

May 7, 1935.

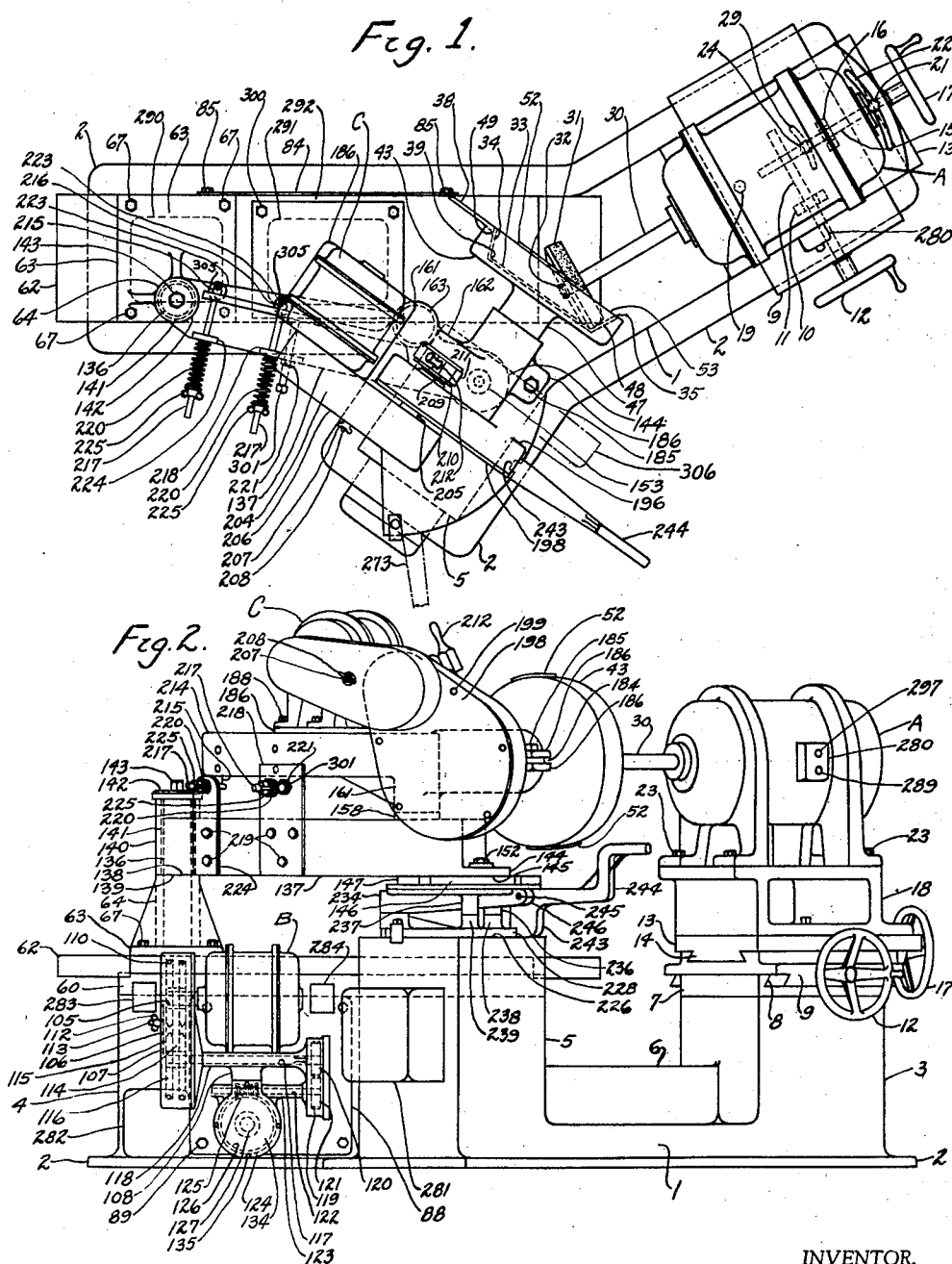
G. A. CARLSON

2,000,216

GRINDING MACHINE

Filed July 1, 1933

4 Sheets-Sheet 1



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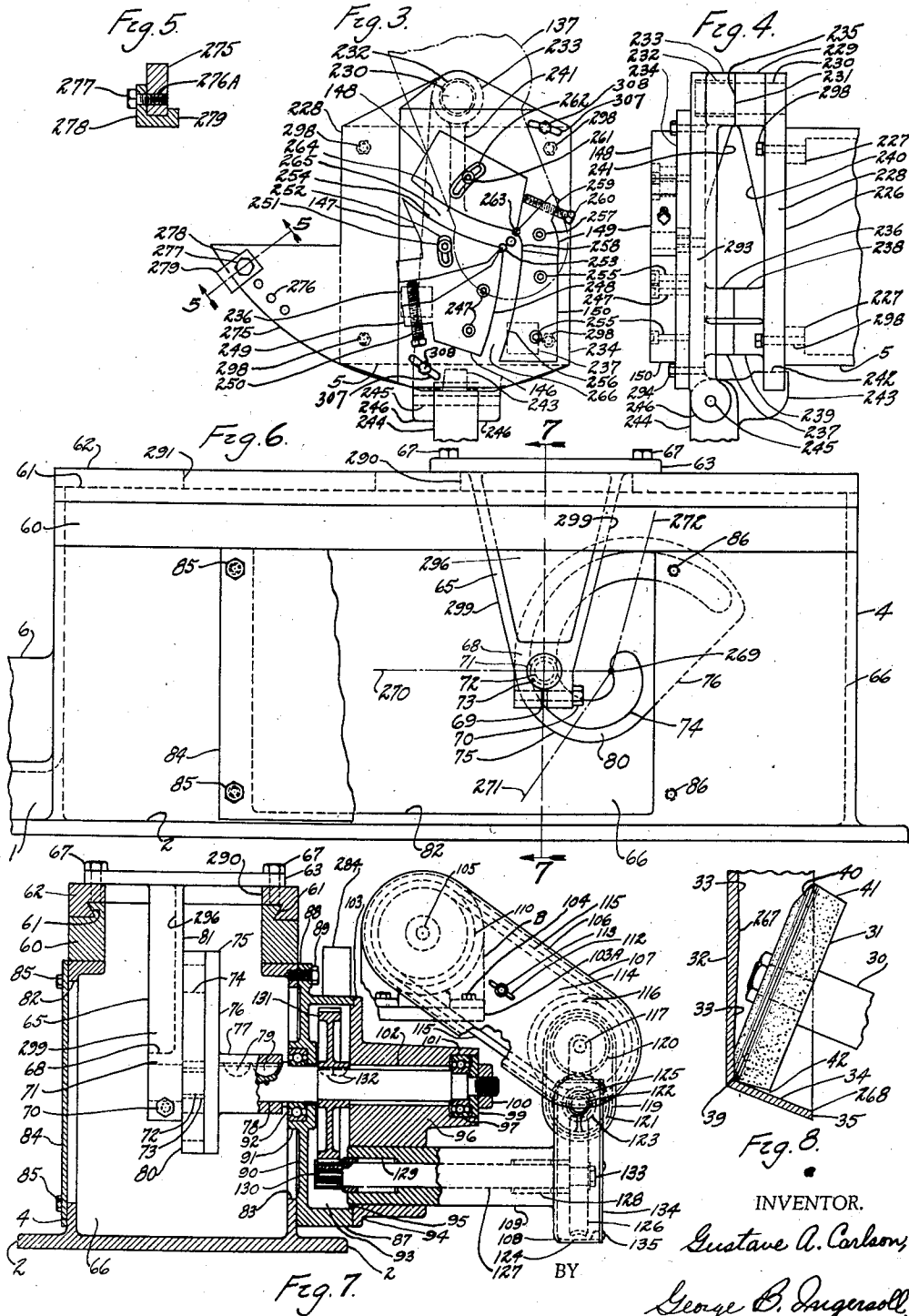
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4 Sheets-Sheet 2



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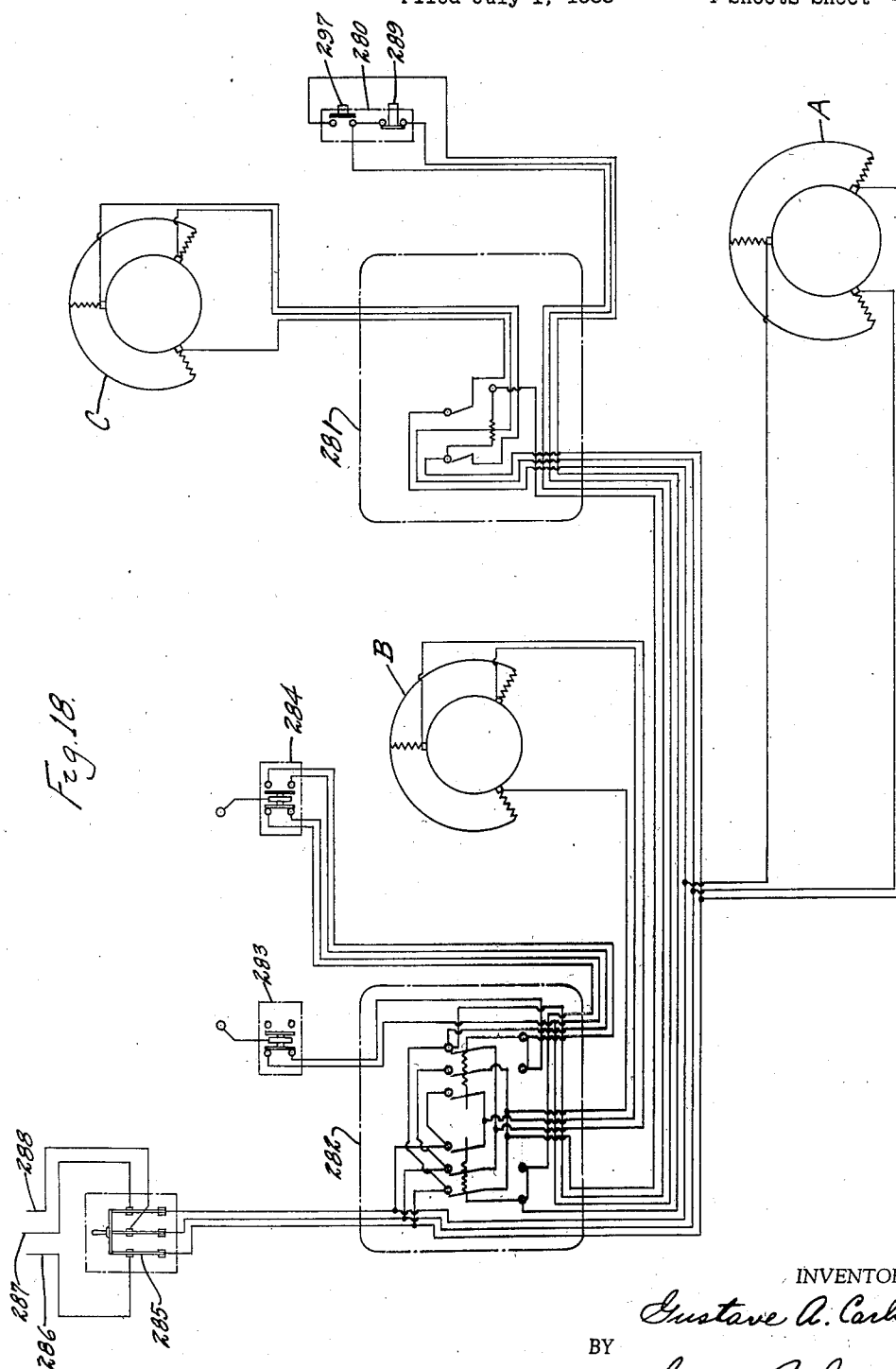
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,000,216

GRINDING MACHINE

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Application July 1, 1933, Serial No. 678,589

32 Claims. (Cl. 51—100)

My invention relates to improvements in grinding machines in which a grinding wheel operates in conjunction with a movably operated mechanism for holding the object or work to be ground; and the objects of my improvements are, first, to provide a grinding machine in which the object to be ground may be revolved and also moved along a predetermined path to form the shape of the ground surfaces; second, to provide a grinding machine having a reciprocating carriage actuated to move with varying rates of speed throughout its stroke; third, to provide a grinding machine having a reciprocating carriage supporting an oscillating head mechanism for supporting the object to be ground; fourth, to provide a grinding machine having an oscillating head mechanism mounted on a reciprocatingly and oscillatory operated mechanism; fifth, to provide a grinding machine with means for resiliently actuating the object to be ground toward the grinding member; sixth, to provide a grinding machine with a cam controlled mechanism for varying the reciprocating movement of the object to be ground to form the shape of the ground surfaces; seventh, to provide a cam mechanism for partially supporting a reciprocated carriage member for supporting the object to be ground; eighth, to provide a pivotally supported cam mechanism to permit the object to be ground by a grinding machine to be readily moved to and from the grinding member to provide operating clearance when inserting or removing the object to be ground; ninth, to provide a pivotally mounted mechanism for manually moving the object to be ground, in a grinding machine, from the grinding member, with means for automatically returning the pivotally mounted mechanism to a position in which the object will be in a position to be ground by the grinding member; tenth, to provide a grinding machine with a revolvably mounted chuck having a resiliently actuated clamping mechanism for receiving the object to be ground therethrough; eleventh, to provide a grinding machine having a revolvably mounted chuck for holding the object to be ground, with means for decelerating or stopping the revolvable motion of the chuck; twelfth, to provide a grinding machine having a resiliently actuated chuck for holding the object to be ground, with means for varying the pull of the resilient mechanism to exert varying thrusts of the object against the grinding member at predetermined points in the travel of the object adjacent the grinding member; thirteenth, to provide a grinding machine having a carriage reciprocatingly operated by a revolving cam member having an irregular outline to provide varying rates of speed throughout the stroke of the carriage; fourteenth, to provide a grinding machine having an individual power unit for operating its chuck, grinding member, and carriage for supporting the chuck; fifteenth, to provide a grinding machine having a reciprocating carriage operatively controlled to reverse its movement at one end of its stroke and to terminate its movement at the other end of its stroke; and sixteenth, to provide a grinding machine having an electric motor as its head or head stock member with means for adjusting the position of the electric motor longitudinally, transversely and radially in a horizontal plane.

I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a plan view of the grinding machine; Fig. 2, a side view of the grinding machine; Fig. 3, a plan view of the cam mechanism for guiding the movement of the chuck for supporting the object to be ground relative to the grinding wheel; Fig. 4, a side elevation of the cam mechanism disclosed in Fig. 3; Fig. 5, a sectional view through one of the stop members on the cam mechanism, disclosed in Fig. 3, taken on the line 5—5, Fig. 3; Fig. 6, a partial view of the grinding machine and with its cover member partially removed to disclose a portion of the reciprocating carriage together with its operating cam mechanism; Fig. 7, a partial sectional view taken on the line 7—7, Fig. 6, together with the cam driving mechanism; Fig. 8, a partial sectional view of a skillet and the grinding wheel in its operative position relative to the skillet; Fig. 9, a side view of the chuck for holding a skillet to be ground and with a skillet therein, together with a portion of the chuck operating shaft and its supporting mechanism; Fig. 10, an end view of the chuck and the skillet disclosed in Fig. 9; Fig. 11, a plan view of the chuck and the skillet disclosed in Fig. 10; Fig. 12, an end view of the electric motor and the mechanism for driving the chuck for holding the skillet; Fig. 13, a plan view of the end portion of the guiding arm and its guide member for engaging its cooperative cam mechanism; Fig. 14, an end view of the portion of the guiding arm and guiding member disclosed in Fig. 13; Fig. 15, a plan view of a portion of the chuck supporting and driving mechanism; Fig. 16, a partial sectional view taken on the line 16—16, Fig. 15; Fig. 17, an end view of the brake mechanism; and Fig. 18, a wiring diagram disclosing schematically the various elec-

trically operated and connected units for controlling the operation of the grinding machine. Similar numerals refer to similar parts throughout the several views.

5 The grinding machine is provided with the base 1 which is further provided with the flange 2 from which upwardly extend the head column, pedestal or housing 3, the reciprocating carriage column, pedestal or housing 4, and the cam mechanism supporting column, pedestal or housing 5, said columns 3, 4 and 5 being located angularly relative to one another. The housings 3, 4, and 5 may be suitably connected by the rib member 6 for reinforcing purposes. The column 3 is provided with the bed 7 which is provided with the ways or V portions 8 in which is slidably mounted the cross slide 9, the cross slide 9 being adjustably moved in a conventional way by the shaft 11 which threadably engages the boss 10 of the cross slide 9, the shaft 11 being revolvably operated by the hand wheel 12, thus providing adjustable movement, in a transverse direction relative to the column 3, for the cross slide 13 which is slidably mounted to move longitudinally relative to the cross slide 9, the cross slide 13 being mounted in the ways or V portions 14 of the cross slide 9. The cross slide 13 is operated by the shaft 15 which threadably engages the boss 16 of the cross slide 13, the shaft 16 being revolvably operated by the handwheel 17. The housing member 18 is secured, by the screws 19 and 21 to the cross slide 13 and is adapted to move therewith. The cross slide 13 is provided with the slot 22 which is located radially relative to the screw 19, the screw 21 extending through the slot 22 to permit the housing 18 to be adjustably moved radially about the center of the screw 19, thus providing radial adjustment for the housing 18 together with the electric motor assembly A which is secured to the housing 18 by the screws 23. Additional screws, such as 24 may be used to secure the housing 18 to the cross slide 13 in which case an additional radial slot 25 is provided in the housing 18 to engage the screw 24.

45 The electric motor assembly A is provided with the armature shaft 30 which is extended outwardly from the electric motor assembly A to provide proper operating space and the grinding wheel 31 is suitably mounted at the outer end of said shaft 30 and is secured by the nut 32.

50 It is to be noted that my grinding machine is adapted for performing grinding operations on a great variety of objects or different kinds of work and makes possible, as hereinafter disclosed, the grinding of different kinds of work in a very quick, efficient, and easy way which is especially advantageous where the object or work is such as can only be produced and marketed at a very low or minimum cost. As an example of such objects or work, I have disclosed my grinding machine as being used for grinding the inner bottom surfaces 33 and the inner flange surfaces 34 of a skillet or spider 35 which may be constructed, as by casting, with the lips or flared portions 36 and 37 which are used as a spout for pouring liquids from the skillet 35, the skillet 35 being further constructed with the handle 38.

65 It is thus to be noted that, with an object such as the skillet 35 which is constructed as by casting in a sand mold of cast iron or similar material, it is imperative that the inner surfaces 33 and 34 be produced with a finished surface condition in the quickest possible time and at the lowest possible cost in order to profitably produce such an object because the inherent nature of such objects

preclude any excess charges even though they are small. Therefore I have disclosed my grinding machine as operating on a skillet for which it is especially adapted and from such a disclosure it will be readily apparent that my grinding machine can be easily adapted to a great variety of objects without departing from the spirit and scope of my invention.

Figure 8 discloses a sectional portion of the skillet 35 together with the grinding wheel 31 located adjacent the radius or corner 39 of the skillet 35, the grinding wheel 31 being constructed with a shape to conform to the surfaces of the object or work to be ground. In the instance of the skillet 35, the grinding wheel 31 will be provided with the surface 40, which, as hereinafter disclosed, is adapted to grind the surfaces 33 as the skillet 35 is operatively moved, the grinding wheel 31 being further provided with the surface 41 which may be provided with a clearance space 42, the surfaces 40 and 41 being located angularly relative to one another to form the desired radius or corner 39, the grinding wheel 31 being further adapted to grind the surface 34 as the skillet 35 is operatively moved, as hereinafter disclosed. The skillet 35 is supported, during the grinding operation, in the chuck or fixture 43 which is mounted on the shaft 44 and is adapted to revolve with the shaft 44, the chuck 43 being driven by the keys 45 which suitably engage a keyway in the hub 47 of the chuck 43, the chuck 43 being secured on the shaft 44 by the nut 46, the shaft 44 being operatively mounted as hereinafter disclosed. The chuck 43 is provided with the recess 48 which is formed to engage and fit with the outside surfaces of the skillet 35. The chuck 43 is also provided with the cut away portion or notch 49 to clear the handle 38 of the skillet 35.

The chuck 43 is further provided with the holes 50 through which extend the bolts 51 which are suitably secured to the clamp members 52; the clamp members 52 being resiliently urged toward the outer surface 53 of the chuck 43 by the springs 54 which are retained on the bolts 51 by the washers 55 and the pins 56, the springs 54 being contained within the recesses 57 of the chuck 43. The clamp members 52 are each provided with the notch or recess 58 which permit the flared portions 36 and 37 of the skillet 35 to be inserted therethrough when the skillet 35 is being secured in the chuck 43, the handle 38 of the skillet 35 occupying a position, as indicated by dotted lines at 59, in Fig. 10, and the skillet 35 can now be rotated about the axis of the chuck 43 and the shaft 44 until the flared portions 36 and 37 have been moved to positions under the clamp members 52 or to a position in which the handle 38 will occupy the position indicated by the full lines of the handle 38 in Fig. 10, and in which position the flared portions 36 and 37 will be resiliently clamped by the clamp members 52 and the skillet 35 will be secured in the chuck 43 preparatory to the grinding operation.

65 It is to be noted that the skillet 35 can thus be easily and quickly inserted to or removed from its clamped position in the chuck 43 thus facilitating economical and high quantity production of the skillet 35 relative to the grinding operation thereof.

The column 4 is provided with the bed member 60 which is suitably secured thereto and in turn provided with the ways or V shaped portions 61 on which is slidably mounted the table or cross slide 62 to which is secured, by the screws 67, the carriage or housing member 63 which is provided,

at its upper side, with the column, pedestal or boss 64 and on its lower side with the arm, extension, or bracket portion 65 which extends within the chamber 66 of the column 4.

5 The arm 65 of the carriage 63 may be constructed with a triangular shape having oppositely disposed walls 299 with a connecting web 296, all terminating in or connecting at their lower ends, with the boss 68 provided with the slot 69 and the clamp bolt 70 for clamping the boss 68 and securing the stud 71 therein, the stud 71 being provided with the extension end 72 on which is suitably secured the bushing 73 which acts as a cam follower for engaging the groove 74 of the cam member 75.

10 The cam member 75 is provided with the wall 76 which closes one side of the groove 74 and supports the side walls of the groove 74, the inner surfaces of said side wall being engaged by the bushing 73 which together with the extension end 72 extends into the groove 74 of the cam member 75. The cam member 75 is also provided with the hub 77 which is secured in a driven position on the shaft 78 by the keys 79, the outer end of the bushing 73 and the extension end 72 contacting with the bottom surface of the groove 74 and the outer surface 80 of the cam member 75 contacting with the surface 81 of the arm 65.

15 The column 4 is provided with the opening 82 in one of its walls at a point opposite or in alignment with the arm 65 and the cam member 75 and is also further provided with the opening 83 in one of its walls at a point approximately opposite the opening 82 and in alignment with the arm 65 and the cam member 75. The opening 82 is closed by the cover 84 secured to the column 4 by the screws 85 which engage the threaded holes 86 in the walls of the column 4. The opening 83 is closed by the housing 87 which is provided with the flange 88 through which extend the screws 89 for securing the housing 87 to the walls of the column 4. The housing 87 is further provided with the wall 90 which is provided with the boss 91 in which is supported the bearing assembly 92 for supporting the shaft 78. The housing 87 is further provided with the recess 93 which is closed at its outer side by the housing 94 which has a pilot portion 95 for extending within the recess 93, said housing 94 being provided with the extension boss 96 for supporting the bearing assembly 97 in which is supported the outer end of the shaft 78. The shaft 78 is provided with the washer or flange 99 and the nut 100 for securing the bearing assembly 97 on the shaft 78, the washer 99 fitting within and closing the outer end of the recess 101 which contains the bearing assembly 97, suitable operating clearance being provided between the washer 99 and the inside surface of the recess 101 to permit the washer 99 to revolve with the shaft 78 which extends through the hole 102 of the housing 94. The housing 94 is provided with the flange 103 which may be suitably secured as by screws extending through the flange 103 into the walls of the housing 87.

20 The housing 94 may be further provided with the bracket 103A which may be suitably secured thereto by screws or by constructing it integrally with the housing 94. The electric motor assembly B is secured to the bracket 103A by the screws 104 and is provided with the shaft 105 which extends into the chamber 106 of the housing 107 which may be suitably supported on the shaft 105 and on the housing 108 which is provided with an extension portion 109 which extends within and is supported by the housing 94.

The driver sprocket 110 is suitably mounted on the shaft 105 and is adapted to be driven thereby, the end of the shaft 105 and the sprocket 110 revolving in the chamber 106. The housing 107 may be provided with the cover 114 which is secured by the wing nut 112 and stud 113, the stud 113 being suitably anchored in the housing 107, the cover 114 being thus readily removable to permit access to the chamber 106 to inspect and service the chain 115 which engages the driver sprocket 110 and the driven sprocket 116, the driven sprocket 116 being suitably mounted on the shaft 117 which is suitably supported and operatively mounted in the boss portion 118 of the housing 108 which is further provided with the gear case 119 in which operate the gears 120 and 121, the gear 120 being suitably, mounted on the end of the shaft 117, the gear 121 being suitably mounted on the end of the shaft 122 which is suitably mounted in the boss portion 123 of the housing 108, the shaft 122 extending into the upper portion of the gear chamber 124 in which are suitably mounted the worm 125 and the worm gear 126, the worm 125 being suitably mounted on the shaft 122 and the worm gear 126 being suitably mounted on the shaft 127 which is rotatably mounted in the bearing assemblies 128 and 129 which are suitably mounted in the extension portion 109 of the housing 108.

25 The shaft 127 extends through the extension portion 109 and is provided at its outer end with the nut 133 for securing the worm gear 126 thereon, said shaft 127 being provided at its inner end with the gear 130 which may be machined integrally with said shaft 127, the gear 130 extending within the chamber 93 and the meshing with the gear 131 which is secured, by the keys 132, to the shaft 78, the gear 131 being adapted to operate in the chamber 93.

30 The housing 108 may be provided with the cover 134 secured thereto by the screws 135, said cover 134 being readily removable to permit access to the gear chamber 124. The shaft 136 is suitably secured in the column 64 of the carriage 63 and extends upwardly therefrom to permit the boss portion 140 of the guiding arm 137 to be movably mounted thereon, the boss portion 140 being provided with the surface 138 for contacting the supporting surface 139 of the column 64, the boss portion 140 being provided with the bushing 141 for a bearing on the shaft 136, the guiding arm 137 being retained on the shaft 136 by the cap or washer member 142 which is secured by the screw 143 which threadably engages the end of the shaft 136. The guiding arm 137 is further provided at its opposite end with the flange 144, as disclosed in Figs. 13 and 14, the flange 144 having the surface 145 which engages and rests upon the upper surfaces of the cam members 146, 147, 148, 149 and 150 as disclosed in Figs. 3 and 4 and as hereinafter more fully disclosed.

35 The stud 151 is secured in the flange 144 by the nut 152 and is provided with the end or cam follower 153 which is adapted to extend within the cam grooves formed between the above mentioned cam members 146, 147, 148, 149 and 150 as hereinafter more fully disclosed.

40 The guiding arm 137 is provided with the boss portion 154 in which is suitably secured the shaft 155 which extends upwardly therefrom, the boss portion 154 being provided with the pilot portion 156 which fits within and locates the lower bearing race 157 of the bearing assembly 158, the upper bearing race 159 of the bearing assembly 158 being located by the pilot portion 160 of the 75

hub 161 of the housing head 162 which supports the shaft 44 as hereinafter disclosed.

The hub 161 is provided with the chamber 163 at the lower end of which is supported the lower bearing assembly 164 which is secured adjacent the shoulder 165 of the shaft 155 by the nut 166 and the lock nut 167. The upper bearing assembly 168 is suitably supported in the cage 169 which is inserted within and threadably engages the chamber 163, the upper bearing assembly 168 being retained in the cage 169 by the threaded retainer 170 which also closes the upper end of the chamber 163. The bearing assembly 168 is secured adjacent the shoulder 171 of the shaft 155 by the nut 172 and the lock nut 173. The above mentioned shaft 44 is operatively supported in the bearing assembly 174 and the bearing assembly 301A which are supported in the sleeve 182 of the housing head 162, the bearing assembly 174 being secured adjacent the shoulder 175 by the nut 176 and the lock nut 184, the bearing assembly 174 being further secured in the sleeve 182 by the retainer 177, the bearing assembly 301A being secured adjacent the shoulder 178 by the nut 179 and the lock nut 180, the bearing assembly 301A being further secured in the opposite end of the sleeve 182. The sleeve 182 fits and extends within the bore 183 of the housing head 162 which is provided with the clamping slot 184 and the clamp screw 185A which is adapted to clamp the bosses 186 and lock the sleeve 182 in the bore 183. The housing head 162 is provided with the bracket 350 which may be constructed integrally therewith as by casting same in conjunction with the hub 161, or by means of the plate 186A being secured to the upper surface of the bracket 350 by screws engaging the plate 186A and the threaded holes 187 of the bracket 185A. On the upper surface of the plate 186A is supported the electric motor assembly C which may be secured thereto by the screws 188 which engage flange portions of the electric motor assembly C and the holes 189 in the plate 186.

The electric motor assembly C is provided with an armature shaft 190 on which is secured and supported the driver sprocket 191 which drives the chain 192 which in turn engages the driven sprocket 193 which is supported and secured on the shaft 194 which is suitably supported in the boss 195 of the gear case 196, which may be constructed integrally with the housing head 162, and in the boss 197 of the cover 198 which closes the gear chamber 295 of the gear case 196, the cover 198 being secured in position by the screws 199 engaging the gear case 196.

The gear 200 is suitably secured and supported on the shaft 194 and operatively engages the gear 201 which also operates in the gear chamber 295, the gear 201 being suitably secured and supported on the shaft 44 by the keys 202 and the nut 203 said shaft 44 extending into the gear chamber 295.

Fig. 12 discloses a true side view of the electric motor assembly C and the gear case 196 together with the chain case 204 for enclosing the chain 192 and the sprockets 191 and 193, the chain case 204 being suitably supported on the armature shaft 190 of the electric motor assembly C and on the extension portion 205 of the shaft 194, the chain case 204 being provided with the cover 206 which is secured by the wing nut 207 which engages the stud 208 which is suitably secured to portions of the chain case 204 thus

permitting access to the inside of the chain case 204 for inspection and service operations.

The shaft 194 is provided with the extension portion 209 on which is mounted the brake drum 210 which is engaged by the brake band 211 which is operated by the lever 212 to engage the brake drum 210 to provide means for decelerating, braking, and stopping the movement of the chuck 43 and the skillet 35 when secured therein, the lever 212 being suitably mounted on the stud 213.

It is to be noted that the housing head 162 is further provided with the arm 214 to which are suitably secured the members 215 and 216 which are each provided with suitable neck or undercut portions 222 to engage the eye portions 305 to provide a swivel or pivotal engagement for the eye portions 305 of the rods or shafts 217 which extend through and are supported in the plate or bracket members 218 and 224 which are secured to the guiding arm 137 by the screws 219. The rods 217 are provided with the springs 220 which tend to always pull the arm 214 towards the bracket members 218 and 224, thus tending to always oscillate the housing head 162 about the shaft 155 and force the skillet 35 against the grinding wheel 31. The reaction thrust of the springs 220 is taken against the thumb nuts 225 which threadably and adjustably engage the rods 217. The set screw 301 is threadably and adjustably mounted in the plate member 218 to provide a stop member for engaging the arm 214 to limit its oscillating or pivotal movement in one direction, the set screw 220 being locked in its adjusted position by the lock nut 221.

Figs. 3 and 4 disclose the cam members 146, 147, 148, 149 and 150 which are so supported on the column 5 as to provide the proper cam grooves to engage the end or cam follower 153 of the stud 151 in the guiding arm 137 so as to provide the proper pivotal or oscillating movement of the housing head 162, when the carriage 64 is reciprocated by the cam member 75, to move the skillet or similar object to be ground in the proper path to enable the grinding wheel 31 to perform the required grinding operation.

The column 5 is provided with the upper surface 226 together with the bosses 227 and the support member 228 is suitably secured to the upper surface 226 by the screws 298 extending through the support member 228 and into suitable holes in the bosses 227. The support member 228 is provided with the boss portion 229 in which is suitably secured the stud member 230 which extends above the surface 231 of the boss portion 229 of the support member 228 and engages the bushing 232 which is suitably secured in the boss portion 233 of the member 293 to which is secured the cam block 234 by means of the screws 294, the boss portion 233 having its surface 235 engaging the surface 231 of the support member 228, the cam block 234 being further supported by the surfaces of the boss portions 236 and 237 of the member 293 contacting similar surfaces on the boss portions 238 and 239 of the support member 228.

The support member 228 may be provided with the rib 240 and the member 293 may be provided with the rib 241 for reinforcing purposes.

The support member 228 is provided with the notch 242 which is adapted to be engaged by the lug 243 of the lever 244 which is pivotally mounted on the pin 245 which is suitably mounted in the bosses or ears 246 between which the lever 244 is thus operatively mounted, the bosses or ears

246 being constructed with or supported on the member 293.

The cam member 146 is secured to the cam block 234 with the screws 247 and is provided with the convex cam surface 248 together with the extension portion 249 in which is threadably mounted the set screw 250 which engages and constitutes a reaction, backing or support member for the cam member 147 which is secured to the cam block 234 by the screw 251, the screw 251 extending through the radially disposed slot 252 thus providing radial adjustment of the cam member 147 about the approximate center or point designated at 253. The cam member 147 is provided with the concave cam surface 254 which extends approximately to a point adjacent the inner end of the convex cam surface 248 of the cam member 146. The cam member 150 is secured to the cam block 234 by the screws 255 and is provided with the concave cam surface 256. The cam member 149 is located adjacent the end of the cam member 150, is secured to the cam block 234 by the screw 257, and is provided with the concave cam surface 258 which forms an extension of the concave cam surface 256 of the cam member 150, said cam member 149 being further provided with the extension portion 259 in which is threadably mounted the set screw 260 which engages and constitutes a reaction, backing or support member for the cam member 148 which is secured to the cam block 234 by the screw 261 which extends through the radial slot 262, thus providing radial adjustment about the approximate center point designated at 263.

The cam member 148 is provided with the convex cam surface 264 which forms an extension of the concave cam surface 258 of the cam member 149.

It is to be noted that the cam surfaces 248, 256, 258, 254 and 264, will form the cam grooves 265 and 266 in which moves the end or cam follower 153 of the stud 151, the shape of the grooves 265 and 266 determining, in conjunction with the reciprocating movement the carriage 63, the movement of the skillet 35 relative to the grinding wheel 31, enabling the grinding wheel 31 to properly grind the surfaces 33 and 34 and to form the radius 39 of the skillet 35.

The cam grooves 265 and 266 are so laid out and constructed that the grinding wheel 31 will grind the surface 33 along a slightly angular path or surface, relative to the outside bottom surface of the skillet 35, so that the surface 33 will be slightly higher at its center point, designated at 267, in Fig. 8 than at the radius 39, the grinding wheel 31 thus running out at the point 267 at the center of the skillet, the thickness of the bottom wall of the skillet 35 thus being greater at the point 267 than at the junction of the surface 33 and the radius 39.

It is to be noted that as the cam follower 153 moves in the grooves 265 and 266, the housing head 162 and the skillet 35 will oscillate about the shaft 136 thus causing the pull of the springs 220 to vary and to exert varying loads on the arm 214 and the housing head 162 with a consequent varying thrust of the skillet 35 against the grinding wheel 31.

It is to be noted that the shape of the cam grooves 265 and 266 will thus cause the cam follower 153 and its operatively connected mechanism to so move in cooperation relative the grinding wheel 31 and the springs 220 that the springs 220 will exert their minimum pull and a consequent minimum thrust of the skillet 35 against

the grinding wheel 31 when the grinding wheel 31 is running out or ceasing grinding contact at the point 267 and at the point 268, in Fig. 8, which is the edge of the surface 34.

It is also to be noted that the cam groove 74 of the cam member 75 is so laid out and constructed that the cam follower 73 will occupy varying positions relative to the axis of the shaft 78, the axis of the cam member and the shaft 78 being approximately located and designated 10 at the point 269, Fig. 6.

It is thus to be noted that the cam follower 73 and the carriage 63 and the mechanism operatively connected therebetween together with the housing head 162 and the skillet 35 will be moved by the reciprocating movement of the carriage 63 with varying rates of speed to provide the minimum rate of travel of the skillet 35 relative to the grinding wheel 31 at the point where the radius 39 is being ground, the contact of the cam follower 73 and the cam groove 74 extending approximately between the angular lines 270 and 271, extending through the point 269, when the grinding wheel 31 is thus grinding the radius 39.

It is thus to be noted that the movement of the carriage 63 will decrease from the point of intersection of the line 271 with the groove 74 to the point 269 where the groove 74 approximately terminates, this portion of the movement of the carriage 63 corresponding to the normal maximum peripheral surface speed of the skillet 35 and of the surface 34.

Also the movement of the carriage 63 will increase from the point of intersection of the line 270 with the groove 74 to the approximate position determined by the intersection of the line designated by the numeral 272, with the groove 74, which corresponds approximately to the normal minimum surface speed of the skillet 35, which occurs when the grinding wheel is running out at the point 267 at the center of the skillet 35.

In order to facilitate the insertion and removal of the skillet 35 from the chuck 43, the lever 244 is pivotally moved upward to release the lug 243 from engagement with the notch 242 thus permitting the member 293 and its supported parts to be pivotally moved about the stud 230 until the handle 244 occupies the position indicated by the dotted lines 273, and the check 43 occupies the position indicated by the dotted lines 306, Fig. 1, in which position the skillet 35 can be readily removed from the chuck 43 and another skillet 35 inserted within the chuck 43 ready for grinding without interfering with the grinding wheel 31. In order to facilitate the pivotal movement of the cam block 234 and the member 293 and to limit their pivotal movement to a predetermined position, according to the amount of clearance space required with different objects to be ground, the portion 275 of the support member 228 may be provided with the series of holes 276 for receiving the screw 276A for securing the stop member 278 which is provided, as disclosed in Fig. 5, with the extension 279 for engaging the lower side of the portion 275, the stop member 278 being adapted to engage and limit the movement of the lug 243 which in turn limits the movement of the cam block 234 and the member 293 and their connected mechanism.

It is also to be noted that when the handle 244 is in the position indicated by the dotted lines 273, Fig. 1, and is manually released, the pull of the springs 220 will automatically cause the housing head 162 and its connected parts to pivotally move back to the position in which the skillet 35

will be in grinding position adjacent the grinding wheel 31 and in which position the lug 243 will automatically become engaged again with the notch 242.

- 5 The cross slide 62 is constructed with the opening 290, through which extends the arm 65 of the carriage 63, and may be constructed with an additional opening 291, for inspection or manufacturing purposes, the additional opening 291 being closed by the cover 292 secured by the screws 300, as disclosed in Fig. 1.

- 10 The push switch 280 is suitably mounted on the electric motor assembly A, the switch box 281 is suitably mounted on the column 5, and the switch box 282 is suitably mounted on the column 4. The switch 280, the switch box 281 and the switch box 282 are also indicated by the same numerals in the wiring diagram, as disclosed in Fig. 18, said wiring diagram disclosing in a conventional way the electrical circuit for controlling the mechanism of the grinding machine, the electric cables and wires being omitted from Figs. 1 and 2 to clarify the disclosure of the mechanism of the grinding machine.

- 20 The reversing switch 283 and the stop switch 284 are suitably mounted adjacent the reciprocating cross slide 62 and the carriage 63 so as to be engaged by suitable portions or parts attached to the cross slide 62 or carriage 63, the reversing switch 283 and the stop switch 284 thereby being actuated at the ends of the movement of the cross slide 62 and the carriage 63 to electrically control the operation of the various electric power units of the grinding machine. The switches 283 and 284 are of the double throw, single pole limit switch design and are always normally closed on one side. Said switches 283 and 284 are of the quick make and quick break acting type and will easily return to their normally closed position when said switches are not operatively connected with the portions of the cross slides 62 or 63 by which they are operated. Said switches 283 and 284 incorporate a spring or similar mechanism which maintains the switches in their closed position when not contacted by said portions of the cross slides 62 or 63 and are thus of conventional type and design as used commercially in such units.

- 40 The knife switch 285, as disclosed in Fig. 18, is suitably mounted and is electrically connected to the supply wires 286, 287, and 288.

- 50 It will be noted that when the knife switch 285 is closed the electric current will flow to and immediately operate the electric motor assembly A and the grinding wheel 31 and also the electric current will flow to the push button switch 280 as well as the switch boxes 281 and 282, the operation of the push buttons 289 and 297 of the push button switch 280 controlling the starting of the electric motors B and C for operating the cross slide 62 and the carriage 63 and their supported mechanism and also for revolvably operating the chuck 43, the relay switches in the switch boxes 281 and 282 being thus controlled by the operation of said push buttons 289 and 297. The reversing switch 283, when actuated by the reciprocation of the cross slide 62 and carriages 63, at the end of their inward movement will cause the electric motor B to reverse its direction of rotation and thus cause the cross slide 62 and the carriage 63 to reciprocatingly move in the opposite or outward direction until the cross slide 62 or carriage actuates the stop switch 284 and stops the rotative operation of the electric motor B, thus stopping the cross slide 62 and the carriage 63 at the

outward end of their stroke, the operation being repeated when the operator again actuates the starting push button of the starter switch 280.

It is to be noted that when the electric motor assembly C is electrically controlled to rotatively operate, the rotative operation of the electric motor assembly B with its armature shaft 105 will operate the drive sprocket 110 which will cause the chain 115 to drive the driven gear 116 which operates the shaft 117 and the drive gear 120 which drives the driven gear 121 which operates the shaft 122 and the work 125 which in turn drives the worm gear 126 operatively connected with the shaft 127 and the drive gear 130 which drives the driven gear 131 which operates the shaft 78 upon which is mounted the cam member 75, which engages the cam follower 73, thus providing a drive mechanism for the cross slide 62 and the carriage 63 and their supported mechanism which is greatly reduced in speed relative to the rotative speed of the grinding wheel 31 or the chuck 43, this being necessary to provide the proper cutting or grinding speed in the operation of grinding the skillet 35.

The cam block 234 is provided with the radial slots 307 and the screws 308 suitably mounted and extending to permit adjustment of the cam block 234.

I claim:

1. In a grinding machine, the combination of a base provided with a plurality of columns, an electric motor assembly, means for adjusting said electric motor assembly in a plurality of positions in horizontal planes, said means being supported on one of said columns, a grinding member mounted on and operatively driven by said electric motor assembly, a carriage slidably mounted on one of said columns, said carriage being provided with an arm extending below said carriage, a cam follower suitably mounted on said arm of said carriage, a cam member provided with an irregular shaped groove to cause said carriage to travel with varying rates of speed, the groove of said cam member engaging the cam follower of the arm of said carriage, means for revolving said cam member, a second electric motor assembly for driving said means for revolving said cam member, a guiding arm pivotally mounted on said carriage, said arm being provided with a cam follower, cam mechanism suitably supported on one of the columns of said base, said cam mechanism being engaged by the cam follower of said guiding arm, a housing head pivotally mounted on said guiding arm, a chuck rotatably mounted on said housing head, said chuck being adapted to support the object to be ground, a third electric motor assembly suitably mounted on said housing head, said third electric motor assembly being adapted to drive said chuck, manually operated means for pivotally moving said chuck together with its supported object away from said grinding member, means for resiliently moving said chuck and its supported object toward said grinding member, and control means for controlling the operation of said electric motor assemblies, said control means reversing the rotative operation of said second electric motor assembly at one end of the movement of said carriage, said control means stopping the rotative operation of said second electric motor at the other end of the movement of said carriage.

2. In a grinding machine, the combination of means for grinding, a chuck mechanism for holding the object to be ground, driving mechanism for said chuck mechanism, an arm pivotally

mounted and supporting said chuck and said driving mechanism to enable said chuck mechanism and said object to be pivotally moved in a horizontal plane away from said means for grinding, reciprocating means supporting said arm and adapted to move said chuck mechanism and said object to and from said means for grinding, cam means engaging said arm to move said arm and its supported mechanism in a horizontal plane and in a transverse direction to the movement of said reciprocating means, electrically operated means for reversing the movement of said reciprocating means at one end of its movement, and a second electrically operated means for stopping said reciprocating means at the end of its movement.

3. In a grinding machine, the combination of a grinding member, chuck means for holding the object to be ground, pivotally mounted means supporting said chuck means, a second pivotally mounted means supporting said first mentioned pivotally mounted means, means for reciprocating said first mentioned and said second pivotally mounted means together with said chuck means, and means for oscillating said first mentioned and said second mentioned pivotally mounted means together with said chuck means, said reciprocating and said oscillating movements combining to provide a resultant movement enabling said grinding member to grind irregular surfaces on said object.

4. In a grinding machine, the combination of a carriage movably mounted, means for reciprocating said carriage, a guide arm pivotally supported on said carriage, means for supporting and guiding said guide arm at one of its ends, a housing head pivotally supported on said guide arm, a chuck rotatively supported on said housing head, said chuck supporting the object to be ground, means for driving said chuck, said means for guiding said chuck being supported on said housing head, a member for grinding the object supported in said chuck, and means for driving said grinding member.

5. In a machine for grinding an object, the combination of a carriage movably mounted, means for reciprocating said carriage, a grinding arm pivotally mounted at one of its ends only on said carriage, cam mechanism mounted to engage said guiding arm, said cam mechanism supporting the other end of said guiding arm, a housing head pivotally mounted on said guiding arm, a chuck pivotally mounted on said housing head and adapted to support said object, said chuck being actuated by the associated movements of said carriage and said guiding arm to move said chuck together with said object in an irregular path, and a grinding member engaging said object.

6. In a grinding machine, the combination of a chuck rotatively mounted, said chuck being adapted to receive the object to be ground, clamping members on said chuck, said clamping members being provided with notches to permit extension portions of said object therethrough, said clamping members securing said object when the extension portions of said object have been moved between said clamping members and said chuck, and resilient members for urging said clamping members toward said chuck.

7. In a grinding machine, the combination of a carriage mounted to reciprocate and provided with an arm member, a cam follower mounted in said arm member, a cam member mounted to engage said cam follower and provided with cam

surfaces shaped to cause, when engaged by said cam follower, a reciprocating movement of said carriage with varying rates of speed, means for rotating said cam follower, and means mounted on said carriage for supporting the object to be ground.

8. In a grinding machine, the combination of a base provided with a column, a carriage movably mounted on the column of said base, a cam member operatively connected with and adapted to reciprocate said carriage at varying rates of speed throughout the movement of said carriage, a power unit suitably mounted on said column, and gear reduction mechanism operatively connecting said cam member and said power unit.

9. In a grinding machine for grinding an object having a pair of surfaces extending at an angle with one another and joined by a radius, the combination of a grinding member rotatably mounted and fixed against axial movement, means for holding the object to be ground, said means being pivotally mounted to move in a plane substantially parallel with the axis of said grinding member, and means for actuating said first mentioned means to cause said object to move past said grinding member, said second mentioned means moving said object at a different rate of speed when the radius of said object is engaged by said grinding member than the rate of speed at which said object is moved when said grinding member is engaging either of the other of the pair of surfaces of said object.

10. In a grinding machine, the combination of a carriage mounted to move in a horizontal plane, a guiding arm mounted on said carriage and adapted to pivotally move in a horizontal plane, a cam mechanism suitably mounted and adapted to control the pivotal movement of said guiding arm, said cam mechanism being independently supported relative to said carriage, said cam mechanism supporting one end of said guiding arm, a housing head mounted on said guiding arm and adapted to pivotally move in a horizontal plane, a chuck rotatively mounted on said housing head, means for driving said chuck, and means for moving said carriage.

11. In a grinding machine, the combination of a cam mechanism provided with a groove in its uppermost surface, a carriage, a guiding arm pivotally mounted on said carriage and provided with a cam follower, engaging the groove of said cam mechanism, means for reciprocating said carriage and said guiding arm, said guiding arm being pivotally moved on said carriage by the cam follower moving in the groove of said cam mechanism, a chuck rotatively mounted and adapted to hold the object to be ground, means for driving said chuck, said means being mounted on said guiding arm, and a grinding member engaging the object to be ground.

12. In a grinding machine, the combination of a carriage reciprocatingly mounted and provided with a pivotally mounted arm, a cam mechanism engaging the pivotally mounted arm, said cam mechanism being pivotally mounted, to move in a longitudinal plane, means for pivotally moving said cam mechanism, a stop member limiting the pivotal movement of said cam mechanism, resiliently operated means opposing the pivotal movement of said cam mechanism, a chuck rotatively mounted on said carriage, and means for driving said chuck.

13. In a grinding machine, the combination of a carriage movably mounted and provided with a

cam follower, and means for reciprocating said carriage, said means comprising a cam member having an irregular shaped cam surface for engaging a portion of said carriage, said cam member being suitably mounted to rotate about an axis extended substantially at right angles to the line of movement of said carriage, said irregular shaped cam surface being located in the end of said cam member and engaged by the cam follower of said carriage, said cam surface being adapted to cause said carriage to move at a relatively slow rate of speed when one end of said irregular cam surface is engaging said portion of said carriage, said cam surface being adapted to cause said carriage to move at a relatively fast rate of speed when the other end of said cam surface is engaging said portion of said carriage.

14. In a grinding machine, the combination of a pair of columns supported on a base, a carriage movably mounted on one of said columns, a cam mechanism movably mounted on the other of said columns, a guiding arm pivotally mounted on said carriage and engaging said cam mechanism, a chuck rotatively mounted on said guiding arm, means for revolving said chuck, and means for reciprocating said carriage and said guiding arm.

15. In a grinding machine, the combination of a work supporting member, electrically operated power means for reciprocating said work supporting member, and switch units suitably located adjacent said work supporting member so as to be engaged and operated by said work supporting member at the ends of its reciprocating movement, said switch units being electrically connected with and adapted to control said electrically operated power means to respectively reverse and to stop the reciprocating movement of said work supporting means at the ends of its reciprocating movement.

16. In a grinding machine, the combination of a base provided with three columns, a power unit suitably mounted on one of said columns and provided with a grinding member, a carriage suitably mounted to reciprocate on one of said columns, a guiding arm pivotally mounted on said carriage and provided with a cam engaging member, cam means suitably mounted on one of said columns and engaging the cam engaging member of said guiding arm, a housing head pivotally mounted on said guiding arm, work holding means suitably mounted on said housing head, means for actuating said carriage, said means further actuating said guiding arm to movably engage said cam means, and means for rotatably driving said work holding means.

17. In a grinding machine, the combination of a reciprocating mechanism provided with a guiding arm pivotally mounted thereon and extending therefrom at an angle with the direction of the reciprocating movement, a column partially supporting said reciprocating mechanism, cam means engaged by and partially supporting said guiding arm of said reciprocating mechanism to vary the direction of movement of said reciprocating mechanism, a second column supporting said cam means, means for driving said reciprocating mechanism, work holding means suitably mounted on said reciprocating mechanism, and means for driving said work holding means, said last mentioned means being supported by said guiding arm.

18. In a grinding mechanism, the combination of a hollow column, a carriage slidably mounted on said column and provided with a cam follower extending within said hollow column, a cam

member revolvably mounted and extending through one of the sides of said hollow column at right angles to the direction of the reciprocating movement of said carriage, said cam member being provided with a cam groove extending longitudinally in a parallel plane with the direction of the reciprocating movement of said carriage, said cam member engaging said cam follower, a power unit suitably supported on the outside wall of said hollow column, said power unit being operatively connected with said cam member, and work holding means suitably mounted on said carriage.

19. In a grinding machine, the combination of a carriage suitably mounted to reciprocate, said carriage being provided with a depending bracket, a cam follower suitably mounted in the bracket of said carriage and having its axis extending at right angles to the direction of the reciprocating movement of said carriage, a cam member revolvably mounted and provided with an open sided groove engaging said cam follower, the open side of said groove extending parallel with the direction of the reciprocating movement of said carriage, power means for revolving said cam member to reciprocate said carriage member, and work holding means suitably mounted on said carriage.

20. In a grinding machine, the combination of a carriage provided with a bracket, a cam follower suitably mounted in said bracket, a cam member revolvably mounted and provided with a groove for receiving said cam follower therein, the axis of said cam member extending substantially at right angles with the longitudinal center of said carriage, said groove extending in a single plane, means for revolving said cam member, and work holding means suitably mounted on said carriage.

21. In a grinding machine, the combination of a chuck rotatably mounted and provided with a recess conforming to the shape of the object to be ground, said chuck being provided with one or more notches adjacent said recess to permit a portion of the object to be ground to extend through one or more of said notches when said object is entered in said chuck, and clamping means suitably mounted adjacent said notches to retain the object to be ground in the recess of said chuck, said clamping means being limited to move relative to said chuck, in a direction extending parallel with the axis of said chuck, said object being rotated radially to cause said portions of the object entering through said one or more of said notches of said chuck to pass under said clamping means.

22. In a grinding machine, the combination of a chuck provided with one or more notches for receiving the work to be ground, clamping members extending across each of the notches of said chuck, each of said clamping members being provided with a notch to receive there-through a portion of the work to be ground, bolt members connected with said clamping members and extending through portions of said chuck, and resilient means suitably mounted on said bolt members and adapted to urge said clamping members toward said chuck to retain said work therein.

23. In a grinding machine, the combination of a column provided with an opening in one of its walls, a housing closing the opening of said column, a carriage reciprocatingly mounted on said carriage and provided with a bracket, a cam follower suitably mounted in the bracket of said

carriage, a cam member provided with a shaft extension mounted in said housing, a driven gear member suitably mounted on the shaft extension of said cam member within said housing, a second housing suitably mounted in said first mentioned housing, a shaft suitably mounted in said second housing and provided with a gear engaging the driven gear of said cam member, said last mentioned shaft being provided with a worm gear, a worm suitably mounted and engaging said worm gear, an electric motor suitably mounted on said first mentioned housing, gear means operatively connecting said electric motor and said worm, and work holding means suitably mounted on said carriage.

24. In a grinding machine, the combination of a carriage suitably mounted to have a reciprocating movement, said carriage being provided with a pedestal, a shaft suitably mounted in the pedestal of said carriage, a guiding arm pivotally mounted on said shaft, a cam follower suitably mounted in said guiding arm, a second shaft suitably mounted on said guiding arm, a housing head pivotally mounted on said second shaft, said housing head being provided with an arm, resiliently actuated means suitably mounted on said guiding arm and adapted to move the arm of said housing head toward a stop, a stop member suitably mounted to limit the pivotal movement of the arm of said housing head, work holding means suitably mounted on said housing head, cam means suitably mounted and engaging the cam follower of said guiding arm, and means for actuating said carriage.

25. In a grinding machine, the combination of a carriage, a pair of pivotally mounted members, resiliently actuated means adapted to pivotally move one of said pivotally mounted members relatively to the other, a stop member suitably mounted to limit the pivotal movement of said one of said pivotally mounted members, work holding means suitably mounted on one of said pair of pivotally mounted members, means for reciprocating said carriage, and means for varying the direction of movement of one of said pivotally mounted members when said carriage is reciprocated.

26. In a grinding machine, the combination of a carriage reciprocatingly mounted, a guiding arm pivotally mounted on said carriage, fixed cam means engaging said guiding arm, a housing head pivotally mounted on said guiding arm, work holding means revolvably mounted on said housing head, an electric motor suitably mounted on said housing head, gear means suitably mounted on said housing head and operatively connecting said electric motor and said work holding means, brake means for decelerating the movement of said work holding means, said brake means being operatively connected with said gear means, means for causing pivotal movement of said housing head relative to said guiding arm, means for limiting the pivotal movement of said housing head relative to said guiding arm, and means for actuating said carriage in its reciprocating movement.

27. In a grinding machine, the combination of a column, a member suitably supported on said column and provided with a pivot portion together with a notch portion, a second member supported on said first mentioned member and adapted to be pivotally moved about the pivot portion of said first mentioned member, a lever pivotally mounted on said second member and adapted to engage the notch portion of said first

mentioned member, a cam block suitably mounted on said second member, a plurality of cam blocks suitably mounted on said cam block to form a cam groove therebetween, a carriage reciprocatingly mounted, a guiding arm pivotally mounted on said carriage and adapted to engage the cam groove between said cam blocks, work holding means pivotally mounted on said guiding arm, and resilient means suitably mounted to oppose the pivotal movement of said second member.

28. In a grinding machine, the combination of a member suitably mounted, a second member supported on and pivotally connected with said first mentioned member, means for locking said second member against pivotal movement, cam means suitably supported by said second member and providing a cam groove, a carriage reciprocatingly mounted, a guiding arm pivotally mounted on said carriage and engaging the cam groove of said cam means, resilient means suitably mounted to oppose the pivotal movement of said second member, and work holding means pivotally mounted on said guiding arm.

29. In a grinding machine, the combination of a plurality of cam blocks suitably mounted to provide a cam groove therebetween, a carriage reciprocatingly mounted, a guiding arm pivotally mounted on said carriage and supported at one of its ends on said cam blocks, a cam follower suitably mounted on said guiding arm and engaging the groove between said cam blocks, means for adjusting the position of one or more of said cam blocks, work holding means suitably mounted on said guiding arm, and means for reciprocating said carriage together with said guiding arm and said work holding means.

30. In a grinding machine, the combination of a plurality of cam blocks, means for pivotally adjusting each of said cam blocks, a plurality of cam blocks suitably mounted and each provided with extension portions, stop members suitably mounted in the extension portions of each of said last mentioned cam blocks and adapted to contact one of said first mentioned cam blocks to form reaction members therefor, a carriage movably mounted, a guiding arm pivotally mounted on said carriage and engaging said cam blocks to vary its pivotal movement, work holding means suitably mounted on said guiding arm, and means for actuating said carriage.

31. In a grinding machine, the combination of a pivotally mounted member, cam blocks suitably mounted on said member and providing a cam groove, a pivotally mounted handle on said pivotally mounted member, means suitably mounted to engage said pivotally mounted handle to lock said pivotally mounted member against pivotal movement, stop means suitably mounted to limit the pivotal movement of said pivotally mounted member in one direction, a carriage movably mounted, a guiding arm pivotally mounted on said carriage and engaging the cam groove of said cam blocks, a work holding means suitably mounted on said guiding arm, resilient means suitably mounted to oppose the pivotal movement of said pivotally mounted member, and means for actuating said carriage.

32. In a grinding machine, the combination of a pivotally mounted member, a cam block supporting member suitably mounted on said pivotally mounted member and provided with radial grooves therethrough, a plurality of cam mem-

bers suitably mounted on said cam block and providing a cam groove, fastening means extending through the radial grooves of said cam block and engaging said pivotally mounted member, means for locking said pivotally mounted member against pivotal movement, a carriage movably mounted, a guiding arm pivotally mounted on said carriage and engaging the cam groove provided by said plurality of cam members, a work holding means suitably mounted on said guiding arm, and means for actuating said carriage.

GUSTAVE A. CARLSON.