March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 1

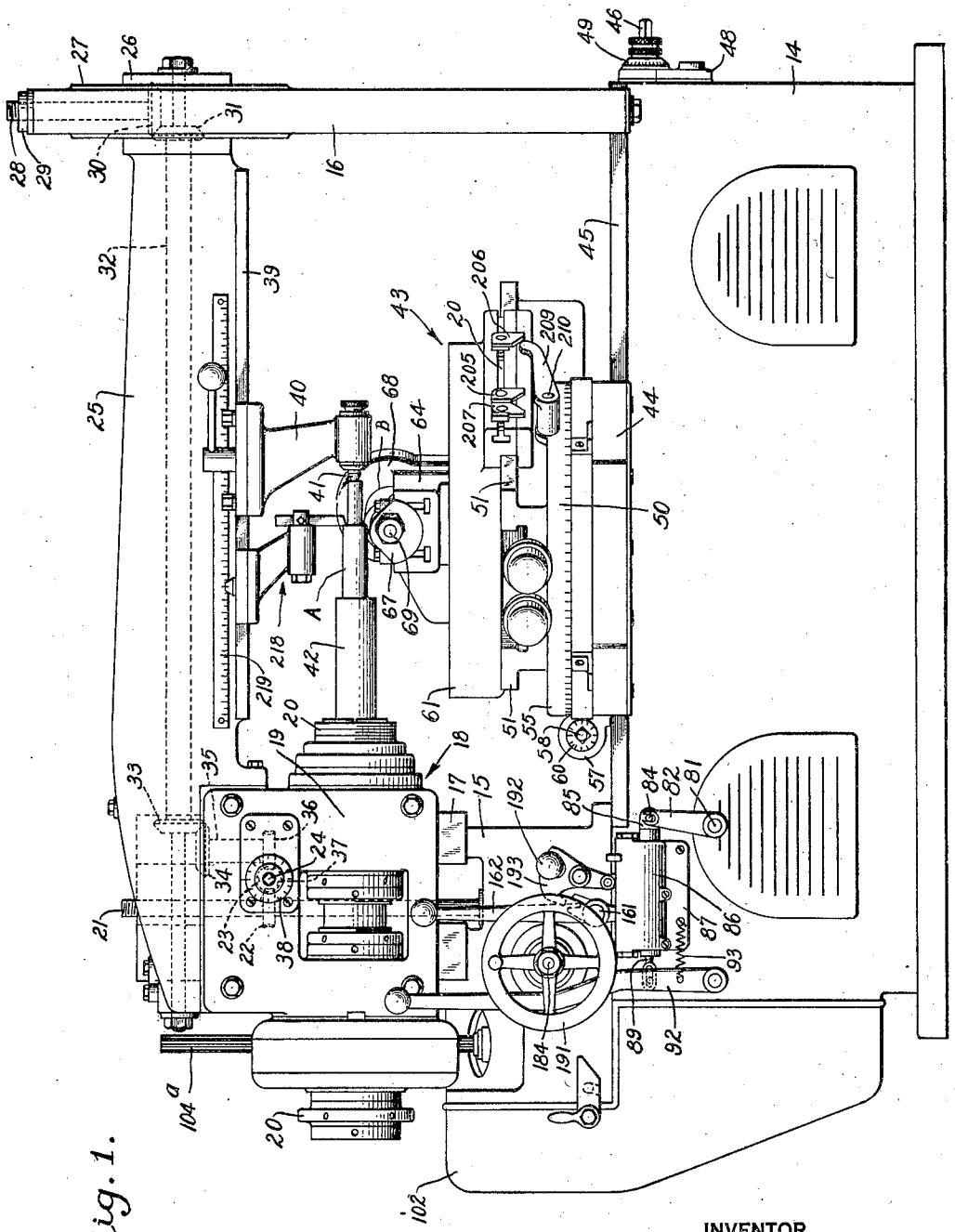


Fig. 1.

INVENTOR
John Edgar
BY
Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 2

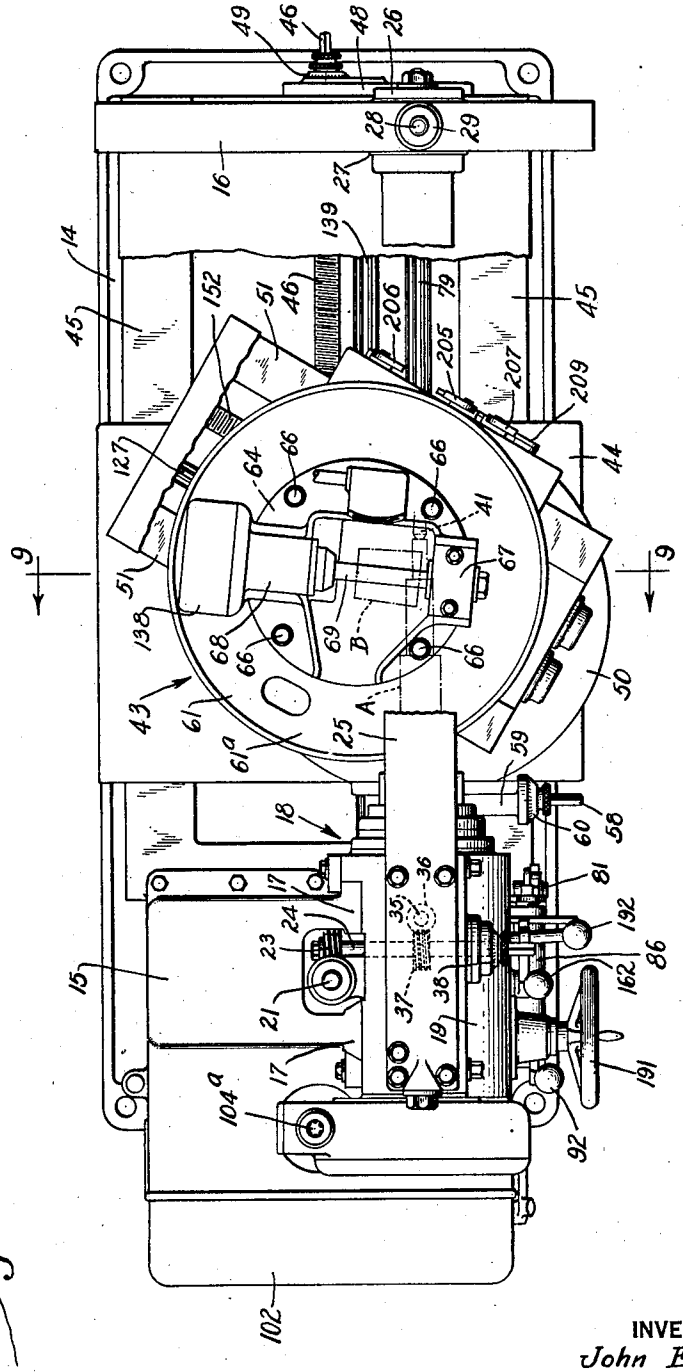


Fig. 2.

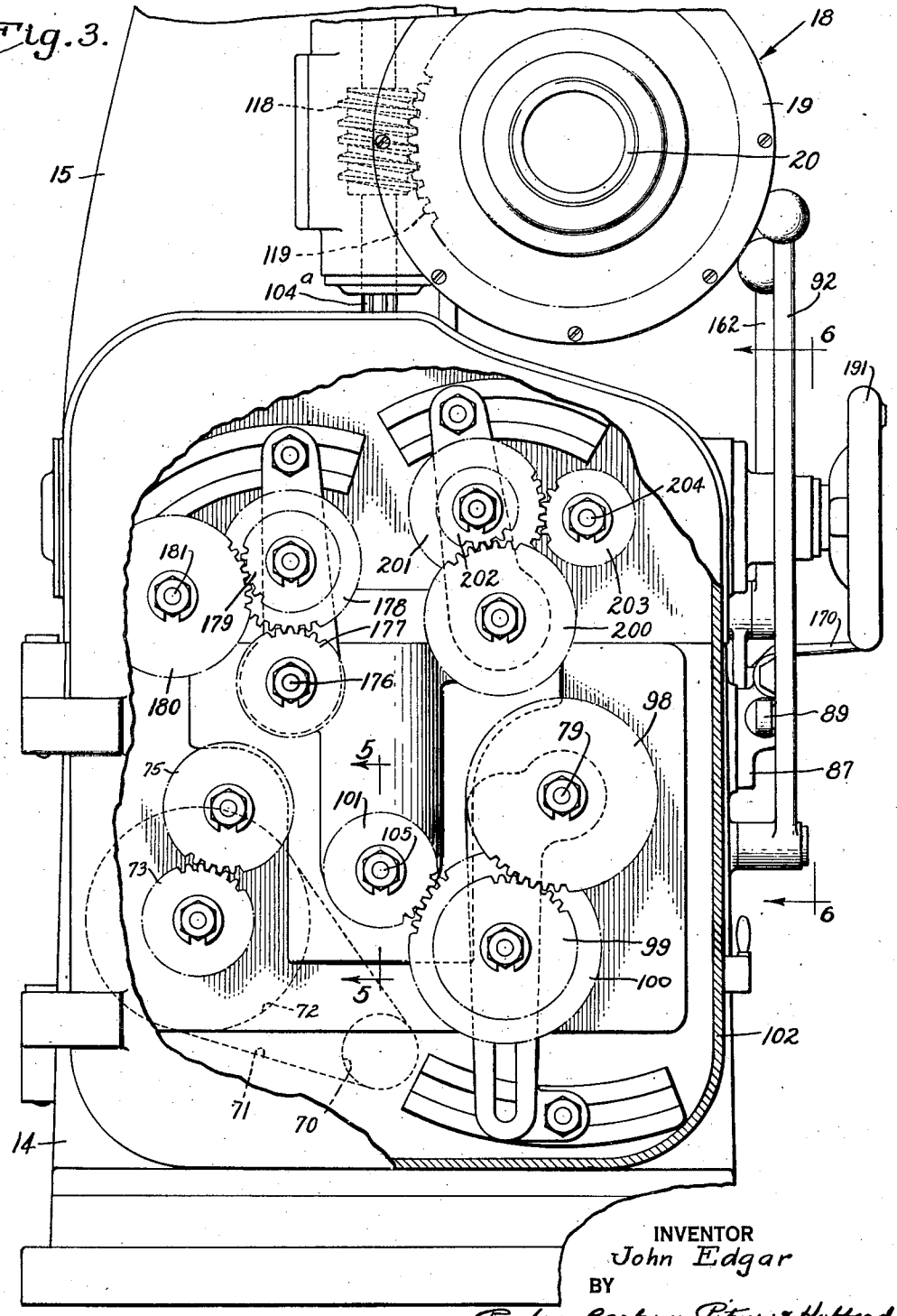
INVENTOR
John Edgar
BY
Parker, Carlton, Pitney & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 3

Fig. 3.



INVENTOR
John Edgar
BY
Parker, Carlson, Pitney & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 4

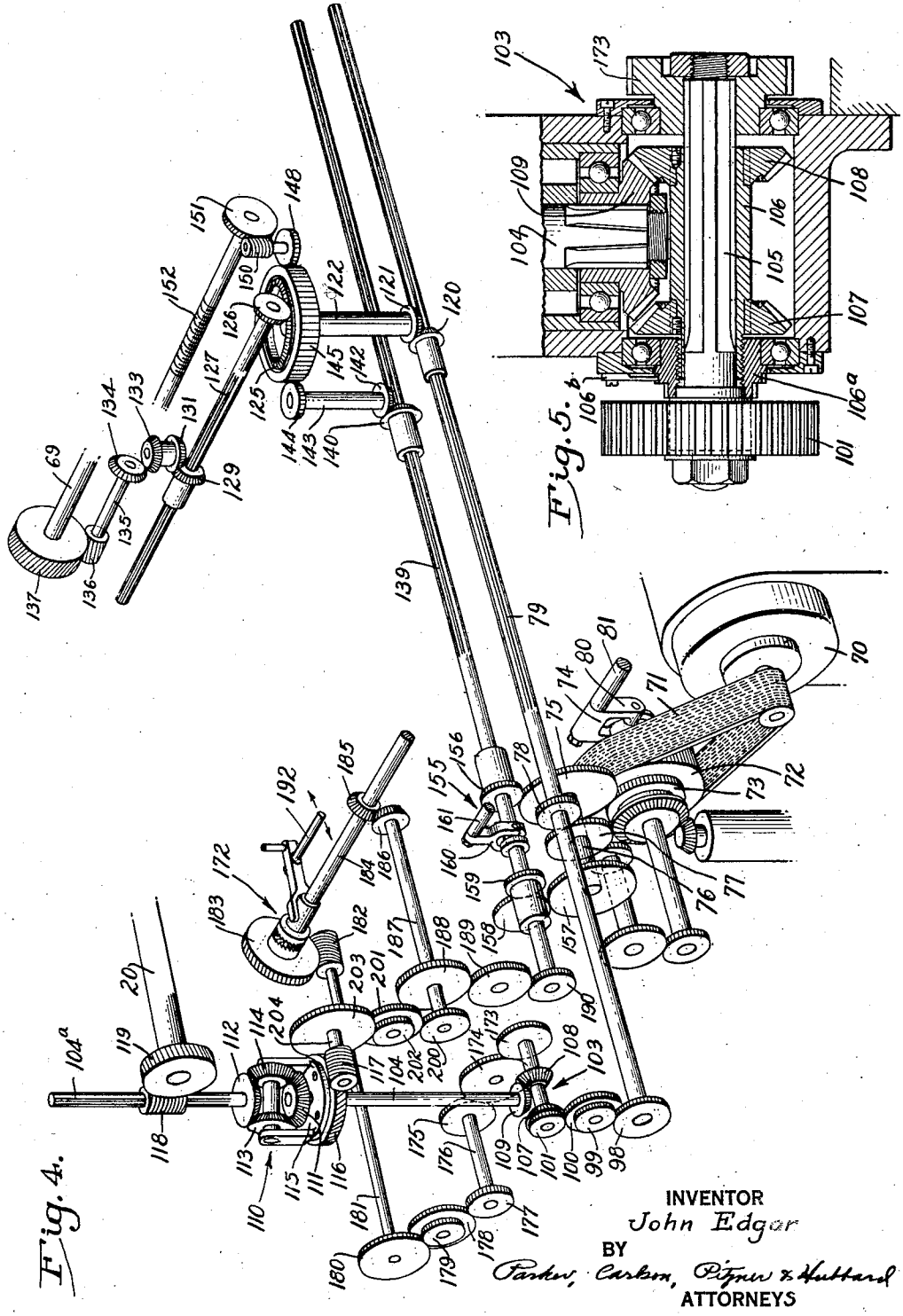


Fig. 4.

Fig. 5.

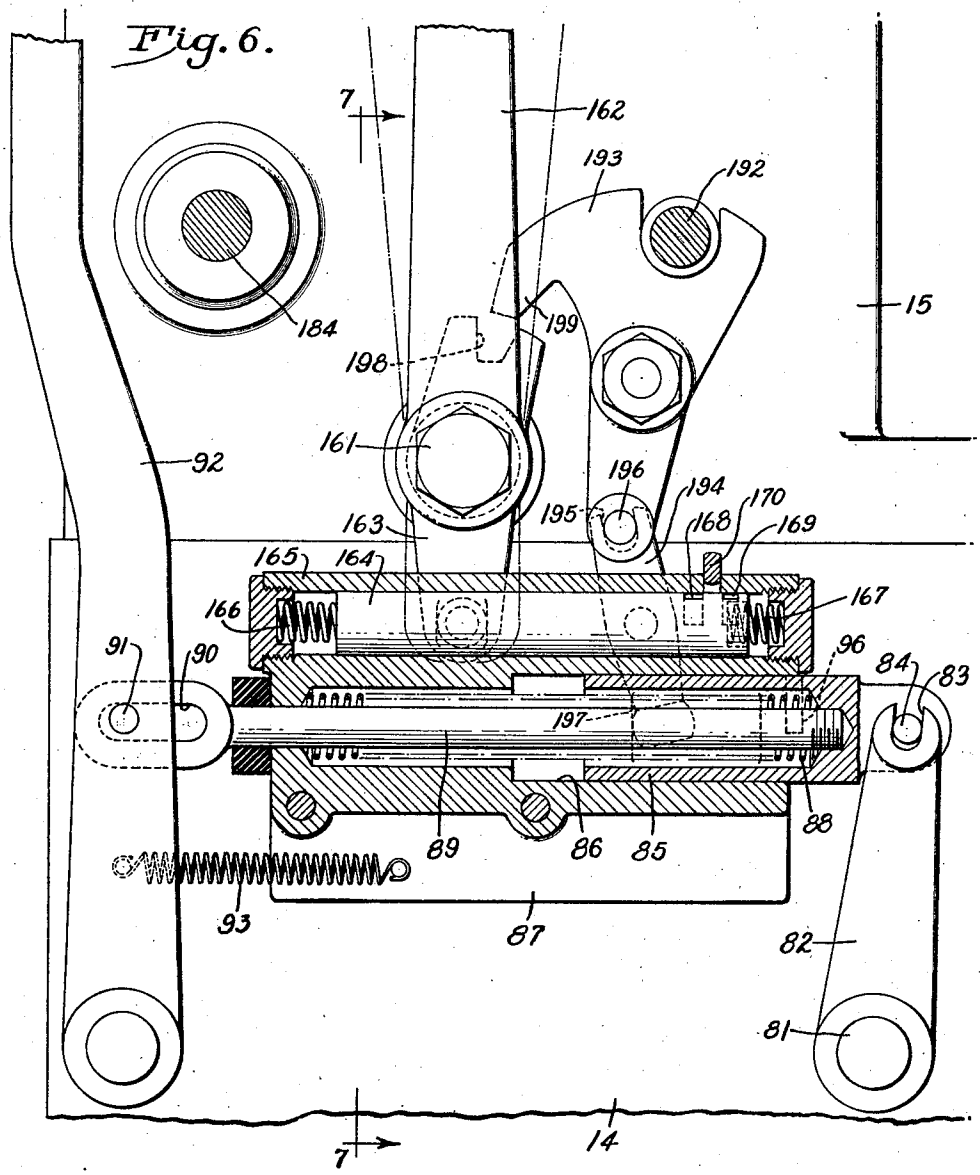
INVENTOR
John Edgar
BY
Parker, Carlson, Pitney & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 5

Fig. 6.



INVENTOR
John Edgar
BY
Parker, Carlson, Pitney & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 6

Fig. 7.

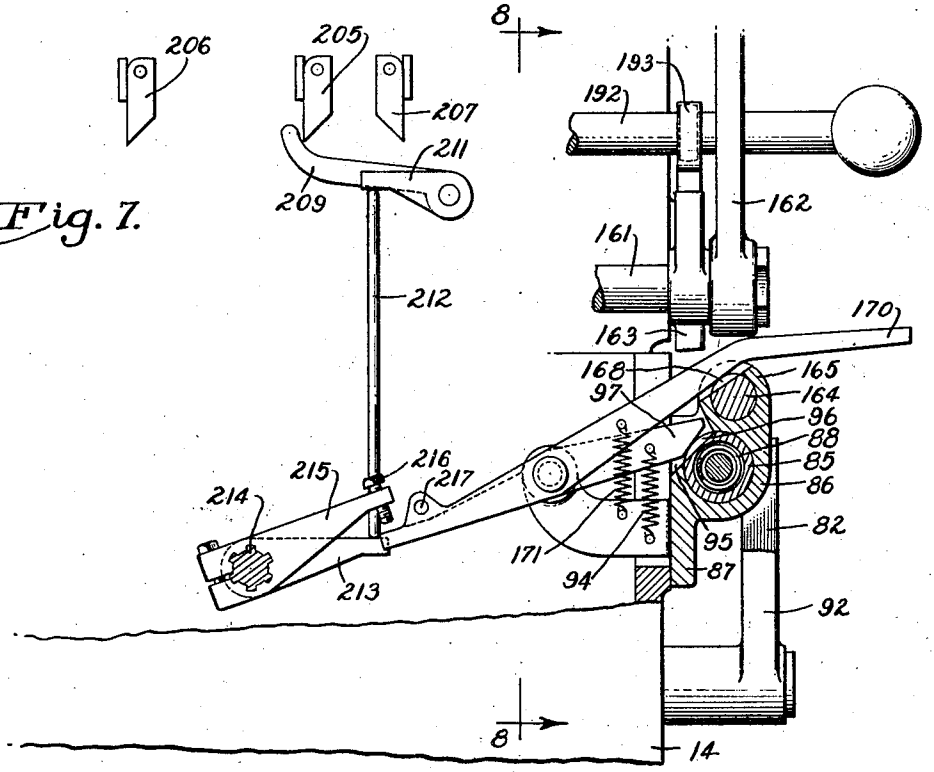
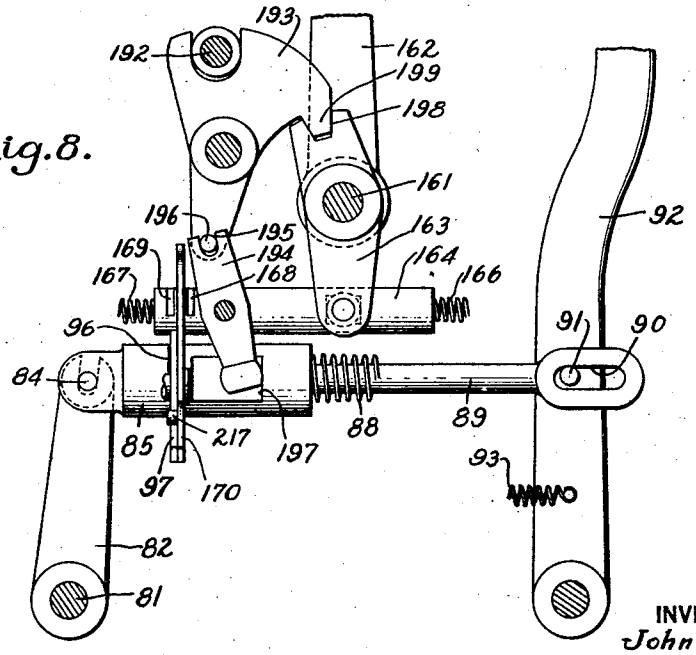


Fig. 8.



INVENTOR
John Edgar
BY
Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 7

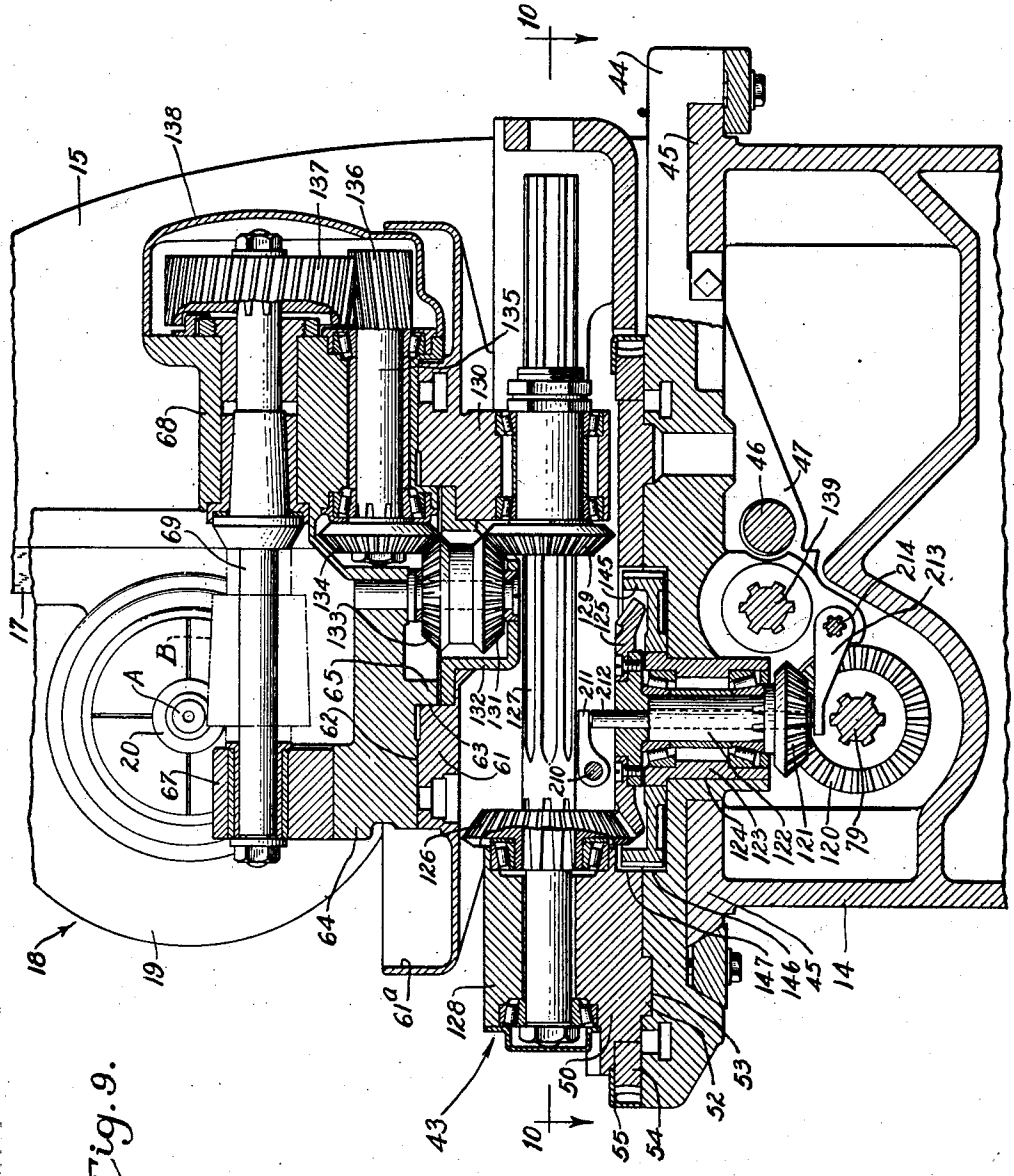


Fig. 9.

INVENTOR
John Edgar
BY
Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 8

Fig. 10.

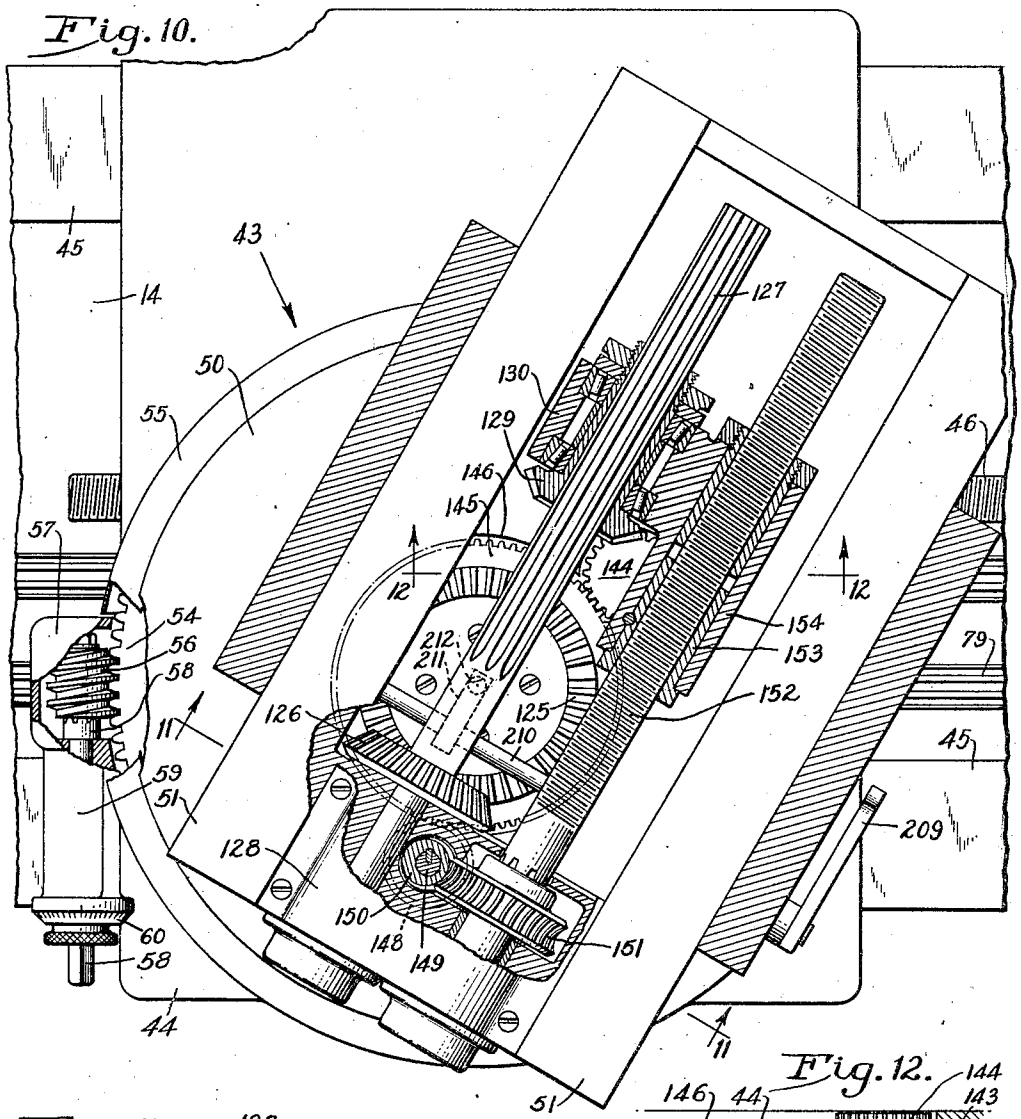


Fig. 11.

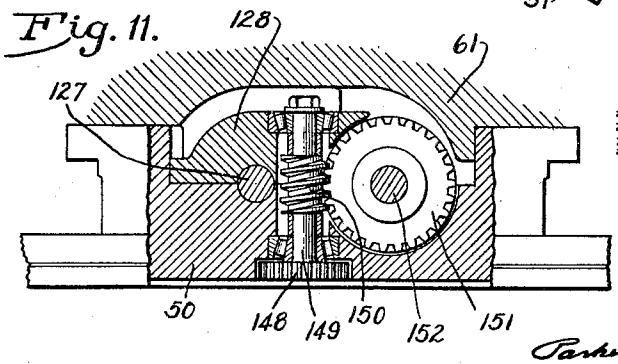
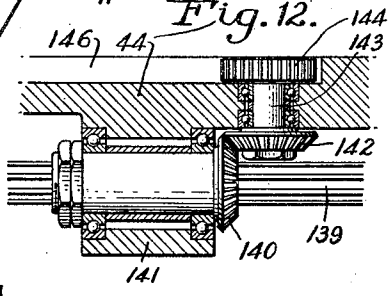


Fig. 12.



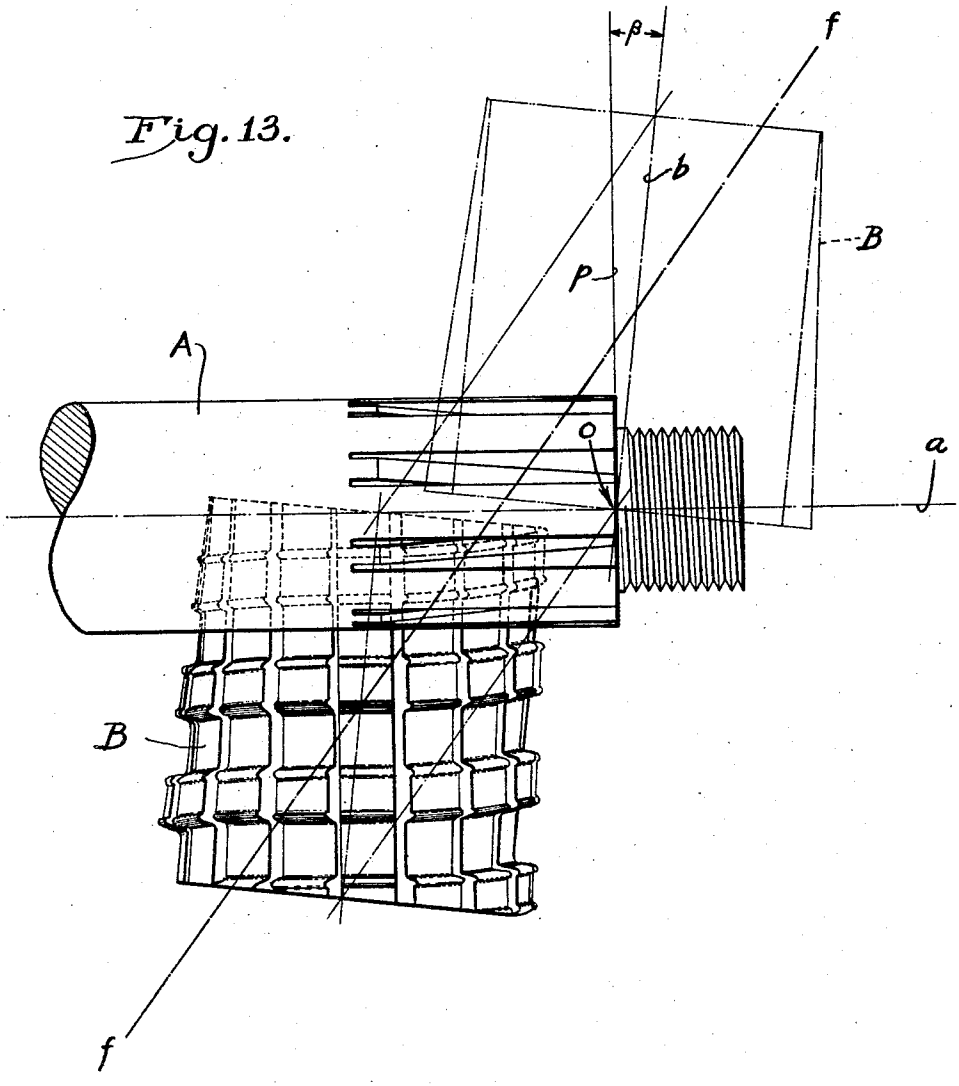
INVENTOR
John Edgar
BY
Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

March 28, 1939. J. EDGAR 2,152,469

HOBBING MACHINE

Filed Sept. 11, 1935 9 Sheets-Sheet 9

Fig. 13.



INVENTOR
John Edgar
BY
Parker, Carlson, Pitman & Hubbard
ATTORNEYS

Patented Mar. 28, 1939 2,152,469

UNITED STATES PATENT OFFICE

2,152,469

HOBBING MACHINE

John Edgar, Rockford, Ill., assignor to Barber-Colman Company, Rockford, Ill., a corporation of Illinois

Application September 11, 1935, Serial No. 40,041

18 Claims. (Cl. 90—3)

The present invention relates to improvements in hobbing machines, and has particular reference to a new and improved machine of this character having a wide and flexible range of usefulness adapting it for many different kinds of work.

One of the objects of the invention is to provide a novel hobbing machine in which the hob can be fed relatively across the work tangentially, longitudinally or obliquely.

A more specific object resides in the provision of a new and improved hobbing machine in which the hob has two swivel adjustments relative to the work, one to define the angle of hob feed, and the other to define the angle of the hob axis relative to the direction of feed.

Another object is to provide a novel hobbing machine including a differential interposed in the drive for one of the work and tool spindles, and operable in timed relation to the relative feed translation between the work and the tool.

A further object resides in the provision of a hobbing machine having novel power means for translating the tool relatively to the work selectively in a rapid traverse or feed, the power means including traverse and feed controls and interlock means therebetween.

Other objects reside in the provision of a new and improved scale-located stop for positioning the work, and novel direct-reading dials for locating the work spindle vertically and the hob spindle horizontally.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a front elevational view of a machine embodying the features of my invention.

Fig. 2 is a plan view of the machine.

Fig. 3 is a fragmentary end view, partially broken away to show one arrangement of speed-change gearing in the machine.

Fig. 4 is a perspective diagrammatic view of the various machine drives.

Fig. 5 is a fragmentary sectional view, taken substantially along line 5—5 of Fig. 3, and showing a reversing gearing in one of the drives.

Fig. 6 is a fragmentary view, partially in section, along line 6—6 of Fig. 3, and illustrating the controls for the drives.

Fig. 7 is a fragmentary vertical sectional view, partially diagrammatic in character, taken substantially along line 7—7 of Fig. 6.

Fig. 8 is a fragmentary vertical sectional view taken along line 8—8 of Fig. 7.

Fig. 9 is a fragmentary transverse vertical sectional view of the machine taken along line 9—9 of Fig. 2.

Fig. 10 is a fragmentary horizontal sectional view taken along line 10—10 of Fig. 9.

Figs. 11 and 12 are fragmentary sectional detail views taken respectively along lines 11—11 and 12—12 of Fig. 10.

Fig. 13 is a diagrammatic view illustrating the operation of the machine.

Referring more particularly to the drawings, the machine constituting the preferred embodiment of my invention has a frame structure (see Fig. 1) generally comprising a horizontal elongated floor bed 14, and a headstock column 15 and an upright end support 16 rigidly mounted respectively on opposite ends of the bed.

Mounted for vertical translation along parallel guides 17 (see Fig. 2) on the front of the column 15 is a headstock 18 having a housing 19 in which a horizontal spindle 20 is suitably journaled for a rotary power drive.

In the present instance, the spindle 20, which extends longitudinally of the bed 14, is adapted to support and drive the work A in a fixed adjustable position. Thus, the housing 19 is supported for manual adjustment by means of a vertical screw 21 fixed in the column 15, and a rotary nut 22 mounted on the rear of the housing 19 and in threaded engagement with the lower end portion of the screw. The nut 22 constitutes a worm wheel in mesh with a worm 23 on the rear end of a horizontal adjusting shaft 24 journaled in the housing 19. The shaft 24 extends to the front of the housing 19 where it is squared for engagement by a suitable hand tool (not shown).

Rigidly attached at one end to the top of the housing 19 and extending in vertically spaced relation along the top of the bed 14 is a horizontal over arm 25. The other end of the arm is supported by a slide block 26 mounted for vertical adjustment along guides 27 on the end support 16. A vertical adjusting screw 28 is rotatably anchored at its lower end in the block 26, and is in threaded engagement at its opper end with a nut 29 fixed on the support 16. The screw 28 is connected through bevel gears 30 and 31 to one end of a horizontal shaft 32 which is supported in and extends through and along the over arm 25. The other end of the shaft 32 is connected through bevel gears 33 and 34 to a vertical stub shaft 35 which is journaled in the housing 19, and which is connected through a worm wheel 36 and worm 37 to the adjusting shaft 24. Operation of the shaft 24 will adjust the housing

19 and over arm 25 as a unit. A direct reading micrometer dial 38 is provided on the forward end of the shaft 24 to indicate the vertical adjustment of the work.

The over arm 25 is provided on its under side with longitudinal parallel guides 39. A depending tail stock 40 of suitable construction is mounted on the guides 39 for adjustment along the arm 25, and has a center 41 in axial alignment with the spindle 20.

The machine may be used for cutting various types of work pieces, for example gears and spline members. If a gear blank is to be cut, it is mounted upon an arbor 42 extending into and clamped in the spindle 20 and in end engagement with the center 41. The machine is especially adapted for the cutting of the externally keyed members, of multiple key shaft couplings, having longitudinally acting wedge surfaces, for example on the sides of the keys as disclosed in my copending application Serial No. 620,449, filed July 1, 1932, or on the roots of the spaces between the keys as disclosed in my prior patent, No. 1,905,278, dated April 25, 1933. For purposes of illustration, the inside member of a coupling of the last mentioned character is shown in Fig. 13 hereof. More particularly, the finished work blank A is shown as comprising a cylindrical shaft end having a plurality of uniformly peripherally spaced longitudinal keys separated by interdental spaces with longitudinally tapered roots. These roots are arcuate in cross-section, and segments of a cone.

Mounted on the bed 14 between the column 15 and the end support 16 is a tool support 43 (see Figs. 1, 2 and 9 to 12). In its preferred form, the support 43 comprises a saddle or carriage 44 secured to the bed 14 for adjustment along longitudinal guides 45. A screw 46, extending longitudinally between the guides 45, is in threaded engagement with a fixed nut 47 on the underside of the saddle 44, and is rotatably anchored in a bracket 48 on one end of the bed 14. The outer end of the screw 46 is squared for hand actuation by means of a tool (not shown), and is provided with a direct reading micrometer dial 49.

Mounted on the top of the saddle 44 is a slide swivel or support 50 provided with parallel horizontal guides 51. The support 50, which preferably is generally circular in form, has an annular tongue 52 on its underside engaging in a groove 53 in the top of the saddle 44, and hence is confined for rotary adjustment about a vertical axis into any desired angular position through 360 degrees. Secured about the periphery of the support 50 is a coaxial worm wheel 54 which is substantially enclosed by a guard 55, and which meshes with a worm 56 in a casing 57 on one side of the saddle 44. The worm 56 is fixed on a shaft 58 journaled in an elongated bearing sleeve 59 on the casing 57, and extending therethrough to the front of the bed 14 for hand actuation. A micrometer dial 60 is provided on the forward end of the shaft 58.

A tool slide 61 is mounted on the swivel 50 for a power feed along the guides 51, and is formed with an annular seat 62 about a central opening 63. A tool swivel or bracket 64 is mounted for angular adjustment on the seat 62, and is centered by an annular depending flange 65 bearing in the opening 63. The tool swivel 64 is secured in position of adjustment by means of a plurality of bolts 66 engaging in a coaxial inverted T-slot in the seat 62. An annular trough 61a on the slide 61 surrounds the tool swivel 64.

The top of the swivel 64 is provided at opposite sides of its axis with two upstanding bearings 67 and 68 in which a power driven tool spindle 69 is suitably mounted. Any suitable tool may be mounted on the spindle 69, depending on the character of the work to be performed, and in the present instance I have shown a hob B comprising a series of relieved finishing teeth arranged in a single helical thread of constant lead in a cylindrical pitch surface. The tooth thread is uniform in width at the pitch surface and is tapered in height from end to end relative to the hob axis. The tops of the teeth are laterally inclined in any axial plane of the hob so as to be coincident with the longitudinal taper of the latter.

It will be evident that the hob swivel 64 permits the hob to be adjusted at an angle to the work corresponding to the thread angle. Thus, in Fig. 13, the axis of the hob B is disposed at an angle β to the perpendicular to the work blank A so that the hob thread will extend longitudinally of the blank in the cutting zone. The slide swivel 50 affords a second adjustment by reason of which the hob B may be power fed in any desired angular direction relative to the work. Suitable verniers are provided for indicating the angular adjustment of the hob and slide swivels. For cutting spur gears, the hob B would be fed axially of the spindle 20. For cutting worm wheels the hob B would be axially fed perpendicularly of the spindle 20. For cutting the coupling member A, the hob B would be fed at an angle to its axis and diagonally across the axis of the work so as to cut in an axial plane of the work a foreshortened projection of the longitudinal form of the hob.

The work and tool spindles 20 and 69 are driven in timed relation from a common power source. In the present instance, power is supplied by an electric motor 70 connected through a belt 71 to a pulley 72 which is adapted to be connected to a drive gear 73 through a one-way speed clutch 74. The gear 73 meshes with a gear 75 on a shaft 76 connected through gears 77 and 78 to a main drive shaft 79 journaled within the base 14 and extending longitudinally therethrough. Parallel gear drives lead from the shaft 79 to the spindles.

The clutch 74 is operable by a yoke 80 on a rock shaft 81 journaled in and extending to the front of the base 14. A lever 82 (see Fig. 6) is secured to the forward end of the shaft 81, and is formed with a slot 83 in its free end engaging a pin 84 on one end of a plunger 85. The other end of the plunger 85 is hollow and extends slidably into a cylinder 86 on a bracket 87 on the front of the bed 14. A coiled compression spring 88 in the cylinder 86 tends to urge the plunger 85 outwardly, and thereby to open the clutch 74. Extending axially through the cylinder 86 and connected at one end to the plunger 85 is a pull rod 89. The outer end of the rod 89 has a head formed with a longitudinal slot 90 receiving a pin 91 on an actuating lever 92 pivoted to the bed 14. A tension spring 93 tends to oscillate the lever 92 in a direction to release the rod 89. Pivotally mounted on the bracket 87 and normally urged by a spring 94 through a slot 95 in the cylinder 86 into a transverse notch 96 in the plunger 85 is a retaining latch 97 (see Fig. 7). It will be seen that movement of the lever 92 to the left, as viewed in Figs. 1 and 6, will close the clutch 74 against the action of the spring 88. In the closing operation, the latch 97 will snap into the notch 96 to hold the clutch 74 in closed posi-

tion. Upon release of the latch 97, the spring 88 will cause the clutch 74 to open.

The rotative drive for the work spindle (see Figs. 3 to 5) is taken from the shaft 79 through a series of index change gears 98 to 101. These gears are mounted within a gear casing 102 on the left end of the bed 14. The gear 101 is connected through a reversing mechanism 103 (see Fig. 5) to the lower end of a vertical shaft 104. In its preferred form, the reversing mechanism 103 comprises a spline shaft 105 to one end of which the gear 101 is fixed and on which a sleeve 106 is keyed for axial adjustment. Bevel gears 107 and 108 are fixed on opposite ends of the sleeve 106 for movement selectively into meshing engagement with opposite sides of a bevel gear 109 fixed on the lower end of the shaft 104. The adjustment of the mechanism 103 is adapted to be effected by a rotary collar 106a threaded on the sleeve 106, and normally secured in fixed position by a lock 106b.

The vertical shaft 104 is sectioned, the upper section being identified as 104a, and the two sections are connected by a differential mechanism 110. In the present instance, the differential mechanism comprises bevel gears 111 and 112 secured respectively on the adjacent ends of the sections 104 and 104a and meshing with opposite sides of two bevel gears 113 and 114. The latter are journaled in a yoke 115 which is rigid with a worm wheel 116 rotatable on the shaft 104, and meshing with a worm 117. When the worm wheel 116 is stationary, the shaft section 104a will rotate oppositely to but at the same speed as the shaft section 104. The direction of rotation may be reversed by means of the mechanism 103.

Splined for axial movement on the upper end of the shaft section 104a, to accommodate the vertical adjustments of the headstock 18, is a worm 118 which meshes with a worm wheel 119 on the spindle 20 to complete the power drive.

The drive for the tool spindle 69 (see Figs. 4, 9 and 10) comprises a bevel gear 120 having an elongated hub splined for axial movement to the shaft 79 to accommodate adjustment of the saddle 44 along the bed 14. The gear 120 is movable with the saddle 44, and meshes with a bevel gear 121 on the lower end of a vertical stub shaft 122 extending through and journaled in a bearing sleeve 123 (see Fig. 9). The sleeve 123 is seated in an opening 124 in the saddle 44, and is coaxial with the slide swivel 50 so that the drive will be completed regardless of the direction of feed of the slide 61. A crown gear 125 is fixed on the upper end of the shaft 122, and meshes with a pinion 126 on a horizontal spline shaft 127 journaled at one end in a split bearing 128 on the slide swivel 50. The shaft 127 extends diametrically of the slide swivel 50, and slidably through a bevel gear 129 journaled in a depending lug 130 on the underside of the hob slide 61.

Meshing with the bevel gear 129 is a bevel gear 131 which is journaled for rotation on the axis of the hob swivel 64, and which is substantially enclosed by a housing 132. A bevel gear 133, coaxial and rigid with the gear 131, meshes with a bevel gear 134 fixed on a shaft 135 parallel to the hob spindle 69 and journaled in the hob swivel 64. It will be evident that the drive connection from the gear 129 to the gear 134 is maintained regardless of the angular position of adjustment of the hob swivel 64. The shaft 135 is connected to the spindle 69 through meshing spiral gears 136 and 137 suitably enclosed within a housing 138 on one end of the hob swivel 64.

The translatory drive for the hob slide 61 is taken from a spline shaft 139 which extends longitudinally within the bed 14, and which is adapted to be driven in timed relation to the shaft 79 at a feed rate in one direction, or at a rapid traverse in either direction. The drive comprises a bevel gear 140 (see Fig. 12) journaled in a bearing lug 141 on the underside of the saddle 44 for movement therewith, and splined for free axial movement on the power shaft 139. A bevel gear 142, fixed on a vertical stub shaft 143 journaled in and extending through the saddle 44, meshes with the gear 140. Fixed on the upper end of the shaft 143 is a gear 144 meshing with a large gear 145 mounted in a circular recess 146 in the top of the saddle 44 for rotation about the axis of the slide swivel 50. In the present instance, the gear 145 is journaled on the bearing sleeve 123, and projects from the recess 146 upwardly into a registering recess 147 in the slide swivel 50. Meshing with the gear 145 within the recess 147 is a gear 148 fixed on the lower end of a vertical stub shaft 149 (see Fig. 11). A worm 150 on the shaft 149 meshes with a worm wheel 151 on a feed screw 152. One end of the screw 152 is suitably journaled in the split bearing 128 and the other end is in threaded engagement with a fixed nut 153 in an elongated tubular lug 154 on the underside of the slide 61.

The rapid traverse drive for the feed shaft 139 is adapted to be connected by a reversing clutch 155 from the shaft 76 either through the gear 75 and a gear 156 or through gears 157, 158 and 159. The clutch 155 (see Figs. 4 to 8) comprises a yoke 160 on a rock shaft 161 extending to the front of the bed 14. Secured to the forward end of the shaft 161 is an operating lever 162. A second lever 163 is fixed intermediate its ends to the shaft 161, and is pivotally connected at its free end to a plunger 164 reciprocable in a cylinder 165 in the bracket 87. Coiled compression springs 166 and 167 engage opposite ends of the plunger 164, and tend to center the latter, and thereby to move the clutch 155 into intermediate or neutral position. To provide means for holding the rapid traverse clutch 155 releasably in either operative position, the plunger 164 is formed with transverse notches 168 and 169 adapted for selective engagement by a retaining latch 170 pivoted on the bracket 87. A coiled tension spring 171 tends to urge the latch 170 against the plunger 164.

The feed drive for the shaft 139 is taken from the shaft 79, and is under the control of a one-way clutch 172. Thus, the shaft 105 (see Figs. 4 and 5) is connected through gears 173, 174 and 175 to a shaft 176 which in turn is connected through feed change gears 177, 178, 179 and 180, in the housing 102, to a shaft 181. A worm 182 on the shaft 181 meshes with a worm wheel 183 rotatable on a shaft 184 and adapted to be connected thereto by the clutch 172. The shaft 184 is connected through bevel gears 185 and 186 to a shaft 187 which in turn is connected through gears 188, 189 and 190 to the shaft 139.

The shaft 184 extends to the front of the machine, and is there provided with a hand wheel 191 whereby a manual feed may be effected when the clutches 155 and 172 are open.

The clutch 172 is operable through a rod 192 from the front of the machine by a two-position lever 193 pivoted intermediate its ends to the column 15. A second lever 194, pivoted intermediate its ends to the bed 14, has a pin and slot connection 195, 196 with the lower end of the

feed lever 193, and is positioned at its other end for engagement by a shoulder 197 in the side of the plunger 85 to open the feed clutch 172 automatically upon movement of the plunger to open the speed clutch 74. It will be evident that the feed clutch 172 can be closed only when the machine drive is connected through the clutch 74, and will be opened automatically through the levers 194—193 when the clutch 74 is opened.

The actuators for the rapid traverse and feed clutches 155 and 172 are interlocked so that both cannot be closed simultaneously. Thus, the upper end of the lever 163 (see Figs. 6 and 8) is formed with a notch 198 which when in neutral or intermediate position only is adapted to receive a tooth or projection 199 on the upper end of the lever 193 upon closing of the clutch 172. When the clutch 155 is closed in either direction, the end face of the lever 163 on either side of the notch 198 will through coaction with the projection 199 lock the feed clutch 172 in open position. When the clutch 172 is closed, the projection 199 will engage in the notch 198 to lock the clutch 155 in neutral position.

The rotation of the work spindle 20 is adjusted to compensate for the translation of the hob B relative to the work A. To this end, the shaft 187 is connected through differential change gears 200 to 203, in the housing 102, to a shaft 204 on which the worm 117 is fixed. Thus, when the translatory drive for the hob B is disconnected, the differential worm wheel 116 will be held stationary, and the speed of the shaft 104a will be the same as that of the shaft 104 in the work spindle drive. When either the rapid traverse or feed is connected, the worm wheel 116 will be rotated in synchronism therewith to advance or retard the rotation of the shaft 104a relative to the shaft 104, depending on the direction of translation. By reason of the differential adjustment, the hob B can be fed through the work, or allowed to come to rest at any point in its feed movement and merely rotate in mesh with the work.

The clutches 74, 155 and 172 are controlled by dogs on the hob slide 61 to provide a hob feed program comprising a rapid approach, a feed and a rapid return. Referring to Figs. 1 and 7, three pivotal dogs 205, 206 and 207 are mounted on the slide 61 for adjustment along a T-slot 208. Each dog has an inclined cam face on its lower end disposed for engagement with the free end of a lever 209 fixed on a shaft 210 journaled in the slide swivel 50. In the present illustration, the cam ends of the dogs 205 and 206 are adapted to engage and depress the lever 209 in the course of forward movement of the slide 61, and the dog 207 is arranged to act similarly upon reverse movement of the slide.

Secured to the shaft 210, is an arm 211 (see Fig. 9) arranged to engage and depress a rod 212 extending slidably through the shaft 122. The lower end of the rod 212 engages the free end of an arm 213 on a horizontal rock shaft 214 extending through the bed 14 to the left end of the machine. An arm 215 is adjustably clamped to the shaft 214, and has a bolt 216 threaded in its free end for engagement with the tail end of the detent lever 170. A transverse pin 217 on the lever 170 overlies the tail end of the latch 97, and is operable to release the latter from the notch 96 when the lever 170 is released from the plunger 164.

Mounted on the over arm 25 for adjustment along the ways 39 is a work stop 218. A suitable scale 219 serves to indicate the position of adjustment of the stop 218.

In operation, the work to be cut is mounted for rotation by the spindle 20. The position of the work longitudinally of the over arm 25 is determined by the stop 218 and the vertical position of the work is determined by a direct reading of the micrometer dial 38.

The tool spindle 69 is appropriately adjusted to suit the particular work to be cut. Thus, the saddle 44 is adjusted into the desired position longitudinally of the bed 14 by means of the screw 46 as indicated by the micrometer dial 49. The angular position of the swivel 50 is adjusted by means of the shaft 58 as indicated by the micrometer dial 60 to determine the path of movement of the slide 61 and hence the direction of feed of the hob B. The adjustment is also indicated by the vernier scale on the swivel 50. The angular position of the hob axis relative to the direction of feed is adjusted by means of the swivel 64 which may be clamped in place by the bolt 66.

For cutting a spur gear, the swivel 50 is so adjusted that the slide 61 is translated longitudinally of the work spindle 20, and the hob swivel 64 is so adjusted that the hob axis will be inclined to the perpendicular to the work spindle at an angle corresponding to the lead angle of the hob thread. For cutting a worm wheel, the swivel 50 is so adjusted that the slide 61 will be fed perpendicularly to the work spindle 20, and the swivel 64 is so adjusted that the axis of the hob also is perpendicular to the work spindle. Thus, the two swivel adjustments for the hob B adapt the machine for cutting widely different types and kinds of work pieces.

The machine is particularly adapted for the cutting of externally splined members as indicated in Fig. 13. For this operation, the swivel 64 is so adjusted that the hob axis *b* is inclined to the perpendicular *p* to the axis *a* of the work A at an angle B corresponding to the lead angle of the hob thread. The swivel 50 is so adjusted that the direction of feed extends diagonally across the work as indicated by the line *f*—*f*.

In operation, the saddle 44 and the slide 61 initially are so positioned relative to the work A that the large end of the hob B will in being fed along the path *f*—*f* cut the outer end of the work A to full depth at the point *o*. Initially, the lever 92 is actuated to the left to close the clutch 74, and the lever 162 is actuated to the left to close the clutch 155 and thereby institute a rapid approach. The feed clutch 172 is locked in open position. When the hob B is about to move into cutting engagement with the work A, the dog 205 engages the lever 209 thereby releasing the detents 97 and 170. As a result, the clutch 74 is opened and the clutch 155 is returned automatically into neutral position.

To now institute the feed, the lever 92 is actuated to the left to close the clutch 74 and, through movement of the shoulder 197 from the lever 194, to release the clutch 172 for closing movement. The lever 193 is actuated to the left to close the clutch 172, thereby instituting the feed drive. The traverse lever 162 is locked in neutral position. The hob B is fed from the position indicated in dotted outline in Fig. 13 completely across the work. During the cutting engagement, the work A and the hob B are rotated in timed relation, the relative rotation being suitably adjusted by the differential mechanism 116 to compensate for the feed. In the course of the

cutting action, the longitudinal form of the hob is projected in the direction *f—f* onto the work to produce a foreshortened form on the latter as the cut proceeds progressively from end to end. At the end of the cutting operation, the dog 206 engages the lever 209 to release the detent 97. Thereupon, the spring 88 shifts the plunger 85 to the right to open the clutch 74, and through the levers 194 and 193 to open the feed clutch 172.

The lever 92 now is again actuated to the left to close the clutch 74 and the lever 162 is actuated to the right to close the clutch 155 in a direction to institute a rapid return movement. In this movement, the lever 209 lifts the pawl 205 without being depressed. At the end of the return movement, the dog 207 depresses the lever 209 to open the clutches 74 and 155, thus completing the cycle.

I claim as my invention:

1. A hobbing machine comprising, in combination, a work spindle, means for supporting said spindle in a fixed position, a saddle adjustable axially of said spindle, a hob spindle, means on said saddle for supporting said hob spindle for translation in different selective angular directions relative to said work spindle including a direction axially of said work spindle and a direction perpendicular to said work spindle and for adjustment into different angular positions relative to the direction of translation, power drive means for rotating said spindles in timed relation, and power drive means for translating said hob spindle and simultaneously adjusting the rotary phase relation of said spindles in timed relation to the translation of said hob spindle.

2. In a hobbing machine, in combination, a base, a saddle slidable on said base, a swivel mounted on said saddle for angular adjustment about a vertical axis, a slide mounted on said swivel for translation transversely of said axis, drive means for feeding said slide in any angular position of said swivel and including control clutch means in said base, an automatic trip mechanism for effecting opening of said clutch means and operable by said slide in any angular position of said swivel, a swivel mounted on said slide for adjustment about a vertical axis, a spindle mounted on said last mentioned swivel, and drive means for rotating said spindle in any angular position of said slide and in any angular position of said spindle relative to said slide.

3. In a hobbing machine, in combination, a swivel mounted for angular adjustment about an axis, a slide mounted on said swivel for translation transversely of said axis, drive means coaxial with said axis for feeding said slide in any angular position of said swivel, a swivel mounted on said slide for adjustment about an axis parallel to said first mentioned axis, a spindle mounted on said last mentioned swivel, and drive means coaxial with said last mentioned axis for rotating said spindle in any angular position of said slide and in any angular position of said spindle relative to said slide.

4. A hobbing machine comprising, in combination, a frame, a work spindle, a hob spindle, a slide on said frame for supporting one of said spindles for translation, means for supporting the other of said spindles on said frame, common drive means having branch drives for rotating said spindles in timed relation, a differential mechanism in the drive for the work spindle, and drive means parallel to said mechanism for feeding said slide and driving said mechanism in timed relation to the feeding movement.

5. A hobbing machine comprising, in combination, a work spindle, a hob spindle, a slide for supporting said hob spindle, parallel drives for rotating said spindles in timed relation, one of said drives including two aligned shaft sections with bevel gears on their adjacent ends, a cage supporting two bevel gears in mesh with said first mentioned gears and mounted for rotation about said shaft sections, a reversible rapid traverse drive for said slide, a feed drive for said slide branching from one of said spindle drives in advance of said cage, clutch means for selectively connecting one or the other of said two last mentioned drives, and means for rotating said cage in timed relation to the drive of said slide to vary the relative rotation of said spindles so as to compensate at all times for the translation of said slide.

6. In a hobbing machine, in combination, a base, two power shafts extending in said base, a saddle slidable along said base and said shafts, two gears movable with said saddle and splined respectively to said shafts, a vertical bearing sleeve opening through said saddle, a vertical shaft journaled in said sleeve and connected to one of said gears, a slide swivel mounted on said saddle for angular adjustment about the axis of said vertical shaft, a slide mounted on said swivel for adjustment transversely of said axis, a feed screw journaled in said swivel and in operative threaded engagement with said slide, means connecting said screw to the other of said gears and including a gear rotatable on said sleeve, a spline shaft rotatably journaled in said swivel and geared to said vertical shaft, a hob swivel mounted on said slide for adjustment about a vertical axis, a hob spindle mounted on said hob swivel, and a vertical shaft coaxial with said hob swivel and geared to said spline shaft and said hob spindle.

7. In a hobbing machine, in combination, a base, a power shaft extending in said base, a saddle slidable on said base along said shaft, a gear movable with said saddle and splined to said shaft, a vertical shaft journaled in said saddle and connected to said gear, a slide swivel mounted on said saddle for angular adjustment about the axis of said vertical shaft, a slide mounted on said swivel for adjustment transversely of said axis, a spline shaft rotatably journaled in said swivel and geared to said vertical shaft, a hob swivel mounted on said slide for adjustment about a vertical axis, a hob spindle mounted on said hob swivel, and a vertical shaft coaxial with said hob swivel and geared to said spline shaft and said hob spindle.

8. In a hobbing machine, in combination, a base, a power shaft extending in said base, a saddle slidable on said base along said shaft, a gear movable with said saddle and splined to said shaft, a slide swivel mounted on said saddle for angular adjustment about a vertical axis, a slide mounted on said swivel for adjustment transversely of said axis, a feed screw journaled in said swivel and in operative threaded engagement with said slide, a gear rotatable on said axis and having an operative drive connection with said first mentioned gear and with said screw, and a hob spindle on said slide.

9. A hobbing machine comprising, in combination, a base, a column, a support having a work spindle on said column, a support having a tool spindle mounted for translation on said base, means for rotating said spindles in timed rela-

tion and including means for effecting a relative reversal of rotation of said spindles and including a differential mechanism in the work spindle drive, and means parallel to said differential mechanism for translating said tool spindle and driving said differential mechanism in timed relation, said last mentioned means including a reversible rapid traverse drive and a one-way feed drive.

10. A hobbing machine comprising, in combination, an elongated horizontal base, a column on one end of said base, a headstock having a work spindle and vertically adjustable on said column, an over arm movable with said headstock, means including a direct reading gauge for adjusting said headstock, a support slidable on said base, means including a direct reading gauge for feeding said support on said base, a hob spindle mounted on said support for translation in different angular directions and for independent angular adjustment, means for rotating said spindles and means for translating said hob spindle on said support.

11. A hobbing machine comprising, in combination, an elongated horizontal base, a column on one end of said base, a headstock having a work spindle and vertically adjustable on said column, an over arm movable with said headstock, means including a direct reading gauge for adjusting said headstock, a support slidable on said base, means including a direct reading gauge for feeding said support on said base, a hob spindle mounted on said support for translation in different angular directions and for independent angular adjustment, a direct reading gauge for indicating the path of movement of said hob spindle, a work locating support on said over arm, means for rotating said spindles, and means for translating said hob spindle on said first mentioned support.

12. In a hobbing machine, the combination of a bed; an adjustable support on said bed; a swivel, a slide and a second swivel mounted on said support in superimposed relation; a tool spindle journaled on said second swivel; means for driving said slide through a feeding movement and return; means for adjusting said swivels through wide ranges of angular adjustment to position a tool on said spindle in any angular position and for translation along any path paralleling the plane of the slide; drive means journaled in said bed and extending beneath said support; and driving connections between said drive means and said spindle and slide extending upwardly through the superimposed assembly of the swivels and slide and operative in any relative position of adjustment of the parts.

13. In a hobbing machine, in combination, a swivel mounted for angular adjustment about its axis, a slide mounted on said swivel for translation transversely of said axis, a second swivel on said slide mounted for adjustment about its axis, the axes of said swivels being parallel, a spindle journaled on said second swivel, and separate drive means for said slide and spindle each including a member journaled on the axis of the first mentioned swivel.

14. A hobbing machine comprising, in combination, a prime mover having a control clutch, a work spindle, a hob spindle, means including a swivel and slide for supporting said spindles for relative translation and angular adjustment, means for driving said work spindle from said prime mover through said control clutch, a rapid traverse drive for said slide having driving connections with said prime mover through said control clutch and including a reversing clutch, a feed drive for said slide having driving connections with said prime mover through said control clutch and including a feed clutch, the drive connections for said work spindle and slide being effective in any relative angular position of the slide and swivel, means for interrupting said drives at predetermined points in the travel of said slide including interconnecting means between said control clutch and the reversing and feed clutches individually and respectively, and interlock means between said reversing and feed clutches to prevent simultaneous closing thereof.

15. A machine for hobbing the inside member of a spline coupling with elongated generally longitudinal laterally aligned peripheral projections of a predetermined length and separated by elongated spaces with root surfaces concentric in form about the axis of rotation, comprising, in combination, an elongated horizontal base, a column on said base, a horizontal work spindle for supporting said member in axial alignment therewith and extending longitudinally of said base and mounted on said column for vertical adjustment, a saddle slidable longitudinally on said base, a swivel mounted on said saddle for angular adjustment about a vertical axis, a slide mounted on said swivel for translation transversely of said vertical axis, said swivel being adjustable to position said slide for movement in a rectilinear path extending diagonally across the axis of said member, a second swivel mounted on said slide for adjustment about a vertical axis, a horizontal spindle adapted to support a hob and mounted on said second swivel, said second swivel being adjustable to position the axis of said hob at an angle to a perpendicular to the axis of said member corresponding to the hob lead angle, drive means for feeding said slide to move said hob along said rectilinear path at an angle to said hob axis through cutting engagement with said member with said hob in a position longitudinally inclined at said angle corresponding to said lead angle, said hob having an effective length such that the projection of its axis along said rectilinear path on an axial plane of said member is coextensive in length and position with the projections to be cut, and drive means for rotating said spindles in timed relation to each other and to the feeding movement of said slide.

16. A hobbing machine comprising, in combination, a frame, a work spindle, a hob spindle, means for supporting one of said spindles on said frame, a saddle mounted on said frame for adjustment axially of said one spindle, means on said saddle for supporting the other of said spindles for translation in different selective angular relations to said one spindle and for adjustment into different angular positions relative to the direction of translation, common drive means having branch drives for rotating said spindles in timed relation, a differential mechanism in the drive for said one spindle, and drive means parallel to said mechanism for translating said other spindle and for driving said mechanism in timed relation to the translation of said other spindle.

17. In a hobbing machine, in combination, a base; a saddle slidable on said base; a swivel mounted on said saddle for angular adjustment about a vertical axis; a slide mounted on said swivel for translation transversely of said axis; power drive means for feeding said slide in any

angular position of said swivel and including a reversible rapid traverse self-opening transmission, a self-opening feed transmission, and interlock means preventing simultaneous closing of said transmissions; releasable detent means for selectively maintaining one or the other of said transmissions closed and having an operating member coaxial with said axis, and dogs on said slide for actuating said member to release said detent means; a swivel mounted on said slide for adjustment about a vertical axis, a spindle mounted on said last mentioned swivel; and drive means for rotating said spindle in any angular position of said slide and in any angular position of said spindle relative to said slide.

18. A hobbing machine comprising, in combination, a work spindle, a hob spindle, means for supporting one of said spindles in a fixed position, a saddle adjustable axially of said one spindle, means on said saddle for supporting the other of said spindles for translation in different selective angular directions relative to said one spindle including a direction axially of said one spindle and a direction perpendicular to said one spindle and for adjustment into different angular positions relative to the direction of translation, a power drive, a transmission including a self-opening main clutch for connecting said drive to rotate said spindles in timed relation, releasable detent means for holding said clutch in closed position, a rapid traverse transmission branching from said first transmission and including a self-opening reversing clutch for translating said other spindle, releasable detent means for holding said reversing clutch in closed position, a feed transmission branching from said first mentioned transmission in advance of said reversing clutch and including a one-way clutch for translating said other spindle, interlock means for opening said one-way clutch upon opening of said main clutch, interlock means for preventing simultaneous closing of said reversing clutch and said one-way clutch, and means for automatically releasing said detent means upon movement of said other spindle into a predetermined position of translation.

JOHN EDGAR.