a pair of diametrically disposed notches 127 formed therein, these notches bearing a predetermined relationship with respect to the chuck rings 92 whereby with the chuck rings in substantially horizontal position one of the notches will be in a position to cooperate with a latch 128 having a pivotal mounting 129 in the sliding bearing 115. This latch is provided with a release finger 130, and is normally urged in a counter-clockwise direction, as viewed in Figure 12, and into latching position by a suitable spring 131. By reason of this construction it will be apparent that each chuck, upon releasing its latch 128, may be rotated through substantially 180 degrees whereupon it will be automatically indexed in substantially the desired position by its latch 128.

In actual operation of the machine, upon elevation of the chuck table 87, the sliding bearings 104 and 115 in the bearings 96 and 97 respectively move vertically in the caps for a distance determined by the vertical movement imparted to the table. By reference more particularly to Figures 5, 12 and 15, it will be noted that each of the chuck rings is provided on its upper and lower surfaces with accurately machined seats 132. These seats 132, with the table in lower position, are adapted to engage the bushings 70, which bushings are thereupon effective for determining the final position of the chucks. This is true for the reason that after the seats 132 engage the respective bushings 70, the lowering movement of the table continues to an extent sufficient to provide a substantial space 133 between the table and the respective sliding bearings, as clearly shown in Figures 12 and 15. In this manner, the table itself is relieved of any centering operation with respect to the chucks, this operation being thrown entirely upon accurately machined surfaces carried by the base 63 which is in turn so machined, by the spindles themselves, as to insure absolute accuracy. It will be understood that the bushings 70 for the chuck rings, as well as the bushings 71 for the pilots, may be either formed by the spindles or by a separate machining operation on lathes, it being possible with careful lathe work to produce seating surfaces accurately conforming to the supporting flanges 68 and the bushing supports 69. We have found that by thus entirely relieving the chuck table of the duty of accurately positioning the chucks, and imposing this

duty upon a portion of the apparatus especially prepared for that purpose, much greater accuracy is insured.

With machines of the general nature herein shown adapted for operation on large sized bushings, the table and its associated parts are heavy enough so that the movement thereof represents a considerable problem. We have found that it is possible by the anti-friction mountings 83 to so mount the table that it may be turned freely enough by hand, but the repeated turning imposes, in many instances, an unnecessarily heavy duty on the machine operative. In order to obviate this objection, there may be provided means either for mechanically and intermittently moving the table as desired throughout its complete range of movement, or throughout only a portion of this movement. In Figures 8 to 11 both inclusive there is illustrated one form of mechanism which may be utilized for effecting this table movement. Assume a condition in which the table is adapted to rotate in the direction of the arrow 134 of Figure 10. Under such conditions, depending upon the number of chucks carried by the table, there will be provided a number of projections 135, these projections corresponding in number to the number of chucks. Adapted to successively cooperate with the projections 135 is a vertical movable table moving pin 136 normally urged upwardly by means of a spring 137 but provided with a curved rear face 138 adapted to permit a projection to freely ride over the pin and push it downwardly as may be required. The pin 136 may be held against rotation in its guide 139 by a suitable key 140, the guide 139 in turn being carried by a crosshead 141 slidable horizontally in guides 142. This sliding movement is adapted to be produced by a piston 143 movable in a cylinder 144, the cylinder being mounted in fixed position by a bracket 145. Under normal conditions of operation, fluid under pressure is admitted to the cylinder 144 through a port 146, thereby urging the piston 143 to the left against the action of a compression spring 147, as clearly shown in Figure 10. While the fluid under pressure might be utilized for producing the working stroke of the piston, as pointed out in connection with the cylinders 58, such an operation preferably does not take place for the reason that this air pressure is subject to a wide variation. For this reason, when it is desired to initiate a table movement, the operator, after having first lifted the table by operation of the piston 76, releases air pressure from the cylinder 144 permitting the spring 147 to start movement of the table. The stroke of the piston 143 is preferably less than that required for a complete table movement so that at the

time the table approaches the limit of its movement it is free from any operating mechanism. It has been found in actual practice, that by imposing the initial movement of the table on a suitable mechanism, an operator may easily exert the effort required to effect continuance of such movement.

It is conceivable that during the rotation of the table, fluid under pressure might accidentally be released from below the piston 76, thereby permitting the table 87 to lower unless suitable means for preventing such an operation is provided. We have found that such a safety means may conveniently comprise a plurality of pins 148 projecting upwardly from the cylindrical member 74 and adapted to normally ride on the lower surface of a flange 149 formed on the table. This flange, however, is provided at intervals with cut away portions adapted to receive the pins 148 as clearly shown in Figures 15 and 16. With such a construction, the table is held in elevated position once rotation has started until substantially the final movement of the table is obtained, whereupon the pins 148 come into registration with the cut away portions in the flange 149 and permit the table to drop. This constitutes a crude indexing means for the table as well as a safety appliance.

In the interest of accuracy which the present machine is designed to obtain, it will be obvious that the bushings 70 and the seats 132 must be so accurately machined as to reduce the possibility of clearance therebetween to a minimum. Even with this small clearance, however, it is necessary to produce an indexing operation much more accurate than that which can be obtained by the pins 148 working on the comparatively small diameter represented by the flange 149. For accomplishing this accurate indexing of the table we may utilize a mechanism as illustrated in Figures 18 to 21 both inclusive. The construction is illustrated in Figure 18 as applicable to a table moving in the direction of the arrow 150. Figure 18 is illustrative of the table in its accurately indexed position, Figure 20 is a view illustrating the table at a mid point in its rotation and Figure 21 is a view similar to Figure 20, both of these views being largely diagrammatic, and illustrating the position of the parts as the desired position is approached. This indexing mechanism for the table may comprise a sleeve 151 carried by the chuck table base 66 and suitably secured thereto. Vertically slidable within the sleeve 151 is a locking and indexing pin 152 which is normally urged upwardly by a spring 153 which cooperates with an adjusting device 154. The upper end of the pin has its forward surface 155, extending in the direction of rotation of the table in-

clined upwardly and rearwardly, while its back face is provided with a hardened steel wear plate 156. The entire pin may be held against rotation in the sleeve 151 by a suitable key 157 whereby reciprocation in the desired plane is insured.

The table at equidistantly spaced points, the number of which depends upon the number of chucks, carries a series of indexing plates 158 each of which is formed with a recess 159 shaped to accurately cooperate with and receive the upper end of the indexing and locking pin. The rear face of each of the recesses 159 is preferably formed by a hardened steel wear plate 160 similar in construction and operation to the plate 156.

After the combined indexing and locking pin is forced to the position illustrated in Figure 18, it is held in this position by a horizontal reciprocable latch 161 having its inner end fitting within a groove 162 in a pin 152 and provided with a wear plate 163 cooperating with a similar plate 154 carried by the pin. The latch 161 is normally urged inwardly into operative position by a spring 165 abutting at one end against a shoulder 166 on the latch and at its opposite end against an inwardly directed shoulder formed in the cap 167 within which the latch slides. The latch is adapted to be moved outwardly against the action of the spring 165 by a bell crank lever mounted for movement about a bearing 168, one arm 169 of the bell crank lever being adapted to directly cooperate with the latch and the other arm 170 being pivotally connected to a link 171 which in turn is pivotally connected to a lever 173 having a pivotal mounting 174 on the sleeve 151. The outer end of the lever 173 may carry an anti-friction roller 175, this roller being so located that it is adapted to be engaged by a cam 176 on the table, there being one of these cams for each of the latch plates 158. The latch is held against rotational movement during reciprocation, to insure proper cooperation of the plates 163 and 164 in any desired manner as by a key 177.

In actual operation of the machine, after an operation has been performed on the table, the table is raised from the position shown in Figure 18 to release it from the combined indexing and locking pin 152. The pin 152 is prevented from rising by reason of the latch 161. The table moving mechanism may now be energized to rotate the table in the direction of the arrow 150. After a predetermined amount of rotation, one of the cams 176, as illustrated in Figure 20, will approach the roller 175, and upon continued movement of the table will press the roller 175 and the lever 173 downwardly, as shown in Figure 21 thereby rotating the bell crank lever in a clockwise direction and releasing the pin 152. Under the in-

fluence of the spring 153 the pin 152 jumps upwardly into a position preparatory to entering the recess 159 in the plate 158. This plate is provided with an inclined leading edge 158^a which engages the upper end of the pin and moves it downwardly to an extent required to permit it to pass over the pin. As soon, however, as the recess 159 comes over the pin, the pin enters the recess and by reason of the shape of the recess and the upper end of the pin, accurately indexes the same and prevents any further movement. As the table is lowered at the completion of its rotational movement, the latch 161 is again set so that the parts are in position for a succeeding operation.

Referring to Figure 3 of the drawings, the table 87 is adapted to rotate in the direction of the arrow 178. This brings one of the chucks first under the boring spindle B and then under the tapping spindle T. Under the boring spindle one end of the coupling is bored out to the desired size with the chuck supported in one of the bushings 70, and thereafter the bored end of the coupling is passed to the tapping spindle. The coupling is then tapped, while the chuck is seated in the other bushing 70, it being understood that during both the boring and the tapping operation the respective spindles are guided by the pilots 72 cooperating with the bushings 71. After the completion of the threading, which may have taken place concomitantly with the boring of another coupling in a following chuck, the table is again rotated to position to bring the bored and tapped coupling out from under the tapping spindle. Thereupon the chuck is rotated and the coupling again successively operated upon by the spindles. As each coupling is completed, it is released from its chuck, and a new coupling inserted in position in the chuck.

It has been before pointed out that it is desired to normally maintain the spindles in their upper positions. While in such positions free rotation of the table is permitted without any danger of injury thereto or to the pilots. As a coupling C is brought into position beneath a spindle, however, it is necessary to lower the spindle to perform the desired operation thereon. This may be accomplished by providing an operating lever 179 adapted to control the lowering of the boring spindle and a similar lever 180 adapted to control the lowering of the tapping spindle. In like manner there may be provided an operating lever 181 for controlling the manual release of the boring spindle and a similar lever 182 for controlling the manual release of the tapping spindle. In connection with these levers, their construction and operation, attention is called more particularly to Figures 1, 2, 4, 120

22 and 23 of the drawings. In Figure 22 the frame 3 of the machine is illustrated as being provided on opposite sides thereof with bearings 183 and 184 respectively, and with an intermediate bearing 185. Extending transversely of the frame and through all of these bearings is a shaft 186 adapted to rotate at one end within the bearing 183 and at the other end within suitable bushings provided within a sleeve 187 which in turn rotates in the bearings 184 and 185. It will be understood that the shaft and sleeve are adapted to be individually and separately operated as found desirable. The outer end of the shaft 186 has secured thereto the operating lever 180 before referred to while the outer end of the sleeve 187 has secured thereto the operating lever 179.

Secured to opposite ends of the free portion of the shaft 186 are levers 188, while secured to the opposite ends of the sleeve 187 are similar levers 189, the levers 188 and 189 respectively being adapted respectively for the operation of cams which control the mechanism for lowering the boring spindle and the tapping spindle. This mechanism is duplicated for each of the spindles, and comprises half-nuts 190, as clearly shown in Figure 4 adapted to be closed by cams 191 of Figure 1, the cams being provided with cam slots 193 cooperating with pins 194 projecting from the half-nuts. A pair of the cams 191 is provided for each spindle, as clearly indicated in Figure 2. Projecting upwardly from each of the cams is a lug 195 with which cooperates a link 196 secured to the levers 188 or 189 before referred to. Upon pulling down on the operating lever 179, the half-nuts which control the tapping spindle will be closed, while upon similarly operating the lever 180, the half-nuts which control the boring spindle will be closed. Prior to the closing of the half-nuts, the cylinders 58 will have had the fluid pressure released therefrom to permit the springs 65 therein to lift the counterweights and lower the spindles into such position that the threaded portions 197 thereon will be in position to be engaged by the half-nuts.

In Figures 1 and 4 the half-nuts are illustrated as being in closed position. Such an operation involves rotation of either the shaft 186 or the sleeve 187 in a clockwise direction as viewed in Figures 1 and 4. The shaft 186 has secured thereto a spring lever 198 while the sleeve 187 carries a similar spring lever 199. As illustrated in Figure 4, each of these spring levers cooperates with a tension spring 200, one end of which is directly secured to the lever and the opposite end of which is carried by a portion of the frame of the machine. Closing of the half-nuts therefore places these springs under tension and accordingly the springs are normally urging such a rotation of the shaft

186 or the sleeve 187 as to open the half-nuts. It is not desirable to require an operator to manually hold the parts in position against the action of these springs, and therefore the shaft 186 is provided with a catch lever 201 while the sleeve 187 is provided with a similar catch lever 202. These catch levers are adapted to cooperate with catches 203 one of which is carried by a sleeve 204 in such position as to cooperate with the catch lever 202, while the other is carried by a shaft 205 rotatably mounted within the sleeve 204, and so disposed as to cooperate with the catch lever 201. The sleeve 204 and the shaft 205 are normally each rotated in a counter-clockwise direction as viewed in Figures 1 and 4 by means of springs 206, there being one spring each for the sleeve and the shaft. The springs 206 are normally effective for holding the catches 203 in such position that when the levers 179 or 180 are operated to close the respective half-nuts controlled thereby, the catch levers 201 and 202 will be engaged by the catches and held in such position that the half-nuts are held closed.

It will be apparent that if this condition were continued for too long a period, the spindles would be lowered to such an extent as to loosen the couplings. In order to obviate the possibility of such an occurrence, there is provided automatic means for releasing the catch levers. This means comprises a trip rod 207 for the sleeve 45 which controls the boring spindle and a similar trip rod 208 for the sleeve 39 which controls the tapping spindle. As the respective spindles are lowered, it will be apparent that the levers 55 and 51 which control the counterweights also move upwardly. As the trip rods are directly connected to these levers, a predetermined movement thereof in the upper direction will be effective for bringing the adjustable stop 209 thereon into contact with an arm 210 projecting rearwardly one from the sleeve 204 and one from the shaft 205. This will tend to rotate either the sleeve or the shaft in a clockwise direction and accordingly move the catch 203 into a position to release the respective catch lever engaged therein. By adjusting the stop 209, the amount of feed of the boring spindle or the tapping spindle may be individually and accurately controlled.

At times during the operation of the machine an operator may see trouble ahead and desire to manually release the catch levers. This may be accomplished by providing an operating lever 181 before referred to for the sleeve 204 and a second lever 182 for the shaft 205, these operating levers being effective in a manner similar to the operation of the trip rods 208.

In some cases it may be desirable instead of providing a cylinder, such for example as

the cylinder 58 or 59, operative merely for overcoming inertia of certain of the parts and initiating movement thereof, to provide means effective for moving such parts to a predetermined position. In the illustrated embodiment of the invention, the spindles are moved freely a predetermined distance, and are thereafter operated by means of threads which are engaged by the half nuts which are moved into position to cooperate therewith. With the cylinders 58 and 59 the spindles are merely given a start, and are thereafter moved to final position wherein the threaded portions may be engaged by the half nuts by a manual operation. In Figure 24 there is illustrated a modified embodiment of the invention in which parts corresponding to parts heretofore described are designated by the same reference characters having a prime affixed thereto. This figure of the drawings merely discloses a form of cylinder adapted to replace the cylinder 58, for example, of Figure 1. It will be apparent, however, that a similar cylinder may be applied to the opposite side of a machine to replace the cylinder 59.

In this modified embodiment the lever 51' has secured thereto a link 215, one end of which is connected to the piston rod 216 of the piston operable in the cylinder 217. The piston rod carries an adjustable stop 218 adapted to cooperate with a movable stop 219. This movable stop is illustrated as comprising a lever having a pivotal mounting 220, one end of the lever extending beyond the pivotal mounting and being bifurcated to straddle the piston rod for cooperation with the adjustable stop 218, while the opposite end extends rearwardly and is pivotally connected to a toggle link 221. The free end of the toggle link 221 has a pivotal connection to a second toggle link 222 having a fixed pivotal mounting 223 at a suitable point on the frame of the machine. The common pivotal connection of the toggle levers has operatively connected thereto a link 224 pivotally connected at its outer end to an inverted T-shaped lever 225. This T-shaped lever also has a fixed pivotal mounting 226 on the frame of the machine and is normally swung in a counter clockwise direction as viewed in this figure of the drawings by the action of suitable means such as a spring 227. The movement of the lever under the influence of the spring may be controlled by an adjustable stop 228 whereby the movement will be just sufficient to bring the toggle links into line for holding the stop lever 219 in the desired position to cooperate with the adjustable stop 218. The opposite arm of the T lever 225 has connected thereto a link 229 having an elongated slot 230, the bottom of which is formed by an adjustable stop 231. Working in the slot 230 is a pin 232 projecting outwardly from the lever 179',

corresponding to the lever 179 before described, and controlling the operation of the half-nuts 190.

In the operation of the form of mechanism shown in Figure 24, when it is desired to lower a spindle, fluid, or other operating medium, will be supplied to the cylinder 217 for moving the piston upwardly therein. This upward movement will continue until the stop 218 engages the stop lever 219 at which time further movement will be prevented. Thereupon an operator will manually lower the control lever 179' to close the half-nuts. At substantially the completion of the movement of the lever 179' the pin 232 will engage the stop 231 and rotate the inverted T lever in a clockwise position to break the toggle and move the stop lever 219 to an inoperative position. In this position the spindle will be under the control of the half nuts which will continue the movement thereof as before described. When the lever 179' is released at the conclusion of the operation of its cooperating spindle, the pin 232 will be permitted to move upwardly in the slot 230 whereby the inverted T lever will again be under the influence of the spring 227 for straightening the toggle links and bringing the stop lever 219 into position for a succeeding operation. It will be apparent that the operating lever 219 can not assume the position shown in Figure 24 until after such time as the stop 218 has moved to such a position that it will not interfere with this return movement. Thereafter the parts are again in operative position for a succeeding operation. Such a construction eliminates the necessity of any manual movement of either of the spindles, and in many cases, particularly with large installations, such a construction has been found to be extremely desirable.

It will be apparent to those skilled in the art that with the construction shown in Figure 24 it is possible to so position the adjustable stop 218 as to insure movement of the spindle to such an amount as to bring the cutter thereon almost into operative position and then retain the cutter in such position until the half nuts have been closed. Where there has been provided only a cylinder for initiating movement, it frequently happens with an unskilled operator that before the half nuts are closed the counterweighting mechanism for the spindles has produced a partial return movement thereof whereby time is subsequently lost in the slower movement to operative position under the influence of the lead screw.

Throughout the specification, the terms "raising", "lowering" and the like are used as words of description to designate movement away from or toward some predetermined point respectively, and are not used as words of limitation, it being obvious that

for certain purposes the machine herein disclosed might be arranged horizontally to facilitate certain operations.

The advantages of the present invention arise from the provision of a machine of the general character herein referred to embodying a base plate having accurately machined surfaces adapted to support the chucks during the performance of any operations on articles carried thereby.

Other advantages arise from the provision of a base for the chuck table of such construction that certain surfaces thereon may be machined by tools carried by the tapping and boring spindles, whereby absolute accuracy between the spindles and surfaces is insured.

Still other advantages arise from the provision of means for positively raising the chuck table to unseat the chucks, and for means preventing lowering of the table until substantially the desired position thereof has been reached.

Still other advantages of the invention arise from the provision of control mechanism adapted to be bodily reversed with respect to the machine in such manner that all of the control levers may be disposed at any one time entirely on one side of the machine. In this manner, a pair of machines may be assembled in adjacent relationship with the controls on one machine at the right hand side thereof and the controls for an adjacent machine at the left hand side thereof whereby one operator may control both machines. In Figure 22 the control mechanism is illustrated in position for a machine as shown in the drawings, while in Figure 23 it is illustrated as reversed end for end, the bearings 183 and 184 being reversed with the mechanism. Where two machines are disposed in such side by side relationship, one machine can be rotated in a clockwise direction, and the opposite machine in a counter clockwise direction, thereby enabling one operator to load both machines from a common point.

Further advantages arise from the mounting of the chucks on the tables in such manner that an adjustment can be made by reason of the caps which cooperate with the chuck trunnions to thereby insure accuracy of mounting of the chucks for the boring and tapping operations.

Still further advantages arise from the feature of latching the half nuts in position against the action by means normally tending to open the same. By reason of such a construction, when either of the spindles reaches a predetermined point in its lowering movement it is automatically released and permitted to move to inoperative position.

Still further advantages arise from the provision of mechanism for mechanically

initiating movement of the chuck table and from means for indexing the table and the chucks as well as from the provision of means for overcoming the inertia of the counterweights for the spindles and their associated mechanism.

We claim:

1. In a metal working machine, a chuck table, a rotatable chuck carried thereby, a chuck seat, and means for effecting a substantially vertical movement of said table to bring either side of the chuck thereon into supporting engagement with said seat.

2. In a metal working machine, a spindle, a chuck table, a plurality of chucks carried thereby, a plurality of chuck seats, and means for effecting substantially vertical movement of said table to bring the chucks into supporting engagement with said seats, said table being rotatable whereby the chucks effectively engage different seats.

3. In a metal working machine, a chuck table, a reversible chuck movably carried by said table, a chuck seat, and means for effecting movement of said table to move the chuck out of supporting engagement with said seat.

4. In a metal working machine, a chuck table, a chuck movably carried by said table, a chuck seat, means for effecting movement of said table to move the chuck out of supporting engagement with said seat, and means for rotating said chuck to bring another side thereof into engagement with said seat.

5. A chuck table for a metal working machine comprising a rotatable and floating chuck, carrying means for the chuck, indexing means for the chuck indexing means for the carrying means, a seat for the chuck and other means for moving the chuck into accurate supporting engagement with the seat.

6. In a metal working machine, a chuck table, means for displacing said table, said table being rotatable, means holding said table in displaced position until it has substantially reached a predetermined point in its rotation, a chuck on said table, and separate centering means for said chuck effective when said table is in normal position.

7. In a metal working machine, a chuck table, means for displacing said table, said table being rotatable, means for indexing said table, floating chucks carried by said table, and centering means for said chucks effective when the table is in normal position.

8. A metal working machine comprising a plurality of spindles, and means located entirely at one side of the machine for controlling the operation of said spindles, said control means being bodily reversible whereby the machine may be controlled from either side at will.

9. In a metal working machine, a spindle, a counterweight therefor, and means for

overcoming the inertia of said counterweight during at least part of the lowering movement of said spindle.

10. In a metal working machine, a spindle, a counterweight therefor adapted to normally maintain the spindle in inoperative position, and means for overcoming the inertia of the counterweight and at least initiating movement of the spindle into operative position.

11. In a metal working machine a movable spindle, means controllable at will for at least moving said spindle partly, and other means for completing movement of said spindle.

12. In a metal working machine, a spindle, a counterweight therefor, and spring means controllable at will for overcoming the effectiveness of said counterweight.

13. In a metal working machine, a spindle, a counterweight therefor, and fluid pressure control means for overcoming the effectiveness of said counterweight.

14. In a metal working machine, a spindle, a counterweight therefor, and combined fluid pressure and spring means controllable at will for determining the position of said counterweight.

15. In a metal working machine, a spindle, and spring means controllable at will for overcoming the inertia of said spindle.

16. In a metal working machine, a spindle, and fluid pressure control means for overcoming the inertia of said spindle.

17. In a metal working machine, a spindle, and combined fluid pressure and spring means controllable at will for determining the position of said spindle.

18. In a metal working machine, a rotatable chuck, means adapted to stop rotation of said chuck at approximately any desired point, a fixed centering means, and means for vertically moving the chuck into engagement with the centering means.

19. In a metal working machine, a reversible chuck, means adapted to stop said chuck at approximately any desired point, and chuck supporting means for accurately centering said chuck.

20. In a metal working machine, a chuck, means for moving the chuck to different stations, and means at said stations forming centering seats for the chucks, said seats having a diameter materially greater than

the diameter of the material being operated upon.

21. In a metal working machine, a chuck table, a chuck carried thereby, a chuck seat, in the form of a recess, and means for effecting relative movement between the chuck and chuck seat to bring the chuck and chuck seat into cooperative relation.

22. In a metal working machine, a chuck table, a chuck carried thereby, a chuck seat in the form of a recess, and means for effecting relative movement between the table and chuck seat to bring the chuck and chuck seat into cooperative relation.

23. In a metal working machine, a chuck table, a chuck carried thereby, a chuck seat in the form of a recess, means for effecting relative movement between the chuck and chuck seat to bring the chuck and chuck seat into cooperative relation, and means for rotating said table.

24. In a metal working machine, a chuck table, a chuck carried thereby, a chuck seat in the form of a recess, means for effecting relative movement between the table and chuck seat to bring the chuck and chuck seat into cooperative relation, and means for rotating said table.

25. In a metal working machine, a spindle, a table, a reversible chuck carried by said table, means adapted to stop reversible movement of said chuck at approximately any desired point, and means positioned beneath the chuck and cooperating with and supporting the same for centering the same relatively to said spindle, and positioning the same in a plane substantially normal to the axis thereof.

26. In a metal working machine, a spindle, a table, a reversible chuck carried by said table, means adapted to stop reversible movement of said chuck at approximately any desired point, and means cooperating with said chuck for centering the same relatively to said spindle and positioning the same in a plane substantially normal to the axis thereof, said last mentioned means being mounted independently of said table to permit relative movement between the same and said table.

In testimony whereof we have hereunto set our hands.

EDGAR H. WILSON.

ROBERT W. SCHUETTE.