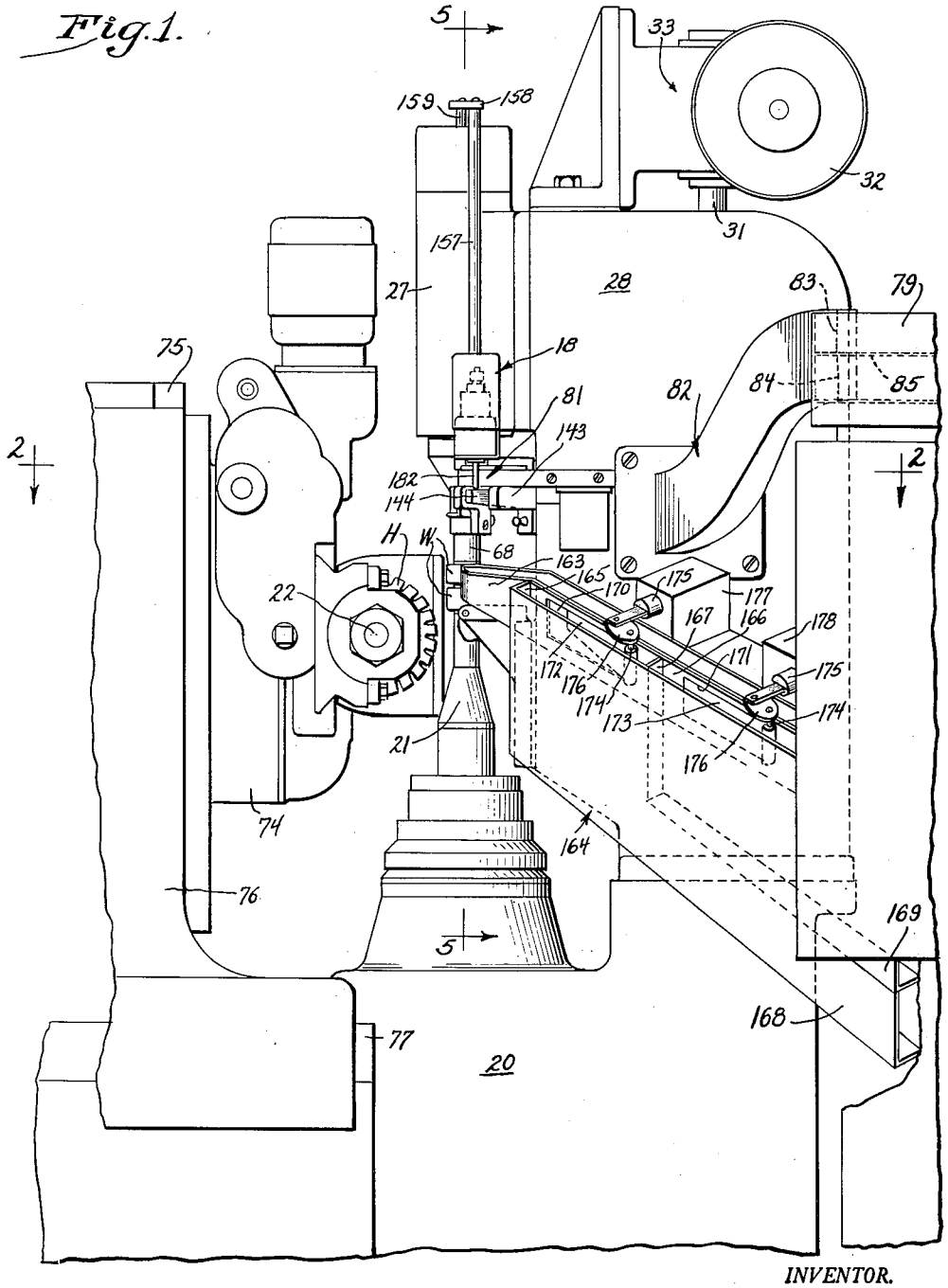
Feb. 20, 1962 A. C. DURDIN III 3,021,764

AUTOMATIC HOBBING MACHINE

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Fig. 1.



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Fig. 2.

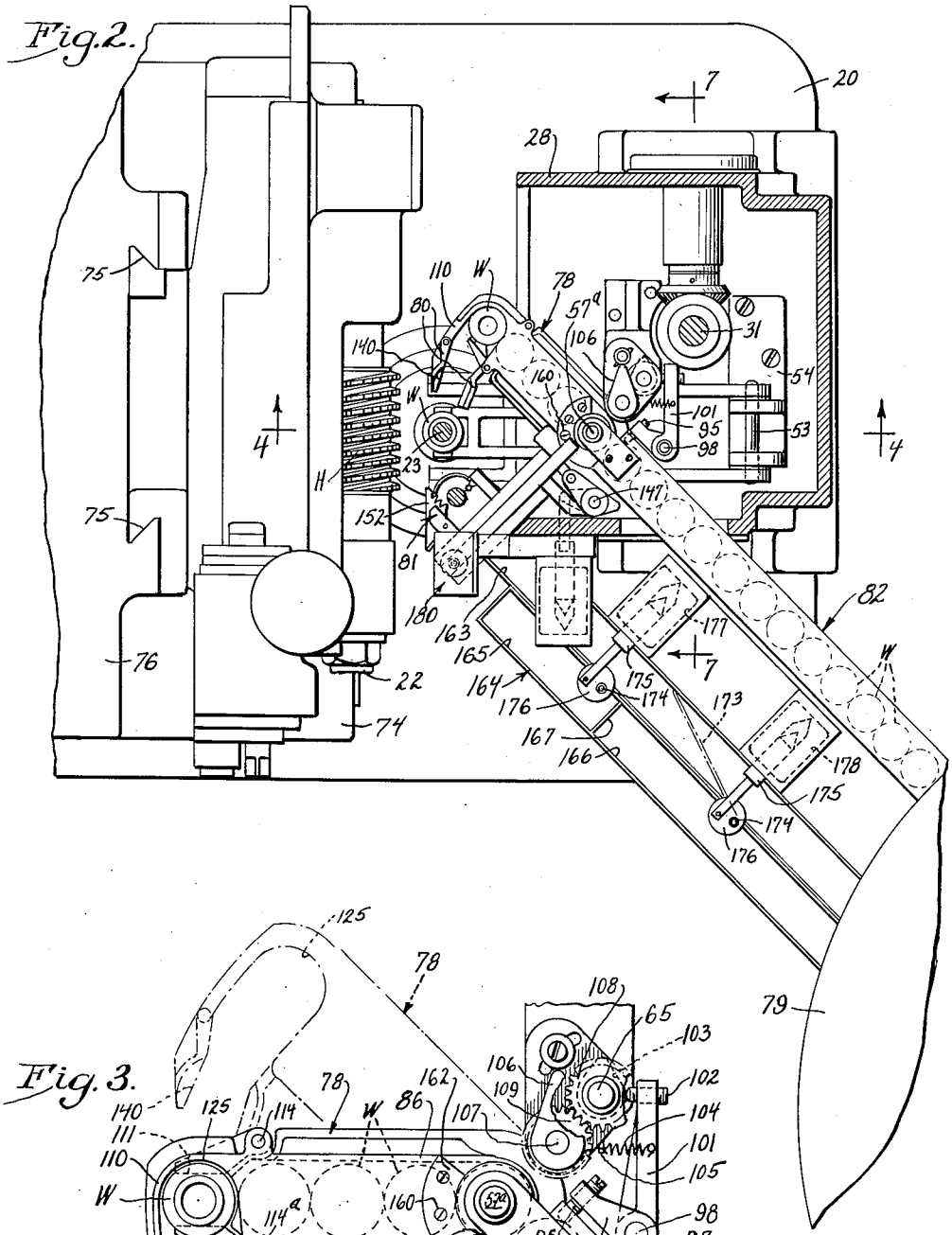


Fig. 3.

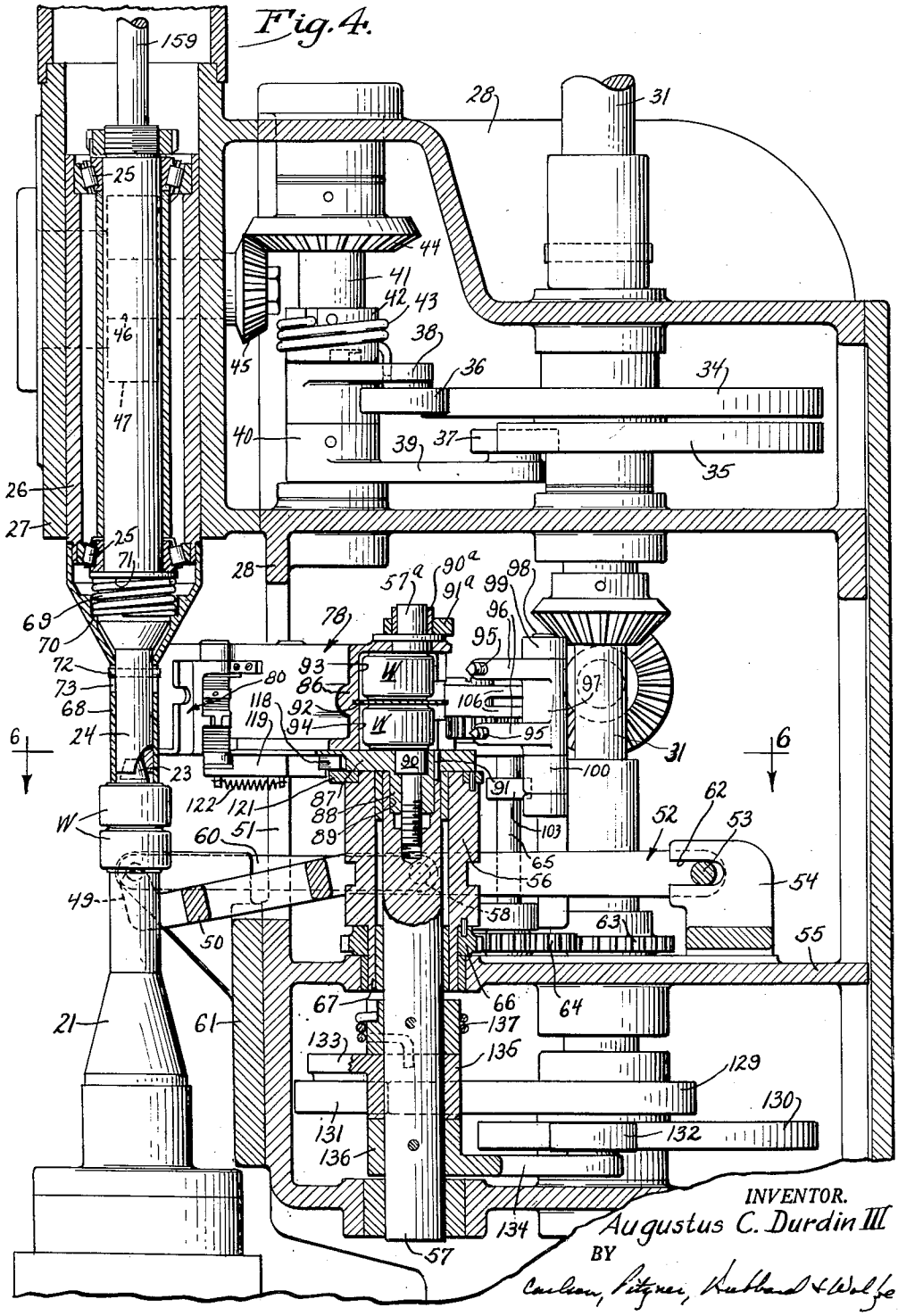
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AUTOMATIC HOBBING MACHINE

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Fig. 4.



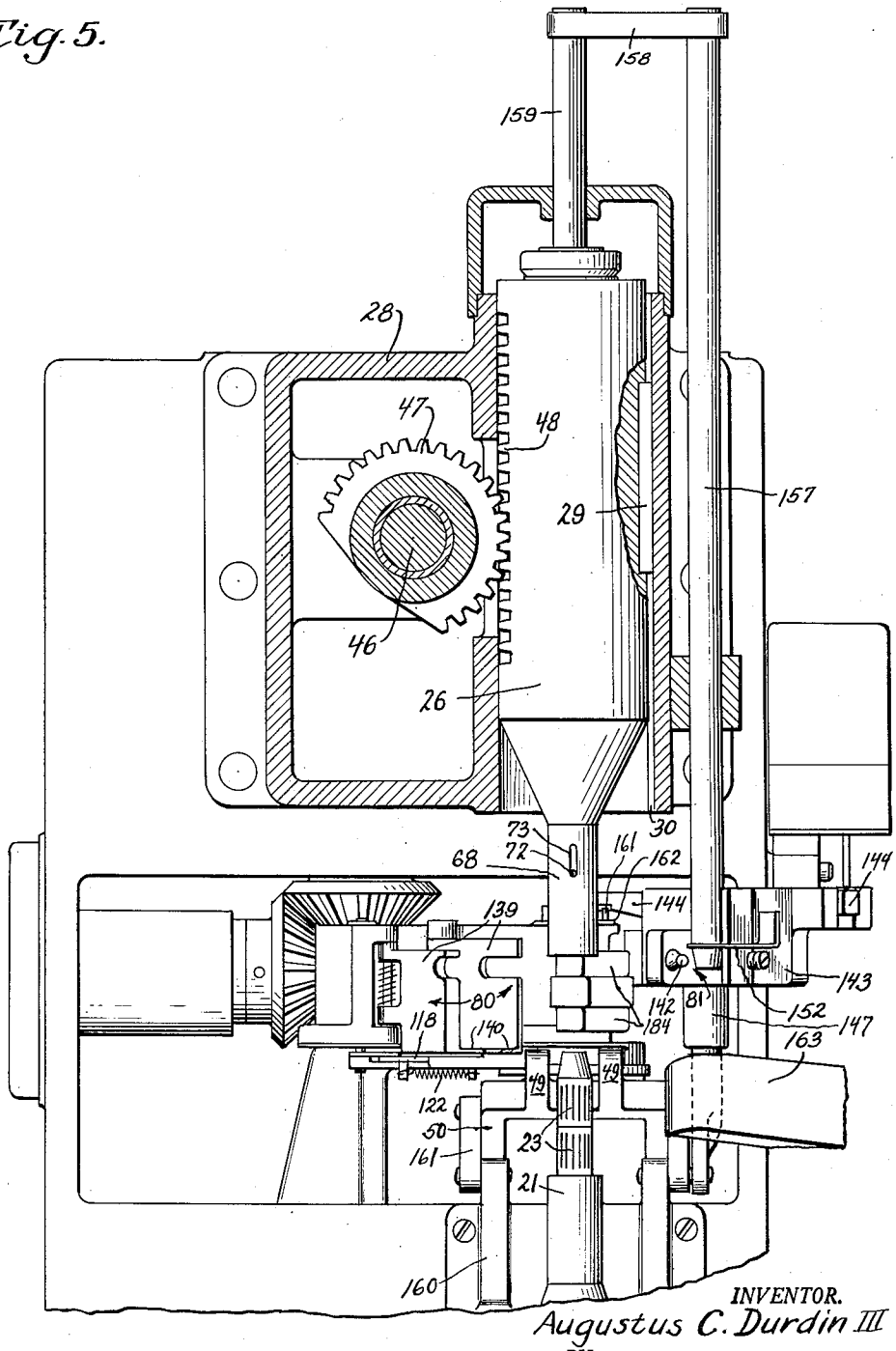
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AUTOMATIC HOBBING MACHINE

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Fig. 5.



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Fig. 6.

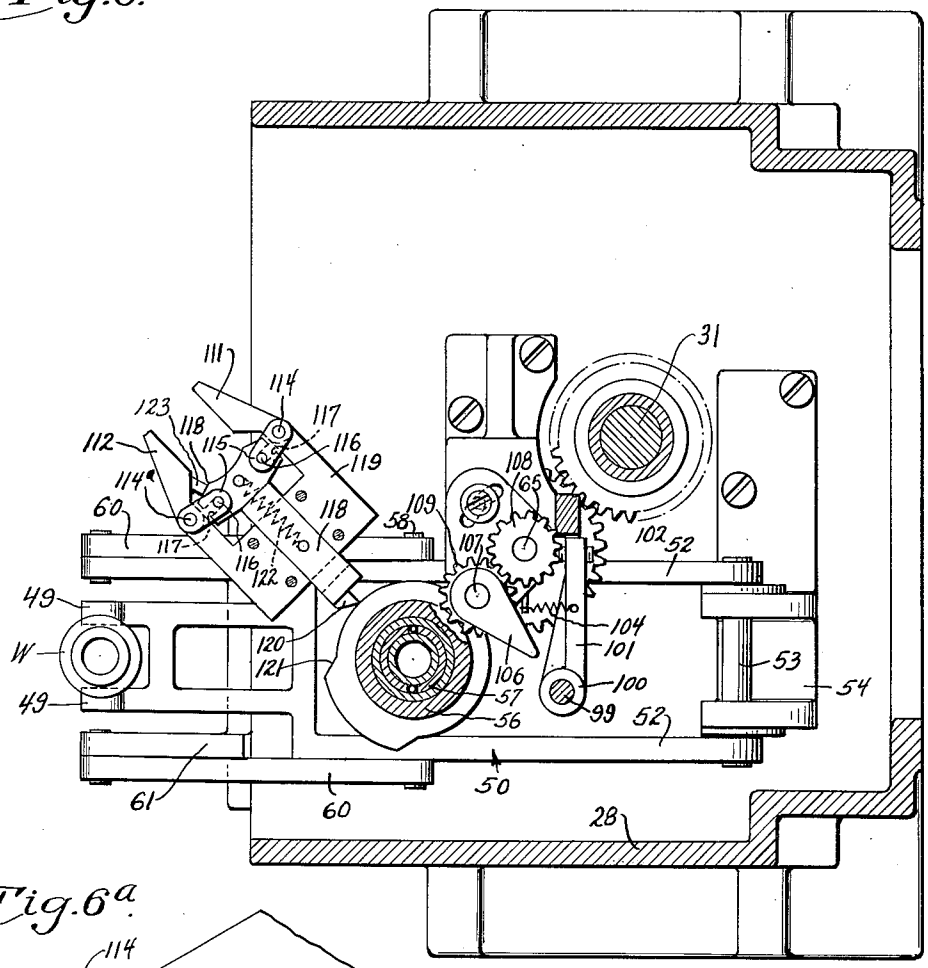
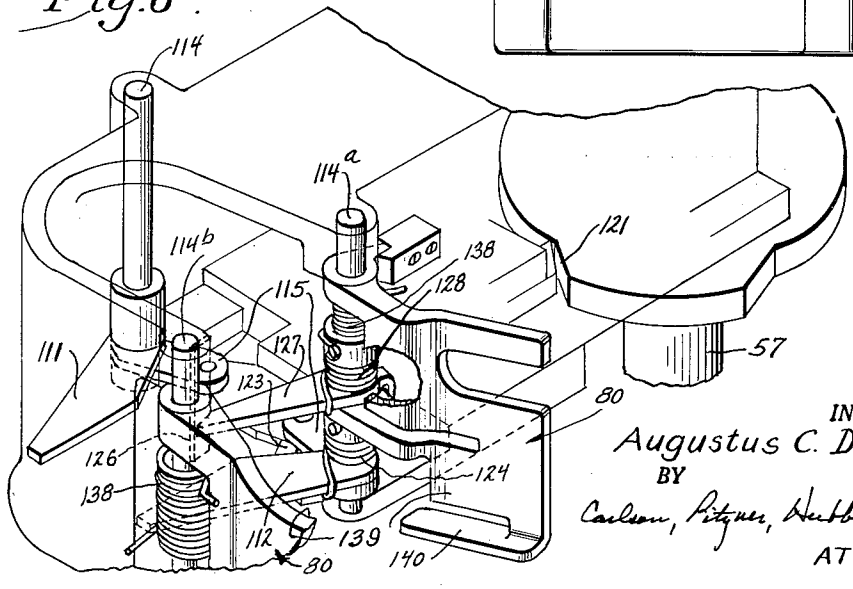


Fig. 6a



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Fig. 7.

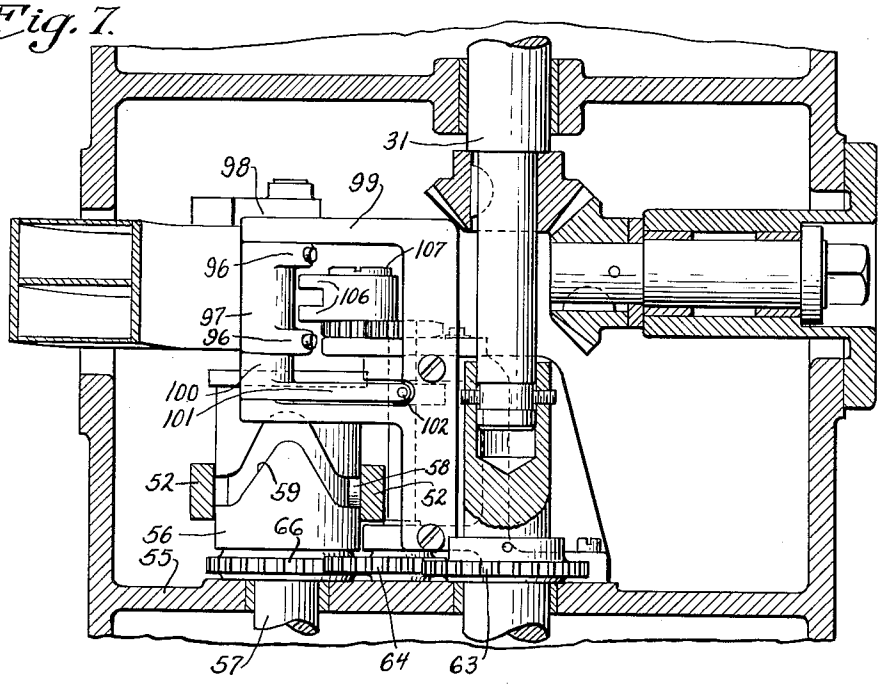
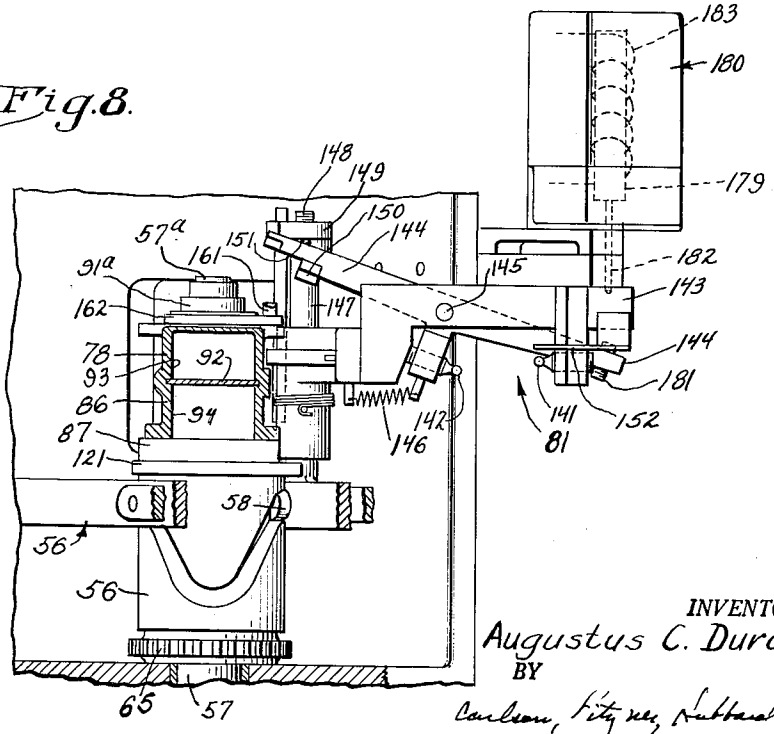


Fig. 8.



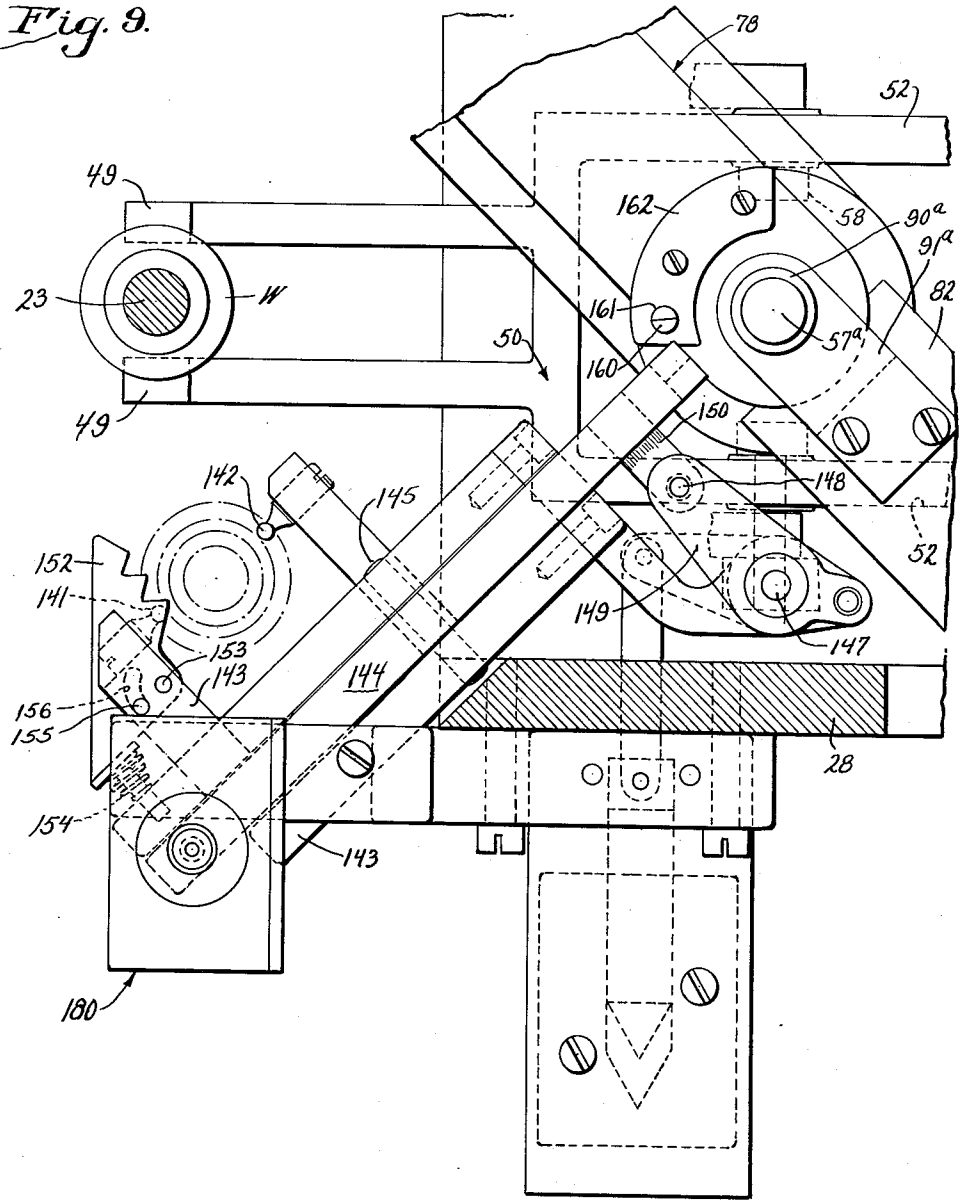
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Fig. 9.



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Fig. 10.

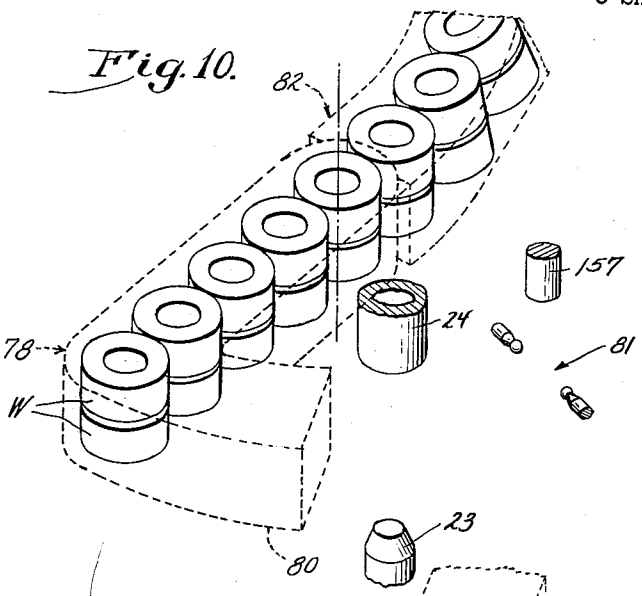
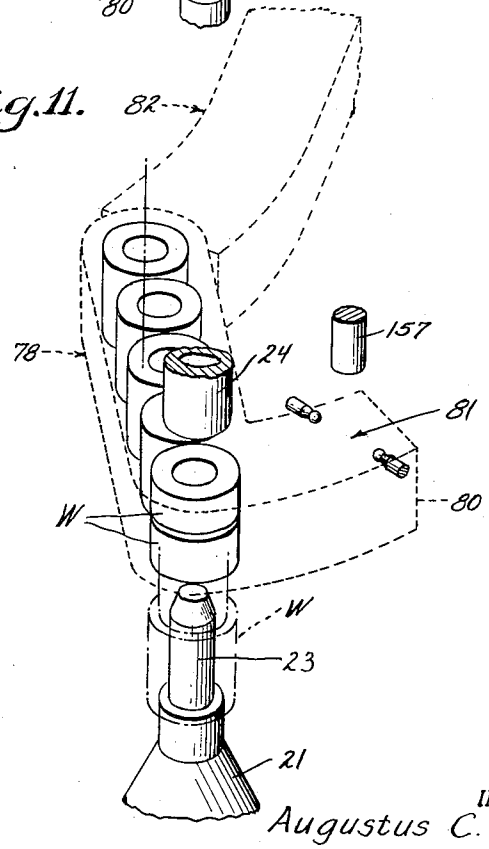


Fig. 11.



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Fig. 12.

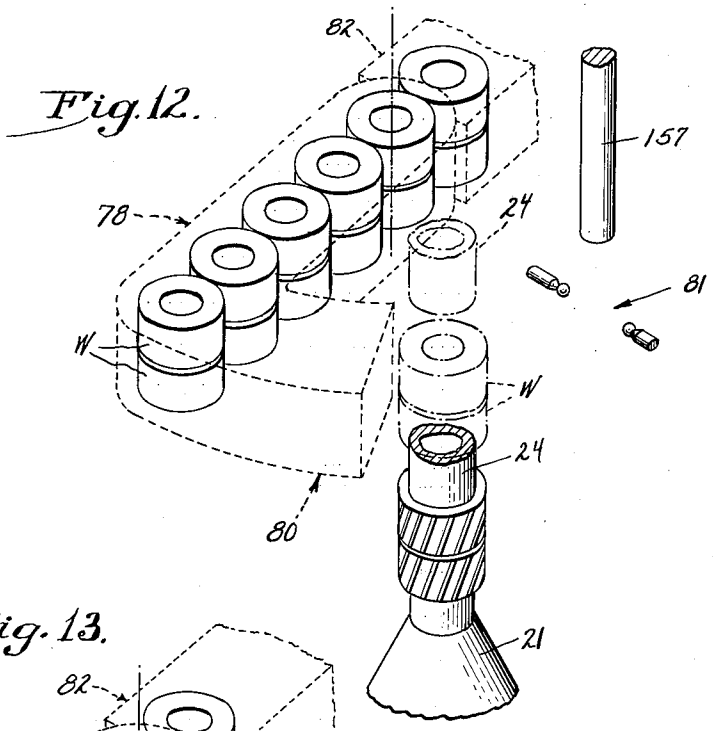
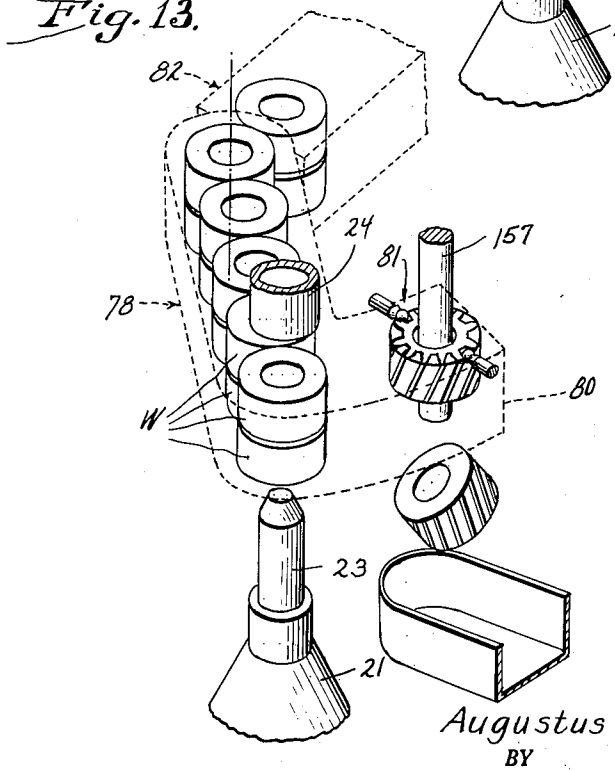


Fig. 13.



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United States Patent Office 3,021,764 Patented Feb. 20, 1962

3,021,764

AUTOMATIC HOBBING MACHINE

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Filed Aug. 30, 1956, Ser. No. 607,085
15 Claims. (Cl. 90—1)

This invention relates to hobbing machines for cutting gears, splines and the like and, more particularly, to one in which one or more workpieces are supported on a work spindle and are hobbed by a cutter supported on a tool spindle.

The general object of the invention is to provide a new and improved hobbing machine of the above character which is completely automatic in operation, which retains positive control of the work blanks and the finished workpieces and which is adapted for automatic compensation of inaccuracies.

A more detailed object is to provide a movable member which both loads the workpieces on the work spindle and removes the finished work from the spindle.

Another object is to utilize the member to transfer the finished work to a checking device so that the work always is under the positive control of the automatic mechanism until it is discharged from the machine.

A further object is to arrange the parts in a novel manner so that the finished work is removed from the work spindle and presented to the checking device and the work blank is delivered to the spindle all in a single motion of the movable member.

The invention also resides in the particular construction and arrangement of the movable member, the checking device and associated parts.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

FIGURE 1 is a fragmentary front elevation of a hobbing machine incorporating the novel features of the present invention.

FIG. 2 is a fragmentary sectional view taken along the line 2—2 in FIG. 1.

FIG. 3 is an enlarged view similar to FIG. 2 but shows the parts in a different position.

FIG. 4 is an enlarged fragmentary sectional view taken along the line 4—4 in FIG. 2.

FIG. 5 is an enlarged fragmentary sectional view taken along the line 5—5 in FIG. 1.

FIG. 6 is a sectional view taken along the line 6—6 in FIG. 4.

FIG. 6*a* is an enlarged fragmentary perspective view of the movable member.

FIG. 7 is an enlarged fragmentary sectional view taken along the line 7—7 in FIG. 2.

FIG. 8 is a fragmentary elevation of the checking mechanism and associated elements, parts being broken away and shown in section.

FIG. 9 is an enlarged fragmentary plan view of the checking device.

FIG. 10 is a schematic perspective view of the movable transfer member in its starting position.

FIG. 11 is a schematic perspective view showing the member presenting a workpiece to the work spindle.

FIG. 12 is a schematic perspective view showing the positions of the parts during the hobbing operation.

FIG. 13 is a schematic perspective view showing the transfer member presenting a workpiece to the work spindle and a finished workpiece to the checking device.

While the invention is adapted for use in various types of hobbing machines, it is shown in the drawings, for

purposes of illustration, embodied in a machine of the vertical type which comprises a base 20 supporting the operative elements of the machine. Supporting the work, herein one or more gear blanks W, from which gears are hobbed is a vertical work spindle 21 upstanding from the base and turned by a suitable drive motor (not shown). In the present instance, two blanks are supported by the spindle and are hobbed by a cutting tool or hob H on a horizontal tool spindle 22.

The gear blanks W are received on an arbor 23 (FIGS. 4 and 5) which projects upwardly from the upper end of the spindle 21 and through bores in the blanks. The arbor is expansible against the walls of the bores to cause the blanks to rotate with the spindle. Arbors of this type are well known in the art and may be expanded pneumatically.

To hold the blanks W down on the spindle 21, a hollow vertical tail stock 24 engages the top of the work as shown in FIG. 4. The tail stock is journaled in vertically spaced antifriction bearings 25 on a slide 26. The latter is movable up and down in a cylinder 27 on the side of a hollow column 28 upstanding from the base 20. A key 29 (FIG. 5) rigid with the slide 26 rides in a groove 30 in the cylinder 27 to prevent the slide from turning.

For loading and unloading the blanks W, the slide 26 is moved up to back the tail stock 24 away from the spindle 21 so that the blanks may be slipped onto and off the arbor 23. Such movement of the slide is effected by a vertical camshaft 31 (FIG. 4) which is journaled in the column 28 and is driven by a motor 32 (FIG. 1) through suitable reduction gearing 33. As will be seen later, the shaft is turned one revolution for each hobbing operation.

Two cams 34 and 35 (FIG. 4) fast on the camshaft 31 engage follower rollers 36 and 37 respectively, the rollers being on the ends of horizontal arms 38 and 39. The arm 39 is integral with a collar 40 which is pinned to a vertical shaft 41 journaled in the column 28 adjacent the cylinder 27. The other arm 38 is free to turn on another collar 42, also pinned to the shaft 41, and is connected to this collar by a coiled torsion spring 43 encircling the collar with its ends secured to the collar and the arm. The arms 38 and 39 are angularly spaced and the cams are shaped so that one follower engages a rise while the other is on a fall and vice versa. With this arrangement, the followers are held against their respective cams whereby rotating the camshaft 31 oscillates the shaft 41.

Oscillation of the shaft 41 is utilized to raise and lower the slide 26 and hence the tail stock 24. This is achieved by pinning a bevel gear 44 (FIG. 4) on the shaft 41 to mesh with a bevel gear 45 which is fast on one end of a horizontal shaft 46 journaled on the column 28 alongside the cylinder 27. At its other end, the shaft 46 carries a segment gear 47 (FIG. 5) which meshes with the teeth of a rack 48 formed vertically on the side of the slide 26. The two cams 34 and 35 operate together to turn the shaft 41 first in one direction and then in the other thereby to raise and lower the slide. The torsion spring 43 provides a yieldable connection between the camshaft 31 and the slide so that the camshaft may continue to turn should the tail stock jam as would be the case if the bores in the gear blanks W were too small for the arbor 23.

To unload finished gears from the work spindle 21, the tail stock 24 is raised and the gears are lifted off the arbor 23 so that they may be shifted laterally out from between the tail stock and the arbor. Lifting of the finished gears is effected automatically and at the proper time by fingers 49 (FIGS. 4 and 6) which engage the underside of the lower gear and are moved up by the camshaft 31.

In the present instance, the fingers 49 straddle the work

spindle 21 and are formed integrally as projections on the end of a U-shaped lever 50 (see FIGS. 4 and 6). The lever is disposed horizontally within the column 28 with the fingers projecting out through an opening 51 and is fulcrumed at the ends of the legs 52 of the U by a pin 53 on a bracket 54 upstanding from a horizontal wall 55 within the column. The legs 52 straddle a barrel cam 56 rotatably mounted on an upright shaft 57 which is journaled in the column 28. A pin 58 (FIG. 7) projects inwardly from one of the legs and into a cam groove 59 on the cam so that, as the latter is turned, the lever 50 is swung up and down about its fulcrum 53 thereby raising and lowering the fingers 49. Links 60 (FIG. 6) are pivotally connected at one end to the pins 58 and at the other end to a bracket 61 projecting outwardly from the side of the column 28. As the lever 50 is swung up, the links pull the lever forward, this being permitted by disposing the fulcrum pin 53 in a horizontal slot 62 in the bracket 54. Thus, the links cause the fingers 49 to follow a generally straight path and remain under the gears being lifted off the arbor 23.

To turn the cam 56 from the camshaft 31, a gear 63 (FIG. 4) fast on the camshaft meshes with a gear 64 on a vertical shaft 65 which is journaled in the column 28 between the camshaft and the shaft 57. The gear 64, in turn, meshes with a gear 66 pressed and pinned on the hub 67 of the cam 56. The gears 63, 64 and 66 are the same size so that the cam 56 makes one revolution for each revolution of the camshaft 31.

The finished gears are held down on the fingers 49 as the latter are raised by a sleeve 68 which encircles and is slidable on the tail stock 24. The sleeve is urged downwardly relative to the tail stock by a compression spring 69 (FIG. 4) acting between an internal shoulder 70 on the sleeve and a shoulder 71 rigid with the tail stock. The amount the sleeve can slide is limited by a pin 72 whose ends project laterally from the tail stock and into slots 73 in the sleeve.

As shown in FIGS. 1 and 2, the hob H is supported on the tool spindle 22 which extends transversely of the work spindle 21 and herein is horizontal. The hob, at the start of a cycle, is in the position illustrated in FIG. 1 and first is moved horizontally toward the work spindle and then is fed up into the gear blanks W. After the cut is completed, the hob is backed off and then is rapid traversed down to its starting position.

To obtain the desired movements of the hob H, the tool spindle 22 is carried on a tool head 74 which slides up and down in ways 75 on a saddle 76. The latter slides horizontally on ways 77 on the base 20. The head and the saddle are moved along their respective ways by suitable power actuators which are energized automatically in a manner known in the art to provide the proper program of hob movement.

The present invention contemplates the provision of a novel mechanism for loading and unloading the work spindle 21 automatically and in timed relation with the movements of the hob H. This mechanism includes a member 78 (FIG. 2) which receives work pieces W from a hopper 79 and presents them to the work spindle. The member moves transversely from a starting position at one side of the spindle to a loading position in which it holds the work or gear blanks over the arbor 23 and between the latter and the tail stock 24. The tail stock is up away from the arbor when the member presents the blanks to the spindle and then moves down to remove the blanks from the member and push them onto the arbor.

Movement of the member 78 from the starting position to the loading position is utilized to remove the finished gears from the work spindle 21. For this purpose, elements 80 carried by the member engage the finished gears as it approaches the loading position and remove the gears as this position is reached. In this way, the member 78 both loads and unloads the work spindle.

Advantage is taken of the removal of the finished gears from the work spindle 21 by the member 78 to present at least one of the gears thus removed to a checking device 81 which determines the accuracy of the hobbing operation as by measuring the pitch diameter of the gear. In this way, the gear is checked while it still is under the positive control of the member and, moreover, the measurement may be made before the next blanks are hobbed so that, if desired, the device 81 may give a signal that a correction should be made or, alternatively, the device may automatically effect the correction.

The checking device 81 is disposed alongside the work spindle 21 on the opposite side from the starting position of the member 78. The lateral spacing of the device and the work spindle is such that the elements 80 present the finished gears to the checking device as the member moves into the loading position. Thus, a simple movement of the member unloads the finished gears, presents them to the checking device and loads gear blanks onto the work spindle.

FIGS. 10 through 13 illustrate schematically the successive movements of the gear blanks and the resulting gears in the preferred embodiment of the invention. Initially, the member 78 is disposed at one side of the work spindle 21 as shown in FIG. 10 and carries a plurality of pairs of gear blanks W, in this instance five pairs, which it has received from the hopper 79. With the tail stock 24 in its upper position, the member is moved laterally to place the front pair of blanks between the tail stock and the arbor 23 as shown in full lines in FIG. 11. Then, by a mechanism to be described later, the blanks are released from the member and the tail stock is lowered to push the blanks onto the arbor (see broken lines in FIG. 11).

After the blanks W have been loaded on the work spindle 21, the member 78 moves back to its starting position where it receives another pair of blanks from the hopper 79 and the hob H is fed into the blanks to cut the gear teeth. When the hob has finished its cutting stroke and has been backed off, the motor 32 (FIG. 1) is started by a suitable timing control (not shown) so that the camshaft 31 raises the tail stock 24 and the fingers 49 to return the finished gears to the level of the member 78 (see FIG. 12).

Next, the member 78 again is moved toward the loading position and, as it approaches this position, the elements 80 pick up the finished gear from the work spindle 24. The member continues on toward the loading position and, when it reaches that position, the elements 80 have presented the upper one of the finished gears to the checker 81 (see FIG. 13). When this gear has been measured, it is released. At the same time, the next set of blanks are pushed down on the arbor 23 and the member is returned to its starting position so that the parts again are ready for the hobbing operation.

In the present instance, the member 78 is a horizontal arm pivotally supported at one end to turn about an upright axis disposed behind the work spindle 21. The inner end of the arm is located at the end of a chute 82 (FIG. 1) which guides the blanks W from the hopper 79 to the arm. The hopper may be of the vibratory type and supplies blanks simultaneously to upper and lower passages 83 and 84 of the chute, the passages being formed by a transverse partition 85, so that the blanks are delivered to the arm in pairs.

The arm 78 comprises an elongated horizontal hollow casting 86 (FIG. 4) secured to a flat plate 87 extending across the casting. At its inner end, the plate is formed with a hub 88 which is received in a bore 89 in the upper end of the shaft 57 and the plate is fastened rigidly to the shaft by a screw 90 and pins 91. Thus, the shaft constitutes the pivot for the arm and swings the arm back and forth between the starting and loading positions. Upstanding from the casting and alined with the hub is a stud 57a which is journaled in a bearing 90a. The latter is pressed into a plate 91a (FIG. 3) which is secured

to the chute 82, and provides an upper support for the pivoted arm 78.

A horizontal plate 92 (FIGS. 4 and 8) inside the casting 86 divides the latter into upper and lower passages 93 and 94 which, when the arm 78 is in the starting position as shown in FIG. 2, form continuations of the chute passages 83 and 84. Movable detents 95 (FIGS. 3 and 4) engage the end gear blanks in the chute 82 and hold them in the passages 83 and 84 when the arm swings away from the starting position but release the blanks when the arm returns to this position so that the blanks may enter the arm passages 93 and 94. Herein, the detents 95 are screws threaded through spaced parallel arms 96 which project horizontally from a collar 97 fixed to an upright shaft 98, the shaft being journaled in a bracket 99 (FIG. 7) on the column 28. Also fixed to the shaft 98 is a second collar 100 with an integral horizontal arm 101 that carries a screw 102. The latter constitutes the follower for a cam 103 which is secured to the shaft 65. A contractile spring 104 acting between a stationary lug 105 and the arm 101 holds the follower against the cam. Thus, as the shaft 65 turns, the cam 103 swings the detents into and out of engagement with the end blanks in the chute 82, the cam being shaped so that these blanks are released only when the arm is in the starting position.

To insure the entry of the gear blanks from the chute 82 into the arm 78, the blanks released by the detents 95 are pushed positively into the passages 93 and 94 by fingers 106 (FIGS. 2, 3 and 6). The latter are fast on a vertical shaft 107 and project horizontally. The shaft is disposed near the pivot 57 of the arm 78 so that, when the detents 95 release a pair of gears, the latter begin to slide by gravity toward the arm and then the fingers 106 swing in behind these gears and push them into the passages 93 and 94. The shaft 107 is turned to swing the fingers in timed relation with the movements of the arm and the detents by a gear 108 which is fast on the shaft 65 and meshes with a gear 109 on the shaft 107.

When the arm 78 swings to the active position, it holds the pair of gear blanks W which are at the free end of the arm over the arbor 23 and under the tail stock 24. In this position, the blanks are released and are removed vertically from the arm by the tail stock which pushes the blanks down onto the arbor and clear of the arm. For this purpose, the plates 87 and 92 which support the blanks as they advance along the arm stop short of the wall 110 at the free end of the arm and the two blanks at this end are supported by two flat arms 111 and 112 (FIG. 3) with the upper blank resting on the lower one. Normally, the arms are spaced apart horizontally a distance less than the diameter of the blanks and, when the blanks are over the arbor 23, the arms are moved apart to permit the blanks to be moved down out of the transfer arm 78. The leading side of the transfer arm is open at the outer end as indicated at 113 (FIG. 3) to permit the arm to clear the tail stock 24 as it swings back to the starting position.

In the present instance, the arms 111 and 112 are pivoted on the arm casting 86 by means of small vertical shafts 114 and 114a (FIGS. 3 and 6a). Lever arms 115 project inwardly from the shafts at generally right angles to the supporting arms 111 and 112 and carry pins 116 which are received in slots 117 in a cross slide 118. The latter slides longitudinally of the transfer arm 78 in a block 119 (FIG. 4) secured to the underside of the plate 87.

At its inner end, the cross slide 118 carries a cam follower 120 (FIG. 6) which rides on the periphery of a cam 121 pressed and pinned onto the upper end of the barrel cam 56. The follower is held against the cam by a contractile spring 122 acting between the cross slide and the block 119.

The arm 111 is fast on the shaft 114 so that turning of the lever arm 115 swings this arm. The arm 112, however, is free on the shaft 114a and carries an abutment 123

(FIG. 6) which engages the associated lever arm and a torsion spring 124 (FIG. 6a) acting between the arm 112 and its shaft urges the arm in and holds the abutment against the lever arm. The spring 124 provides a yieldable connection but normally causes the arm 112 to move with its lever. With the foregoing arrangement, the cam 121 moves the arms 111 and 112 together and apart through the medium of the cross slide 118, the pin and slot connections 116, 117 and the lever arms 115. Such movement occurs in timed relation to the movements of the other parts of the machine since the cam 121 is turned by the main camshaft 31.

The gear blanks supported by the arms 111 and 112 are held against the back wall 125 (FIG. 3) of the transfer arm 78 by a small upright bar 126 (FIG. 6a) which engages both of the blanks. The bar is carried on the end of an arm 127 which turns on the shaft 114a and is urged in a direction to hold the bar against the blanks by a torsion spring 128 acting between the shaft and the arm 127.

In order to swing the transfer arm 78 at the proper time, the shaft 57 to which the arm is fixed is turned back and forth under the control of the camshaft 31. For this purpose, a double cam arrangement similar to the one used for turning the shaft 41 is employed. Thus, two cams 129 and 130 (FIG. 4) are secured to the camshaft and cooperate with follower rollers 131 and 132 which are on arms 133 and 134 projecting out from collars 135 and 136. The collar 136 is pinned to the shaft 57 while the collar 135 is connected to the shaft by a torsion spring 137 which yields in cases where the gear blanks fail to seat properly on the arbor 23 and under other similar circumstances.

According to the invention, the transfer arm 78 is used not only for loading the gear blanks on the work spindle 21 but also for unloading the finished gears. To this end, the elements 80 engage the gears as the arm approaches the loading position and shifts the gears laterally away from the spindle as the loading position is reached. In this way, a single motion of the transfer arm performs both the loading and unloading functions.

In order to remove the finished gears as the arm 78 approaches the loading position, the elements 80 are carried by but in advance of the arm where they engage the gears while the arm is still at one side of the axis of the work spindle 21. Herein, the elements 80 are fingers which project laterally toward the work spindle from the leading side of the transfer arm. As shown in FIGS. 2 and 3, the fingers may be pivoted on the arm by mounting one to turn on the shaft 114a and the other to turn on a parallel shaft 114b. Torsion springs 138 (FIG. 6a) urge the fingers 80 toward each other to a position in which the sides 139 of the fingers are spaced apart a distance slightly greater than the diameter of the gears as shown in FIG. 3, this position being determined by suitable stops (not shown). Each finger also includes a ledge 140 projecting inwardly from the bottom of the side 139. Thus, the gears are loosely received between the sides and are supported one on top of the other by the ledges 140.

With the foregoing arrangement, the finished gears first are raised by the lifting fingers 49 into the path of the arm 78. As a result, the pick-off fingers 80 pass on opposite sides of the gears as the arm approaches the loading position. Since the gears are held only frictionally between the fingers 49 and the sleeve 68, the fingers 80 carry the gears with them upon the continued swinging of the arm so that the gears have been shifted to one side of the work spindle 21 when the next pair of gear blanks have been located over the arbor 23.

Advantage is taken of the fact that the arm 78 removes the finished gears from the work spindle 21 to check the accuracy of the gears while they still are under the positive control of the arm 78. Not only does this simplify the checking of the gears, but it makes it possible to make a suitable correction in the hobbing machine either manually or automatically, before the next set of gears is

cut. To these ends, the checking device 81 (FIG. 3) is located alongside the work spindle in the plane of the transfer arm so that one of the gears is presented to the device at the same time that the gear blanks are delivered to the work spindle.

Herein, the checking device 81 measures the pitch diameter of the upper gear and, for this purpose, includes two probes 141 and 142 (FIGS. 2, 3, 8 and 9) which engage the gear on opposite sides and between the teeth. The probe 141 is stationary, being threaded onto a bracket 143 rigid with the column 28, while the probe 142 is mounted to move into engagement with the gear after the latter engages the probe 141.

Supporting the movable probe 142 is one end of a lever 144 which is fulcrumed intermediate its ends at 145 on the bracket 143 and, as shown in FIG. 8, is urged in a direction to swing the probe 142 away from the probe 141 by a contractile spring 146 acting between the lever and the bracket. The lever is swung to move the probe 142 into engagement with the gear (counterclockwise in FIG. 8) by a rod 147 which is slidable vertically in the bracket 143 and is moved up and down by the lever 50 which supports the gear stripping fingers 49, the bottom of the rod being connected to the pivot pin 58 of one of the levers as shown in FIG. 8. For this purpose, an adjustable stop 148 is threaded into an arm 149 which projects laterally from the upper end of the rod 147 and over a plate 150 on one end of the lever 144 (see FIG. 9).

With the arrangement described above, the barrel cam 56 swings the lever 50 down and this slides the rod 147 down. As a result, the stop 148 strikes the plate 150 and turns the lever 144 about its fulcrum 145 to move the probe 142 into engagement with the gear to be measured. The plunger 151 of the stop 148 is spring loaded in a manner conventional in the art so that the probe 142 is pressed against the gears with a uniform pressure.

In order to locate the gear properly on the stationary probe 141, the gear, as it approaches the checking position, engages a toothed member 152 (FIG. 9). The latter is pivoted on the bracket 143 by a pin 153 and is urged toward the gear by a compression spring 154 acting between the member and the bracket, movement of the member being limited by a stop pin 155 projecting from the bracket into a slot 156 in the member. The gear rolls on the teeth of the member 152 and onto the probe 141.

As the gear reaches the checking position on the probe 141, a rod 157 (FIGS. 1 and 5) is lowered into the bore of the gear to hold the gear against lateral shifting. The rod slides vertically in the column 28 and is carried by the tail stock 24 (see FIG. 5), the rod being connected by a bar 158 to a rod 159 upstanding from the upper end of the tail stock. When the gear has been checked, the inclined cam surface 160 of a pin 161, which is upstanding from a disc 162 on the arm 78, passes under the lever 144 and swings it so that the probe 142 is positively disengaged from the gear and the lever returns to its original position under the action of the spring 146.

While the measurement effected by the checking device 81 may be used to produce a visual indication of the gear size or to produce an automatic adjustment of the hobbing machine to correct for inaccuracies, it is used herein to sort the gears. To this end, the finished gears are dropped from the checking position into a trough 163 (FIG. 1) which is provided with a plurality of paths and the path taken by each pair of gears is under the control of the checking device. In the embodiment illustrated in the drawings, there are three such paths, one for gears properly sized, one for oversize gears and one for those which are undersize.

Herein, the trough 163 is a sheet metal channel having one end under the checking device 81 and slopes downwardly so that gears of the proper size slide down the trough to a container (not shown). Alongside the trough is a sheet metal box 164 divided into two compartments 165 and 166 by a vertical partition 167 with each compartment terminating in its own individual chute 168 or 169 which also lead to containers (not shown). The compartment 168 communicates with the trough through an opening 170 while a similar opening 171 connects the trough and the compartment 169. The openings are controlled by gates 172 and 173 respectively and each gate when opened extends across the trough and deflects the gears from the trough to the corresponding compartment. The gate 172 is opened to deflect undersize gears into the compartment 165 while the gate 173 deflects oversize gears into the compartment 166.

Each gate is in the form of a rectangular sheet metal plate secured at one end to a pin 174 which is journaled in a wall of the box 164 and thus constitutes the hinge for the gate. A reciprocating bar 175 is pivotally connected to a crank 176 secured to the upper end of the pin 174 and moves back and forth to open the gate. The bar for the gate 172 is moved by a solenoid 177 while a solenoid 178 actuates the bar for the gate 173.

To energize the solenoids 177 and 178 selectively in accordance with the size of the gears, the lever 144 carrying the probe 142 moves the core 179 of a differential transformer 180 (FIG. 8). For this purpose, the transformer is disposed adjacent the end of the lever 144 opposite the plate 150 and a screw 181 threaded through this end engages the actuator 182 of the transformer when the lever swings the probe 142 into engagement with the gear. Thus, the core 179 of the transformer is shifted an amount which depends upon the size of the gear. Through suitable control circuits well known in the art, the coil 183 of the transformer as energized by the core 179 actuates either the solenoid 177 or the solenoid 178 if the gear is under or oversize and neither solenoid if the gear is within the permissible limits. As a result, the two gears slide along the trough 163 or one of the chutes 168 and 169 according to their pitch diameter.

Operation

Initially, a supply of gear blanks W are placed in the hopper 79 which delivers the blanks in pairs through the chute 82 to the upper and lower passages 93 and 94 of the transfer arm 78. When the arm is properly loaded with five pairs of blanks, the last pair actuates switches 184 (FIGS. 3 and 5) on the inner end of the arm. These switches, in conjunction with interlocking controls responsive to the other elements of the hobbing machine, energize the motor 32 to produce a single revolution of the camshaft 31.

As the camshaft 31 begins to turn, the barrel cam 56 is turned raising the fingers 49 and, simultaneously, the cams 34 and 35 raise the tail stock 24 together with the sleeve 68. This leaves a space between the tail stock and the arbor 23 so that the gear blanks W may be inserted into this space. Also, upon initially turning of the camshaft, the shaft 57 is turned by the cams 129 and 130 to swing the transfer arm 78 away from the starting position and toward the loading position. At this time, the position of the cam 103 (FIG. 3) is such that the detents 95 engage and hold the end blanks in the chute 82.

When the transfer arm 78 reaches the loading position as shown in FIGS. 3 and 11, the cams 34 and 35 on the camshaft 31 lower the tail stock 24 against the blanks and the cam 121(FIG. 6) slides the cross slide 118 forward. Thus the supporting arms 111 and 112 move out from under the blanks at the outer end of the transfer arm. Since these blanks were supported only by the arms 111 and 112, the tail stock pushes them down out of the transfer arm and onto the arbor 23. The fingers 49 are lowered simultaneously by the barrel cam 56. Then the

arbor is expanded and the camshaft, through the medium of the cams 129 and 130, returns the transfer arm 78 to the starting position. This completes the cycle produced by one revolution of the camshaft and, at this time, the motor 32 is deenergized and the parts are ready for the hobbing operation.

Next, the saddle 76 is advanced to project the hob H under the work blanks and then the head 74 is moved up to feed the hob into the work. When the cutting stroke has been completed, the arbor 23 is collapsed to release the finished gears. Also, the saddle is retracted and this conditions the control circuit so that, if the switches 134 have been actuated by the blanks in the transfer arm 78, the motor 32 again is energized to produce another revolution of the camshaft 31.

As the camshaft 31 starts its second revolution, the tail stock 24 again is raised by the cams 34 and 35 and the fingers 49 are swung up by the barrel cam 56. The fingers lift the finished gears off the arbor 23 and hold them frictionally against the sleeve 68. As the transfer arm 78 approaches the loading position, the pick-off fingers 80 pass on opposite sides of the finished gears and then, upon the continued movement of the arm, the fingers carry the gears to one side of the work spindle 21 with the gears resting on the ledges 140.

When the transfer arm 78 reaches the loading position, the upper gear carried by the fingers 80 rolls over the toothed member 150 and onto the stationary probe 141. At this time, the tail stock 24 is being lowered to push the next set of gear blanks onto the arbor 23, the same as in the previous cycle, and this lowers the rod 157 into the bores of the gears. Also, as the barrel cam 56 lowers the fingers 49, it slides the rod 147 down swinging the lever 144 (FIG. 8) about its fulcrum 145 to move the probe 142 into engagement with the upper gear. The size of the gear determines the amount the lever 144 turns and thus the distance the core 179 of the transformer 180 is shifted. If the core is shifted a predetermined normal distance, the gear being measured and hence the other gear hobbed at the same time are of a proper size and neither of the solenoids 177 and 178 is energized. Both gears, therefore, slide along the trough 163 when they are released by the pin 161 and spring 146 causing the lever 144 to retract the probe 142 from the gear. Through a suitable control circuit responsive to the cam 56, the circuit of the transformer is energized only momentarily during a dwell of the transfer arm when the probes are in full engagement with the gear being checked.

Had the gears been undersize, the core 179 would have moved a greater amount and the solenoid 177 would have been energized opening the gate 172 and deflecting the gears into the compartment 165. If, on the other hand, the gears had been oversize, the core 179 would have moved shorter than the normal distance and the solenoid 178 would have been energized to deflect the gears into the compartment 166.

After the finished gears have been delivered to the checking device 81 and the next set of gear blanks presented to the work spindle 21, the transfer arm 78 again is returned to the starting position and the hobbing operation is repeated. The timing of the parts may be such that the arm begins to swing back before the measurement of the upper gear is completed. This means that the lower gear is released as shown in FIG. 13. Nevertheless, the measurement is made quickly enough that the proper gate, if any, is opened before the lower gear reaches the trough 163.

I claim as my invention:

1. In a machine tool, the combination of, a work spindle for supporting a workpiece during the machining operation, a tool spindle operable to hold a cutter for machining a workpiece on said work spindle, a transfer member movable transversely of the axis of said work spindle first from a starting position laterally spaced from said axis forward to a loading position in which a part of the member is alined with the work spindle and then back to said starting position, means on said part for supporting a workpiece whereby the member carries the workpiece into axial alinement with said work spindle, elements engageable with the workpiece when said member is in said loading position and operable to shift the workpiece axially onto said spindle, said elements frictionally engaging the machined workpiece after the machining operation and while said member is out of said loading position and operable to return the workpiece into the path of the member, and fingers projecting forwardly from the leading edge of said member and operable as the member approaches said loading position to remove the machined workpiece from said elements.

2. In a machine tool, the combination of, a work spindle for supporting a workpiece during the machining operation, a tool spindle operable to hold a cutter for machining a workpiece on said work spindle, a transfer member movable transversely of the axis of said work spindle first from a starting position laterally spaced from said axis forward to a loading position in which a part of the member is alined with the work spindle and then back to said starting position, means on said part for supporting a workpiece whereby the member carries the workpiece into axial alinement with said work spindle, a device operable when said member is in said loading position to move the workpiece axially off said member and onto said work spindle, said device being operable after the machining operation and while said member is out of said loading position to return the machined workpiece into the path of the member, and fingers projecting forwardly from the leading edge of said member and operable as said member approaches said loading position to pick off the machined workpiece and carry the latter to one side of said axis.

3. In a machine tool, the combination of, a work spindle for supporting a workpiece during a machining operation, a tool spindle operable to hold a cutter for machining a workpiece on said work spindle, a transfer member movable transversely of the axis of said work spindle first from a starting position laterally spaced from said axis forward to a loading position in which a part of the member is alined with the work spindle and then back to said starting position, means on said part for supporting a workpiece whereby the member carries the workpiece into axial alinement with said work spindle, a device operable when said member is in said loading position to move the workpiece axially off said member and onto said work spindle, said device being operable after the machining operation and while said member is out of said loading position to return the machined workpiece into the path of the member, and elements carried by said member and operable to pick up the machined workpiece as the member delivers a new workpiece to said work spindle.

4. In a machine tool, the combination of, a base, a work spindle for supporting a workpiece during a machining operation and journaled on said base to turn about an upright axis, a hollow arm pivotally mounted at one end on said base to swing about a second upright axis and comprising top, bottom and side walls and a horizontal partition disposed between the top and bottom walls to divide the interior of the arm into two horizontal passages, means for delivering workpieces to both said passages, said bottom wall and said partition terminating short of the free end of said arm to form a space for the two end workpieces in the arm, a device operable to support the end workpieces and movable to permit the workpieces to move down out of the arm, mechanism operable to swing said arm about said second axis to dispose the free end portion of the arm over said spindle, and means subsequently operable to move said device and thereby release the end workpieces in said space.

5. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a pre-

determined axis and operable to support a workpiece during a machining operation, a hollow arm pivotally mounted on said base to swing about a second and parallel axis between a first position in which the free end portion is at one side of the spindle axis and a second position in which the end portion is axially alined with the spindle, means defining a passageway terminating adjacent said second axis and operable to deliver workpieces to the interior of said arm, said arm being open at its inner end to receive the workpieces from said passageway, an element engageable with the workpiece at the end of said passageway and operable when said arm is in said first position to move the end workpiece out of the passageway and into the arm thereby to advance the workpieces successively to the free end portion of the arm, and means operable when said arm is in said second position to transfer the workpiece in said end portion from said arm to said spindle.

6. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a predetermined axis and operable to support a workpiece during a machining operation, a hollow arm pivotally mounted on said base to swing about a second and parallel axis between a first position in which the free end portion of the arm is at one side of the spindle axis and a second position in which the end portion is axially alined with the spindle, means defining a passageway terminating adjacent said second axis and operable to deliver workpieces to the interior of said arm, said arm being open at its inner end to receive the workpieces whereby the latter advance successively to the free end portion of the arm, a detent movable in timed relation with said arm and operable to engage and hold the end workpiece in said passageway when the arm is out of said first position and to release the workpiece when the arm is in said first position, and means operable when said arm is in said second position to transfer the workpiece in said end portion of the arm from the arm to said spindle.

7. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a predetermined axis and operable to support a workpiece during a machining operation, a hollow arm pivotally mounted on said base to swing about a second and parallel axis between a first position in which the free end portion is at one side of the spindle axis and a second position in which the end portion is axially alined with the spindle, means defining a passageway terminating adjacent said second axis and operable to deliver workpieces to the interior of said arm, said arm being open at its inner end to receive the workpieces whereby the latter advance successively to the free end portion of the arm, and means operable when said arm is in said second position to transfer the workpiece in said end portion from said arm to said spindle.

8. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a vertical axis and operable to support a workpiece during a machining operation, an arm pivotally mounted on said base to swing about a second vertical axis between a first position in which the free end portion is at one side of the spindle axis and a second position in which said end portion is axially alined with the spindle, a device carried on said end portion and operable to support a workpiece, and mechanism operable in timed relation with the swinging of said arm to move said device and release said workpiece thereby to transfer the workpiece from the arm to said spindle.

9. In a machine tool, the combination of, a work spindle adapted to support a workpiece during a machining operation, a hollow transfer member normally disposed in an initial position at one side of said spindle and movable forward in a direction transversely of the axis of the spindle to carry a workpiece and dispose the latter along said axis but axially spaced from the spindle, said member having an opening through which the workpiece may be moved axially to place the workpiece on said spindle, a device operable to hold a workpiece on said member and movable when the workpiece is axially alined with the spindle to release the workpiece and permit the latter to move out of said member through said opening, and an element engageable with the workpiece when released by said device and operable to push the workpiece onto said spindle, said member being open at its leading edge to permit the member to move back toward said initial position after the workpiece is held between said spindle and said element.

10. In a machine tool, the combination of, a work spindle for supporting a workpiece during a machining operation, a hollow transfer member movable back and forth transversely of the axis of said spindle and operable to carry a workpiece and position the latter along said axis but axially spaced from the spindle, said member having an opening through which the workpiece may be moved axially to place the workpiece on said spindle, a device normally holding the workpiece in said member and movable when the workpiece is axially alined with the spindle to release the workpiece and permit the latter to move out of the member through said opening, and an element operable in timed relation with said member and said device to engage the workpiece and push the latter onto said spindle after said device releases the workpiece.

11. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a predetermined axis and operable to hold a workpiece, a transfer member mounted on said base to move back and forth in a plane perpendicular to said axis, first and second work holders mounted side by side on said member, means for moving said member laterally in said plane from a starting position alongside said spindle to an intermediate position in which said first work holder is alined with the spindle and on to an advanced position in which said second work holder is alined with the spindle, and mechanism operable when said member is in said intermediate position to transfer a finished workpiece from said spindle to said work holder and when said member is in said advanced position to transfer a workpiece from said second work holder to the spindle.

12. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a first axis and operable to hold a workpiece, an arm journaled on said base to turn about a second and parallel axis and spaced a predetermined distance from said first axis, first and second work holders mounted on said arm side by side and each spaced from said second axis a distance equal to the spacing between said two axes, means for swinging said arm about said second axis from a starting position alongside said spindle to an intermediate position in which said first work holder is alined with the spindle and on to an advanced position in which said second work holder is alined with the spindle, and mechanism operable when said arm is in said intermediate position to transfer a finished workpiece from said spindle to said first work holder and when said arm is in said advanced position to transfer a workpiece from said second work holder to the spindle.

13. In a machine tool, the combination of, a base, a work spindle journaled on said base to turn about a first axis and operable to hold a workpiece, an arm journaled on said base to turn about a second and parallel axis and spaced a predetermined distance from said first axis, said arm being in a plane extending transversely of said first axis and disposed beyond the end of said spindle, first and second work holders mounted on said arm side by side and each spaced from said second axis a distance equal to the spacing between said two axes, means for swinging said arm about said second axis from a starting position alongside said spindle to an intermediate position in which said first work holder is alined with the spindle and down to an advanced position in which said second work holder is alined with the spindle, a transfer device

operable to shift a finished workpiece axially of said spindle and into said plane to be held by said first work holder when said arm is in said intermediate position, and mechanism operable when said arm is in said advanced position to move a workpiece axially on to said spindle from said second work holder.

14. In a machine tool, the combination of, a work spindle for supporting a workpiece to be machined, a cutter operable to machine a workpiece supported on said spindle, a member mounted to reciprocate between a first position and a second position and along a path which crosses the axis of said spindle, said member including a part operable to support a workpiece and alined with said spindle when the member is in said second position, an element engageable with a finished workpiece on said spindle and operable in advance of said member to move the workpiece axially off the spindle and into said path, a device carried by said member in advance of said part and operable when the member is between said positions to engage and pick up a finished workpiece, said member in the continued movement to said second position delivering a new workpiece to said spindle and simultaneously a finished workpiece to a checking position alongside the spindle, means operable while said member is in said second position to move said new workpiece out of said path and onto said spindle, and checking mechanism disposed at said checking position and operable to sense a dimension of the finished workpiece.

15. In a machine tool, the combination of, a work spindle for supporting a workpiece to be machined, a

cutter operable to machine a workpiece supported on said spindle, a member mounted to reciprocate between a first position and a second position and along a path which crosses the axis of said spindle, said member including a part operable to support a workpiece and alined with said spindle when the member is in said second position, an element engageable with a finished workpiece on said spindle and operable in advance of said member to move the workpiece off the spindle and into said path, a device carried by said member in advance of said part and operable when the member is between said positions to engage and pick up a finished workpiece, said member in the continued movement to said second position delivering a new workpiece to said spindle and simultaneously a finished workpiece to a point alongside the spindle, and means operable while said member is in said second position to move said new workpiece out of said path and onto said spindle.

References Cited in the file of this patent

UNITED STATES PATENTS

379,307	Codling	Mar. 13, 1888
1,604,128	Lorden	Oct. 26, 1926
1,933,226	Smith et al.	Oct. 31, 1933
2,337,696	Van Nest	Dec. 28, 1943
2,389,083	Rosengren	Nov. 13, 1945
2,411,110	Pruitt	Nov. 12, 1946
2,589,475	Carlsen	Mar. 18, 1952
2,761,560	Pomernacki	Sept. 4, 1956