

April 21, 1942.

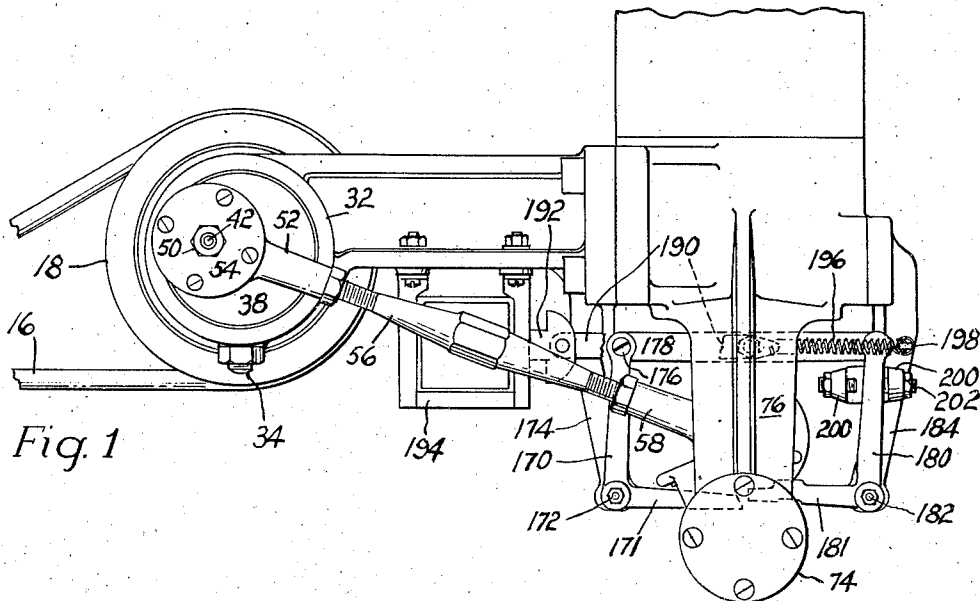
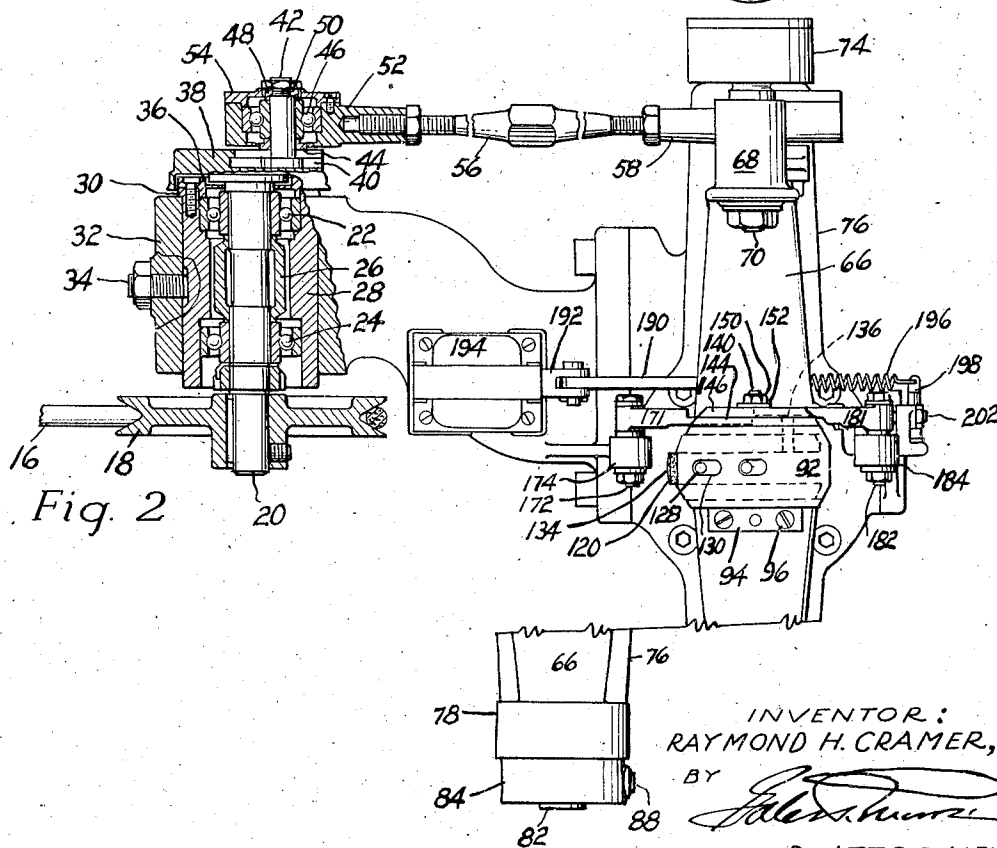
R. H. CRAMER

2,280,379

HONING MACHINE AND METHOD

Filed April 25, 1939

4 Sheets-Sheet 1



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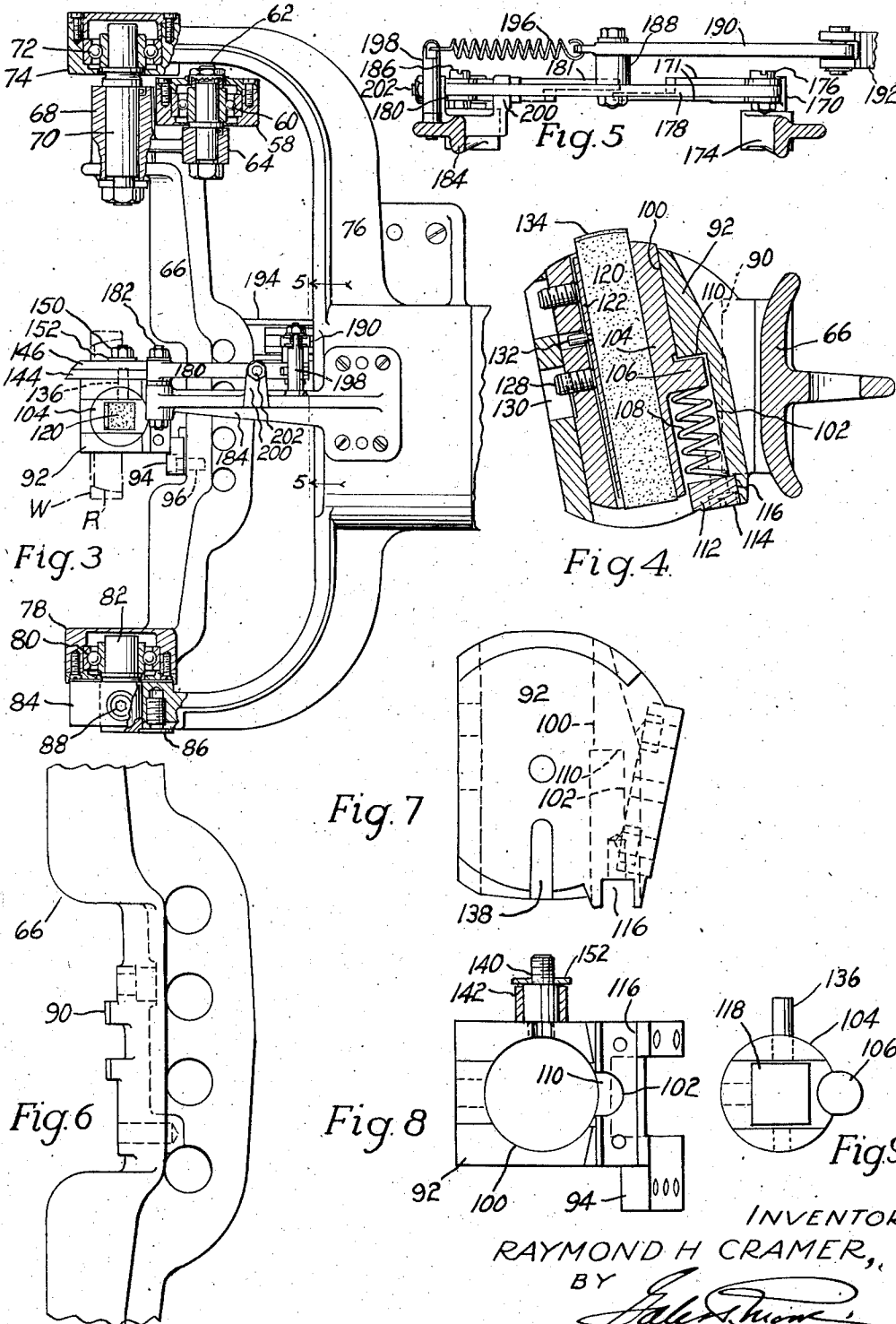
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

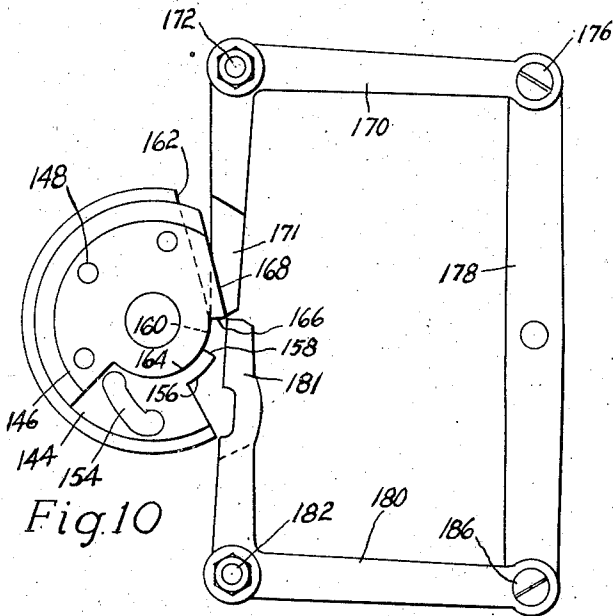


Fig. 10

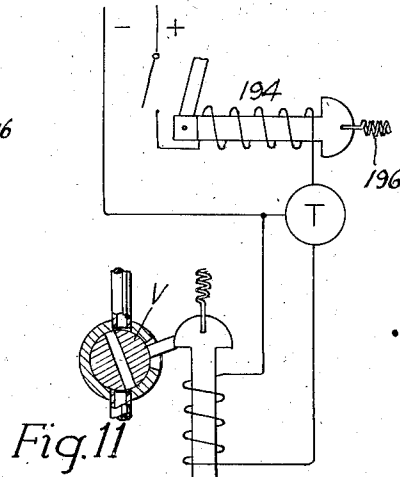


Fig. 11

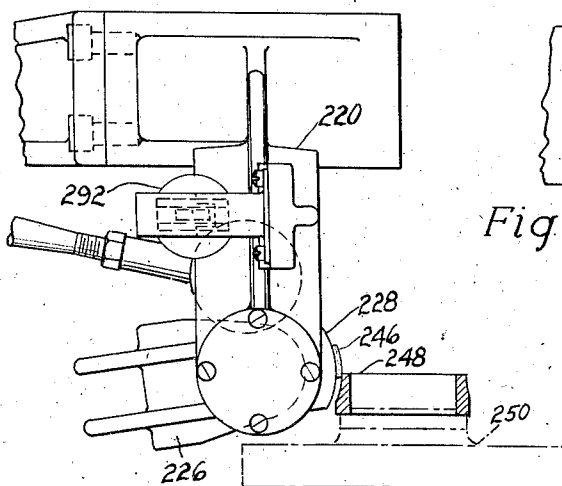


Fig. 12

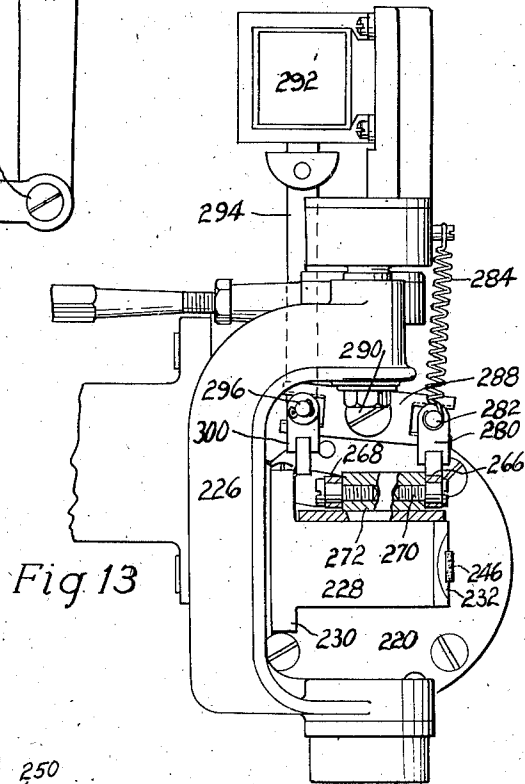


Fig. 13

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4 Sheets-Sheet 4

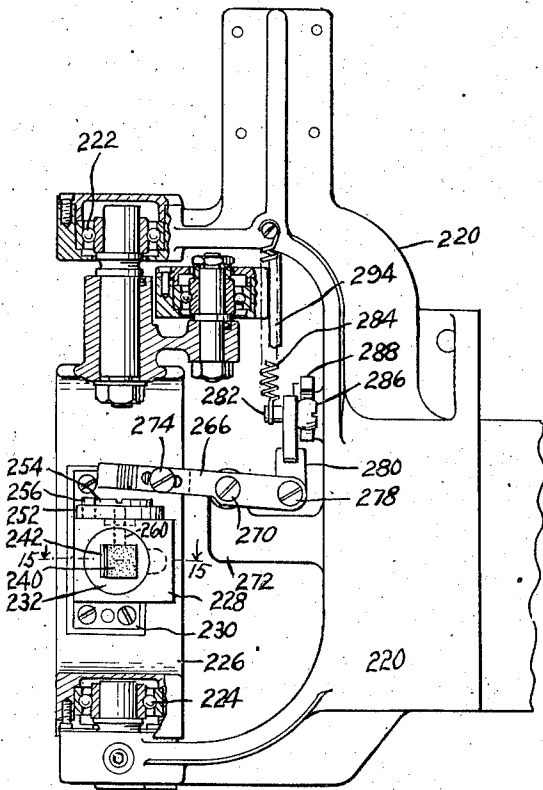


Fig. 14

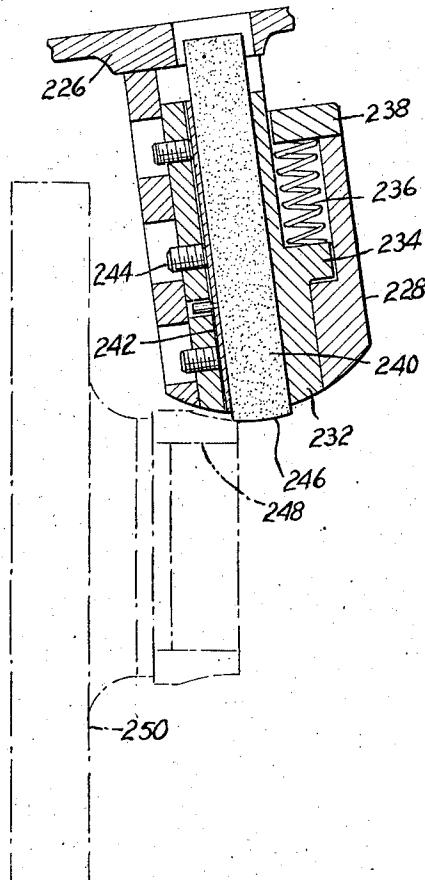


Fig. 15

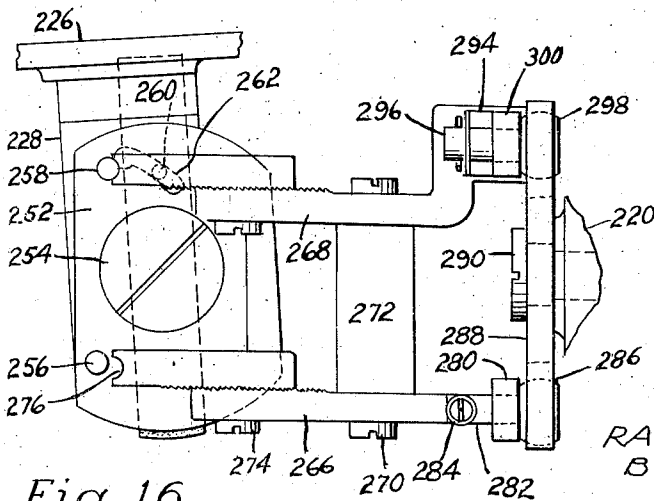


Fig. 16

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UNITED STATES PATENT OFFICE

2,280,379

HONING MACHINE AND METHOD

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Application April 25, 1939, Serial No. 270,548

19 Claims. (Cl. 51—58)

This invention relates to honing and comprises all of the features and aspects of novelty herein disclosed. An object of the invention is to provide an improved machine and method for honing a work surface especially a curved surface of revolution. Another object is to provide a honing machine which will produce a fine finish as by controlling successive intervals of dry and wet honing. Another object is to provide improved mechanism for controlling advance or retraction of a hone with respect to the work surface as for the purpose of avoiding marring of the surface when the work and hone come into contact or separate.

To these ends and also to improve generally upon devices of this character, the invention consists in the various matters hereinafter described and claimed. In the drawings,

Fig. 1 is a plan view.

Fig. 2 is a front elevation of Fig. 1 with parts broken away and in section.

Fig. 3 is a side elevation of Fig. 2 with parts broken away and in section.

Fig. 4 is a horizontal, sectional view of the hone and adjacent parts.

Fig. 5 is a vertical sectional view on the line 5—5 of Fig. 3.

Fig. 6 is a side view of a portion of a yoke.

Fig. 7 is a plan view of a hone casing.

Fig. 8 is an end view of Fig. 7 with additional parts in section.

Fig. 9 is an end view of a hone holder.

Fig. 10 is a plan view of the hone retracting cam members and their cooperating stop arms.

Fig. 11 is a diagram.

Fig. 12 is a plan view of a modification.

Fig. 13 is a front elevation of Fig. 12 with parts broken away and in section.

Fig. 14 is a side elevation of Fig. 12 with parts broken away and in section.

Fig. 15 is a horizontal sectional view on line 15—15 of Fig. 14.

Fig. 16 is a plan view of the stop levers and associated parts.

A motor driven belt 16 and pulley 18 rotate a vertical shaft 20 which is journaled in ball bearings 22 and 24, the inner race rings of the bearings being spaced by a sleeve 26. The outer race rings of the bearings are mounted in a housing 28 which is flanged at 30 to rest against a supporting bracket 32 in which the housing is received. The outer race ring of the upper bearing 22 rests against a supporting shoulder in the housing which is held from rotation by a screw 34 which is shown out of position in the sectional

view. An apertured cap 36 closes the upper end of the housing. The shaft 20 projects through the cap, and carries a crank disc 38 which is flanged to surround the cap. The crank disc has a radial slot 40 undercut to receive the square head of a crank pin or eccentric stud 42. On the stud is received a spacing washer 44, the inner race ring of a bearing 46 and a flanged clamping washer 48, all of these parts being clamped by a nut 50.

Surrounding the bearing 46 and supported by the outer race ring thereof is a housing 52 having a cap 54 and a tapped projection to receive the threaded end of a connecting rod 56. The other end of the rod is oppositely threaded in a similar projection on a housing 58 which is journaled on a ball bearing 60. The connecting rod thus will function as a turnbuckle. The inner race ring of the bearing is clamped by a washer and a nut against a collar on a stud 62 which is clamped in a lug 64 projecting from an oscillated yoke 66.

The upper end of the yoke has a hollow arm or boss 68 clamped to a pivot stud 70 projecting upwardly into the inner race ring of a ball bearing 72. The outer race ring of the bearing rests on a shoulder in an enlargement 74 of a supporting bracket 76. The lower end of the yoke 66 has an arm or boss 78 journaled on a ball bearing 80 supported by a shouldered stud 82. The stud is mounted in an enlargement 84 of the supporting bracket 76 for vertical adjustment by means of a headed screw 86 overlapping a portion of the lower end of the stud. The stud is held from rotation by a set screw 88 engaging a flat thereon.

From the foregoing, it is evident that the motor will effect driving of the crank pin 42 and, through the connecting rod 56, oscillate the yoke 66 around an axis defined by the upper ball bearing 72 and the lower ball bearing 80 which are in alignment. The yoke carries a spring loaded hone as will appear. The amplitude of oscillation is adjusted by shifting the stud 42 in the slot 40 and the position or field of oscillation is adjusted by the rod 56. A large arc of oscillation is desirable.

At the central portion of the yoke are a pair of locating ribs 90 which enter a groove in a casing or carrier 92 having a lug 94 fastened by screws 96 threaded in the yoke. Other screws pass through the yoke above its upper rib 90 and are threaded in the carrier. The carrier has a round horizontal bore 100 and a side recess 102 which opens into the bore. Slidable in the bore

100 is a hone holder 104 having a lug 106 projecting into the side recess 102. A coil spring 108 engages the lug and urges it towards the stop shoulder 110 formed by the bottom of the recess. The spring is backed up a lug 112 on a plate 114 fastened by screws in a vertical groove 116 at the rear of the carrier 92. The hone holder has a rectangular opening 118 to receive a square hone 120 and a thin serrated clamp plate 122 which is engaged by a pair of clamping screws 128 which project for access into slots 130 of the carrier 92. The clamp plate 122 is retained in the opening 118 by a retaining pin 132 entering a hole in the holder 104. When the work surface is spherical, the front end 134 of the hone 120 is curved on a segment of a sphere to conform to the work surface. A hone retracting pin 136 is press fitted in a hole near the rear end of the hone holder and projects upwardly through an open ended slot 138 in the casing or carrier 92 and into a cam slot as will appear, such cam acting to retract the hone or to release the hone for advance against the work by spring pressure.

At the center of the casing or carrier 92 on the top thereof, and in alignment with its axis of oscillation, is a hole in which the lower reduced end of a shouldered pivot pin 140 is press fitted. The enlarged portion of the pin freely enters a bushing 142 which is press-fitted in aligned holes in a pair of cams 144 and 146, the cams being located and secured to one another by dowel pins 148 to form in effect a single cam member. A nut 150 threaded on the upper reduced end of the pivot pin 140 engages a washer 152 which bears on the enlarged portion of the pin to let the carrier turn with respect to the cams whenever the cams are locked against turning as will appear.

The above mentioned pin 136 projects into a cam slot 154 in the lower cam 144, the cam slot having a uniform rise ending in an offset or holding portion. The cam body comprises a disc with portions cut away for clearance purposes, thus leaving an arcuate portion 156 terminating in a stop shoulder 158 followed by an arcuate portion 160 and a straight portion 162. The upper cam 146 is cut away to leave a long arcuate portion 164 terminating in a shoulder 166 facing in the opposite direction from the shoulder 158 of the lower cam and spaced from such shoulder. There is also a straight portion 168 leading away from the shoulder 166 and only this part of the upper cam overhangs the lower cam. Two bell crank stop levers cooperate alternately with the cam shoulders, as will appear, to limit turning movement of the cams in one direction or the other. The carrier oscillates together with the pivot pin 140 which is pressed into it. These parts are free to turn with respect to the cams and the bushing which is pressed into the cams, but, unless the cams are locked or arrested from turning, the hone retracting pin 136 and its engagement with the cam slot 154 causes the cams to oscillate whenever the carrier oscillates.

A bell crank stop lever 170 has an arm 171 arranged to cooperate with the stop shoulder 158 of the lower cam 144 and pivoted on a shouldered pin 172 adjustably clamped in an elongated slot in a bracket arm 174 forming part of the bracket 32. One end of the bell crank lever is forked and pivoted by a screw 176 to a link 178. Another bell crank stop lever 180 has an arm 181 arranged to cooperate with the stop shoulder 166 of the upper cam 146 and similarly pivoted on a shouldered pin 182 adjustably clamped in an elongated slot in a bracket arm 184 bolted to the

bracket 76. One end of the bell crank lever 180 is forked and pivoted by a pin 186 to the aforesaid link 178 so that both stop levers swing in unison but in opposite directions. The middle of the link 178 is pivotally connected by a shouldered pin 188 to an actuating bar 190 which has one end pivoted to the forked end of a plunger 192 of a solenoid 194. The other end of the bar 190 is connected by a tension spring 196 to an anchor stud 198 on the bracket arm 184. The bell crank lever 180 extends between a pair of spaced lugs 200 projecting upwardly from the bracket arm 184 and provided with adjustable stop screws 202.

When the solenoid is energized, the stopping arm 171 on the bell crank lever 170 is swung away from the lower cam 144 while the stopping arm 181 on the other bell crank lever 180 is swung towards the upper cam 146. The arm 171 is cut away on its upper face to avoid the upper cam and the arm 181 is cut away on its lower face to avoid the lower cam. When the arm 171 thus swings away from the lower cam, the arm 181 swings in front of the shoulder 166 of the upper cam so that clockwise swinging of the connected cams will be limited. Whenever the solenoid is de-energized, the coil spring 196 swings the arm 181 away from the shoulder 166 on the upper cam and swings the arm 171 towards the lower cam to lie in the path of the shoulder 158 so that counterclockwise swinging of the cams will be limited. As will appear, this releases or retracts the hone.

The work W, herein shown as a bearing outer race ring with a spherical raceway R to be honed, is mounted for rotation in a suitable chuck. A suitable slide supporting the honing mechanism is then advanced parallel to the chuck axis to bring the hone carrier 92 into the work, the pivot 140 and the yoke pivots 70 and 82 lying in a vertical line passing through the center of curvature of the raceway while the horizontal center of the carrier lies at the level of the axis of the race ring. When the motor is started, the yoke 60 is oscillated and this causes the carrier and hone to oscillate. The hone at this time is away from the work, its retracting pin 136 lying in the offset or outer end of the cam slot 154 and the spring 100 releasably holding it there. This causes the cams to oscillate with the carrier. After the motor starts the solenoid 194 is energized by closing a switch. This swings the stop arm 171 away from the lower cam 144 and swings the stop arm 181 in front of the shoulder 166 of the upper cam thereby temporarily limiting clockwise swinging of the connected cams. The carrier 92 however will complete its stroke and so will carry the hone retracting pin 136 into the spiral or inner portion of the cam slot whereupon the hone is free to advance radially against the work by spring pressure and is oscillated across the work by the oscillation of the carrier. The speed is desirably 2,000 complete oscillations per minute.

The cams now oscillate with the carrier because the pin 136 engages the sides of the cam slot but the cams now maintain a different angular position with respect to the carrier than before because they were arrested in their clockwise swinging while the carrier was not. The hone operates dry for an interval of say ten seconds under control of a time switch T whereupon a valve V is opened as by a solenoid to squirt honing compound of well-known commercial composition from a pipe upon the work for an interval of say twenty seconds. The dry honing leaves cross marks about at right angles to one an-

other, as determined by moving the hone across the work at approximately the speed with which the work surface moves across the hone, and then the compound squirted on the hone and its bonding material changes the action into a sort of burnishing action which removes the marks and produces a high polish. After the wet honing interval, the timing switch controls de-energizing of the solenoid. The coil spring 196 then swings the stop arm 181 away from the shoulder 166 and swings the stop arm 171 in the path of the shoulder 158 so that the cams cannot complete the next counterclockwise stroke. The carrier 92 however will complete its stroke and so forces the hone retracting pin 136 out into the offset or outer end of the cam slot. This retracts the hone directly away from the work. The radial movement of the hone into and out of contact with the work is very desirable because it avoids injury to the work especially near the edge. The advance of the hone or its retraction occur while the carrier is at an intermediate portion of its stroke. When the pin 136 is retracted, the cams will thereafter resume oscillation with the carrier 92 in the original field of oscillation. Although the carrier stroke and its field of oscillation can be adjusted, these normally remain constant. The cam member normally oscillates with the carrier but changes its angular relation to the carrier and therefore its field of oscillation whenever one of the stop levers is brought into action.

In Figs. 12 to 16, there is indicated a modification especially applicable to the honing of the arcuate raceway of an inner race ring. A bracket 220 has its upper and lower arms provided with ball bearings 222 and 224 to provide pivots for oscillation of a yoke 226. The mechanism for producing the oscillation is similar to that shown in Figs. 1, 2 and 3 and need not be further described. A hone casing or carrier 228 has lugs 230 secured by screws to the middle of the yoke. The carrier has a round horizontal opening slidably receiving a hone holder 232 which is provided with a lug 234 urged forwardly by a coil spring 236 abutting against a stop plate 238. The holder has a square opening to receive a hone 240 which is clamped by a serrated plate 242 and screws 244 as in Fig. 4.

The front end of the hone is curved at 246 to conform to the raceway of an inner race ring 248 which is rotated on its axis by a suitable chuck 250. The axis of oscillation of the yoke 226 passes through the center of curvature of the raceway and the horizontal center of the hone casing or carrier is at the level of the work axis. A cam 252 is pivoted by a shouldered pivot screw 254 to the top of the carrier 228 and carries two stop pins 256 and 258 by means of which oscillation of the cam can be arrested. This is for the purpose of producing relative angular movement between the carrier and the cam in order to retract the hone or to release it. A retracting pin 260 is secured to the hone holder 232 and passes up through a slot in the carrier and into a spiral cam slot 262 in the cam. This pin normally makes the cam oscillate with the carrier but the pin is caused to move outwardly or inwardly in the cam slot whenever one of the stop pins 256 or 258 is arrested from angular movement in one direction, as will now be described.

Stop levers 266 and 268 are pivoted by screw studs 270 to a bracket arm 272 on the bracket 220. Each lever has an extension arm which can be adjustably secured to it through the me-

dium of serrations and clamping screws 274 which pass through slots in one of the levers. The front end of each extension arm is slotted or forked as at 276 to conform to its pin 256 or 258, one arm being down in the path of its pin when the other arm is raised above its pin. The rear end of lever 266 is forked and pivoted by a screw stud 278 to the lower end of a link 280, the upper end of the link being pivoted on a stud 282 which is urged upwardly by a coil spring 284. The stud has a ball-headed portion 286 conforming to the arcuate edges of a slot in a lever 288 pivoted centrally at 290 on the bracket 220. This is to allow universal action to avoid cramping.

A solenoid 292 is supported on the upper portion of the bracket 220 and its plunger is pivotally connected to a link 294 which is also pivoted to a stud 296 having a ball headed portion 298 engaging the arcuate edges of a second slot in the lever 288 at the end opposite to the head 286. A link 300 similar to link 280 is pivoted at its upper end to the stud 296 while its lower end is pivoted to the offset rear end of the lever 268.

Assuming the work is rotated by the chuck and that the carrier 228 is oscillated in its working position with the hone retracted by the pin 260, energizing of the solenoid 292 will swing the stop levers 266 and 268 so that one is in the path of the stop pin 258 to interrupt clockwise swinging of the cam 252. Continued movement of the carrier carries the hone retracting pin 260 into the inner portion of the cam slot thus releasing the hone for spring-pressed advance against the work. Dry honing followed by wet honing occurs as in Figs. 1 to 11 whereupon the solenoid is de-energized. The coil spring 284 swings the stop levers so that one of them arrests the other stop pin 256 and the cam in their counterclockwise movement. Since the carrier completes its swing, the hone retracting pin is forced outwardly in the cam slot and retracts the hone from the work. This retraction occurs at an instant when a large area of contact remains and damage that might occur by concentrated pressure on a small area is avoided.

I claim:

1. In a machine of the character indicated, a carrier, mechanism for oscillating the carrier around an axis, a hone shiftable with respect to the carrier, a cam having a pivotal support upon the carrier in line with the axis of oscillation, and a stop lever adapted to arrest the cam to control a shifting movement of the hone; substantially as described.

2. In a machine of the character indicated, a carrier, mechanism for oscillating the carrier around an axis, a hone shiftable with respect to the carrier, a pin projecting from the hone, a cam pivoted upon the carrier and having a cam slot engaging the pin, and a stop lever adapted to arrest the cam to cause movement of the pin in the cam slot as the carrier swings on its axis; substantially as described.

3. In a machine of the character indicated, a carrier, a cam pivoted to the carrier, an elongated hone slidably endwise in the carrier, a spring urging the hone endwise, operative connection between the hone and the cam, mechanism for oscillating said parts as a unit around an axis, and means operable during a preliminary swinging movement of the carrier for arresting the cam to control endwise shifting movement of the hone; substantially as described.

4. In a machine of the character indicated, a carrier, mechanism for oscillating the carrier at

high speed around an axis, a hone movably mounted upon the carrier and having a work engaging surface curved about said axis of oscillation, means for supporting a workpiece for rotation on a different axis, means for urging the hone to shift radially of said axis to engage the work, and mechanism operable during said oscillation for retracting the hone against the pressure of said urging means; substantially as described.

5. In a machine of the character indicated, a carrier, mechanism for oscillating the carrier around an axis, a hone movably mounted upon the carrier and having a curved work engaging surface, and mechanism for causing one of the swinging movements of the carrier in its oscillation around said axis to control an advance or retreat of the hone in a direction radially of said axis; substantially as described.

6. In a machine of the character indicated, a carrier, a cam pivoted to the carrier, a hone shiftable endwise upon the carrier, a pin projecting from the hone and engaging the cam, means for oscillating all of said parts around an axis, and means for temporarily arresting the oscillation of the cam to control endwise shifting of the hone; substantially as described.

7. In a machine of the character indicated, a work holder for rotating a hollow work piece on its axis, a hone holder entering the hollow work piece and having a hone elongated radially of said axis and slidable radially against the work, a yoke supporting the hone holder and having aligned pivots outside of the work piece, and means for oscillating the yoke at high speed around said pivots to effect abrading action thereby; substantially as described.

8. In a machine of the character indicated, a work holder adapted to rotate a work piece around its axis, a carrier having an axis adapted to be placed at the center of curvature of a surface of revolution on the work, an elongated hone shiftable radially of the carrier, a spring for urging the end of the hone to yieldingly engage said surface, and means for oscillating the carrier and hone at high speed around the carrier axis to effect abrading action thereby; substantially as described.

9. In a machine of the character indicated, a work holder adapted to rotate a work piece having a curved surface of revolution, a hone having a curved work engaging surface, means for oscillating the hone at high speed around an axis passing through the center of curvature of the curved work surface so that such rapid oscillation will effect honing, and means to insure a shifting movement of the hone into or out of contact with the work surface at an intermediate portion of one of the oscillating strokes; substantially as described.

10. In a machine of the character indicated, a work holder adapted to rotate a work piece having a curved surface of revolution, an elongated hone having its end formed as a curved work engaging surface, means for oscillating the hone at high speed around an axis passing through the center of curvature of the curved work surface to effect honing action, and means for causing one of the oscillating strokes to control a radial movement of the hone with respect to the curved surface and the axis of oscillation; substantially as described.

11. In a machine of the character indicated, a work holder adapted to rotate a work piece around its axis, a carrier having an axis adapted

to be placed at the center of curvature of a surface of revolution on the work, a hone on the carrier, and means for oscillating the carrier and the hone around the carrier axis at a speed to effect honing action, the speed of the hone across the work surface being approximately equal to the speed of the work surface across the hone; substantially as described.

12. In a machine of the character indicated, a hone, mechanism for oscillating the hone at high speed in a dry condition along a work surface, means for urging the hone against the work surface, and mechanism operable after a predetermined interval of dry honing for supplying honing compound to the hone while said hone continues to oscillate and be urged against the work surface; substantially as described.

13. In a machine of the character indicated; a hone, mechanism for oscillating the hone along a work surface at high speed, means for urging the hone against the work surface, and mechanism for supplying honing compound to the hone for a predetermined time interval to glaze the hone while it is oscillated and urged against the work surface; substantially as described.

14. In a machine of the character indicated, a hone, mechanism for oscillating the hone in a dry condition along a work surface for a predetermined time interval, means for urging the hone against the work surface, and mechanism for supplying honing compound to the hone for another predetermined time interval while the hone continues to oscillate and be urged against the work surface; substantially as described.

15. The method of finishing a work surface which consists in rotating a work piece on its axis, oscillating a hone in dry condition along the surface at high speed while urging the hone against the surface, and thereafter supplying honing compound to the hone for wet honing while said oscillation is continued with the hone still urged against the surface; substantially as described.

16. In a machine of the character indicated, a carrier having a pivotal mounting providing an axis of oscillation, the axis of oscillation being located to pass through the center of curvature of a rotating work-piece, a hone slidably mounted on the carrier and elongated in a direction intersecting the axis of oscillation, means centered at the axis of oscillation to control advance or retreat of the hone in the direction of its elongation to engage it with or retract it from the work, and means for oscillating the carrier at high speed for the purpose of effecting abrading action.

17. In a machine of the character indicated, a carrier having an axis of oscillation, an elongated hone shiftable lengthwise on the carrier in a direction intersecting the axis of oscillation to bring the end of the hone into or out of contact with a rotating work-piece, means to oscillate the carrier at high speed to effect abrading action, and means responsive to preliminary swinging movement of the carrier around its axis of oscillation to control said lengthwise shifting movement of the hone into or out of contact with the work-piece.

18. In a machine of the character indicated, a carrier having a pivotal mounting providing an axis of oscillation, the axis of oscillation being located to pass through the center of curvature of a transverse surface on a rotating work-piece, an elongated hone slidably mounted on the carrier and shiftable in the direction of its length

and radially of said axis, a spring urging the hone in one direction to yieldingly engage the rotating work-piece, means for oscillating the carrier at high speed while the work-piece rotates thereby to effect abrading action, a cam 5 normally oscillating with the carrier, and means for interrupting oscillation of the cam for controlling advance or retreat of the hone.

19. In a machine of the character indicated, a hone holder constructed and arranged to enter 10

a hollow work-piece which rotates on its axis, a hone elongated radially of said axis and slidable in the holder radially against the work surface, a yoke having a middle portion supporting the hone holder and having its end portions offset and provided with aligned pivots on opposite sides of the work-piece, and means for oscillating the yoke at high speed around said pivots to effect abrading action by the hone.

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